**MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT**

**CENTRAL PROJECT OFFICE FOR WATER RESOURCES PROJECT**

# PROJECT: MEKONG DELTA INTEGRATED CLIMATE RESILIENCE AND SUSTAINABLE LIVELIHOODS (MD-ICRSL)

# ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

## SUBPROJECT: CONTROL WATER RESOURCES TO ADAPT WITH CLIMATE CHANGE IN SOUTH MANG THIT, TRA VINH AND VINH LONG PROVINCES

**(Final)**

**March 2016**

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| CPMU | Central Project Management Unit of CPO |
| 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 |
| 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 |
| EIA | Environmental and Social Impact Assessment |
| ESC | Environment Safeguard Coordinator |
| 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 |
| ICMB 10 | Infrastructure Construction Management Board No. 10 |
| 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 Committees |
| PMU | Project Management Unit |
| PPMU | Provincial Project Management Unit |
| RAP | Reseetlement Action Plan |
| RPF | Resettlement Policy Framework |
| SIWRR | Southern Institute of Water Resouces Research |
| SSC | Social Safeguard Coordinator |
| UXO | Unexploded Ordnance |
| WB | World Bank |
| NGO | Non-Governmental Organisation |

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# CHAPTER 1. INTRODUCTION AND SUBPROJECT DESCRIPTION

## 1.1. SUBPROJECT BACKGROUND

*The Subproject "Control water resources to adapt with climate change in south Mang Thit, Tra Vinh and Vinh Long provinces"* is a subproject to be implemented under Component 3[1] of the Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods (MD-ICRSL) Project which is proposed by the Government of Vietnam (GOV) for financing from the World Bank (WB). The Central Project Management Unit (CPMU) of the Central Management Office (CPO) of the Ministry of Agriculture and Rural Development (MARD) is responsible for the overall management of the MD-ICRSL project. The development objective of the MD-ICRSL project is to enhance tools for climate-smart planning, and improve climate resilience of land and water management practices in selected provinces of the Mekong Delta in Vietnam. The Subproject owner is the Hydraulic Project Investment and Construction Management Board 10 (ICMB10). The Provincial Project Management Units (PPMUs) of Tra Vinh Department of Agriculture and Rural Development (DARD) and Vinh Long DARD are responsible for the planning and implementation of the subproject during preparation and construction. The Division of Water Resources of Tra Vinh DARD will be responsible during operation. The subproject will be financed by GOV (central and local) and the WB.

### *Need of the subproject*

The subproject is located largely in Tra Vinh province and a very small part of Vinh Long province and divided into 3 zones (zone 2, zone 3a and 3b) as figured out in *Figure 1.1*.

In zone 2 and 3b, these areas are naturally characterized by low flows during the dry season which allow saline water to extend far inland. Over the past twenty years, closed freshwater systems designed for rice production have been developed in this area consisting of large polders ringed by dikes and with sluice gates to control saline water intrusion.

In zones 3a, after completion of construction in 2008, the South Mang Thit Irrigation System has been put into operation to serve for production and socio-economic development of Tra Vinh and Vinh Long province. However, in recent years, salinity of 4 g/l intrudes increasingly through the estuaries of Vung Liem river, Tan Dinh river and Bong Bot canal. In the dry season, the southern area of the irrigation system is lack of fresh water for production; environmental pollution increases; tidal erosion in some structures; salinity intrusion in other areas of the northern area of the subproject through the open gates. Since income from fruit trees is still high and farmers are not ready for brackish water economy, farmers want the subproject to help them prevent saline intrusion until their fruit trees are no longer economically viable. It is assessed that it would take a couple of decade for this area to transition to brackish water economy.

Salinity and rising water level have further impacts on the subproject area due to climate change, and are expected to become so severe that the system will not be capable of meeting water supply demand in Tra Vinh province and a part of Vinh Long province. Therefore, the proposed subproject will assist to overcome the problems mentioned above to supply water for

[1]Component 3 (Adapting to Salinity Transitions in the Estuary) has been designed to address the challenges related to salinity intrusion, coastal erosion, sustainable aquaculture and improved livelihoods for communities living in the coastal areas. This will potentially consist of: i) construction of coastal defenses consisting of combinations of compacted earth embankments and coastal mangrove belts; ii) modification of water and agricultural infrastructure along the coastal zone to allow flexibility for sustainable aquaculture activities and adapt to changing salinity levels; iii) support to farmers to transition (where suitable) to more sustainable brackish water activities such as mangrove-shrimp, rice-shrimp, and other aquaculture activities; and iv) supporting climate smart agriculture by facilitating water use efficiency in the dry season

sustainable production and development, adaptation with climate change and sea level rise by non-structural measures (raising climate change awareness, planting additional mangrove trees, mangrove - shirmp ponds and supporting certification for organically mangrove - shirmp, and buiding steps for gradual transition to brackish water production), and support structural measures (building sluice gates to control salinity for sustainable argicultural production) for 225,682 hectares of the South Mang Thit irrigation system and 82,383 hectares of natural land of Vung Liem, Tra On districts in Vinh Long province and Cau Ke, Cang Long district in Tra Vinh province. The subproject is particularly important for such a province like Tra Vinh with a high poverty rate and many Khmer ethnic minority people.

### *Link of the subproject to the Regional Environmental Assessment*

During the MDICRSL project identification and preparation a Regional Environmental Assessment have been carried out to identify the main environmental and social issues and challenges that relevant to the project and subproject design and environmental management. The section below provides a summary of the REA findings and recommendations for the subproject.

**a) The main environmental and social challenges in the Delta estuary**

The Delta estuary the riverine levies and alluvial floodplains of Can Tho, Vinh Long, Tien Giang, Long An, Kien Giang, Soc Trang and Ben Tre. The inter-tidal zone is under the mixed influence of upstream hydrology as well as coastal processes such as tidally-induced saline intrusion and channel-flow reversal. In the delta estuary under mixed coastal and freshwater influence, rice is still an important crop accounting for 30% of provincial area, with brackish aquaculture accounting for a further 11%. Rapid population growth and intensive agricultural and aquaculture development over the past decades have significantly reduced the natural values in the delta estuary.

***Salinisation of the estuary***

- **Salinity intrusion into the delta estuary is reducing agricultural productivity and leading to dry season freshwater shortages.** Tidal fluctuations drive saline intrusion more than 80km inland, affecting 40% of the Mekong Delta. Seven provinces are highly prone to saline intrusion, including: Kien Giang, Tra Vinh, Ben Tre, Soc Trang, Ca Mau, Bac Lieu and Long An, with more than 1 million hectares experiencing salinity concentrations above 4g/L.
- **The situation of salinity intrusion in Mekong Delta is complex.** Each year the situation is different, depending on the magnitude of the previous years flooding, the ability to supply fresh water upstream in the dry season, the production level of Summer-Autumn paddy and the onset of the rainy season. Salinity can intrude far inland when rains start late, as happened for instance in 1977, 1993, 1998 and in 2004-2005. Highest salinity levels are reached at the end of the dry season, usually in April, but when rains are late sometimes even into early May. Figure 44 below shows the duration of salinity intrusion (>4g/L) in the delta estuary provinces of Ben Tre, Tra Vinh and Soc Trang.
- **Expected sea level rise will further increase salinity levels in the delta's river branches and its water network.** A sea level rise of one metre would increase the area of 4g/L salinity with 334,000 ha in relation to the benchmark year of 2004, a rise of 25%. Deep salinity intrusion is occurring already during dry seasons, giving rise to significant crop losses. Its extent and frequency is likely to increase due to climate change, giving rise to even higher and more frequent economic losses.
- **Water control infrastructure has been constructed in coastal provinces to control salinity intrusion into the estuaries**. Sea dikes have been constructed along estuaries

and coasts in Tien Giang, Tra Vinh, Soc Trang, Bac Lieu, Kien Giang, Ben Tre and Ca Mau provinces**.** In Ben Tre and Ca Mau the sea dike system is not closed, and only gives partial protection. Both the height and strength of the dikes need upgrading.

- **Saline water is prevented to enter the canals by the construction of sluices that can be closed when the seawater rises with the tide above river water levels**. However, many canals do not have such sluices. Where sluices do exist, this creates conflicts between the freshwater needs of agriculture and the brackish water needs for aquaculture, which will be explored further in the following section. A large decline in capture fisheries is also associated with construction of a sea dikes to cut off saltwater flow into mangrove habitats so it could be used for rice farming. Estuarine fish and other animals rely on these intertidal habitats for feeding so impacts on coastal and freshwater fisheries also need to be considered.

***Estuary balance between saline and freshwater farming***

- **Balancing the needs of freshwater agriculture and brackish aquaculture is required to effectively adapt to salinity intrusion in the delta estuary**. In the delta estuary under the influence of both river flow and tidal action, the provincial authorities are faced with the decision to protect freshwater farming systems from salinity intrusion or open up the estuary floodplains for saline tolerant systems. The brackish water environment in the coastal provinces of the delta estuary and are gaining importance, not only due to emerging salinity issues, but also by the growing importance of adapting to this unfavourable situation. Measures to create a clear borderline between brackish and the freshwater environment remain underdeveloped.
- **Investment in large water control infrastructure for salinity intrusion will have far-reaching and long-lasting impacts on the delta system.** At present Ben Tre province is exploring the potential for a major investment in dykes and sluice gates, including a ring of sluice gates is proposed at the canal entrances for Ben Tre provinces. The provincial authorities are making decisions for the installation of sluices and dikes, which will shape the future land use in the province and the farming opportunities available to local communities. In the past, the development of water control infrastructure has lead to conflicting interests and inflexible water management when local rice farmers sought to benefit their income through the conversion of their farms from rice to shrimp. Rice production has been unstable due to droughts, salinity intrusion and excessive flooding in the delta estuary.
- **Aquaculture area and aquaculture and shrimp production has increased in the delta estuary.** From 1995-2013 the total aquaculture area (ha), aquaculture and shrimp production increased significantly in Ben Tre, Tra Vinh and Soc Trang. Aquaculture in the delta estuary primarily includes *pangasius* catfish (Ben Tre and Tra Vinh only), shrimp and bivalve.
- **The areas of high value fruit crops have decreased from 2005 to 2012 due to issues with drought, salinity intrusion and conversion to aquaculture**.

***Dry season freshwater shortages and droughts***

- **Coping with dry season fresh water shortages and droughts and securing fresh water supply is a critical challenge for the delta estuary**. Ben Tre, Tra Vinh and Soc Trang, like many other coastal provinces suffer from several negative trends, like increased salinity intrusion, decreasing availability of fresh water of sufficient quality, depletion of aquifers. Sea-level rise and dry-season salinity intrusion limit the possibilities for fresh water agriculture and horticulture. Water quality problems put strain on (saline) aquaculture. There is a conflict in water use and availability between brackish areas and fresh areas, and more broadly between agricultural, industrial and

domestic water uses. Some parts of Soc Trang and Kien Giang experience dramatic changes in seasonal freshwater available as surface waters in the dry season are almost exclusively dominated by tidal forces and the main source of freshwater is rainfall.

- **The droughts in 2002 and 2004-05 caused extensive damage to agricultural crops and water supply in the delta estuary**. The drought of 2002 was a dry season drought that occurred from February to April. Some 70,300 ha of the delta were affected, with crops lost from 17,800 ha (25 per cent of the affected area). Crop losses in the Mekong Delta accounted for about 25 per cent of the national crop loss and, based on these figures, the cost of this drought to the delta was estimated as approximately US$24 million (US$1350 per ha of crop loss).
- **The 2004 wet season finished early, causing salinity intrusion to occur further upstream than normal leading to widespread failure of the autumn rice crop and reduced dry season water supply.** More than 104,000 ha of rice were damaged in the delta. Ben Tre was the worst affected province, where 7000 ha of rice and 15,000 ha of fruit orchards worth US$33 million were destroyed. As well, more than 82,000 families were forced to buy water. The total drought damage bill to the delta was US$42 million.
- **Water supply in many areas, such as Ca Mau, Bac Lieu and Soc Trang water is used without treatment, so water quality is below the required standards**. Existing water infrastructure is said to operate at no more than 55-65% of the design capacity. According to the report of the Southern Institute for Urban and Rural Planning, around 60-65% of the urban population in the Delta receive water from the existing supply systems. The groundwater has been exploited for industrial and agricultural use since 1941. Up till now, there are about 200 large wells to provide water for urban areas and over 25,000 small-scale drilled wells to provide water for rural areas. The current total exploited groundwater amounts in the order of 480,000 m3/day**.** The freshwater shortages calls for a detailed assessment of the effectiveness of horticulture, freshwater agriculture and brackish aquaculture in the delta estuary, especially as climate change is expected to bring increased average temperatures and further salinity intrusion.
- **Reduced retention area and sea level rise increase the vulnerability to flooding in the delta estuary leading to an increased need for capital-intensive measures for flood protection**. Conversion of agricultural land and floodplains decreases flood retention in the wet season, exacerbating the impacts of flooding in urban areas. Raising dykes in the upper delta to enable triple instead of double crop rice takes retention area from the river system decreases and increases flooding risks downstream. Drainage capacity is insufficient in many areas during periods of heavy rainfall and high river discharges, causing floodwaters to recede late.
- **The trend in industrialisation and urbanisation is growth, taking more land out of agricultural production**. At the same time more people need to be provided with food and fresh water. Ongoing industrialisation will also take up more space and increase the demand for water as well as the production of wastewater. Both trends will increase the need for proper spatial planning, efficient water supply and further investments in water treatment.

***Ethnic minorities and reduced farm-based income***

- **A high number of Khmer people are living in Soc Trang and Tra Vinh, the Khmer are some of the poorest households in the Mekong Delta**. The Khmer people living in the Tra Cu district of Tra Vinh are living with poor water sanitation and hygiene conditions and relying on untreated groundwater for drinking. Their livelihoods totally depend on the natural resource base. Government initiatives have been targeted at the

Khmer people and some improvements have been made. However, the proportion of Khmer households with improved income and wealth was lower than other households.

- **Khmer households and farmers are vulnerable to water related issues in the delta estuary**. Khmer farmers in the Soc Trang and Tra Vinh provinces are experiencing rice losses due to salinization and droughts in the early rainy season and pollution of inlet canal water is causing high mortality rates of culture shrimp. The pollution of surface water from disposal of human and animal wastes and run-off agro-chemicals from rice fields are impacting human health, agriculture and aquaculture. Poor sanitation conditions have increased the prevalence of mosquitoes carrying dengue and malaria.

**b) Strategic direction for the Delta Estuary - Adapting to salinity transitions**

The strategy for the delta estuary must address flood protection, freshwater supply for the horticultural/agricultural areas of Ben Tre and Tra Vinh, the limitation of groundwater aquifer exploitation to sustainable levels and livelihoods improvements. Adapting to salinity intrusion is required to address the challenges related to salinity intrusion, flooding through transitions to sustainable aquaculture and improved livelihoods for communities living in the coastal areas. The key components in the strategy for the delta estuary and other coastal areas is to strengthen coastal protection through a mix of 'building with nature' type (where possible) and infrastructural measures (where needed) and facilitate a gradual transition from existing fresh water based rice production towards a brackish and diversified aquaculture system that adapts to increasingly saline conditions. An additional priority is the protection of groundwater aquifers, due to increasing evidence that excessive groundwater extraction accelerates land subsidence.

This subproject has been designed taking into account the strategic direction recommended by the REA to include restoration of mangroves along the provincial coastline, construction/upgrades of river and coastal embankments, and sluice gates to improve water quality, efficiency and sustainability of aquaculture in the brackish water zone, and supporting a gradual transition from rice and other freshwater crops in the saline intruded zone to a brackish water economy including aquaculture through demonstration and aquaculture extension together with necessary adjustments to land-use plans in a longer term.

### *Subproject objectives*

General objectives: The primary objective of this subproject is to address the challenges related to salinity intrusion, sustainable and improved livelihoods for communities living in the 3 districts of Tra Vinh and Vinh Long provinces.

The key objectives are as follows:

- To complete the South Mang Thit irrigation system to maximize its efficiency;
- Modification of water and agricultural infrastructures along the coastal zone to allow flexibility for sustainable aquaculture activities and adapt to changing salinity levels; and
- Supporting climate smart agriculture by facilitating water use efficiency in the dry season.

### *Organization of environmental impact assessment*

**Subproject approval authority**: Ministry of Agriculture and Rural Development

**Subproject owner**: Hydraulic Project Investment and Construction Management Board 10 (ICMB10)

**The consultant:** Southern Institute of Water Resources Research (SIWRR)

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

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

Phone: (08) 39233700 - Fax: (08) 39235028

As part of project preparation of the Project (MD-ICRSLP), the Ministry of Agriculture and Rural Development (MARD) assigned the Vietnam Institute for Water Resources Research (SIWRR) to prepare the ESIA report for the subproject to conform with the provisions of Vietnam and the requirements of the World Bank.

SIWRR was established in 1978 based on the Decision No 864 QD/TC dated 19 August, 1978 of the Ministry of Water Resources (now it is Ministry of Agriculture and Rural Development). Over 35 years of operation, development and growth, the Institute's activities have always been focusing on agriculture and rural development, integrated water resources management, natural disaster mitigation, land reclamation, environmental protection, etc. in the Southern provinces, especially in the Mekong Delta.

SIWRR has legal capacity to prepare this report. Regarding the research facility, SIWRR has second facility for experimental laboratories located in Binh Duong province with three specialized laboratories registered LAS -1037, LAS - 155, LAS - 143 with the Ministry of Construction.

Besides the ISO 9001 – 2008 of the Institute, the Labs have been accredited by the Laboratory Accreditation System. Regarding Machinery and Equipment: In addition to common machinery and equipment, the Institute's professional units are also equipped with many advanced research machines and devices such as Distomat wind meter; Wave height-speed-direction and current data in a single Instrument, Acoustic Doppler Velocimeter, Sediment Instruments for all environment, Echo-sounding meter, ADCP (acoustic doppler current profilers), GPS, gas chromatography, atomic absorption spectrometer, Programmable electromagnetic four quadrant liquid velocity meter, control unit for ultrasonic high concentration meter (UHCM), concrete compression gauging machine, cement bending compression machine and steel laminating machine, triaxial compressor (ELLE), etc. and advanced supporting softwares: ArcGIS, Satellite image processing software, MIKE set, HYDROGIS, DUFLOW, KOD, SAL, VRSAP, IMSOP, SOIL, SOICHEM. Regarding human resources, SIWRR has 178 staffs working in different professional scientific and technological field. To implement this report, SIWRR has nominated the necessary staffs (*Table 1.1*) with good competence and high experience not only on specialist knowledge but English as well. They are really reliable staffs of our Institute to fulfill the tasks of this report.

*Table 1.1: List of consultants working for this report and their roles*

| No | Full name | Background | Assigned tasks |
|---|---|---|---|
| **I** | **Representative of subproject owner – CPO irrigation** | | |
| 1 | Nguyen Truong Son | Water resources | Directing the implementation of reporting environmental impact assessment |
| 2 | Nguyen The Anh | Environment | - Providing subproject information for the consultant<br>- Collaborating with the consultants in working with local authorities<br>- Monitoring EIA report implementation of the consultant |
| **II** | **Consultant – Southern Institute of Water Resources Research** | | |
| 1 | MSc. Vu Nguyen Hoang Giang | Environmental Ecology | - Team leader - The administrative procedures, contacts and transactions related to the reporting EA<br>- Public consultation<br>- Writing EA report |

| No | Full name | Background | Assigned tasks |
|---|---|---|---|
| 2 | MSc. Dong Thi An Thuy | Environment and climate change | - Writing report on analyzing and evaluating the impact of the works on the environmental quality of land, water and air in stages of the subproject.<br>- Analyzing and assessing impacts of climate change on the region, considering and impacts of the subproject with or without climate change<br>- Public consultation |
| 3 | Ass. Prof. Vo Khac Tri | Water resources | - Hydraulic and water quality modelling<br>- Assessing the results of water quality and salinity intrusion models |
| 4 | MSc. Le Van Kiem | Construction - Water works, water supply | - Develop and implementing scenarios of salinity intrusion<br>- Developing and implementing scenarios of organic pollution forcasting<br>- Writing section on hydrological and meteorological characteristics in the sub project area and the affected areas |
| 6 | BSc. Nguyen Thi Tam | Analytical chemistry | - Writing report on the existing environmental quality (water, soil, air and sediment quality).<br>- Developing environmental monitoring and management in subproject life<br>- Estimating costs of environmental monitoring.<br>- Organizing public consultation |
| 6 | Prof. Dr. Tran Thi Thanh | Water resources – land improvement | - Writing report on existing water resources works and river/canal system in the subproject area and its surroundings |
| 7 | BSc. Tran Thi Thu Huong | Biology | - Writing report on analysis and evaluation of the subproject impacts on the biodiversity due to subproject implementation<br>- Proposing mitigations to control and mitigate subproject impacts on biodiversity |
| 8 | MSc. Pham The Vinh | Construction of marine works | - Writing report on impacts of the subproject on water transport.<br>- Developing program to control and mitigate impacts of the subproject on water transport |
| 9 | Ass Prof. Dr. Thai Thanh Luom | Forestry | - Developing forest management plan during subproject operation |
| 10 | Dr. Nguyen Minh Nien | Aquaculture | - Analysis impacts of shrimp model on environment and propose mitigation measures |

## 1.2. NATIONAL LAWS AND REGULATIONS AND WB SAFEGUARD POLICIES

### *Relevant National Laws and Regulations*

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

- Law on Environmental Protection No. 55/2014/QH13 of the National Assembly of Vietnam 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 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 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.
- Decree No. 113/2010/NĐ-CP dated 3 December 2010 of the Government on valuation of damages caused to the environment.
- Decree No. 83/2009/ND-CP of 15 October 2009 of the Government on amending and supplementing a number of articles of Decree No. 12/2009/ND-CP of the Government on management of investment projects on the construction of works.
- 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 Minsitry 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.

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 03:2008/BTNMT: National technical regulation on permitted limit of heavy metal in land
- QCVN 05:2013/BTNMT: National technical regulation on ambient air quality
- QCVN 06:2008/BTNMT: National technical regulation on hazardous substances in ambient air.
- QCVN 08-MT:2015 BTNMT: National technical regulation on water surface quality
- QCVN 09:2008/BTNMT: National technical regulation on underground water quality
- QCVN 10:2008/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 40:2011/BTNMT: National technical regulation on industrial wastewater.

- QCVN 43:2012/BTNMT - National technical regulation on sediment quality in fresh water areas.
- Decision No. 3733/2002/QD-BYT dated 10 October 2002 on application of 21 standards on safety and health.

### *Applicable WB Safeguard Policies*

The environmental and social screening for the subproject has been carried out line with the Environmental and Social Management Framework (ESMF) which has been designed to be applied for the Project (MD-ICRSLP). The screening result shows that the WB policies on Environmental Assessment (OP/BP 4.01)[2], Natural Habitats (OP/BP 4.04)[3], Forests (OP/BP 4.36)[4], Indigenous Peoples (OP/BP 4.10)[5], and Involuntary Resettlement (OP/BP 4.12)[6] are triggered for this 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 on OP/BP 4.10 and OP/BP 4.12 is addressed in the Ethnic Minority Development Framework (EMDF) and the Resettlement Policy Framework (RPF) of the MD-ICRSL project, and the Ethnic Minority Development Plan (EMDP) and Resettlement Action Plan (RAP) of this subproject. The environmental and social screening and the detailed ESIA 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.

*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[7] (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 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.

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

## 1.3. ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGIES AND APPROACHES

Given that the ESIA report will be submitted both to the Government and the WB, the ESIA report has adopted the conventional methods being used for the preparation of an EIA in Vietnam (Sections 1.3.1 and 1.3.2) as well as the technical guidance from the ESMF with respect to the preparation of an ESMP for the *subprojects aiming at installing water/salinity control structures and piloting sustanable livelihood models in the transition to estuary and peninsula areas of the delta*, as recommended by the Regional Environmental Assessment (REA), which will be presented in Chapter 3.

### *Methods of ESIA*

#### *1.3.1.1. Rapid assessment method*

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

In Vietnam, this method is introduced and applied in many ESIA studies, 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).

#### *1.3.1.2. Impact matrix method*

Building correlation between effects of each subproject activity to each issue and environmental composition as shown in the impact matrix. On such basis, to orientate detailed contents to be studied with impacts.

#### *1.3.1.3. Comparison method*

The comparison method is to assess the 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 as well as the related researches and experiments.

#### *1.3.1.4. 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.

#### *1.3.1.5. Listing method*

It is used quite common (since the establishment of the National Environmental Protection Agencies in some countries - NEPA) and bring positive results thank to many advantages as clear approach, systematic provision during system analysis and evaluation. It includes 2 main categories: The description listing table which lists the environment components in need of research in addition to the information on the measurement, prediction and evaluation; and Simple checklist which will list environmental components to be studied and likely to be affected.

#### *1.3.1.6. Method of Public Consultation and Disclosure of Information*

Public consultation is used to help identify opportunities and risks, improved project design and implementation, and increase project ownership and sustainability. Public consultation is specifically required by the World Bank's environmental and social safeguard policies. A meaningful public consultation will be used. This is a two-way process in which beneficiaries provide advice and input on the design of proposed subproject that affect their lives and environment, promotes dialogue between governments, communities, NGOs and implementing agencies to discuss all aspects of the proposed subproject. The feedbacks from consultation will be incorporated into the subproject ESIA and design.

Those affected by the subproject include those resettled and those in the nearby community affected by subproject impacts, intended beneficiaries of the subproject, key interest groups – depends upon the project, local NGOs/Mass organizations, including women's unions, local, state and central governments, other donor and development agencies, and other stakeholders.

Disclosure of the project information including the subproject safeguards instruments allows the public access to information on environmental and social aspects of subprojects. Disclosure is mandated by policies for the WB's Environmental Assessment, Involuntary Resettlement and Indigenous Peoples. The subproject safeguards instruments will be disclosed in country and in local languages and at the World Bank Infoshop, like consultation, it is an ongoing process during project preparation and supervision.

#### *1.3.1.7. Modeling*

MIKE set is the model which is developed by DHI, Denmark. In this report, the MIKE model is used to predict the impacts of salt water intrusion, water distribution and water quality before and after the subproject implementation in conditions with and without climate change.

### *Other Methods*

#### *1.3.1.8. 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.

#### *1.3.1.9. 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, survey of status of natural environment, hydrography, weather conditions, land use, vegetation cover, fauna and flora in the subproject areas. These survey results will be used for assessment of natural conditions of the subproject area.

#### *1.3.1.10. Consensus method*

Based on knowledge and experiences in environmental science of EIA, the specialists of the consultant team and and other scientific research units with in the institute will discuss and agree the the fidings of the ESIA.

#### *1.3.1.11. Sampling and analyzing methods in laboratory*

Sampling and analyzing samples of environmental components (soil, water, air) are integral to identify and evaluate status of baseline environment quality in the subproject area as following:

- Surface and underground water quality: samples were taken and analysed, complying with the Vietnam standards, and results compared with National Technical Regulation on Surface Water Quality (QCVN 08-MT:2015/BTNMT) and National Technical Regulation on Underground Water Quality - 09/2008/BTNMT.
- Ambient air quality: samples were taken and analysed, complying with the Vietnam standards, and results compared to QCVN 05:2013/BTNMT– National Technical Regulation on ambient air quality.
- Noise and vibration: samples were taken and analysed, complying with the Vietnam standards, and the results compared to QCVN 26:2010/BTNMT- National technical regulation on noise and QCVN 27:2010/BTNMT- National technical regulation on vibration.

## 1.4. SUBPROJECT DESCRIPTION

### *Subproject name*

"*Control water resources to adapt with climate change in south Mang Thit, Tra Vinh and Vinh Long provinces*".

### *Subproject owner*

- Subproject owner: Hydraulic Project Investment and Construction Management Board 10 (ICMB10)
- Address: 11 Mau Than, Xuan Khanh ward, Ninh Kieu district, Can Tho city
- Telephone: 0710.6290322 - Fax: 0710.3830849
- Email: banquanly10@vnn.vn
- Representative: Mr. Do Van Nhan

### *Subproject location and affected area*

The geographical scope of the subproject covers Vung Liem and Tra On district of Vinh Long province, and Tra Vinh province. The total area is approximately 265,931 hectares of natural land with 1.4 million beneficiary people. The boundaries of the subproject area (*Figure 1.1*) border Mang Thit River to the North - West, Co Chien River to the North, East Sea to the East and South - East, and Hau River to the South - West.

It is notable that the subproject area is located between the two rivers, Co Chien River and Hau River). It is the area with young alluvial soils affected by floods from the Mekong River, suitable for the development of agricultural production. The impact of floods on the Hau River and Co Chien River deeply into the interior areas combined with high tides affect the water quality and crop cultivation.

In essence, Zone 1 has an area of protective forest which is rather large. Since some forest plantation projects are being implemented in this zone, there's no need for support from the subproject additional for mangrove planting in this area. Therefore, the subproject will invest in both structure and non-structure components for the 3 zones (Zone 2, Zone 3a, Zone 3b) as shown in *Figure 1.2*. Detailed locations of components under the subproject are shown in *Table 1.2*.

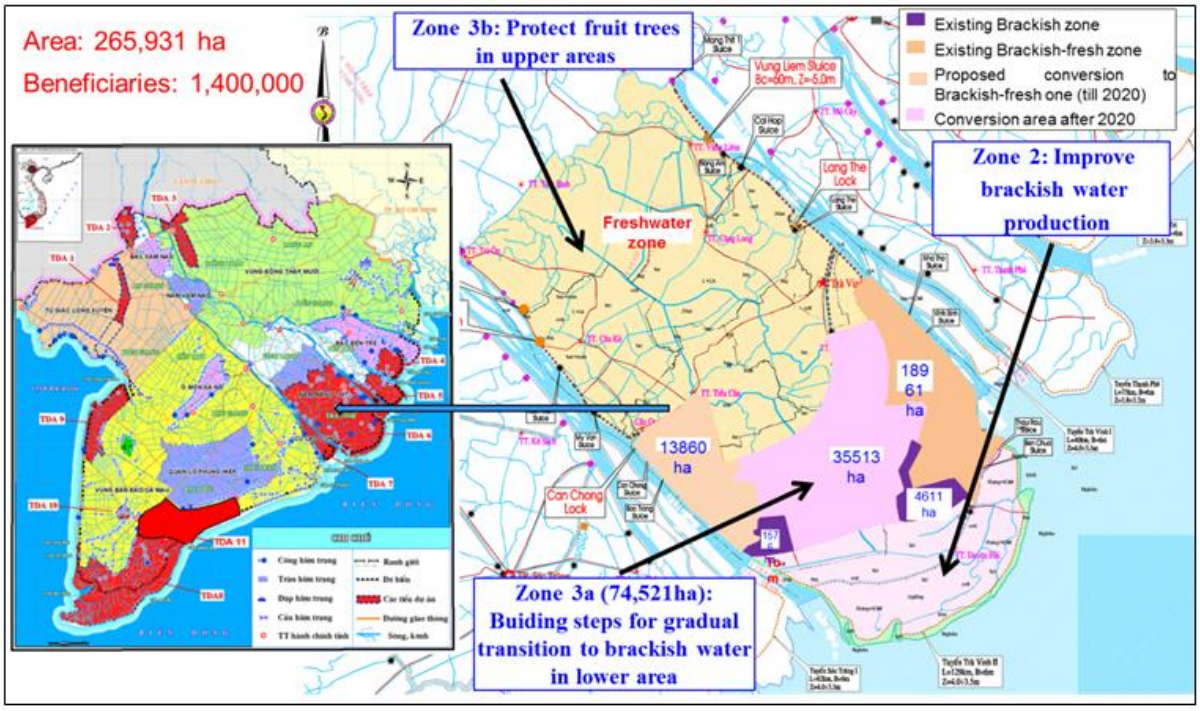


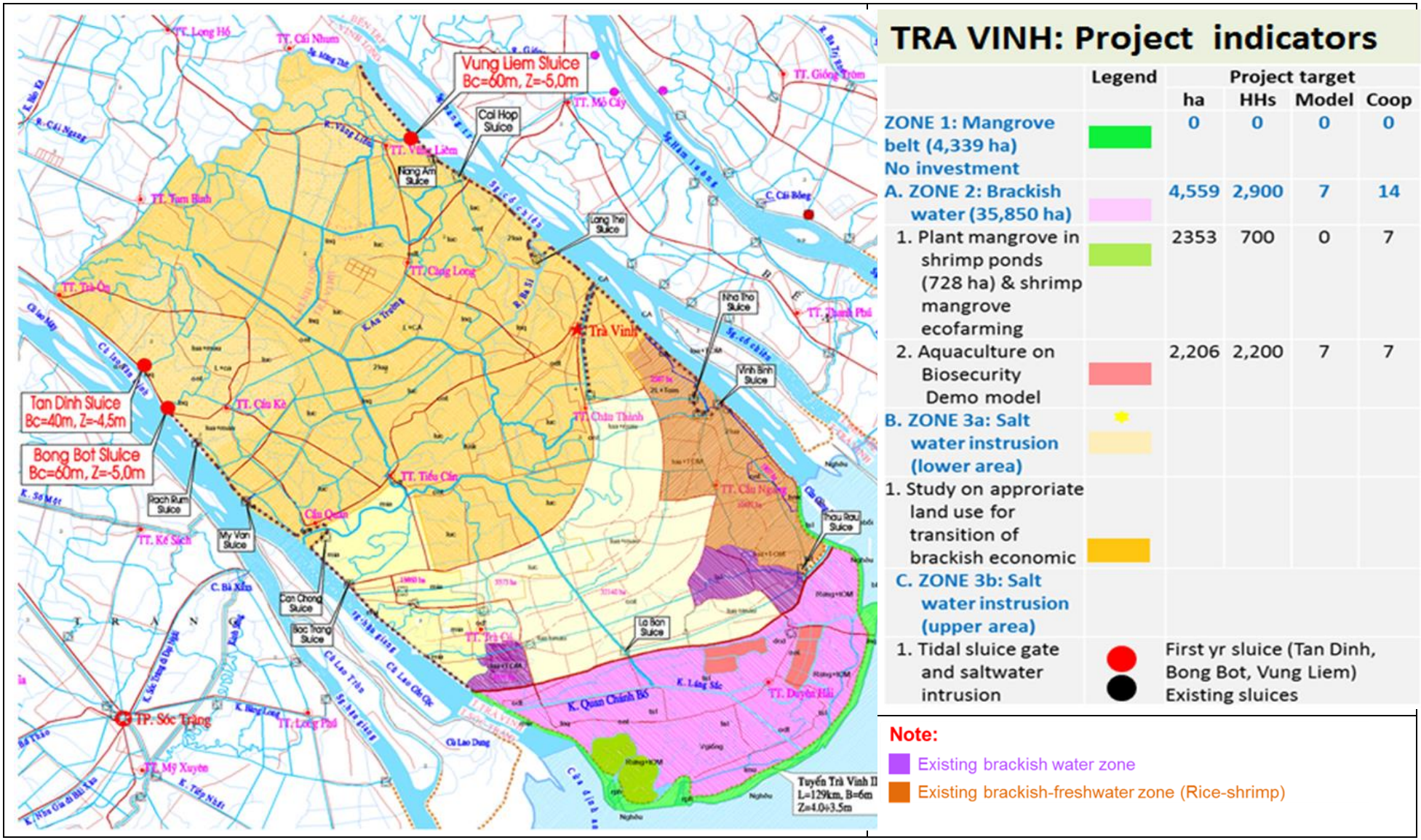

*Figure 1.1: Location of the subproject*

*Table 1.2: Location of components under the subproject*

| No | Components/ activities | Location |
|---|---|---|
| ***1*** | ***Component 1: Zone 2 - Promotion of good aquaculture practices*** | |
| 1.1 | Planting additional mangrove in shrimp ponds (to meet standards for eco-farming certification) | In Long Vinh, Dong Hai communes, Duyen Hai district, Tra Vinh province |
| 1.2 | Aquaculture on Biosecurity | In the aquaculture area belongs to Dong Hai, Long Vinh, Long Khanh communes, Duyen Hai town, Tra Vinh province |
| ***2*** | ***Component 2: Zone 3a - Study on transition to brackish water economy*** | |
| 2.1 | Study on approriate land use for transition to brackish water economy | |
| ***3*** | ***Component 3: Zone 3b - Prevention of salinity for paddy rice farming*** | |
| 3.1 | Vung Liem sluice gate | It is located on Vung Liem river. The North belongs to Trung Thanh Tay commune, Vung Liem district, Vinh Long province. The South belongs to Trung Thanh Dong commune, Vung Liem district, Vinh Long province. The central part of the sluice gate is about 1,700 m away from Co Chien river to the North West, with co-ordinates: 10º05'939''N and 106º12'397''E |
| 3.2 | Tan Dinh sluice gate | It is located on Tan Dinh river. the left bank belongs to An Phu Tan commune, Cau Ke district, Tra Vinh province, the right bank belongs to Tich Thien commune, Tra On district, Vinh Long province. The central part of the gate is about 700m away from Bassac |

| No | Components/ activities | Location |
|---|---|---|
| | | river, with co-ordinates: 9°54’219’’N and 105°59’412’’E |
| 2.3 | Bong Bot sluice gate | The sluice gate is located on Bong Bot canal, the left and right banks belong to An Phu Tan commune, Cau Ke district, Tra Vinh province. The central part of the gate is about 600m away from Bassac river, with co-ordinates: 9°52’192’’N and 106°00’669’’E |

The location of the subproject in relation to (i) natural receptors (Tra Vinh and Vinh Long in particular such as Chua Hang bird sanctuary, Tra Cu bird sanctuary, Duyen Hai bird sanctuary, Duyen Hai mangrove forest, Long Khanh natural reserve area); (ii) socio-economic receptors (Ba Om Pond, Ba Dong beach, Hang pagoda, An Tinh temple, Hung Giao temple, Ben Cat ferry, Tan Dinh ferry, Duyen Hai Thermal Power Plant) is illustrated in *Table 1.3* and *Figure 1.3*. Based on the distances from these sensitive receptors to the sluice gate construction sites, it can be concluded that they will not affected by the construction activities except for the two ferries at Ben Cat and Tan Dinh, An Tinh and Hung Giao Temple.




## TRA VINH: Project indicators

| | Legend | Project target | | | |
|---|---|---|---|---|---|
| | | ha | HHs | Model | Coop |
| ZONE 1: Mangrove belt (4,339 ha) No investment | | 0 | 0 | 0 | 0 |
| A. ZONE 2: Brackish water (35,850 ha) | | 4,559 | 2,900 | 7 | 14 |
| 1. Plant mangrove in shrimp ponds (728 ha) & shrimp mangrove ecofarming | | 2353 | 700 | 0 | 7 |
| 2. Aquaculture on Biosecurity Demo model | | 2,206 | 2,200 | 7 | 7 |
| B. ZONE 3a: Salt water instrusion (lower area) | | | | | |
| 1. Study on approriate land use for transition of brackish economic | | | | | |
| C. ZONE 3b: Salt water instrusion (upper area) | | | | | |
| 1. Tidal sluice gate and saltwater intrusion | First yr sluice (Tan Dinh, Bong Bot, Vung Liem)<br>Existing sluices | | | | |

**Note:**

Existing brackish water zone

Existing brackish-freshwater zone (Rice-shrimp)

*Figure 1.2: Locations of components under the subproject*

*Table 1.3: Distance from the subproject components to natural and socio-economical sensitive receptors in Vinh Long and Tra Vinh provinces*

| No | Subproject component/activities | Distance (in kilometers) from the subproject's components to | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Chua Hang bird sanctuary** | **Tra Cu bird sanctuary** | **Duyen Hai bird sanctuary** | **Duyen Hai mangrove forest** | **Duyen Hai Thermal Power Plant** | **Ba Om pond** | **Long Khanh natural reserve area** | **Ba Dong beach** | **An Tinh temple** | **Hung Giao temple** | **Ben Cat ferry** | **Tan Dinh ferry** |
| 1 | Vung Liem sluice gate | 27.50 | 38.50 | 58.40 | 57.30 | 55.10 | 23.67 | 54.12 | 65.97 | 32.07 | 2.33 | 33.38 | 32.67 |
| 2 | Tan Dinh sluice gate | 38.45 | 39.50 | 62.86 | 50.10 | 48.26 | 34.39 | 58.34 | 69.86 | 4.22 | 3.76 | 4.34 | 0 |
| 3 | Bong Bot sluice gate | 36.58 | 36.08 | 58.88 | 46.88 | 39.55 | 32.44 | 62.20 | 66.11 | 0.28 | 0.28 | 0 | 4.34 |
| 4 | Planting additional mangrove in shrimp ponds | 32.07 | 9.49 | 13.56 | 13.61 | 16.29 | 36.16 | 7.67 | 20.1 | 54.23 | 0.88 | 57.25 | 50.98 |
| 5 | Area of raising aquaculture on Bio-safety | 33.4 | 17.19 | 5.42 | 5.17 | 8.07 | 38.59 | 7.15 | 11.75 | 60.79 | 2.33 | 60.34 | 64.09 |

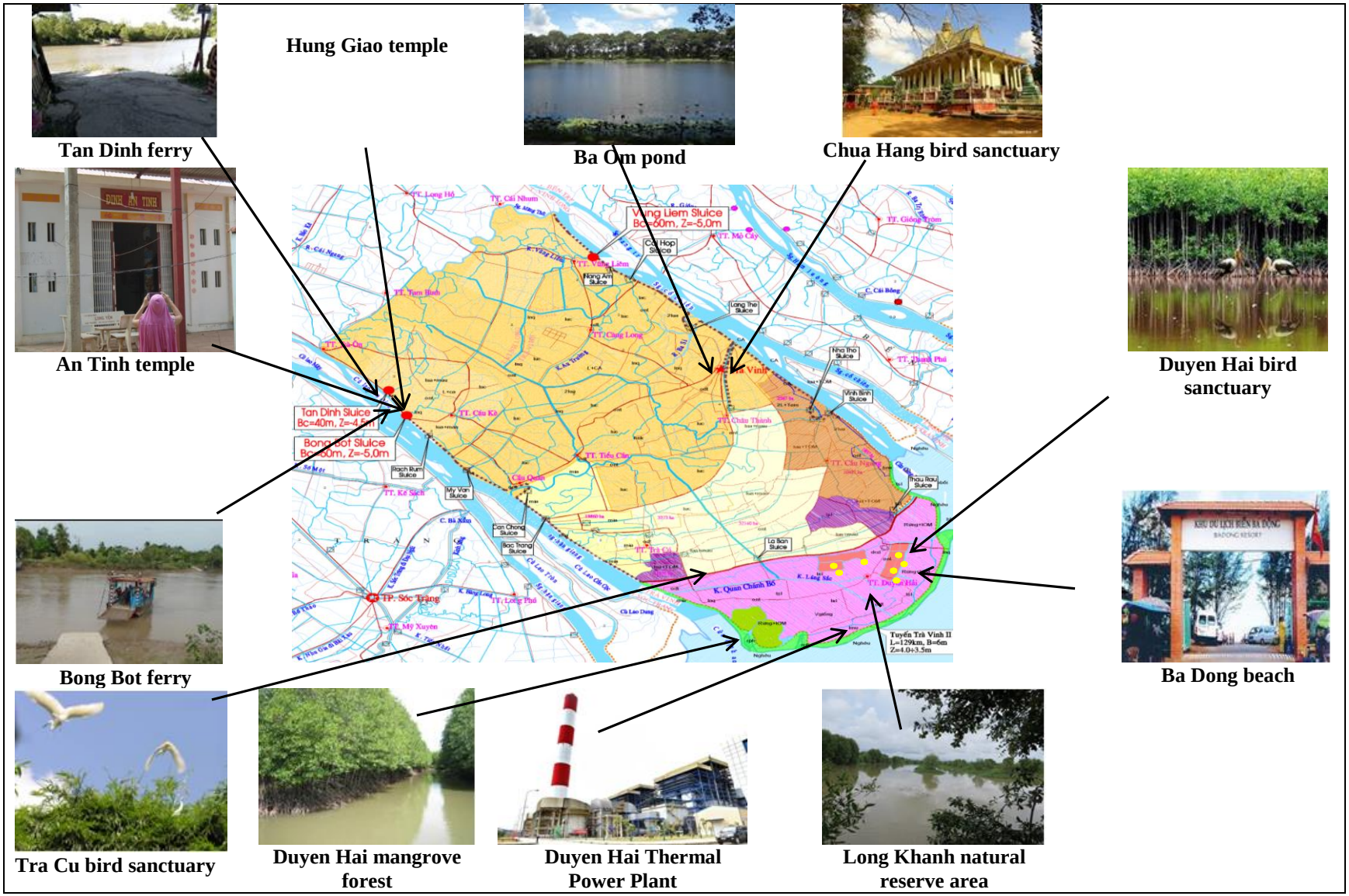



*Figure 1.3: Location of the subproject in relation to natural and social receptors*

### *Subproject components*

To achieve the subproject objectives, investment in the 3 components or 3 zones (*Figure 1.2*) will be financed with the following main components:

#### *1.4.1.1. Component 1: Zone 2 – Promotion of good aquaculture practices*

The investment in this zone is aimed to improve stability and efficiency of brackish water aquaculture production through reducing losses due to high tides, improving water quality, establishing farmer organizations and promoting Good Aquaculture Practices (GAP). The following activities will be implemented:

- Training for famers on GAP and climate resilience livelihoods models.
- Establishing 14 farmer groups for 4,559ha area of aquaculture.
- Additional planting mangrove trees on 728ha of shrimp ponds and supporting certification of organically shrimp - mangrove ecofarming for 1,921ha of 700 households in Duyen Hai district.
- Support to promote biosecurity aquaculture for 2,206ha of 2200 households by setting up pilot models in Duyen Hai district. The pilot models will change from monoculture shrimp to shrimp - rice, shrimp - Oreochromis niloticus, shrimp - crab farming.

This component will support the implementation of five livelihood models in the subproject area. These models have been selected and designed based on the results of some pilot models being implemented in the Mekong Delta. However, the final design and locations of the demonstration sites will be confirmed after discussion and confirmation with the local authorities and communities during the preparation of an implementation plan.

#### *1.4.1.2. Component 2: Zone 3a – Study on transition to brackish water economy*

- Conducting study on appropriate land use for transition of brackish water economy.

#### *1.4.1.3. Component 3: Zone 3b – Prevention of salinity for paddy rice farming*

This area has saline intrusion a few months a year causing huge losses for fruit trees. Since income from fruit trees is still high and farmers are not ready for brackish water economy, farmers want the subproject to help them prevent saline intrusion until their fruit trees are no longer economically viable. It is assessed that it would take a couple of decades for this area to transition to brackish water economy. The following activities will be proposed in this zone:

- Conducting campaigns for raising awareness of local people on climate change.
- Building 3 sluice gates to complete the South Mang Thit irrigation system as follows (*Figure 1.4* to *Figure 1.6*):
    - Vung Liem sluice: (i) three sluice gates (20m wide each); a transportation bridge over the sluice (147.22m long and 6m wide), and (c) a management office of 120m$^2$.
    - Bong Bot sluice: (i) three sluice gates (20m wide each); a transportation bridge over the sluice (147.22m long and 6m wide); and (c) a management office of 240m$^2$.
    - Tan Dinh sluice: (i) two sluice gates (20m wide each); a transportation bridge over the sluice (109.85m long and 6m wide); and (c) a management office of 120m$^2$.

#### *1.4.1.4. Other activities*

- Support for linking farmers to markets.
- Supporting provincial organizations to establish real-time water quality monitoring system to predict water quality (Temperature, pH, alkality, salinity, turbidity, DO, BOD, $NH_3$, $NO_2$, $H_2S$, Vibrio spp, phytoplankton, zooplankton) in the canals supplying brackish water for

aquaculture; monitoring aquaculture seed quality; and onitoring aquatic animal (shrimp) disease (White Spot Syndrome Virus, Yellow Head Virus, Taura Syndrome Virus, Infectious Hypodermal and Haematopoietic Necrosis Virus, Hepatopancreatic Parvovirus, Infectious Myonecrosis Virus, vibro,viral nervous necrosis).

### *Subproject construction measures, technology, and items for zone 3b*

#### *1.4.1.5. Main activities of sluice gate construction*

The main sluice gate construction activities include construction of auxiliary works (construction of the approach roads, worker camps), construction of the sluice gates and management houses for management of the sluice gates and the bridges over sluice gates.

- *Construction of sluice gates*. The sequence for construction of the sluice gates is follows: (i) Preparation of the ground, positioning, pile foundation treatment under the culvert construction phase; (ii) Excavation and filling of foundation pit to the height of the design level; (iii) Execution of steel piles, water withdrawal for construction of the layers oreventing the sheeting; (iv) Handling of the foundation pit, construction using reinforced concrete according to the phases of culverts; (v) Carrying out installation of valves and the control system for the valves; (vi) Installation of energy dissipator to connect the lower and upper stream; and (vii) Completion of sluice-gate construction.
- *Construction of bridges over the sluice gates*. The sequence for construction of the bridges over the sluice gates is follows: (i) Construction of roads leading to the bridges; (ii) Construction of abutment, bridge piers; and (iii) Construction of bridge spans.
- *Construction of the approach roads*, completion of the installation of lighting system, green spaces and landscape.
- Completion of all works.

#### *1.4.1.6. Handling waste soil*

Wasted soil is generated primarily from the excavation for sluice gate foundations, surface ground, and construction roads. Total volume of excavated soil of 54,093m$^3$, of which which 14,514m$^3$ will be reused for filling two sides of the sluicegates, and the approach roads. The excavated soil are planned to be stored at the river and canal sides next to the construction sites. The soil storing sites for each sluice gate is presented Table 1.5. The local authorities will have a plan to use the resoidual soil for canal embankment and land filling, etc. The location and area of the disposal sites and disposal method are specified in *Table 1.5* and *Figure 1.7* to *Figure 1.9*.

*Table 1.4: Area of residual soil disposal site*

| No. | Sluice gate | Site area (ha) | | Total area (ha) |
|---|---|---|---|---|
| | | Left bank | Right bank | |
| 1 | Vung Liem | 0.319 | 0.167 | 0.486 |
| 2 | Tan Dinh | 0.261 | 0.152 | 0.413 |
| 3 | Bong Bot | 0.152 | 0.428 | 0.580 |

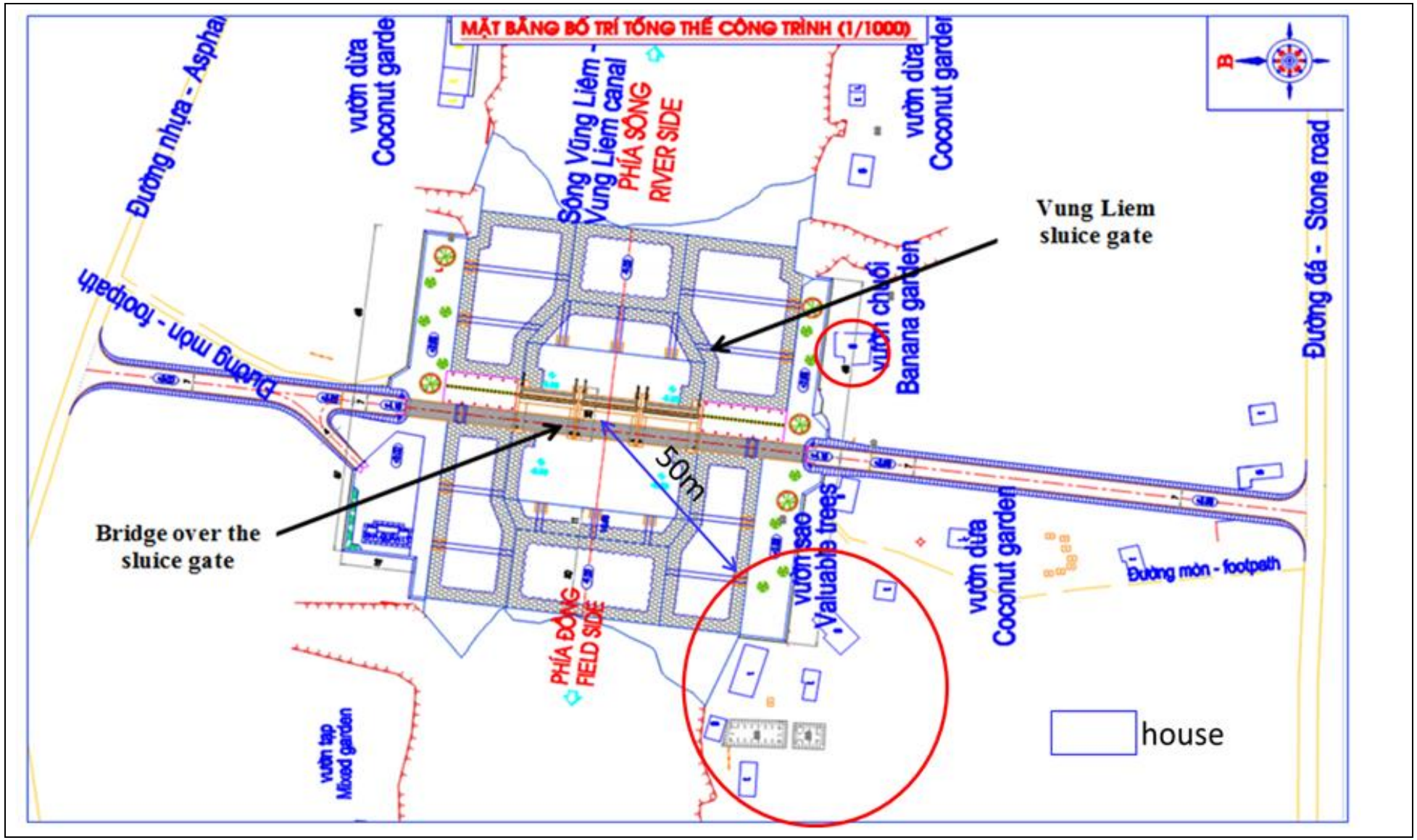



*Figure 1.4: Lay out of Vung Liem sluice gate*

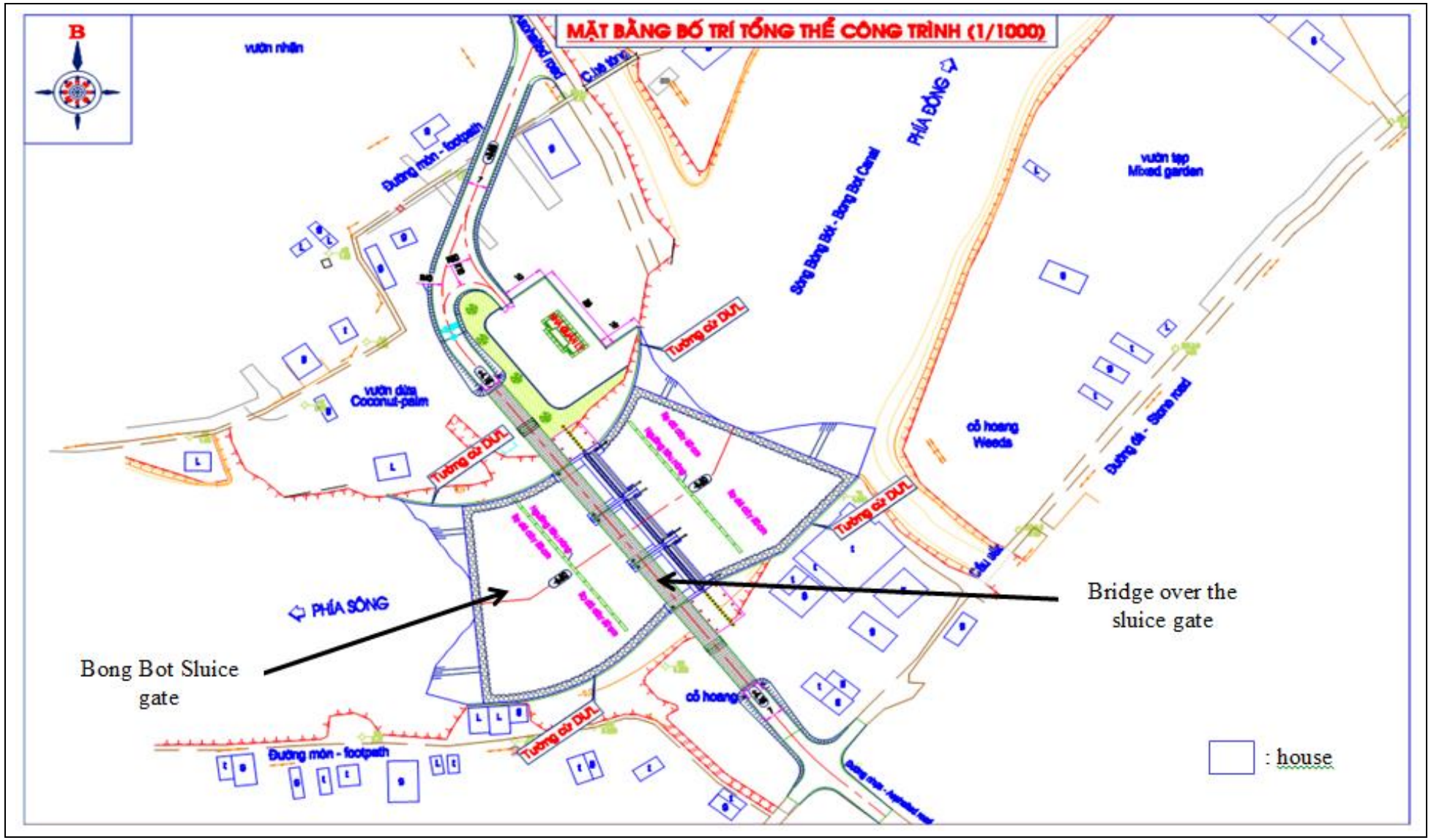



*Figure 1.5: Lay out of Bong Bot sluice gate*

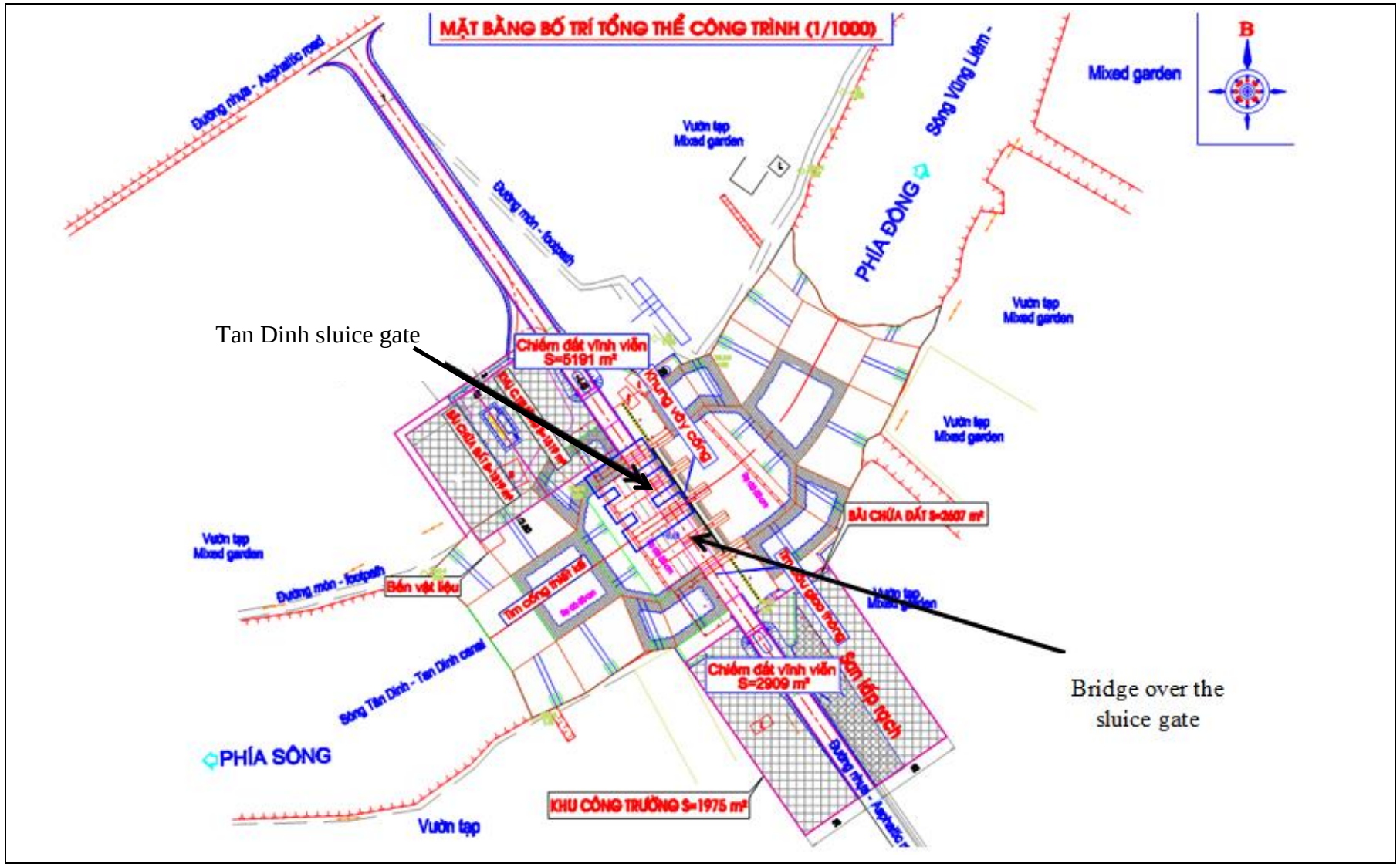



*Figure 1.6: Lay out of Tan Dinh sluice gate*

*Table 1.5: Soil disposal location and area*

| No | Sluice | Expected waste soil volume ($m^3$) | Expected area (ha) | Disposal location and features | Disposal method |
|---|---|---|---|---|---|
| 1 | Bong Bot | 10,512 | 0.53 | The area of the disposal site is agreed to be around 2,500 $m^2$ on the left bank (from field to the river) of Bong Bot canal. The location of the site is next to Lo Moi canal belongs to An Phu Tan commune, Cau Ke district, about 120m from the center of Bong Bot sluicegate.<br>This disposal site is vacant land. There are few fruit trees and weeds on the site ground. | - Transporting waste soil by barge, disposing soil using crane.<br>- Open disposal. |
| 2 | Tan Dinh | 15,898 | 0.79 | The disposal site is agreed to be along Lo Moi canal from the side close to Tan Dinh canal..<br>The disposal sites are located on the canal banks. There are 2 households living near the sites and some fruit trees on the sites. | - Using crane to dispose soil on the banks.<br>- Open disposal. |
| 3 | Vung Liem | 13,169 | 0.66 | Soil is disposed at the existing Nang Am dam, behind Trung Thanh Dong CPC. The location is about 4.5 km from Vung Liem sluicegate.<br>This disposal site is currently a water surface, like a dead-end canal section, located behind Trung Thanh Dong commune people committee. Around it also has a few households living. | - Transporting waste soil by barge, disposing soil using crane.<br>- Open disposal. |

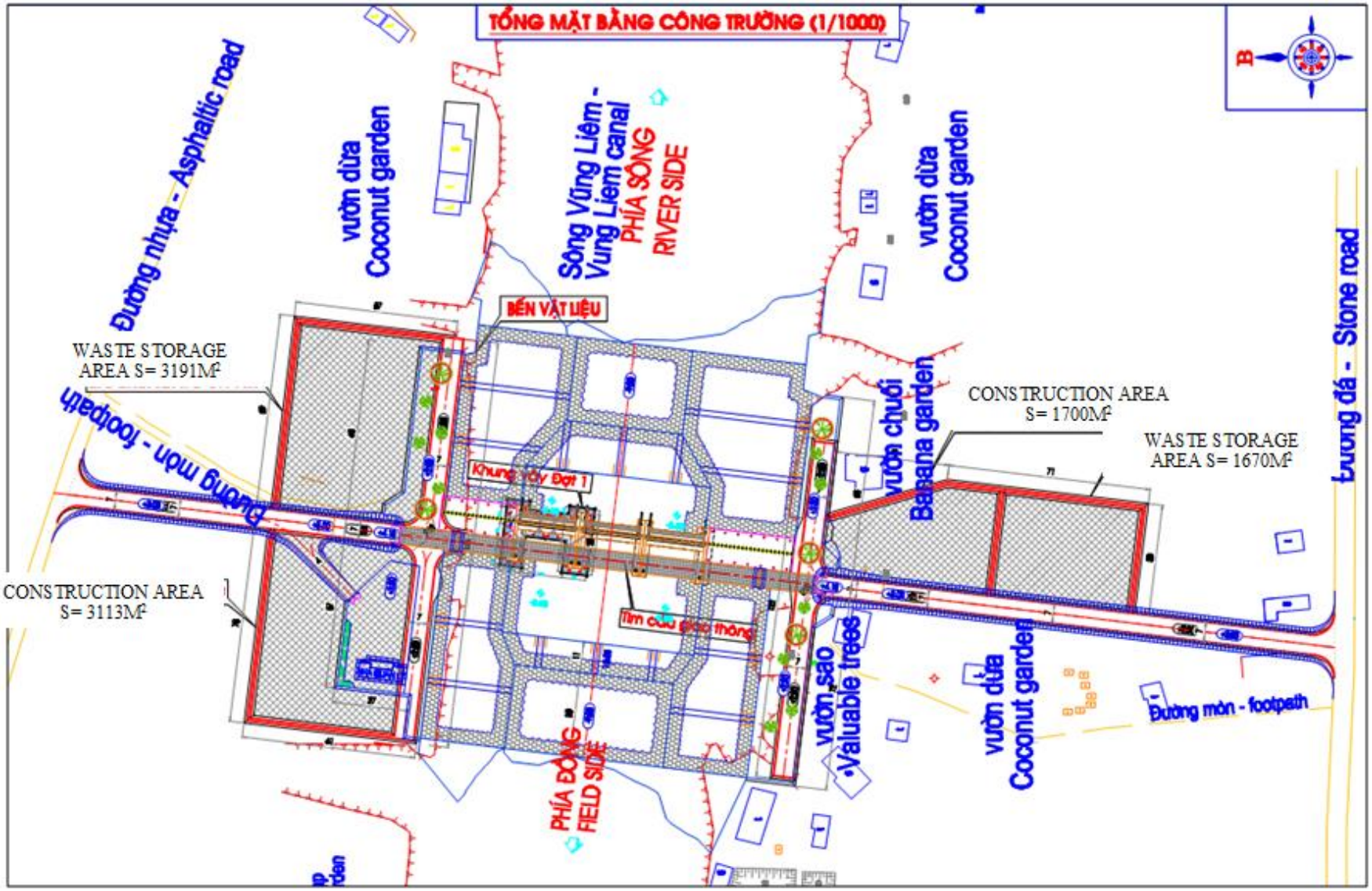



*Figure 1.7: Locations for waste soil storage and disposal during construction of Vung Liem sluice gate*

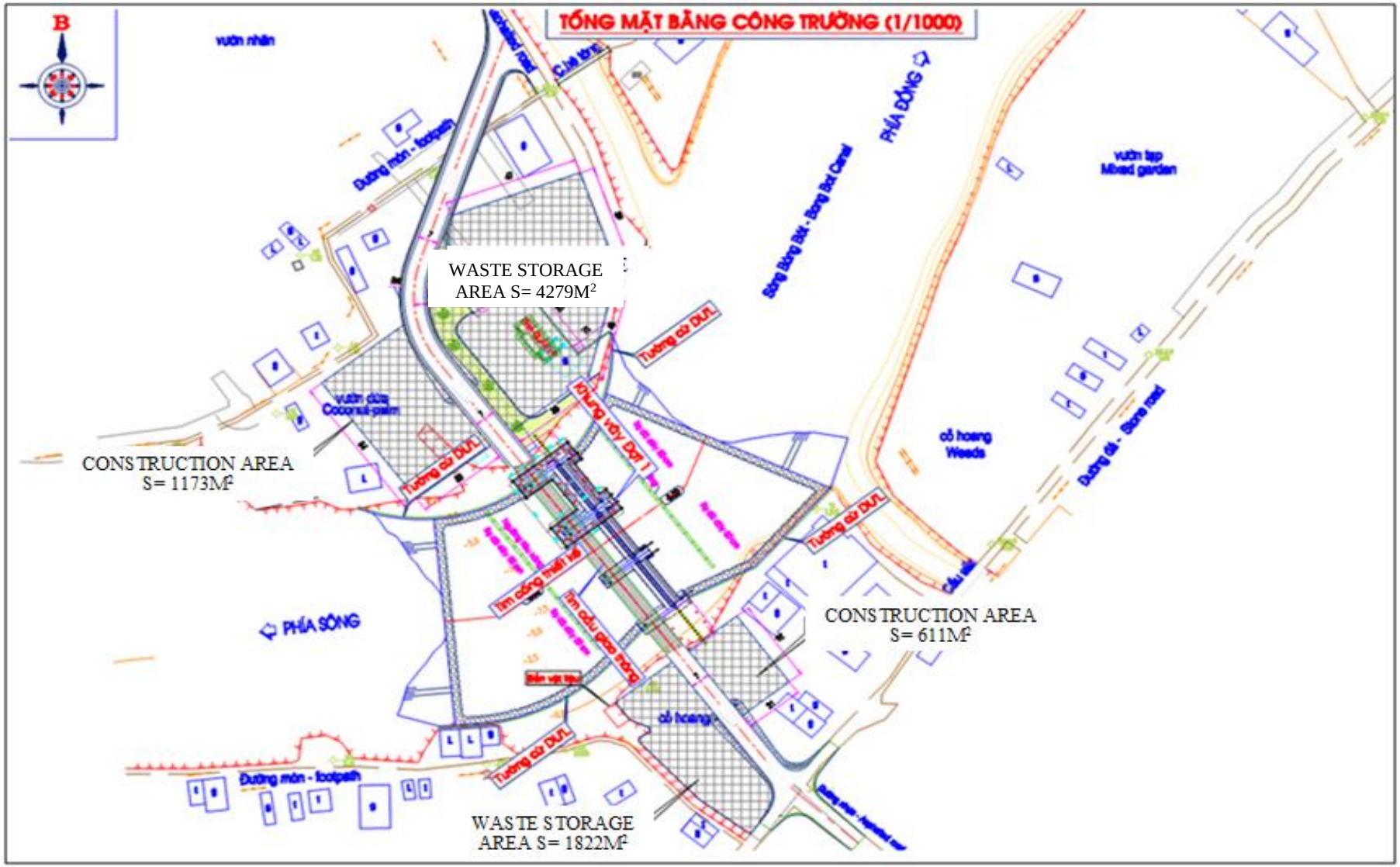



*Figure 1.8: Locations for waste soil storage and disposal during construction of Bong Bot sluice gate*

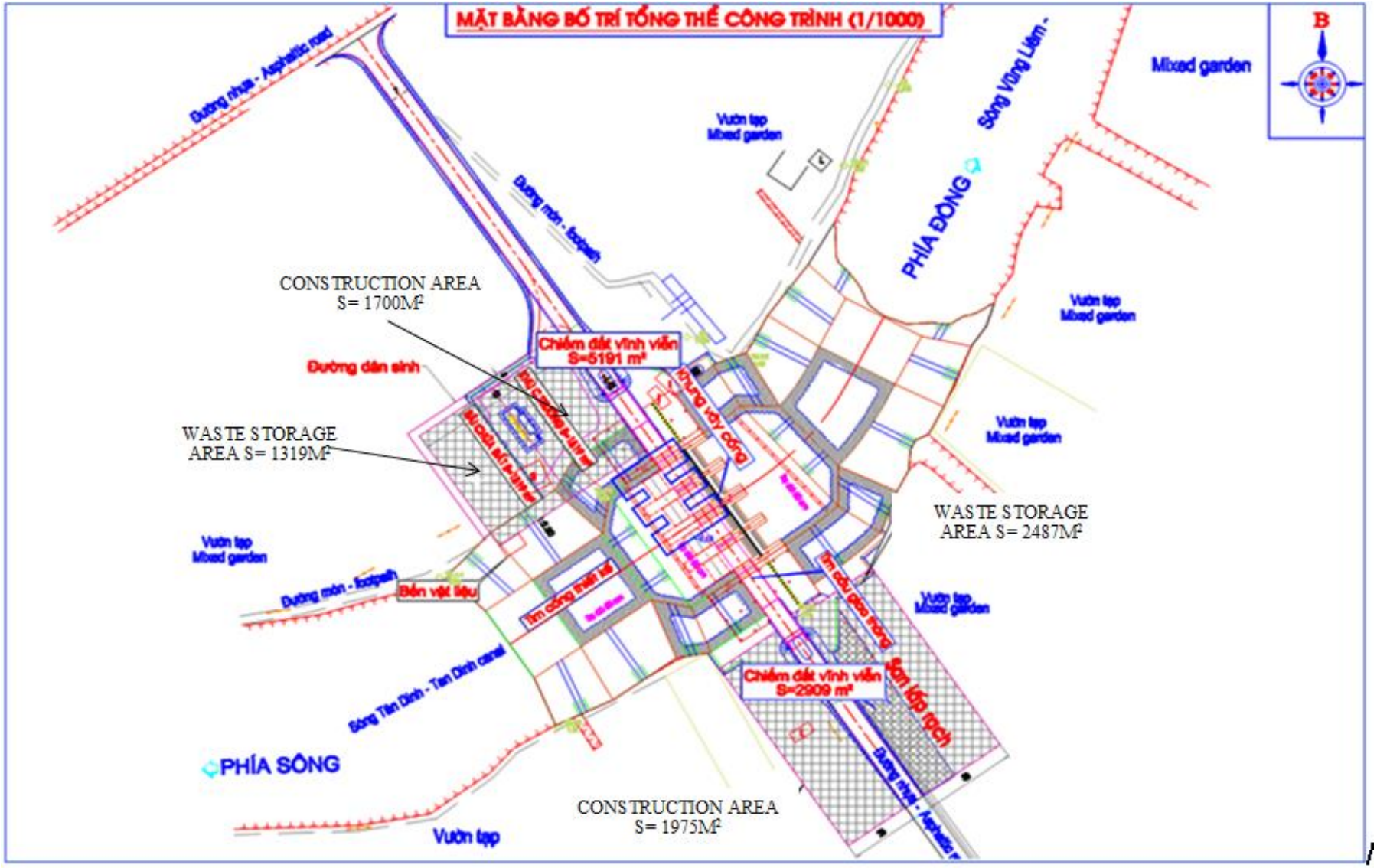



*Figure 1.9: Locations for waste soil storage and disposal during construction of Tan Dinh sluice gate*

### *1.4.1.7. Methods for installation and construction of sluice gates*

*a). Water diversion method for construction of sluice gates*

Diversion for construction needs to be studied for construction works. The river bed needs to ensure drainage flow requirements during construction. There are about 2 - 3 gates for each sluice; the construction process is divided into two or three batches. Thus during construction of the next batch, water can be diverted to the part constructed in the previous batch, still ensuring the required flow for water taking and drainage.

*b). Method for construction of sluice gates*

The sluicegates of the subprojects are constructed by steel sheet pile wall (*Figure 1.11*). The sequence for one batch of sluice construction in steel sheet pile wall includes the following steps: (i) Site preparation, positioning, driving pipes for pile foundation for the sluice; (ii) Driving steel sheet piles to create the wall; Pouring sand to fill foundation pit by barge (deep location) or excavating foundation pit by grab dredgers combined with suction dredgers (shallow location); (iii) Executing the bottom seal concrete layer; (iv) Draining water from foundation pit, executing bracing system for the steel sheet pile wall; (v) Constructing reinforced concrete structure of sluice up to elevation +3.0m (piers and bottom beams); (vi) Removing steel sheet pile wall; (vii) Constructing reinforced concrete structure of sluice from elevation +3.0m upwards (gate frame, service bridge, transport bridge); (viii) Installing sluice gates and gate operation system, systems of monitoring and control, communications, and lighting; (ix) Completion of sluice gates.

*c). Method for construction of bridges over the sluice gates*

The sequence for construction of one span of bridge includes: (i) Site preparation, positioning, driving pipes for the pile foundations of bridge abutments and piers; (ii) Treating foundation pits (excavating pits, sucking mud, etc.), erecting reinforcement, formwork, concreting the abutments and piers; (iii) When the abutments and piers reaches the design strength (28 days), conduct to crane and install beams, then erecting reinforcement, formwork and concreting deck slab. For the spans of cantilever beams, install equipment for cantilever casting work, conduct to cast bridge spans starting from piers; (iv) Finishing the bridge: constructing railings, span joints, bridge surface drainage facilities, spreading asphalt concrete for bridge deck.

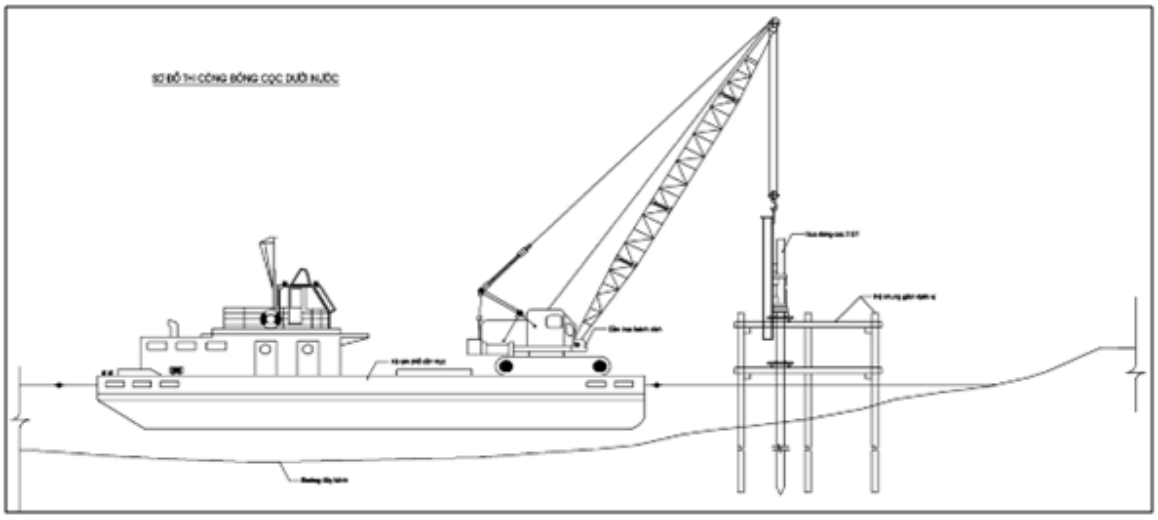


*Figure 1.10. Driving reinforced concrete piles for pile foundation of sluice bottom slab*

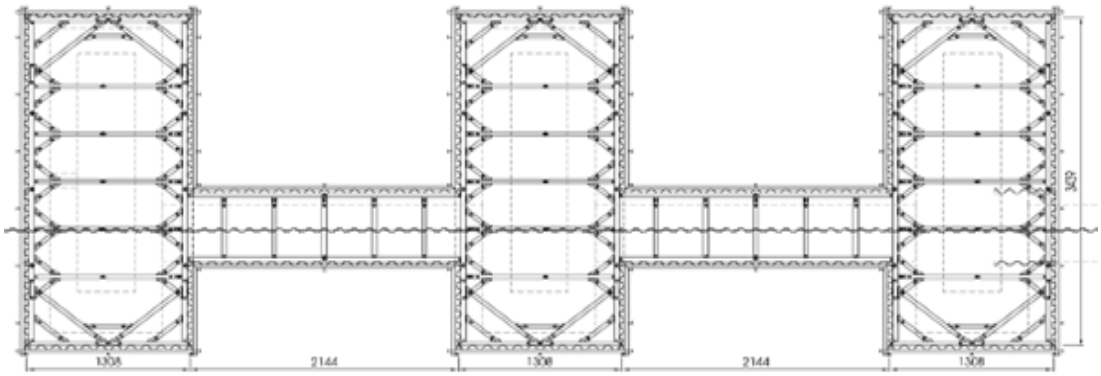


*Figure 1.11. Steel sheet pile coffer dam for sluice gates construction*

*d). Installation and construction of the auxiliary facilities*

Construction of the sluice gates will not require opening of new borrow pits or quarries. Temporary facilities for construction phases will be built as mentioned below (*Table 1.6*):

- Temporary sites on the left and right river banks for stockpiles of sand and stone, loading and unloading of materials.
- Worker camps and contractor offices.
- Power supply: The power supply is to serve the construction, management, and operation of the works in the future. The main power supply source is from the national grid. Building transmission line and 250kVA substation receiving power from the 22kV medium voltage transmission line in the region, reducing by 0.4kV to serve the construction, management, and operation in the future. In addition, a 200 kVA standby generator is arranged to help the process of construction and operation of the facility in case of blackout.
- Water for construction: is to be taken from water supply plants in the subproject area.
- Communications: Using landline and wireless communication system.

*Table 1.6: Work site areas for sluice gates construction*

| No. | Sluice gate | Construction site (ha) | | Storage area (ha) | | Total area (ha) |
|---|---|---|---|---|---|---|
| | | Left bank | Right bank | Left Bank | Right bank | |
| 1 | Vung Liem | 0.311 | 0.17 | 0.319 | 0.167 | 0.97 |
| 2 | Tan Dinh | 0.198 | 0.152 | 0.261 | 0.152 | 0.76 |
| 3 | Bong Bot | 0.065 | 0.117 | 0.152 | 0.428 | 0.76 |

*Source: FS report of the subproject, 2015.*

### *List of tools and equipments using for the construction of zone 3b*

The list of tools and equipment using for the subproject construction is summarized in *Table 1.7* and they are mostly used tools and equipment; however, the depreciation rates are only about 10% to 20% and they are regularly maintained and in good working conditions.

*Table 1.7: List of tools and equipments using for the subproject construction*

| TT | Equipments and tools | Unit | Vung Liem sluice gate | Bong Bot sluice gate | Tan Dinh sluice gate |
|---|---|---|---|---|---|
| *I* | *Excavation of soil and sand* | | | | |
| 1 | 110 CV bulldozer | Pc. | 2 | 2 | 2 |
| 2 | 0.45 $m^3$ Excavator | Pc. | 2 | 2 | 2 |
| 3 | 8T dumping truck | Pc. | 5 | 5 | 5 |

| TT | Equipments and tools | Unit | Vung Liem sluice gate | Bong Bot sluice gate | Tan Dinh sluice gate |
|---|---|---|---|---|---|
| 4 | 9T Compactor | Pc. | 2 | 2 | 2 |
| 5 | Jumping Jack Compactor | Pc. | 3 | 3 | 3 |
| 6 | Tracked crane (0.7÷1.1)m² | Pc. | 2 | 2 | 2 |
| 7 | Barge 400T + dragging ship 360CV | Pc. | 2 | 2 | 2 |
| *II* | *Reinforcement, formwork* | | | | |
| 1 | Iron bending machine 5 KW | Pc. | 2 | 2 | 2 |
| 2 | Iron cutting machine | Pc. | 2 | 2 | 2 |
| 3 | Forging furnace | Pc. | 1 | 1 | 1 |
| 4 | 5T crane boom | Pc. | 1 | 1 | 1 |
| 5 | 50 KW welding machine | Pc. | 2 | 2 | 2 |
| 6 | 50 KW welding transformer | Pc. | 2 | 2 | 2 |
| *III* | *Foundation treatment* | | | | |
| 1 | Piling machine | Pc. | 2 | 2 | 2 |
| 2 | 200T support barge, 180CV tug | Pc. | 2 | 2 | 2 |
| *IV* | *Concrete work* | | | | |
| 1 | Concrete mixer 750L | Pc. | 2 | 2 | 2 |
| 2 | Fixed concrete batching plant 30$m^3$/h | Pc. | 2 | 2 | 2 |
| 3 | Cement silos | Pc. | 2 | 2 | 2 |
| 4 | Trucks for transportation of cement | Pc. | 2 | 2 | 2 |
| 5 | Materials conveyor | set | 2 | 2 | 2 |
| 6 | Cold station | station | 2 | 2 | 2 |
| 7 | 110 CV bulldozer | Pc. | 1 | 1 | 1 |
| 8 | Truck for transportation and mixing of concrete | Pc. | 2 | 2 | 2 |
| 9 | Concrete pumping machine | Pc. | 2 | 2 | 2 |
| 10 | Crawler crane | Pc. | 2 | 2 | 2 |
| 11 | 1.5kW Needle vibrator | Pc. | 7 | 7 | 7 |
| 12 | 1.5kW vibrator plate compactor | Pc. | 5 | 5 | 5 |
| 13 | Concrete jack hammer | Pc. | 5 | 5 | 5 |
| 14 | f 32 mm concrete drilling machine | Pc. | 2 | 2 | 2 |
| *V* | *Other equipment* | | | | |
| 1 | Concrete strength tester | Pc. | 2 | 2 | 2 |
| 2 | Concrete Thermometer | Pc. | 5 | 5 | 5 |
| 3 | Car pump | Pc. | 2 | 2 | 2 |
| 4 | 320 KVA Generators | Pc. | 2 | 2 | 2 |
| 5 | 5T electric winch | Pc. | 2 | 2 | 2 |
| 6 | Fire extinguisher | Pc. | 5 | 5 | 5 |

*Source: Subproject's FS report, 2015*

### *Main supplies, equipment, materials for the subproject construction*

Construction of the scluice gates will not involve opening of new borrow pits or quarries. All kinds of construction materials (*Table 1.8*) will be bought from domestic sources and transported to the construction sites by waterway. These are categorized into two main categories:

- Construction materials such as iron, steel, cement, brick, etc. will be bought from the other provinces, from the construction material wholesale dealers, and factories in the province and in the neighboring provinces like Tien Giang, Can Tho. Transport distances range from 50 to 80 km and no sensitive receptors in material transportation routes.
- Construction materials such as stone, sand, and gravel will be bought from the wholesale suppliers located along the waterway transportation route in Tra Vinh province. At this stage, decision on where to buy sand and stones could not be made because specific requirements on the quality of these materials will only be available during the detailed technical design stage. Nevertheless, during subproject implementation due diligence procedures will be followed to ensure that these sources are legally-produced and practicing sound environmental and social management. Requirements for environmental and social due diligence of materials sources are included in the ESMP.
- All the necessary machinery, mechanical appliances, electrical and mechanical and hydraulic engineering materials (highly durable steel, water pumping station, pressured tank, hydraulic cylinders, etc.) will be directly transported to the construction sites by waterway.

*Table 1.8: Main supplies, materials for the sluice gate construction*

| TT | Materials | Unit | Quantity | | |
|---|---|---|---|---|---|
| | | | **Vung Liem** | **Tan Dinh** | **Bong Bot** |
| 1 | Excavation soil | $m^3$ | 19,346.2 | 20,590.5 | 14,157.0 |
| 2 | Filling soil | $m^3$ | 1,886.5 | 1,039.6 | 709.7 |
| 3 | Different types of sand | $m^3$ | 1,253.7 | 592.2 | 471.7 |
| 4 | Different types of rocks, stones | $m^3$ | 1,922.3 | 908 | 723.2 |
| 5 | Reinforced concrete M300 | $m^3$ | 3,396.7 | 2,600.3 | 3,396.7 |
| 6 | Reinforced concrete M200 | $m^3$ | 46.9 | 37.6 | 46.9 |
| 7 | Concrete M150 | $m^3$ | 1,158.6 | 1,193.7 | 1,158.6 |
| 8 | Concrete M100 | $m^3$ | 162.6 | 133.6 | 162.6 |
| 9 | Mortar M75÷M200 | $m^3$ | 0 | 415.7 | 0 |
| 10 | Different types of round steel | ton | 398.5 | 358.3 | 409.7 |
| 11 | Different types of steel pipes | m | 586.8 | 2,392.6 | 586.8 |
| 12 | Concrete sheet pipe | m | 858 | 572 | 462 |
| 13 | Steel sheet pipe | ton | 2045 | 2,473.5 | 2,949.3 |
| 14 | Box beam | unit | 42 | 48 | 42 |
| 17 | Rock gabion, rock sheet | unit | 0 | 8,344.7 | 5,942.1 |
| 18 | Geotextile | $m^2$ | 0 | 8,344.7 | 8,533 |
| 19 | Different types of figured steels | ton | 351.7 | 199.9 | 352.9 |
| 20 | Different types of iron sheets | ton | 18.6 | 9.8 | 18.6 |

*Source: Subproject FS report, 2015*

### *Investment capital*

Total cost for the subproject implementation is about **34,866,000 USD** and in which cost for ESMP is **545,000USD**, see detail in *Table 1.9.*

*Table 1.9: Total cost for the subproject implementation* (US$'000)

| No. | Item | Expenditures | |
|---|---|---|---|
| | | **Total** | **IDA** |

| | | | | |
|---|---|---|---|---|
| | | | **34,866** | **29,192** |
| **A.** | **ZONE 2: Improving sustainability of brackish water aquaculture** | | **2,147** | **2,091** |
| | 1 | Additional mangrove planting in shrimp ponds (728ha) & supporting to gain certification of shrimp mangrove ecofarming | 1,985 | 1,985 |
| | 2 | Aquacultural on Bio-safety (2206ha/7coops) | 162 | 106 |
| **B.** | **ZONE 3a (Lower area with frequent brackish water intrusion):** | | **1,000** | **1,000** |
| | 1 | Study on approriate land use for a transition to brackish economics | 1,000 | 1,000 |
| **C.** | **ZONE 3b (Upper area, Fruit trees, Freshwater):** | | **24,055** | **24,055** |
| | 1 | Tidal sluice gate and saltwater intrusion | 23,945 | 23,945 |
| | 2 | Climate change awareness campaign | 110 | 110 |
| **D.** | **Linking farmers to markets** | | **200** | **200** |
| | 1. Promoting contract farming (i.e materials, events, etc.) | | 100 | 100 |
| | 2. Product branding | | 100 | 100 |
| **E** | **Supporting provincial organizations** | | **1,846** | **1,846** |
| | 1. DARD/DONRE related depts (Extension, water quality, veterinary…) | | 1,798 | 1,798 |
| | 2. Monitoring and evaluation | | 48 | 48 |
| **F.** | **Land acquisition and compensation** | | **2,081** | **-** |
| **G.** | **The cost of subproject management, consultancy and other** | | **3,537** | **-** |

### *Subproject management and implementation arrangment*

Number of workers for subproject construction in the peak periods is 245 people (*Table 1.10*).

*Table 1.10: Number of workers for sluice gate construction in peak periods*

| | **Vung Liem** | **Bong Bot** | **Tan Dinh** |
|---|---|---|---|
| Worker (people) | 65 | 85 | 95 |

The subproject is a inter-provincial subproject, so it's necessary to establish a management system, and it is very important to implement from the central level to the local level.

**Ministry of Agriculture and Rural Development (MARD)** is the authority with investment decisions and the agency that gives approval to investment subprojects, procurement plan and approve the settlement of the subproject; agencies assisting the Ministry of the project include: Department of the Management of Construction Works, the Central Project Office for Water Resources Project (CPO), and Investment and Management Board for Irrigation System No. 10.

**Department of the Management of Construction** works is in charge of implementing the state management function of the construction works; the Department is responsible for guiding and inspection of the investors to see if management of the subproject is in accordance with the current regulations and guidelines of the State and of the WB.

**The Central Project Office for Water Resources Project (CPO)** is the project implementing agency carrying out coordination functions throughout the project; the office is the direct investor for a portion of the overall project and some of the other works assigned by MARD.

**Investment and Management Boards for Irrigation System No. 10** is the owner of some components of the subproject. The Boards are responsible for implementing and operating the subproject as an investor.

**The provincial People's Committees** participate in directing the project, they are responsible for the entire compensation for site clearance and resettlement works of the subproject. They are responsible for directing the activities of the Department of Agriculture and Rural Development (DARD).

**Department of Agriculture and Rural Developments** (DARD) of the provinces are part owner of the subproject. They perform functions and duties of the investor to closely manage the progress and quality of work, funds invested in the construction process until the end of the subproject.

**The Provincial Project Management Unit** (PPMUs) of investors will help investors implement the component/sub-component of the subprojects.

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

## 2.1. NATURAL SETTINGS

### *Topography and geology conditions*

#### *2.1.1.1. Topography conditions*

**Topography of Vinh Long province** is relatively flat with slope of less than $2^o$, elevation is below sea level (elevation of less than 1.0m is accounted for 62.85% of the area). Topography in center of the province is gradually higher towards Tien, Hau and Mang Thit Rivers and along the major rivers. Elevation of the field is from 1.2 to 1.8 m or less than 0.4 m in some places.

**Topography of Tra Vinh province**. The coastal delta affected by interference of sea and river features prominently in the provincial topography, forming sunken and flat areas alternated with arched sand ridges running in parallel with the coast, which become higher and larger towards the sea. The terrain is relatively complex because it is partitioned by the entangled network of sand dunes, road axes, and waterways. In general, the terrain is mainly flat with elevation of about 0.4 - 1m as of mean sea level, accounting for 66% of total area.

The terrain is flatter in the north than in the south. The highest elevation over 4m comprises sand dunes in the north, distributing in Nhi Truong and Long Son (Cau Ngang District), Ngoc Bien (Tra Cu District), and Long Huu (Duyen Hai District). As for the southern part of Tra Vinh, the terrain is low and cut by arched sand ridges, forming local sunken areas at elevation of 0.5- 0.8m which are inundated for 3 to 5 months a year, comprising communes Tan Son, Ngai Xuyen, Ngoc Bien (Tra Cu District), Thanh My (Chau Thanh District), My Hoa, My Long, Hiep My (Cau Ngang District), and Long Vinh (Duyen Hai District).

The complex terrain has formed a multiform and abundant economy of cash and food crops, fruit trees in sand dunes. Paddy cultivation is predominant in areas of average and sunken elevation. The partition caused by sand dunes has created difficulties for irrigation and inundation after heavy rains in sunken areas being clamped in the middle of sand In general, the terrain having elevation of 0.6 - 1m is suitable for agriculture production thanks to its irrigation and drainage by gravity. As for Duyen Hai District where the elevation is about 0.4 – 1m, the plants of such as mangrove (*Rhizophora apiculata BL*.), nipple palm (*Nypafruticans Wurmb*), *Avicennia marina* can flourish.

In the area where the 3 sluice gates are sited, the topography is relatively flat, getting higher from the Hau, Mang Thit, and Co Chien rivers and lower toward the infield areas, with an elevation varying from 1.25m to 0.5m. The area with elevation levels ranging from 1m to 1.25m includes the riverside villages located near Hau, Mang Thit, and Co Chien rivers. The midle area of the subproject is characterized by the changes in elevation from 0.75 to 1m and from 0.5 to 0.75 m. The topography of the area is bisected by a system of dense canals heavily deposited by sedimentation substantially limiting the irrigation and drainage capacity of the system. Most of the land development area is flooded during the flood season due to its low average elevation of +0.50m. The highest elevation of the the subproject area is +1.10m along the main rivers, Kim Dai canal, Ngang canal, especially in the area for bed planting is +1.3m. The lowest level of elevation is +0.40m attributed to Hang Mai canal near the culverts and the infield area.

#### *2.1.1.2. Geological and engineering conditions*

**In the area of Vung Liem sluice gate.** Geological and engineering conditions are classified into 5 layers: (i) Layer 1: Organic clay in dark grey, brown grey mixed with sand. It has liquid

state; (ii) Layer 2: Clay in green grey, yellow grey mixed with gravel. It has soft, plastic and hard state; (iii) Layer 3: Clay in yellow brown, green grey, reddish brown. It has half-hard and hard state; (iv) Layer 4: Clay in yellow brown, green grey. It has half-plastic, half-hard state; and (v) Layer 5: Sand in yellow brown, white grey. The main component is re-fined material. It is medium compact.

**In the area of Tan Dinh sluice gate.** Geological and engineering conditions are classified into 5 layers: (i) Layer 1: Organic clay in dark grey, brown grey mixed with sand. It has liquid state; (ii) Layer 2: Clay in yellow brown, dark grey, green grey. It has plastic and hard state; (iii) Layer 3: Sand in yellow brown, yellow grey, reddish brown. The main component is re-fined material. It is in plastic and hard state; (iv) Layer 4: Sand in yellow brown, yellow grey, reddish brown. The main component is re-fined material. It is compact and saturated in water; and (v) Layer 5: Clay in dark grey. The main component is re-fined material. It has plastic state.

**In the area of Bong Bot sluice gate.** Geological and engineering conditions are classified into 4 layers: (i) Layer 1: Organic clay in dark grey, brown grey with thin sand streaks. It is in plastic state; (ii) Layer 2: Clay in green grey, yellow brown, white grey. It is in half hard state; (iii) Layer 3: Sand in yellow brown, brown grey, white grey. It is composed of refined sand. It is compact and saturated in water; (iv) Layer 4: Clay mixed with sand in brown grey. It is composed of refined materials and in plastic state.

### *Meteorological Conditions*

The subproject area as well as all the Mekong Delta is in the area with tropical monsoon climate, which is hot, humid, and stable every year. The annual climate is divided into two distinct seasons corresponding to the two forms of the monsoon. The dry season lasts from December to April the following year. This is a harsh sunny season often causing drought, which negatively affects agricultural production. The rainy season, from May to November has an average of 115 rainy days, with rainfall of about 1,400 to 1,500mm. Every year, floods often occur in this season.

The characteristics of the climate and meteorology of the subproject area is described as follows:

- *Temperature:* The average annual temperature is 26.6°C. The hottest month is April with the an average temperature ($T_{bq}$) of 28.0°C; the coldest month is January with a Tbq of 24.9°C (*Figure 2.1*).
- *Rain:* in the dry season from November to June the following year, rainfall is relatively low (about 15% of the average annual precipitation). The rainy season lasts from May to October. During the rainy season, rainfall accounts for 85% of total rainfall throughout the year and is distributed fairly evenly throughout the month with the number of raining days ranging from 13 days to 15 days. The month with the highest rainfall reached 15 to 20% of annual rainfall. The month with the lowest rainfall is reached 10-12% average annual rainfall. January, February, March are the months that there is almost no rain (*Figure 2.1*).
- *Evaporation:* From January to April, evaporation is high and averaged at over 4.1mm/day. In the remaining months, when humidity is high, evaporation is less with only about 3.0mm/day. In the whole year, the average evaporation is about 3.6mm/day.
- *Humidity ($U_{bq}$):* During rainy season average humidity reaches 80.0%, for dry months, humidity ranges from 75 to 80%; August is the wettest month with Ubq of 83.6%. February is the driest month with Ubq of 75.1%.

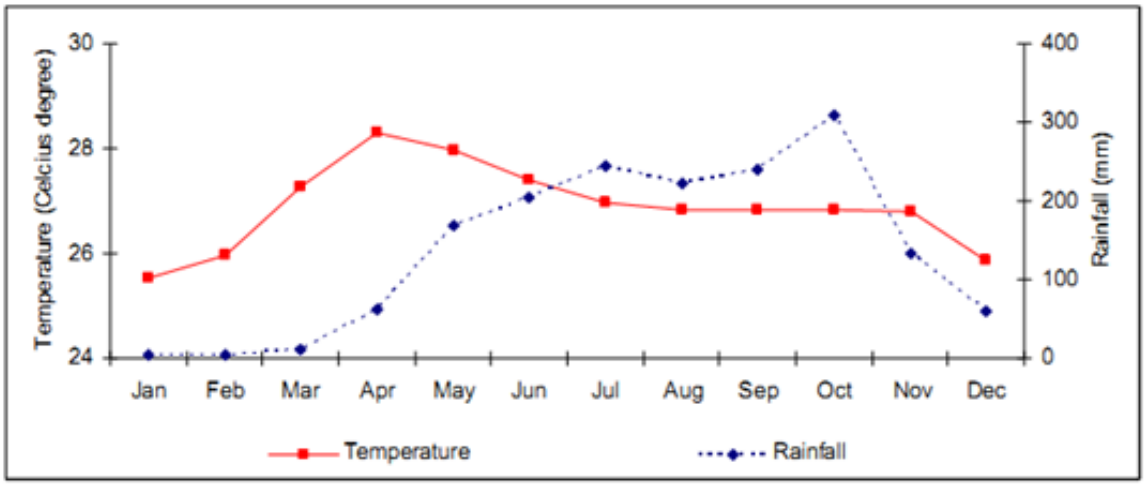



*Figure 2.1: Monthly mean of temperature and rainfall in Tra Vinh province*

- *Wind:* Through the year, there are two seasons of wind: winter monsoon from December to April the following year. Wind direction is mainly East - Northeast. The average wind speed is of 3.2 - 4.0 m/s. Summer wind is from May to November in the direction of West - Southwest. The average wind speed is at about 3.2 - 3.8 m/s.

### *Hydrological Conditions*

#### *2.1.1.3. Water level*

The subproject area has a hydrologic regime closely related to the water flows in the big rivers of Co Chien, Hau, and Mang Thit. Located near the sea, the area is also affected by strong tides. After entering the inland water through the main canals, the amplitude of the tide decreases in the subproject area. At the subproject site, there is no water level measurement station, but the stations at the major rivers surrounding area for water level monitoring. On the main rivers, measurements are carried out for water and flow levels to calculate correlation with the neighboring country stations.

The hydrology is strongly affected by the irregular semi-diurnal tides of the East Sea. There are two times of raising and neap tide a day. Everymonth, there are two periods of high tide (on the 1$^{st}$ and the 15$^{th}$ days of Lunar months) and two periods of tidal flow low (on the 7th and the 23$^{rd}$ days of Lunar month).

The water flowing by gravity is high because the amplitude and water levels in rivers and streams are considerable, resulting in high potential of water drainage in the province. Only a part of Cang Long District and the provincial central area (neighbouring areas of districts Chau Thanh, Tieu Can, Tra Cu, and Cau Ngang) are flooded for 3 – 4 months a year due to the border water from many directions and rapid tidal amplitude.

Tra Vinh has a 65-km coastline and a shallow water territory which is endowned with many valuabe resources not only for aquaculture but also for business and tourism development. The fishery reserve and exploitation volume are 1.2 million tons and 630,000 tons a year, respectively.

Due to the influence of the semi-diurnal tides in a day, the water level in the canals goes up and down twice with two peaks and two bottom levels of unequal amount. In the months with two tidal cycles with each cycle of 15 days. In a cycle period, there are high and low water cycles. Tide period lasts from 5 to 6 days with very high and very low water level. The highest water levels are on 16, 17 days and 1, 2 days of lunar calendar. In the dry season, the water level is lower than flooding season due to impacts from rainfall on the canals. Water level at some stations in the subproject area are shown in *Table 2.1*.

Tide from the East Sea cause impacts to project area throughout the year, even during the flood season from September and October (the most influential periods of flooding of the Mekong River). Tidal amplitude at both ends of the river Mang Thit is very big showing that the flood has no significant impact on the project. Overall, the average monthly water level is biggest in the months of November, December and lowest in VI, VII, VIII, so it can be confirmed that the hydrological regime of the project is affected by main tide from the East Sea.

*Table 2.1. The highest, lowest and average water levels at some of the station in the subproject area*

| TT | Station | Type | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| 1 | Tra Vinh | Max | 1.74 | 1.70 | 1.72 | 1.45 | 1.36 | 1.23 | 1.29 | 1.51 | 1.73 | 1.83 | 1.80 | 1.84 |
| | | Min | -2.02 | -2.02 | -2.01 | -2.02 | -2.17 | -2.40 | -2.32 | -2.15 | -2.00 | -1.73 | -1.80 | -1.86 |
| | | Med | 0.24 | 0.14 | 0.07 | -0.02 | -0.12 | -0.21 | -0.18 | -0.10 | 0.05 | 0.30 | 0.38 | 0.32 |
| 2 | Ben Trai | Max | 1.83 | 1.72 | 1.73 | 1.43 | 1.39 | 1.26 | 1.34 | 1.50 | 1.69 | 1.88 | 1.90 | 1.83 |
| | | Min | -2.35 | -2.22 | -2.08 | -2.15 | -2.40 | -2.51 | -2.58 | -2.50 | -2.35 | -2.12 | -2.30 | -2.36 |
| | | Med | 0.34 | 0.27 | 0.27 | 0.08 | 0.01 | -0.10 | -0.09 | -0.03 | 0.04 | 0.32 | 0.42 | 0.40 |
| 3 | Dai Ngai | Max | 1.93 | 1.86 | 1.90 | 1.77 | 1.60 | 1.53 | 1.59 | 1.78 | 2.02 | 2.14 | 2.00 | 1.99 |
| | | Min | -1.74 | -1.66 | -1.65 | -1.70 | -1.84 | -1.91 | -1.83 | -1.63 | -1.31 | -1.01 | -1.16 | -1.45 |
| | | Med | 0.25 | 0.15 | 0.09 | -0.01 | -0.09 | -0.15 | -0.09 | 0.04 | 0.20 | 0.42 | 0.45 | 0.36 |

*Source: FS report of the subproject, 2015*

#### *2.1.1.4. Salinity intrusion*

Saline water enters from the East Sea and causing salinity intrusion into the project area along the Co Chien River and Hau River. Salinity movements are similar to the tidal fluctuations and depend on the tidal period (more or less intensity), the freshwater flow from the Mang Thit, Co Chien, and Hau Rivers, and the infield meteorological factors such as rain, wind, etc.

Monthly mean of maximum salinity concentrations in the dry season during the 16 years of the period 1995 – 2010 at representative gauging stations, two on the Co Chien river (Hung My and Tra Vinh stations) and two on the Hau river (Tra Kha and Cau Quan stations) are shown in *Figure 2.2*. It shows that salinity levels increase progressively from January, reach peaks in March or April and decrease afterwards. Averages of 16 years, the highest levels of salinity concentration are 7.9, 14.2 and 18.0 g/l in March at Cau Quan, Hung My and Tra Kha stations respectively; whereas this figure is 9.0 g/l in April at Tra Vinh station (*Figure 2.2*).

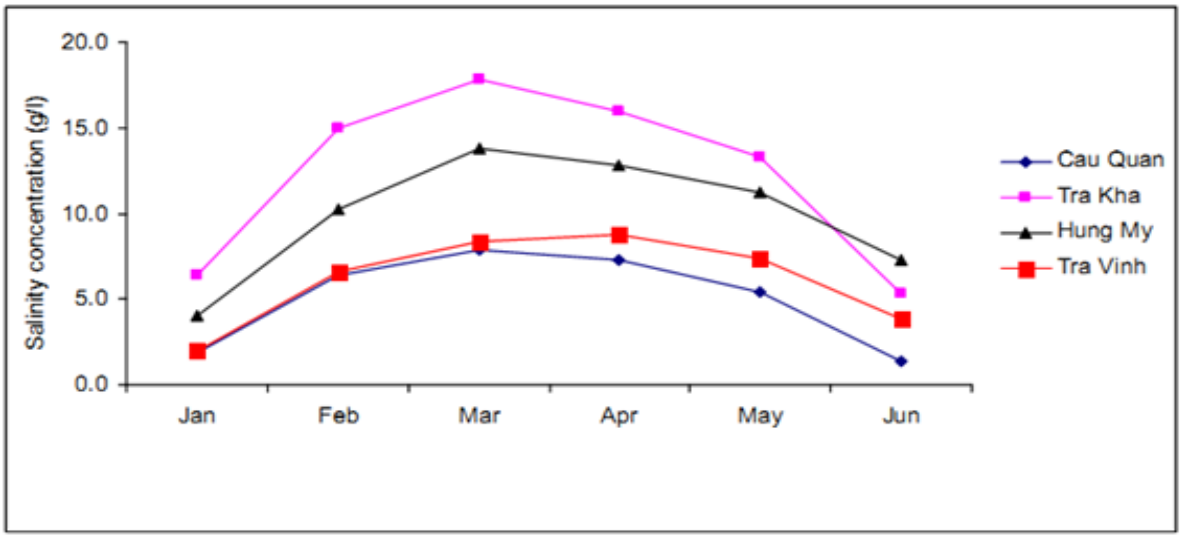



*Figure 2.2: Monthly mean of maximum salinity concentrations at 4 stations in 1995 – 2010*

Water circulation in the coastal zones of the Mekong delta depends on many factors like geographical, climatic and anthropogenic conditions; in particular fresh water discharge of the rivers, local rainfall, tidal movement from the sea, the wind velocity/direction and water use regimes are important (Sam, 2006: p17; Tuan et al., 2007: p40). There is a closed relationship between salinity intrusion and freshwater discharge in the river branches in the delta. River discharges at Tan Chau (upper Co Chien river) and Chau Doc gauging stations (upper Hau river) are very low in the dry season, especially in March and April. Average discharges in these two months are accounted for only 3 – 4% of the annual discharge. Therefore, there is not enough fresh water flow to prevent saline water to penetrate the river branches. It is considered as a major reason for salinity intrusion in river systems and canal networks in the dry season. Sam (2006: p197) calculated that on average the salinity concentration of 1 g/l can intrude 58km further inland on Co Chien river and 54km on Hau river in March.

Besides, weather data in Tra Vinh province shows that less than 20% of total precipitation falls in the dry season (November to April), especially from January to March there seems to be no rain; at the same time, temperature is rising up and getting its peak in April (Figure 5.4). High temperature causes higher evaporation. It is reported that evaporation rate in the dry season is bigger than in the wet season by about 2 per day in the coastal regions of Mekong delta (Sam, 2006). Hence, a combination of high evaporation rate and low rainfall in the dry season is important factors contributing to increase salinity related problems.

Salinity intrusion in the coastal regions is affected by tidal movement from the sea too. The Co Chien and Hau estuaries are influenced strongly by the semi-diurnal tides of the East Sea with large tide amplitude of 3.0 – 3.5 m (Tuan et al., 2007). Moreover, between January and April there are strong winds from the East Sea causing even higher (sea) water level in the river mouths, seriously affecting salinity intrusion in this period (Sam, 2006: p81-82).

Water use regimes also impact salinity intrusion, especially irrigation for Winter-Spring (WS) rice crop from November to April due to the fact that WS crop always needs more water than others. Total water requirement for 1 ha of rice in WS crop is about 8,080 $m^3$, of which 98% from irrigation systems. According to General Statistics Office, the WS crop area has been expanding from 1.0 to 1.6 million ha between 1995 and 2010 (GSO, 2000; GSO, 2011a). Most of this increase comes from upstream and mid-stream areas thanks to well-developed irrigation systems (Nhan et al., 2007: p152) leading to fresh water scarcity clearly becomes more and more problematic issue in downstream regions in the dry season.

So far, it shows that on average salinity concentration in the Mekong delta reaches the highest levels in March or April every year. The state of sea water intrusion in this region is very

complicated and affected by many factors among them not only natural conditions but also economic development, especially in the planned area for freshwater production.

The annual mean of maximum salinity concentrations at 2 representative gauging stations, Hung My on Co Chien river and Tra Kha on Hau river are presented as *Figure 2.3* and *Figure 2.6*. The 16-year long series (1995-2010) data show that:

- At Hung My station: The lowest values of maximum salinity concentrations were observed in 1997 (7.4 g/l) or in 2000 (8.0 g/l). High values were observed in 2004 (21.6 g/l) or in 1998 (20.3 g/l). Between 1995 and 2010, the maximum salinity levels caused negative impacts in descending order as 2004, 1998, 2005, 2010, 2009, 1999, 2006, 2008, 2003, 1995, 2007, 1996, 2002, 2001, 2000 and 1997.
- At Tra Kha station: The lowest values of maximum salinity concentrations were also observed in 1997 (12.5 g/l) or in 2000 (14.1 g/l). High values were observed in 2005 (22.8 g/l) or in 1998 (22.1 g/l). Between 1995 and 2010, the maximum salinity levels caused negative impacts in descending order as 2005, 1998, 2010, 2006, 2004, 2008, 1995, 2007, 1996, 1999, 2001, 2002, 2003, 2009, 2000, and 1997.

Average of 4 stations (Hung My, Tra Kha, Cau Quan and Tra Vinh), the maximum salinity levels caused negative impacts in descending order as 1998, 2004, 2005, 2010, 2008, 2006, 1999, 1995, 1996, 2007, 2009, 2003, 2002, 2001, 2000, and 1997.

Survey data of SIWRR in 2005 (the driest year) show that, in the dry season, salinity contents in the water in Bong Bot canal, Vung Liem and Tan Dinh rivers are above 1mg/l only 4-5 days in March and April (*Figure 2.4* and *Figure 2.5*). It means that the 3 sluice gates are only closed during short time (4-5 days for salinity prevention).

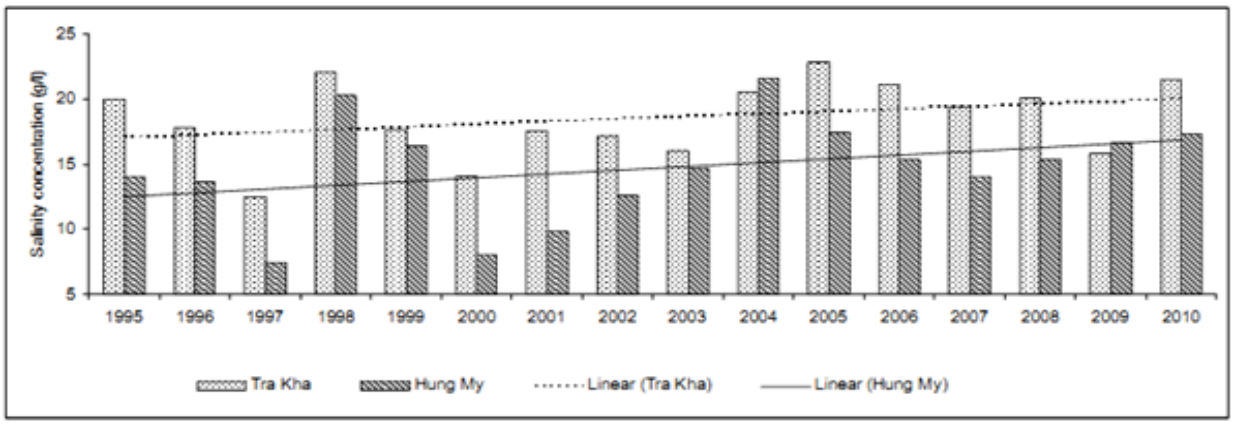



*Figure 2.3: Salinity intrusion trends between 1995 and 2010 at Hung My and Tra Kha stations*

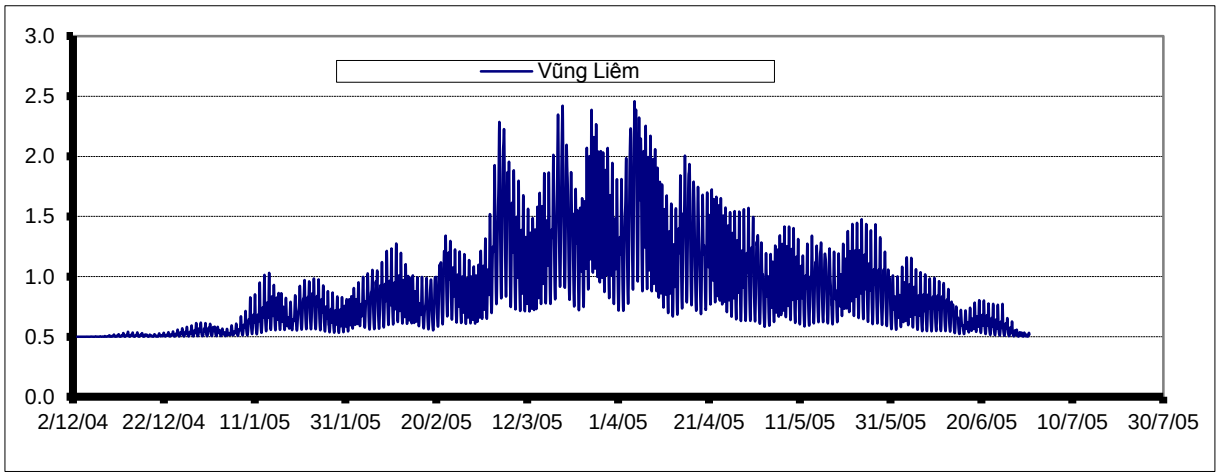



*Figure 2.4: Salinity contents in Bong Bot sluice gate in 2005*

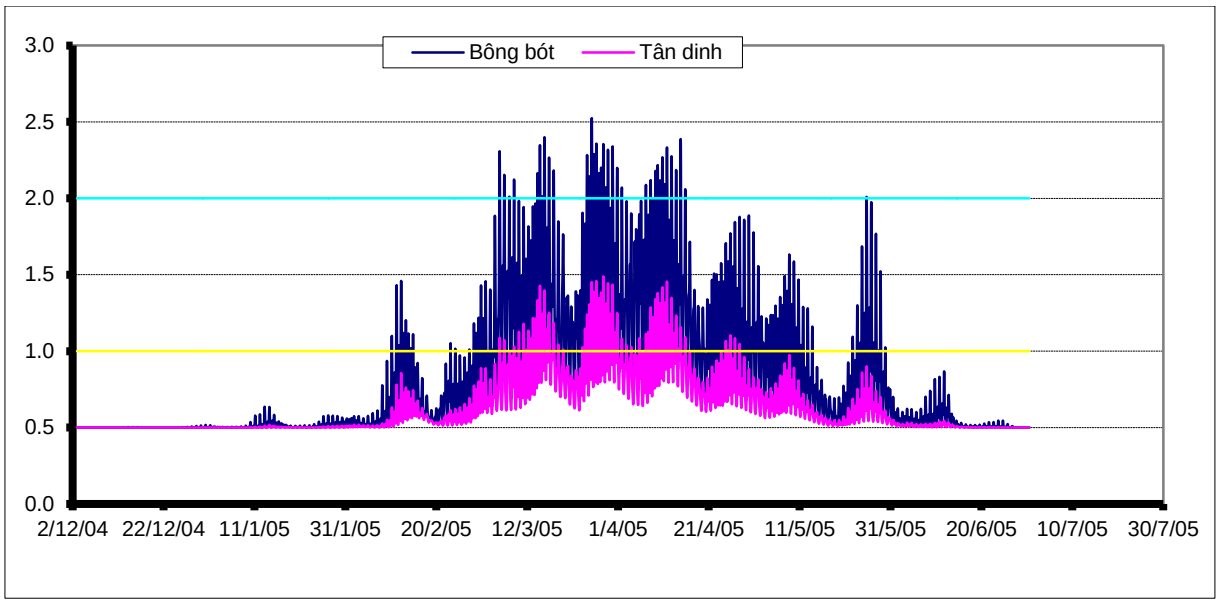



*Figure 2.5: Salinity contents in Tan Dinh and Bong Bot sluice gates in the driest year 2005*

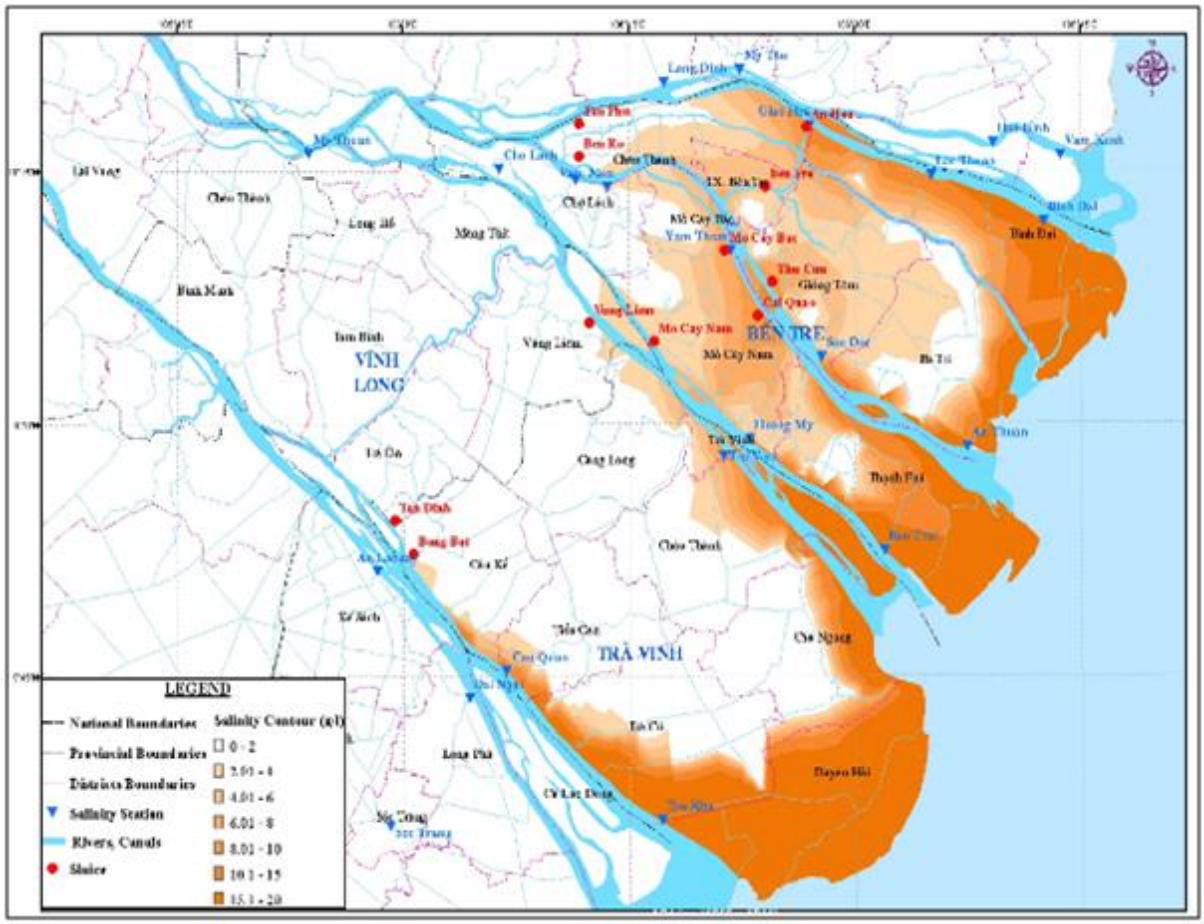



*Figure 2.6. Distribution of salinity levels in the estuary area in hydrological condition of year 2000*

## *Natural Resources*

### *2.1.1.5. Land resources*

According to the General Statistics Office, the total natural area of Tra Vinh until January 1, 2015 is 233,755ha, categorized as follows (*Table 2.2*).

*Table 2.2: Land resource in Tra Vinh province*

| No. | Soil type | Distribution | Elevation (m) |
|---|---|---|---|
| 1 | Sand dunes | Distributing in the arch forms running in parallel with the coast, in districts of Tra Cu, Cau Ngang, Duyen Hai, Chau Thanh | 1.4 - 2 |
| 2 | Alluvium soil | | |
| 2.1 | Alluvium soil developped in sand dunes | Mainly in districts of Tra Cu, Duyen Hai, and Chau Thanh. The soil is free from tidal floodings. | 0.8-1.2 |
| 2.2 | Alluvium soil unaffected by salinity | Mainly in districts of Cau Ke and Cang Long | 0.6 – 1.2 |
| 2.3 | Alluvium soil less affected by salinity | Mainly in the salinity arch, in districts of Tra Cu, Tieu Can, Cau Ngang, and a small section in districts of Cau Ke, Chau Thanh. The soils are almost free from flooding. Water in canals and streams turns saline for 2 to 5 months a year. | 0.6 – 1.2 |
| 2.4 | Alluvium soil of medium salinity | Water salinity lasts for 6-8 months/ year, concentrating in districts of Cau Ngang, Duyen Hai and some sections in districts of Tra Cu, Chau Thanh. The area is flooded during high tides or by season | |
| 2.5 | Aluvium soil of high salinity | Concentrating in Duyen Hai District. The salinity of 10 last for 8 months a year | |
| 3 | Alum soil | | |
| 3.1 | Alum soil without salinity | In districts of Cang Long and Cau Ke, the soil is free from flooding | High elevation |
| 3.2 | Alum soil of slight salinity | In districts of Chau Thanh and Cau Ngang | |
| 3.3 | Alum soil of medium salinity | In districts of Chau Thanh, Duyen Hai, Cau Ngang, and Tra Cu. The soil is free from flooding. | 0.6 – 1.2 |
| 3.4 | Alum soil of high salinity | In Duyen Hai District. | |

Tra Vinh is endowed with agricultural potentials and advantages of fishery farming and capture which produce raw material resources for processing industry. Tra Vinh has 107,599ha of land for annual plants, 97,326 ha of paddy land and 29,374 ha of water surface. Most of the land area of 3 sluice gate construction areas is used for the purposes of agricultural production. Out of the total natural land area of 82,346 ha of the subproject districts, 66,320 ha are used for agricultural production, accounting for 80.5%, see *Table 2.3* and *Figure 2.7*.

*Table 2.3: Land use status (ha) of the subproject area*

| No. | District/province | Total area | Of which | | | |
|---|---|---|---|---|---|---|
| | | | Argicultural production land | Forestry land | Specially used land | Homestead land |
| *1* | *Tra Vinh province* | *234,116* | *148,024* | *6,676* | *13,837* | *4,509* |
| 1.1 | Cau Ke district | 24,662 | 19,984 | - | 1,047 | 841 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.2 | Cau Ngang district | 31,909 | 24,525 | 890 | 1,545 | 321 |
| 1.3 | Tra Cu district | 36,992 | 28,246 | - | 2,559 | 460 |
| 1.4 | Duyen Hai district | 4,207 | 4,980 | 5,726 | 2,757 | 498 |
| *2* | *Vinh Long province* | | | | | |
| 2.1 | Vung Liem district | 1,937.50 | 1895.5 | 0 | 0 | 42 |
| 2.1.1 | Trung Thanh Tay commune | 820.5 | 820.5 | 0 | 0 | 0 |
| 2.1.2 | Trung Thanh Dong commune | 1,117.00 | 1075 | 0 | 0 | 42 |
| 2.2 | Tra On district | 1,809.00 | 1519 | 0 | 20 | 270 |
| 2.2.1 | Tich Thien commune | 1,809.00 | 1519 | 0 | 20 | 270 |

*Source: Statistical data provided by CPCs in the subproject area in 2015*

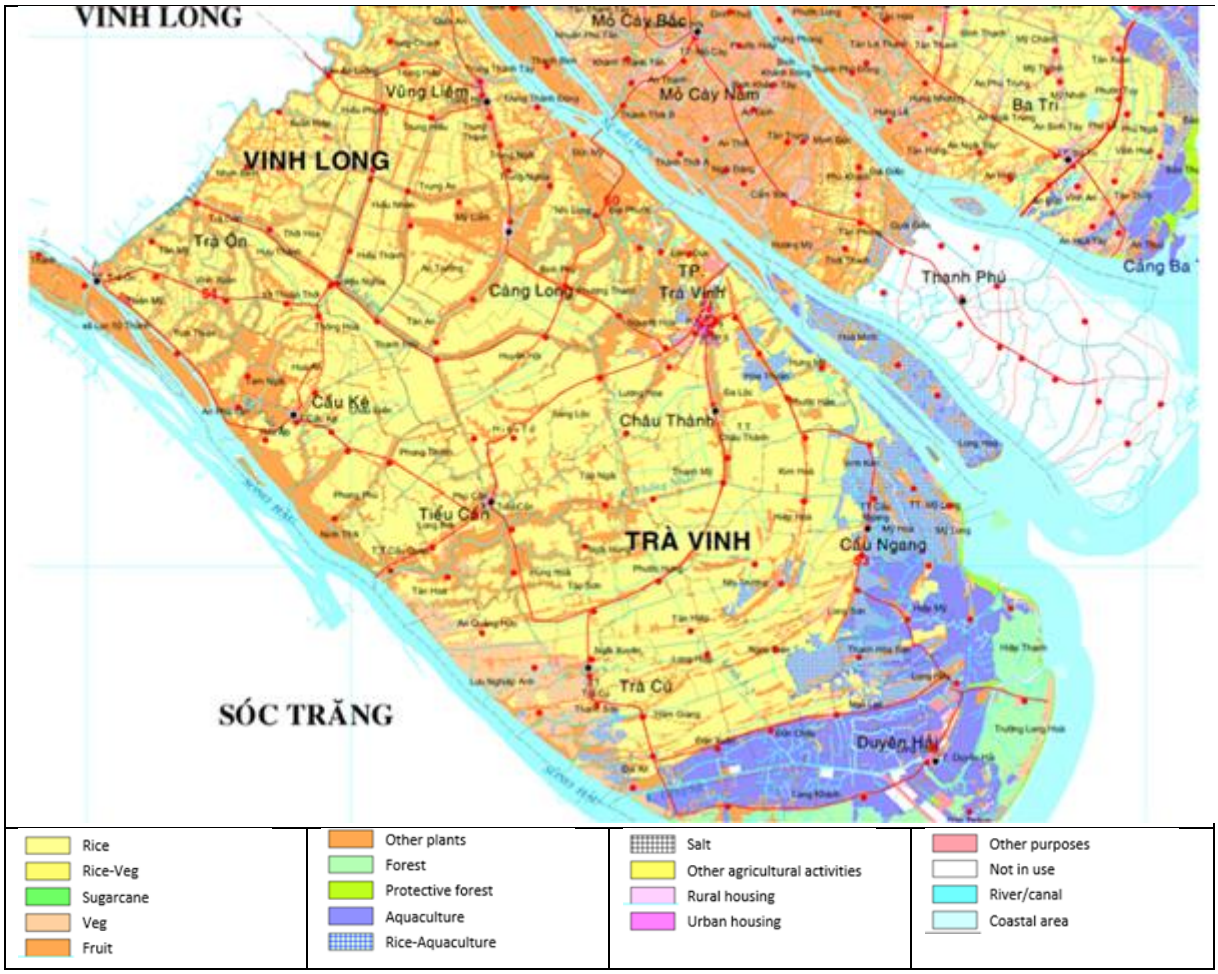



*Figure 2.7. Current land use in Tra Vinh province*

### *2.1.1.6. Water resources*

The 2 rivers of Co Chien and Hau are main suppliers of water for the provincial production and living, as follows:

- Hau River flows in the northeast – southwest direction, crossing a section of 55 km in Tra Vinh and emptying into the East Sea be Dinh An estuary. The average water discharge is 2,000 – 3,000 $m^3/s$.

- Co Chien River is one of 3 branches of the Tien River, crossing a section of 45km in Tra Vinh. Its widest section of 1,800 – 2,000 m is in Cang Long District. The average water discharge is 12,000 – 19,000 $m^3$/s.

Besides, there is a network of complicated waterways providing water for paddy fields. The canal density distribubes relatively even, from 4 - 10 m/ha, increasing to the highest in Tieu Can District (45 m/ha) and decreasing to the lowest in disrtricts of Duyen Hai, Tra Cu, and Cau Ngang (18 – 28 m/ha). Main canal axes comprise: (i) in Co Chien River: streams of Lang The, Bai Vang, Thau Rau, Tra Vinh cana; (ii) in the Hau River: streams of My Van, Tra Cu, Tong Long, Vam Ray, Can Chong River, and Lang Sac canal; and (iii) vertical axis canal system: canals of Tra Ngoa, 3/2, and Thong Nhat.

Five underground aquifers are found in Tra Vinh province. Upper groundwater (middle and upper Pleistocene) aquifers are salinized (salt water intrusion from canals), while the water in the middle 3 layers (Pliocene) is more abundant and of better quality. In general, shallow groundwater at depths below 100m beneath the sand dunes, is supplied mainly from accumulated rainwater. Groundwater at depths deeper than 100 m is pretty rich.

#### *2.1.1.7. Forest resources*

Forest land of Tra Vinh by 2012 is 7,525.72 hectares (in Duyen Hai district the figure is 6,232.75 hectare), accounting for 3.38% of Tra Vinh total area. Within the forest area, the area with forest coverage is 39%, bareland and water coverage is 61% (in which, 31% is aquacultural area).

The foreststed area can be dived into two categories as follows:

- Natural forest accounts for 23% of total forest (1,599.98 ha), including: (i) *Soneratia:* 895.62 ha; and (ii) multi-species of *Avicenia, Rhizophora apiculata, Rhizophora mucronata*: 703.36 ha. Natural forest is located in coastal and estuary areas and is affected by strong winds, high tides, and frequent floods.
- Planted forest accounts for 77% of total forest (5,926.74 ha), including: (i) Casuarina: 326.98 ha located in the coast to prevent sand wind, stabilizing sand dune, landscape environment; (ii) *Soneratia*: 703.36 ha, planted along large estuaries (Tien River and Hau River), mud flat with frequent tide; (iii) *Rhizophora*: 1,817.72 ha, planted in the river side mud flat, and coastal area in the river mud bank, mangrove/shrimp areas; and (iv) other: 2,147.03 ha, including: *Avicenia, Xylocarpus, Lumnitzera, Thespesia, Eucalyptus*. These are species more resistant to strong wind and salinity.

#### *2.1.1.8. Biological resources*

*a). Terrestrial ecosystems*

There is a natural reserve area and many natural areas/sites within Tra Vinh province as follows:

- *Long Khanh natural reserve* is a area of 868.1 ha with protection function, including breakwater, erosion protection, environmental protection and landscaping, eco-tourism development and plants in this area has 64 species, 57 genera, 31 families.
- *Tra Cu bird sanctuary.* Tra Cu bird sanctuary is a very small bird sanctuary (2ha) in the grounds of Tra Cu pagoda in Tra Vinh province. Despite its size, it is one of the most important breeding colonies in the delta. The most notable feature is a substantial breeding population of the globally near-threatened Black-headed Ibis; including juvenile birds, a

large important roosting population of Glossy Ibis[8]. The site is protected and managed by the monks who live in the Tra Cu pagoda complex.

- *Chua Hang bird sanctuary*. Chua Hang is another small bird sanctuary located on the grounds of Chua Hang pagoda, a few kilometres outside Tra Vinh town in Tra Vinh province. Large numbers of birds congregate here to roost, and there is a substantial breeding colony of some of the commoner wetland species. Of most interest are the five roosting Oriental Darters, although breeding could not be confirmed. The site is protected and managed by the monks who live in the Chua Hang pagoda complex.
- *Duyen Hai bird sanctuary* is a small bird sanctuary managed and protected by local families. Over 2,000 birds, mainly Egrets and Little Cormorants roosted here, and breeding reportedly takes place in the wet season. The site holds more than 1% of the regional population of Little Egret. The count of 100 Great Egrets Casmerodius albus was one of the highest of any sites in the delta.
- *Duyen Hai mangrove forest reserve*. In an area of 650 ha, it is home to 64 species of plants belonging to 57 genera, 31 families and animals.

In the areas of 3 sluice gate construction, terrestrial ecosystem includes agricultural ecosystem and rural residential ecosystem. This ecosystem type is artificial ecosystem with poor and unstable representation of species, there is no dominant species. The number and species composition are constantly changing, depending on the use purpose and economic values. The shrubs ecosystem mostly exists along the rivers and canals and within the infield. The statistical results showed 6 species and 35 families and most of them live in the form of shrubs, low and sparse (*Figure 2.8*).

[8] BirdLife International Vietnam Programme, The Conservation of Key Wetland Sites in the Mekong Delta

*Figure 2.8: Terrestrial ecosystem in the area of 3 sluice gate construction area*

*b). Aquatic ecosystem*

Aquatic ecosystem in Duyen Hai district (Zone 2) as follows:

- Phytoplankton: (i) in the mangrove area of Tra Vinh province has 101 species of phytoplankton, which accounted for 90% of algae species biomass of the phytoplankton species primarily as food for shrimp/fish larvae ranges 0.7 to 1.5 million cells / $m^3$; and (ii) in the estuary and coastal areas of Tra Vinh province have determined 73 species of phytoplankton in 5 devisions, including *Bacillariophyta*: 49 species; *Euglenophyt*a: 9 species; *Chlorophyta*: 8 species; *Pyrophyta*: 1species; *Cyanophyta*: 6 species. The dominant species of algae are: *Ceratium macroceros, C. fuscus, Oscillatoria limosa, Chaetoceros lorenzianus, Coscinodiscus radiatus, C. perforatus, C. asteromphalus, C.centralis, Nitzschia sigma*. There are 73 species of phytoplankton of which the majority focuses in silic algae and algae in saline water, with a density of 666 individuals/liter. The zooplankton comprises 48 species with a density of 15,600 individuals/lilters, varying from 4,000 – 34,000 individuals/liters.
- Zooplankton: (i) in mangrove ecosystem with 48 species, in which the dominate species is Arthropoda. Average biomass of zooplankton us 15,600-34,000 cell/$m^3$; (ii) in estuaries only found 48 species distributed in the following divisons: *Protozoa*: 1 species; *Annelida*: 1 species; *Mollusca*: 2 species; *Nemathelminthes*: 10 species, *Cladocera*: 75 species.
- Zoobenthos: (i) in estuaries and coastal areas, only found 73 species in total, in which *Polychaeta*: 16 species, *Sipunculida*: 1 species, *Crustacea*: 41 species, *Bivalvia*: 7 species, *Gastropoda*: 6 species, *Chaetognata* and *Echinoderma*: 1 species.

**Aquatic ecosystem in the rivers and canal network of the proposed 3 sluice gates**. To assess aquatic life in the area of the proposed sluice gates, 10 sites were chosen, at each site 2 samples were taken in low tide and high tide, the analysis results show that there have many groups of organisms have been identified as the group of indicator organisms for the environment, especially the group of lower organisms, single-celled due to the short life cycle, have reacted immediately to the of environmental change, as follows:

- Phytoplankton: The results show that a total of 30 phytoplankton species belonging to 05 phyla was found in the subproject areas. A number of species including 10 species (33.3%) of *Chlorophyt*a, 7 species (23.3%) of *Cyanophyta*, 6 species (20.0%) of *Euglenophyta*, 5 species (16.7%) of *Bacillariophyta*, and 2 species (6.7%) of *Xanthophyta* were found. The average phytoplankton density ranges from 12,500 – 61,400 individuals/$m^3$. Despite the high fluctuation of phytoplankton spicies, the dominant species are *Cyanophyta* (60%) and *Chlorophyta* (24%).
- Zooplankton: The analysis result of zooplankton species in the subproject area shows 33 species of zooplankton in 2 phylum, of which 17 species of Cladocera (51.5%) and 16

species of Copepoda 16 species (48.5%). Zooplankton density varies from 538 - 8,572 individuals/$m^3$.

- Zoobenthos: The result of zoobenthos analysis illustrates (Annex 2) 24 species belonging to 5 phyla. These include 7 species (29.2%) of Gastropoda, 5 species (20.8%) of Oligochaeta, 5 species (20.8%) of Insecta, 3 species (12.5%) of Crustacea, and 4 species (16.7%) of Mollusca. The average zoobenthos density is 265 inviduals/$m^2$ (ranging from 102 to 262 inviduals/$m^2$).

*c). Fishery resources*

Tra Vinh has a 65-km coastline and a shallow water territory which is endowned with many valuabe resources for not only aquaculture but also business and tourism development. The fishery reserve and exploitation volume are 1.2 million tons and 630,000 tons a year, respectively.

There is a natural basin of 21,265ha and about 98,597ha which is inundated for 3 to 5 months a year, providing the inland fishery reserve and frequent exploitation volume of respective 3,000 - 4,000 tons and 2,000 - 2,500 tons. The coastal fishery resource includes estuaries, mangrove forest, and coastal inundated areas intruding 30 - 40m into the land. The fish source includes 40 families, 150 species of inshore sea fish, brackish water fish, and immigrant fish.

The total area of shrimp farming in Dinh An is about 20,000 ha, the largest among the 5 main shrimp farming areas in the Mekong Delta. The estimated shrimp reserves at the two main farms of North Cung Hau and Dinh An are respective 97 – 212 kg/ha and 64 – 249 kg/ha. There are 11 species of crayfishes, which stand behind salt water shrimps in terms of economic value, in the basin areas of Tra Vinh, including giant fresh water prawn, egg-shrimp, little prrawn, freshwater shrimp. It is possible to exploit 2,000 – 3,000 tons of squid, 35 - 49 tons of blood cockle, and 168 - 210 tons of clam a year in the areas.

According to the results of the statistical properties of fisheries in Vinh Long and Tra Vinh the aquatic ecosystems in the estuaries of Tien and Hau rivers include: 123 phytoplankton species in 7 sectors, mostly concentrated in silica and algae industry and groups marine with saltwater origin. The average density reached 173/individuals/liter; zooplankton includes 51 species of zooplankton in coastal areas averaged 12,300 individuals/$m^3$ (varies from 2300-37000/$m^3$); benthic organisms (small) in the estuaries are plentiful but there is a sharp decline in the number and species composition due to the decline in water quality and salinity intrusion by changing species composition in ecosystems. Population of fish – shrimp for economic purpose and other fishery species: they are seen in the brackish estuary –it is the area with saltwater and there are 61 species of fishes, of which 24 species belong to 9 families of fishes adapted to brackish waters, 18 species belong to 8 families of sea fishes migrating into brackish water are, 16 species of fishes of 7 families migrating to brackish and freshwater, 3 species of fish from 2 families of freshwater migratory fishes. Economic fishes include 24 species such as *Anchovies, Lycothrissa, Plotosidae, Australian fish, Mullidae, Latidae*. Because there are so many estuaries in the subproject area, there are nearly 20 species of sea shrimp, in which the commonly seen species are: *Penaeus indicus, P. mergenensis, P. monodon, Malapenaeus ensis, M. lysianssa, M. Munatus, Parapenopsis harwickii*. Besides the fishes and shrimps, there are also abundant resources of clams. However, there has only one migatory fish *Boesemania microlepis* (cá Sủ) in the area of 3 sluice gates (Tong Xuan Tam et.al, 2014)[9].

*Water ecosystem in the freshwater vicinity*: 20 native marine algae (accounting for 19.05% of the total algae and 36% of species of diatoms), and 3 species polychaete; they are good food for shrimp and fish. The economic shrimp, fish: Of 69 known species in the vicinity of

[9] Tong Xuan Tam, Lam Hong Ngoc, Pham Thi Hong Cuc, Study on fish river in lower Hau river in Tra Vinh and Soc Trang province. Science Journal of Ho Chi Minh City Pedagogical University

freshwater, economic fish accounts for 30% (21 species). The economic freshwater fishes that are quite popular in the area include: *Channidae, Fluta alba, Anabas testudineus, Trichogaster pectoralis, Notopteridae, Clarias macrocephalus, Barbodes gonionotus, Tinfoil barb.* The other economic fish such as *Coilia reynaldi, Mugiliformes*, and saltwater fish are fishes migrating into freshwater region. The characteristic economic fishes of the brackish waters vicinity are: *Thalasseleotrididae Xenisthmidae, Kraemeriidae, Pseudapocryptes elongatus*. In addition to fish, in the suproject area, there are eight species of freshwater shrimps, in which *Palaemonidae* is the high economic value one. However, there have no species of fish belong to Red Data Book of Vietnam.

The surveyed results at the proposed locations of 3 sluice gates showed that the common fisheries species here are Gray eel-catfish, Silver carp fish, Silver barramundi fish, Banana prawn, Giant freshwater shrimp.

#### *2.1.1.9. Tourist resources*

Tra Vinh City is named a green town with thousands of over 100 aged-old trees. The ancient villas with French architecture made Tra Vinh town to be as antique as Hoi An City in the Middle of Vietnam. Besides, with 141 Kampuchean architecture pagodas of Khmer people their specific traditional festivals and standard hotel system, Tra Vinh is always a lovely destination of tourists. Some tourist attractions in Tra Vinh province are quite far from the proposed locations of 3 sluice gates (from 5.15 to 34.36km) as described below:

- Ba Om Pond: The pond is square, hence it is also named the Square Pond. One of the most scenic spots in the Mekong Delta. With its surface covering 39,000 $m^2$, the pond enjoys a cool climate all year round. It is surrounded by trees aged hundreds of years whose roots protrude from the underground, making a beautiful view. With its still surface and lotuses, water-lilies, schools of fish and wild ducks which it accommodates, the pond is a lovely scene.
- Ba Dong beach: It is 10 kms in length and located in Truong Long Hoa Ward, Duyen Hai District, over 60 km southwest of Tra Vinh Town. The bathing and rehabilitation resort has been in existence since the early 20th century.
- Chua Hang pagoada (Kompông Chrây Pagoda): is a Khmer pagoda of the Hinayana Buddhism. It has long been the habitat and breeding ground of thousands of birds of all kinds. The monks here lead their religious life, study, listen and chant prayers, as well as look after a bonsai garden with thousands of ancient trees which are painstakingly trimmed into sophisticated shapes. They directly take part in producing fine-art handicrafts of wood sculpture.

### *Natural Environmental Baseline Data*

#### *2.1.1.10. Air quality and noise*

To assess air quality in the subproject area, 5 air samples were collected where the sluice gates will be built and the residential areas near the sluice gate on October 26, 2015 (see locations in *Figure 2.9*).

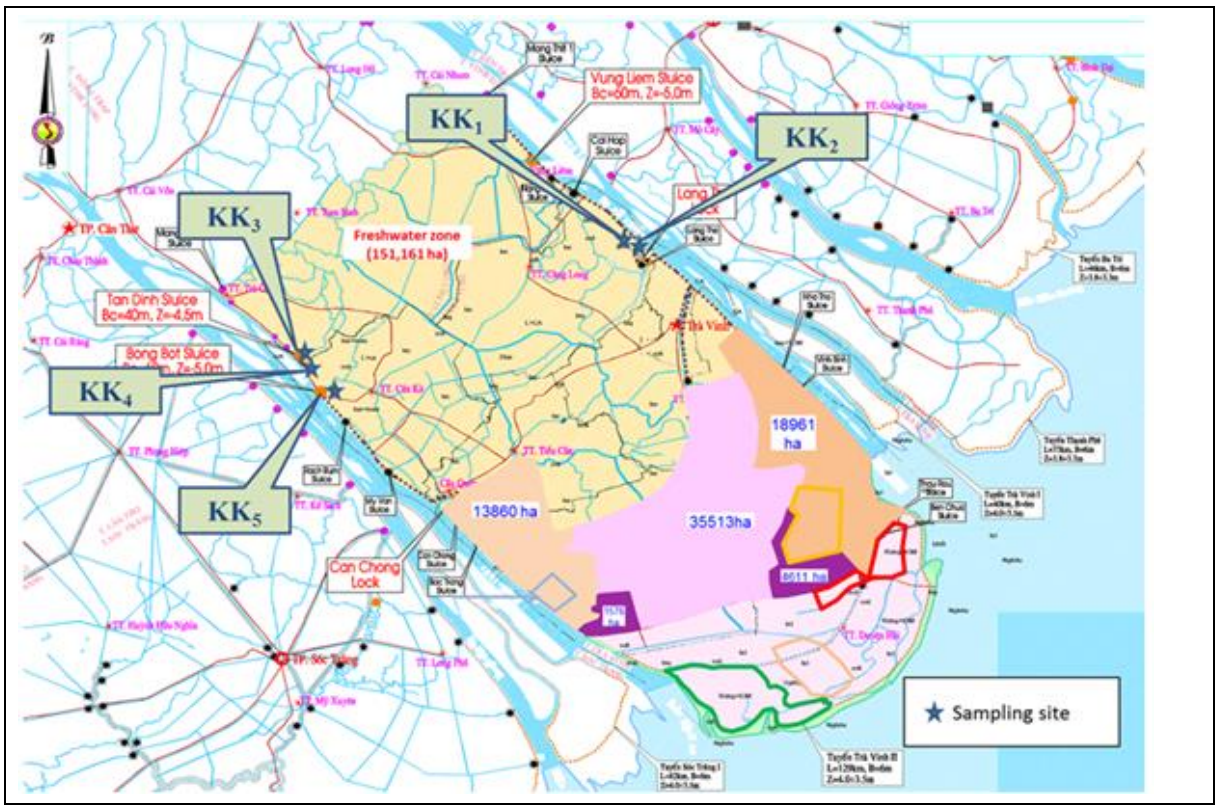



*Figure 2.9: Locations of air sampling sites*

The national regulations of MONRE were used to assess the current state of air quality in the subproject area:

- QCVN 05: 2009/BTNMT: National Technical Regulation on ambient air quality.

- QCVN 26: 2010 / BTNMT: National Technical Regulations on noise.

*a). Noise*

The noise measurements in the subproject area range from 44.8 to 82.9 dB. The maximum of noise levels at the monitoring locations KK2 and KK4 exceed the Viet Nam noise standard (QCVN 26:2010/BTNMT). It caused by the operation of the water transport. The result of the site survey shows that higher noise level occurs temporarily and is related to both operations of the road and waterterway transport vehicles. In normal conditions, the noise is quite low and mostly less than 70dB which is within the standard for mixed use areas during day light hours.

*b). TSP*

The ambient total suspended particles (TSP) level (see Annex 2) shows that the TSP concentrations in the subproject vary from 24.1 to 41.0 $\mu g/m^3$ which are within the National Standard (QCVN 05: 2013/BTNMT, column 1 $\leq$300 $\mu g/m^3$). This shows that the air quality in the area at the sampling time is not contaminated by suspended dust due to the fact that the subproject area is located far from dust generating sources such as traffic routes and urban areas.

*c). $NO_2$*

Nitrogen dioxide ($NO_2$) in the atmosphere is derived mainly from fuel burning. The result analysis of $NO_2$ concentrations at the sampling sites (see Annex 2) shows the $NO_2$ concentrations in the air in the order of 6.12 to 8.16 $\mu g/m^3$ which is far below the national regulation on air quality of 200 $\mu g/m^3$ (QCVN 05: 2013/BTNMT column 1). This suggests that the air quality in the subproject area is very good and not polluted by $NO_2$.

*d). $SO_2$*

Similarly $NO_2$, sulfur dioxide ($SO_2$) in the air are also produced mainly from burning fuels (gas, oil). The survey result (see Annex 2) shows very low $SO_2$ concentrations in the subproject area, ranging from 5.71 to 13.84 µg/$m^3$. It means that the air environment in the area has not been polluted by fuel burning even though there were boats operating at all the monitoring sites during sampling.

*e). Summary of air quality*

The survey results of air quality monitoring in the constrution area of 3 sluice gates show that the status of the air environment in the subproject area has very good quality, with very low concentrations of toxic gases $NO_2$, $SO_2$ that meet the national regulations on ambient air quality (QCVN 05: 2013/BTNMT column 1). Especially, the dust content in the air is quite low due to the very few dust generating sources in the area. This would also be a great pressure to contractors, who should control the air emissions from construction equipments, transportation of materials, soil excavation and filling during the subproject construction phase.

### *2.1.1.11. Soil and sediment quality*

To assess soil quality in the subproject area, on November, 2015, 7 soil sample sites were chosen, at each site 3 samples were taken at 3 soil layers: 1st layer with depth of 0-20 cm, 2nd layer with depth of 50 - 70 cm, 3rd layer with depth of 1.3 - 1.5 m, see soil sample sites in *Figure 2.10*.

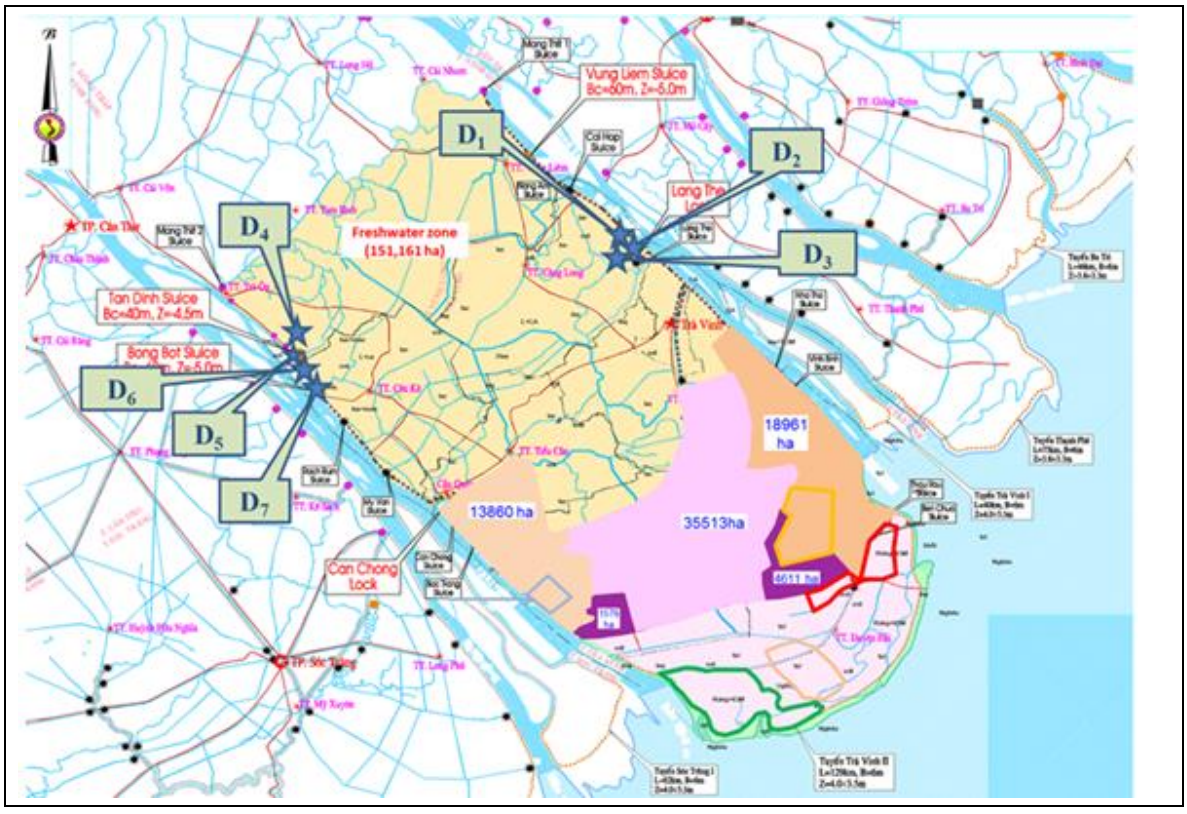



*Figure 2.10: Locations of soil sampling sites*

*a). Salinity content*

Salinity is an important indicator in assessing soil quality, especially soils in the coastal areas of tidal influence. Soil salinity not only affects plants, but also quality of civil work infrastructures due to corrosion by salt in the soil.

Soil salinity is assessed through the electrical conductivity (EC) of soil extraction solution. Soil salinity is also measured through the total soluble salt content in the soil and content of chloride and sulfate ($SO_4^{-2}$). Classification of salinity in soil is shown *Table 2.4*.

The analysed results of EC in soil in the subproject area (*Figure 2.11*) show the value of EC of soil samples ranging from 324-743 µs/cm. Compared with the classification criteria in *Table 2.4*, the soil in the first layer is not affected by salinity while in the 2nd and 3rd layers are slightly contaiminated with salinity. Although these are the agricultural and orchards lands, the high EC levels in the 3rd layer clearly indicate permanent potential for salinity contamination of the soil in the subproject construction area.

*Table 2.4: Soil salinity classes by EC*

| Class | EC 1:5 (µS/cm) |
|---|---|
| Non-saline | <400 |
| Slightly saline | 410–800 |
| Moderately saline | 810–1.600 |
| Very saline | 1600–3.200 |
| Very saline | >3.200 |

*Source: Rana Munns.*

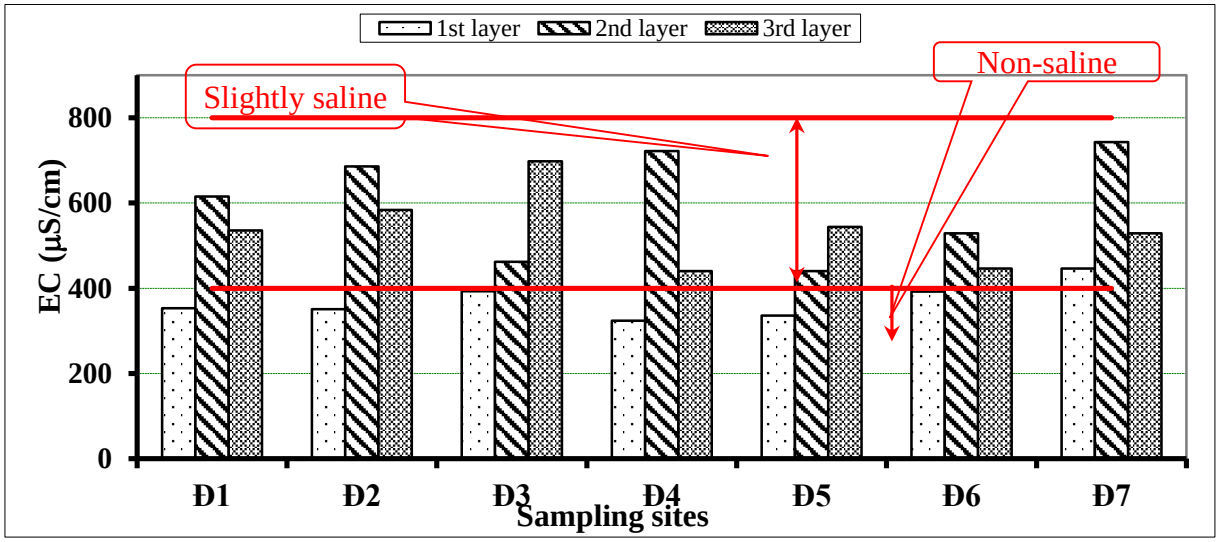



*Figure 2.11: EC contents in the construction area of 3 sluice gates*

*b). Heavy metals*

The analysis results showed that soil samples in the subproject area have no sign of soil pollution by heavy metals (As, Cr, Cu, Pb, Zn), indicators of heavy metals are very low compared with the permissible limits (see Annex 2).

*c). pH level*

Active acidity ($pH_{H2O}$) and exchangable acidity ($pH_{KCl}$) are used to evaluate the acidity of soil. Soil acidity is clasified based on exchange acidity as mentioned in *Table 2.5*:

*Table 2.5: Soil acidity clasification*

| No | pH KCl | Soil acidity level |
|---|---|---|
| 1 | < 4,0 | Extremely acid |

| | | |
|---|---|---|
| 2 | 4,0 – 4,5 | Very strongly acid |
| 3 | 4,5 – 5,0 | Moderately acid |
| 4 | 5,0 – 6,0 | Slightly acid |
| 5 | 6,0 – 7,0 | Neutral |
| 6 | > 7,0 | Alkaline |

*Source: Le Van Khoa, 1996.*

Analysis results of $pH_{KCl}$ in the subproject area showed that $pH_{KCl}$ at the monitoring sites varies from 4.0 to 5.4 (*Figure 2.12*). There is a rather big change in soil acidity at different sampling sites and at different soil layers.

At the first layer, 5 of 7 monitoring samples are moderately acid, 2 of 7 samples have low acidity. In general, medium and low acidity levels do not impact on the plant growth and development in normal plant condition. In case of washing alkaline, there will have no significant impact on the water environment. At the second and third layers, 5 of 7 samples have high acidity and only 2 of 7 samples have moderately acidity.

The above data shows that soil in the area is polluted by acidity, however, the pollution ranges fall into high to medium levels. There is no any sample falls into very high acidity range. Even though the acidity in the area is not high, this should be paid attention by the contractors during the subproject construction. Contractors should ensure to have a monitoring system in place as well as to strictly follow technical measurements in order to minimise the acidity impact on water environment.

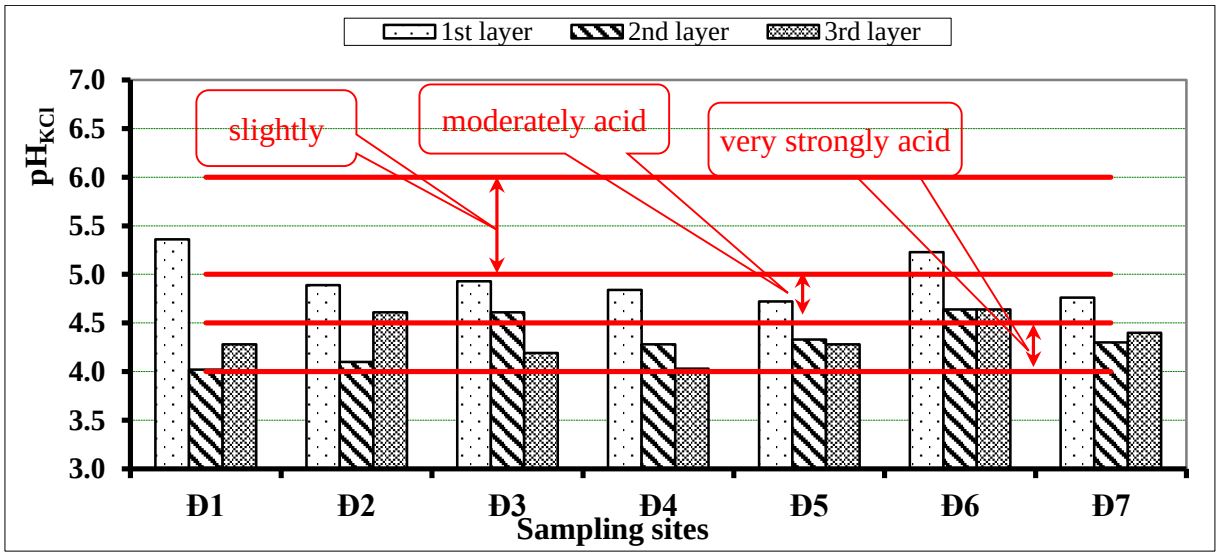



*Figure 2.12: $pH_{KCl}$ in soil sampling sites in the subproject area*

*d). Organic matter content*

Organic matter is an important indicator in assessing the fertility of soil. Amount of organic matter in the soil is related to the chemical composition of the soil. Previous study results present close correlation between the concentration of organic matters and other physical, chemical, and physicochemical parameters which determine the fertility of soil. The organic matter content in soil has a direct influence on nutrition, digestion status, and absorption conditions as well as plant metabolism.

Along with the cultivation, organic matter content in the soil decreases due to the absorption by vegetation and decay of organisms in the soil. However, soil is often added with cultivation

waste products such as residues of crops and other soli enreachment products which would return and add nutrients to the soil. There are many ways to classify soil fertility. In the Mekong Delta, soil humus is divided into 5 groups as in *Table 2.6*.

The results of analysis of organic matter content in the soil at the sampling points in the subprojecta area (*Figure 2.13*) show the organic matter contents of soil samples vary from 1.6 to 2.9%, belonging to the poor to average organic soil. Specifically, all the soil samples in the first and second layers have medium organic matter content, and the third layer is primarily poor organic matter soil.

*Table 2.6: Classification of organic matter in soil*

| No | Organic matter (%) | Class |
|---|---|---|
| 1 | < 1 | Very poor |
| 2 | 1 – 2 | Poor |
| 3 | 2 - 3 | Average |
| 4 | 3 - 5 | Relatively rich |
| 5 | > 5 | Rich |

*Source: Le Van Khoa, 1996.*

*e). Total nitrogen content*

Total N (%): total nitrogen in the soil includes organic and inorganic N, organic forms of nitrogen accounts for about 95% of total protein. Organic matter in the soil usually contains about 5% protein. Hence, the organic matter content in the soil is often accompanied with higher total protein in the soil. The analysis of total nitrogen in the soil is for the purpose of evaluating reserves, the potential of nitrogen in the soil. Soil with high total nitrogen content is considered fertile soil, capable of high-yield if protein in soil is well managed (*Table 2.7*). The analysis results showed that soil in the area has the nitrogen in the total ranged from 0.03 to 0.09%, from very poor to poor (*Figure 2.14*).

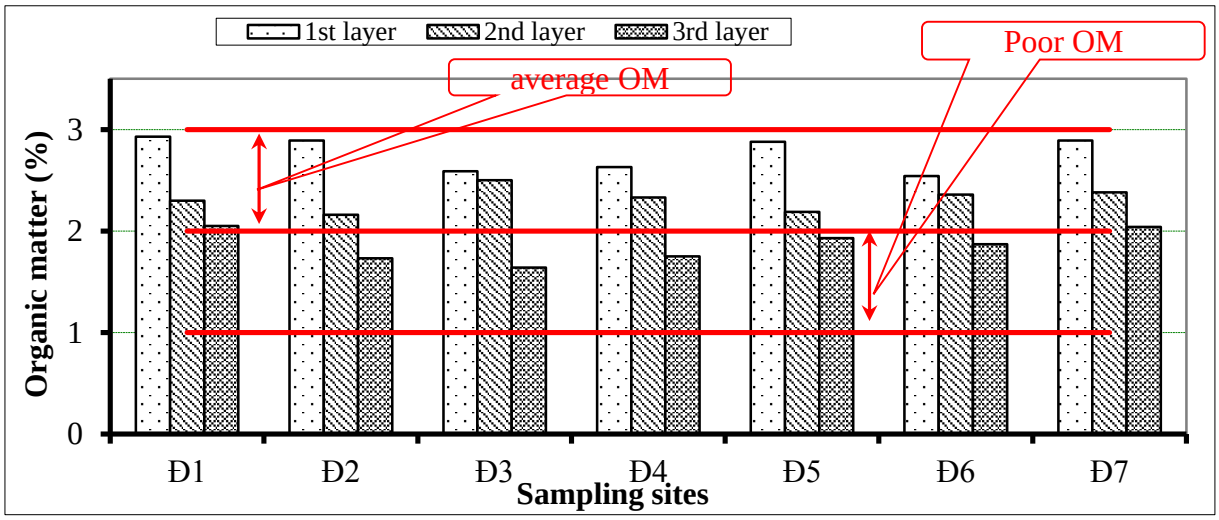



*Figure 2.13: Organic matter contents of samples taken in the subproject area*

*Table 2.7: Assessment of soil in accordance with the total N*

| STT | TN (%) | Class |
|---|---|---|
| 1 | < 0,1 | Very poor |
| 2 | 0,1 – 0,18 | Average |

| STT | TN (%) | Class |
|---|---|---|
| 3 | 0,18 – 0,3 | Relatively rich |
| 4 | > 0,3 | Rich |

*Source: Tran Van Chinh, 2000.*

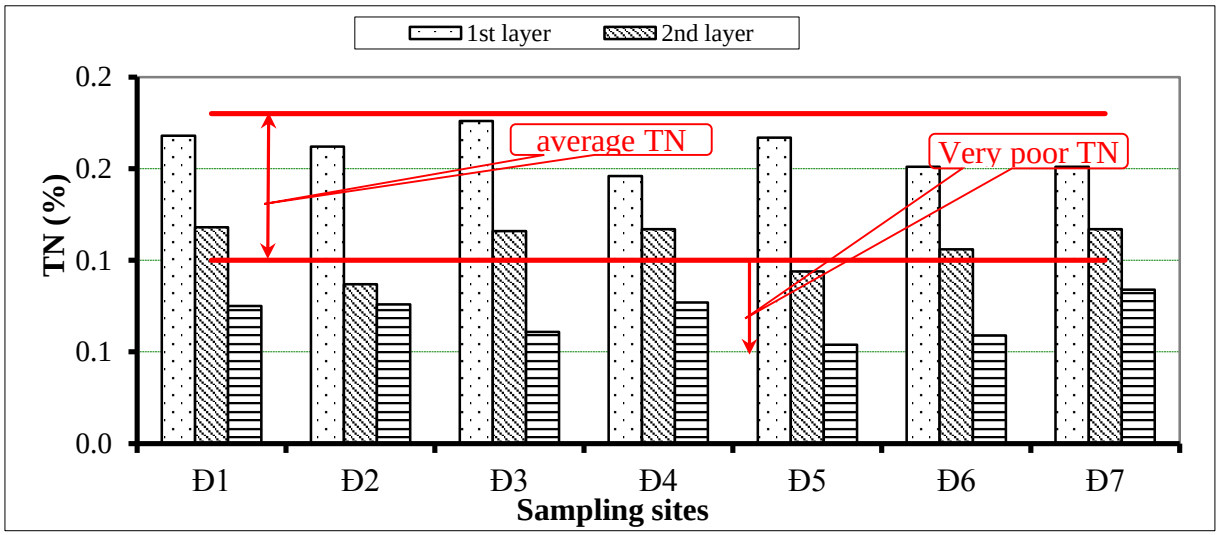



*Figure 2.14: TN contents of samples taken in the subproject area*

### *2.1.1.12. Surface water quality*

Criteria for evaluation of surface water quality: QCVN 08-MT:2015/BTNMT – National technical regulation on surface water quality regulating the classification of surface water quality for various water use purposes:

- Column A1: Water quality for domestic water supply and other purposes, such as columns A2, B1 and B2.
- Column A2: Water quality for domestic water supply but applying appropriate treatment technology; for aquatic plant and animal conservation, or purposes of use as columns B1 and B2.
- Column B1: Water quality for irrigation and drainage purposes or other purposes with similar water quality requirements or other purposes of use such as column B2.
- Column B2: Water quality suitable for transportation and other purposes with low water quality requirements.

According to the monitoring results of the Technical Centre for Natural Resources and Environment and the Department of Aquaculture Management of Tra Vinh province, the fluctuations in the surface water quality in the province in 2008-2012 are as follows:

**pH**: In the period form 2008 - 2012, the pH value does not fluctuate dramatically but tends to increase from 2008 to 2012. The average pH value lies in the limit of the surface water standard (QCVN 08-MT:2015/BTNMT), between 6.5 and 7.8 more over the years. The annual 5-year average of pH value is 7.2.

**Salinity**: The canals in the province are affected by saltwater intrusion, especially in dry months. The salinity in the freshwater districts in rainy season is 0‰, in the dry months is 1-6‰. As the salinity appears in short time, it does not affect the growth and development of shrimp and fish. In brackish districts, the salinity ranges between 4-26‰. The highest salinity appears in March, April every year and the lowest salinity appears in rainy months.

**Alkalinity**: In the freshwater aquaculture areas, the alkalinity remains low, ranging 18-54 mg/L. Therefore, to facilitate the best development of seafood species, farmers must regularly add lime to stabilize their ponds. At monitoring sites in brackish waters, the alkalinity ranges at suitable level of 68-88 mg/L for the growth and development of Penaeus monodon. From March to May, the alkalinity in the monitoring locations is usually higher parallel with the increase of salinity intrusion time. Generally, the salinity is stable from February to June and low from July onwards due to rains and freshwater pouring from the upstream of the rivers.

**Dissolved Oxygen (DO)**: DO level is gradually lower over the years. Since 2008 - 2012, the DO ranges between 2.7 - 6.8 mg/L. The 5-year average is 4.8 mg/L. The low dissolved oxygen level is mainly measured in the canals near residential areas, markets, especially the locations in Chau Thanh, Tra Cu districts.

**Total suspended solids** (TSS). The evolution of suspended solids in the surface water is negligible recent years. The suspended solid averages between 49-296 mg/L. The 5-year average is 96 mg/L. This content exceeds the limit of QCVN 08-MT:2015/BTNMT and is particularly high in the monitoring sites of Duyen Hai, Cau Ngang districts.

**Biochemical Oxygen Demand ($BOD_5$, COD)**. The $BOD_5$ in period from 2008 to 2012 averages between 2.7 and 22.0 mg/L and tends to rise slightly over the years. However, the $BOD_5$ value is within the limits of QCVN 08-MT:2015/BTNMT, Column B1 (for irrigation purpose) and slightly exceeds QCVN 08-MT:2015/BTNMT - Column A2 (for the purpose of conservation of aquatic fauna and flora) in some monitoring sites in the districts of Tra Cu, Cau Ngang, Duyen Hai. The causes of the organic pollution increase in the surface water sources are the increasing effluents with high pollution levels into rivers and canals. The COD in period 2008 - 2012 averages 15-67 mg/L and signs the decline in the brackish districts in two years: 2011-2012. Most COD values exceed the limit of QCVN 08-MT:2015/BTNMT Column A2 and concentrate in some monitoring sites in Cau Ngang, Duyen Hai districts.

**Contents of $N\text{-}NH_4^+$ and Total nitrogen**. Nitrate content in the surface waters over the years from 2008 - 2012 are lower than the limit value of QCVN 08-MT:2015/BTNMT, averaging between 0.14 and 0.83 mg/L (the 5-year average value is 0.37 mg/L) and having no major changes over the years. In 2012, it signs decline in the monitoring locations. Ammonium content in some monitoring sites slightly exceeds the limit value of QCVN 08-MT:2015/BTNMT Column A2, Column B1, ranging between 0.15 and 3.97 mg/L over the years and signing the decline in the waters of the brackish districts. The Nitrite parameter has been observed since 2012, which shows that the average value ranges between 0.023 and 0.106 mg/L and exceeds the limit value of QCVN 08-MT:2015/BTNMT Column A2. In short, the levels of nutrient salt pollution in the surface water in Tra Vinh province remains low and tend to decreasing slightly in recent years.

**Content of $P\text{-}PO_4^-$.** The Phosphate parameter has been observed since 2012. According to the observation results, the annual average phosphate contents ranges between 06 and 0.26 mg/L, which are mostly within the limit value of QCVN 08-MT:2015/BTNMT.

**Coliform**. The average value of Coliform in 2008-2012 ranges between 2,711 - 456,667 MPN/100mL. This value in most monitoring sites exceeds the limit of QCVN 08-MT:2015/BTNMT Column A2, Column B1 many times. The 5-year average value of Coliform is 100,443 MPN/100ml. The microbiological contamination in surface water in the monitoring sites also tends to increase significantly in recent years, which is mainly because the surface waters receive many types of wastewater of different contamination levels and more and more human activities on rivers, canals.

**Metal**. The monitoring results of Pb and As remain within the limit values of QCVN 08-MT:2015/BTNMT - Column A2, Column B1. The Total Fe exceeds the limit values of QCVN

08-MT:2015/BTNMT Column A2, Column B1, especially in 2008, in 2009-2012, the Total Fe decrease has no major difference between the years.

**Oil and pesticides**. There are signs of oil pollution in the monitoring sites in period 2008-2012. This pollution levels are higher in 2008 and lower in the recent years (2009-2012). The 5-year average value is 0,15mg/L. In 2008, the signs of chlorinated organic pesticide pollution are found in the surface water monitoring sites in Duyen Hai district according QCVN 08-MT:2015/BTNMT. However, since 2009-2012 chlorinated organic pesticides and organic P in surface water at the monitoring sites are not found.

In addition, to assess the status of surface water quality before the construction of 3 sluice gates, 10 locations were selected for water sampling to analyze water quality in November 2015 (see *Figure 2.15*). These results will be used as a baseline to evaluate the impact of the subproject activities on the surface water quality during the construction and operation phases. In addition, the results will be analyzed and evaluated to find out which factors negatively affect the aquatic environment, based on which solutions and mitigation measures will be developed to address these adverse impacts.

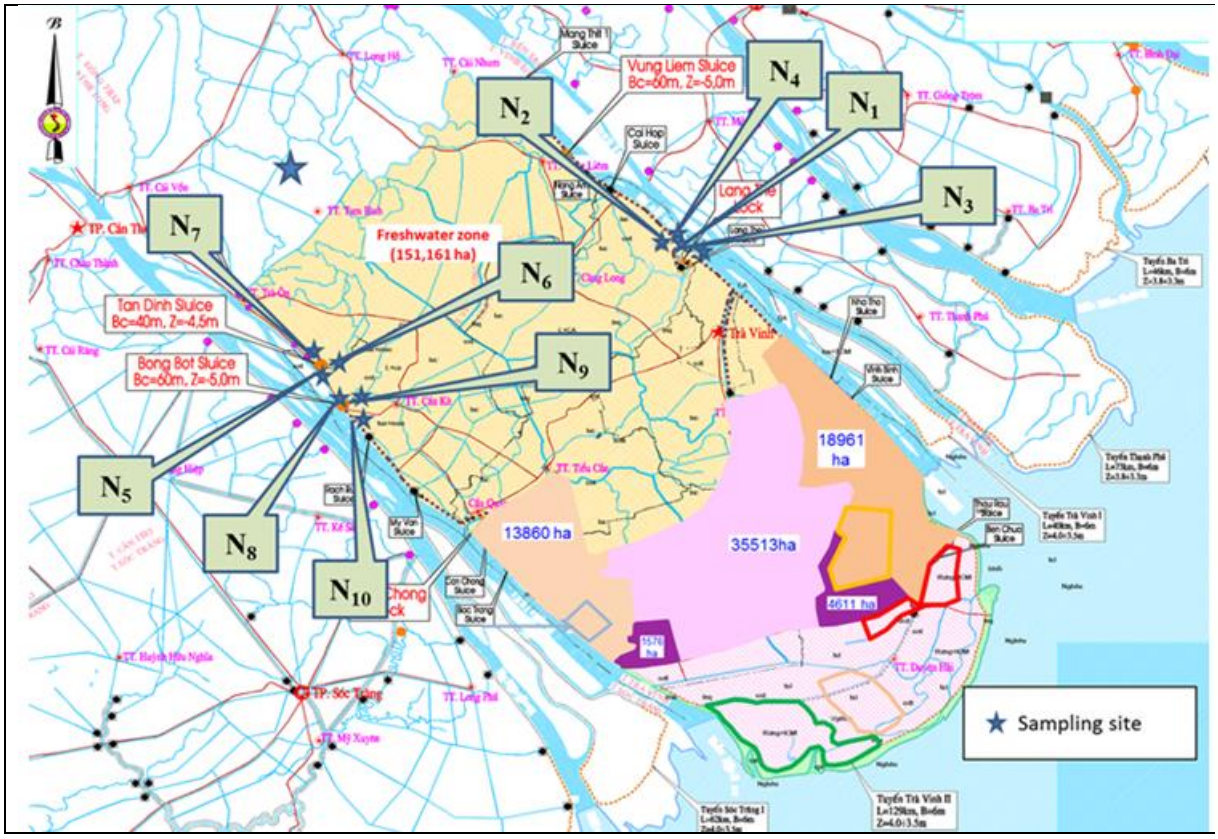



*Figure 2.15: Locations of sampling sites of surface water and aquatic life quality*

The analysis results of samples taken in the construction areas of 3 sluice gates show that:

*a). pH content*

pH is an important parameter which is always measured when taking water samples. According to the national technical regulation, the acceptable pH value of water for column A is from 6 to 8.5. Water with a pH lower than 6 will have a sour taste and does not meet the standard for domestic use or crop irrigation. Water with a low pH will affect crops, aquatic fauna, fish and shrimp; a very low pH can kill fish, aquatic plants and animals.

pH values at the sampling locations range from 6.17 to 7.85 (*Figure 2.16*). These levels are in the neutral condition and meet the national technical regulation on surface water quality

(column A1 of QCVN 08-MT:2015/BTNMT). This is one of the favorable conditions for the use of water for rice cultivation and use in daily life.

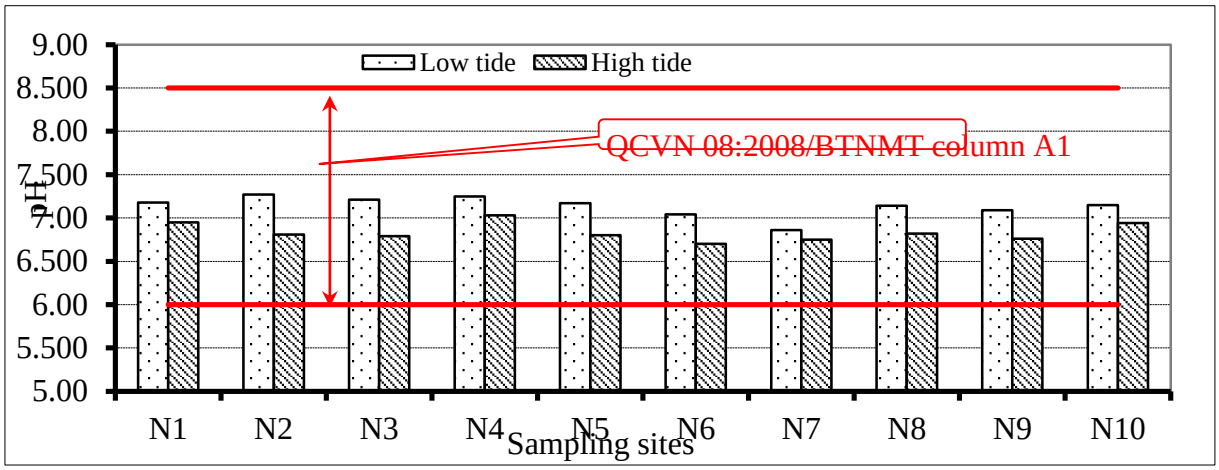



*Figure 2.16: pH values of samples taken in the construction area of 3 sluice gates*

*b). Electrical conductivity*

Electrical conductivity (EC) of water is related to the presence of metal salt ions such as NaCl, KCl, $SO_4^{2-}$ and $Ca^{2+}$. In seawater, EC is mainly caused by NaCl. In freshwater affected by acid, EC increases due to the release of $SO_4^{2-}$, $Fe^{+2}$ and $Al^{+3}$ ions into the water from acid sulfate soils. The impact of varying levels of saline water on crops is presented in *Table 2.8* based on the Environment Protection Authority of Australia guidelines (*Environment Protection Authority 1991, "Guidelines for Wastewater irrigation", Publication number: 168*).

*Table 2.8: Salinity classes of irrigation waters*

| No. | EC range (µs/cm) | Comments |
|---|---|---|
| 1 | 0 - 270 | Can be used for most crops on most soils |
| 2 | 270 – 780 | Can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown, usually without special salinity management practices. Sprinkler irrigation with the more saline waters in this group may cause leaf scorch on salt sensitive crops. |
| 3 | 780 – 2340 | Should not be used on soils with restricted drainage. Even with adequate drainage, best practice management controls for salinity may be required and the salt tolerance of the plants to be irrigated must be considered. |
| 4 | 2340 – 5470 | For use, soils must be permeable and drainage adequate. Water must be applied in excess to provide considerable leaching, and salt-tolerant crops should be selected |
| 5 | 5470 | Not suitable for irrigation except on well-drained soils under good management especially in relation to leaching. |

*Source: Environment Protection Authority 1991.*

The EC measurements taken in the subproject area range from 210 - 2,290µs/cm (*Figure 2.17*). The EC values at low tide vary from 210 - 255µs/cm, and the water can be used for agricultural irrigation. The EC values at high tide are from from 1,735- 2,290 µs/cm indicating that the water is not suitable for crop irrigation, and the use must be strictly controlled. This factor also influences the use of this water to mix concrete, and it also increases the risk of corrosion of materials.

*c). Dissolved oxygen concentration*

Dissolved oxygen concentration is an important parameter which is always measured when taking water samples. Oxygen depletion occurs due to respiration of organisms, by diffusion into the atmosphere, and especially by decomposition of organic compounds by microorganisms. Oxygen is vital for aquatic organisms, particularly for animals like fish, and is an important indicator to measure when assessing water quality.

DO measurements taken in areas affected by salinity range from 6.2 to 7.54 mg/l as shown in *Figure 2.18*, and DO levels at all sampling sites meet column A1 of QCVN 08-MT:2015/BTNMT. This shows that the quality of surface water in the area is quite good, with high value of DO that facilitates fish and aquatic animals. This is also advantageous for the decomposition of organic substances in water to clean the water environment.

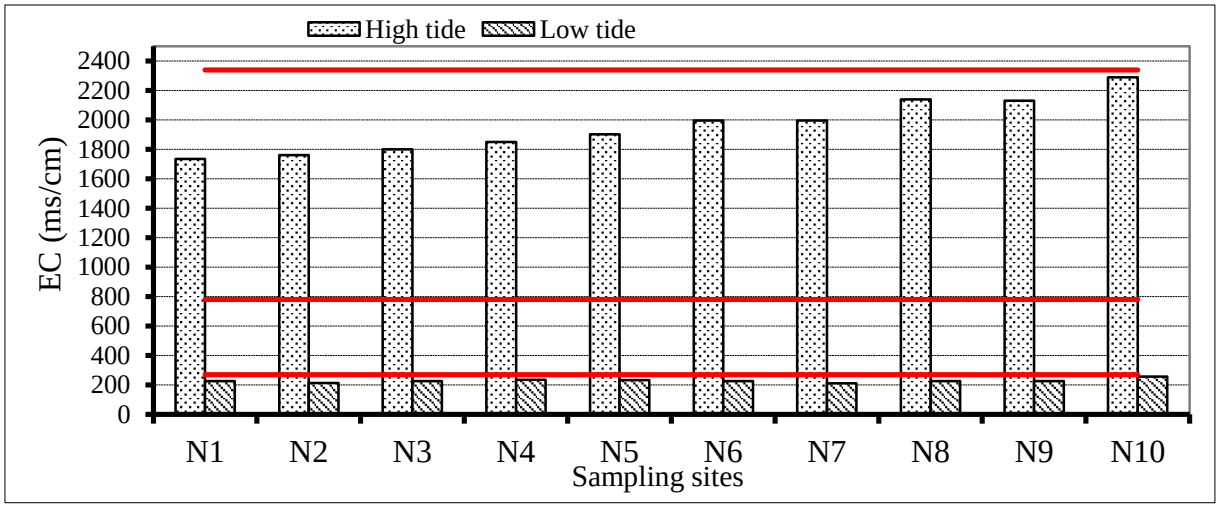



*Figure 2.17: EC values of samples taken in the construction area of 3 sluice gates*

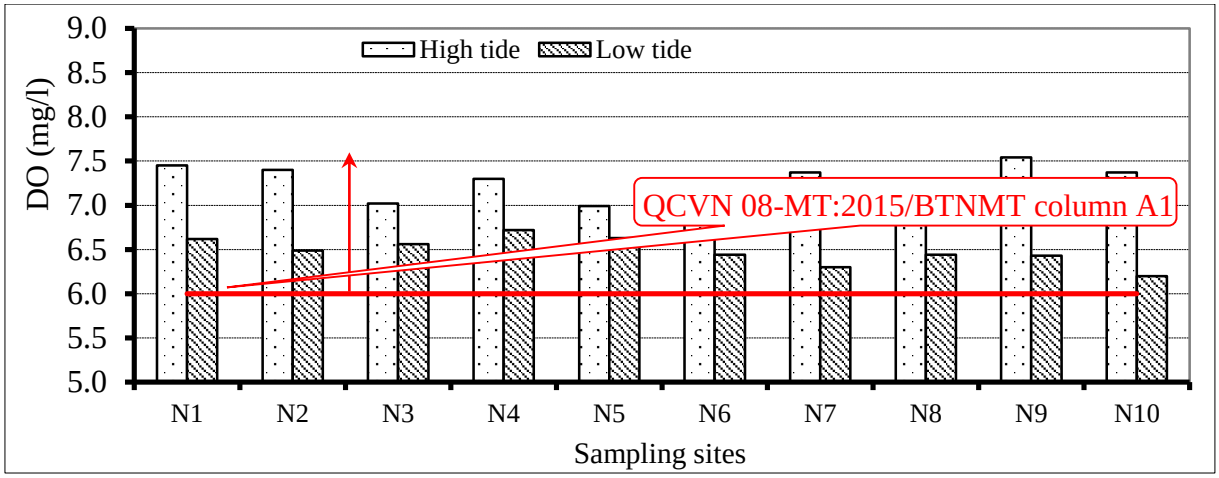



*Figure 2.18: DO values of samples taken in the construction area of 3 sluice gates*

*d). Five-day biochemical oxygen demand ($BOD_5$ )*

$BOD_5$ is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample during five days. This is an important indicator to assess water pollution by organic substances especially in areas affected by wastewater from urban areas, densely populated areas and industrial zones.

$BOD_5$ values from samples taken in the subproject are from 3.5 to 5.8 mg/l (*Figure 2.19*). In general, $BOD_5$ values at all sites meet column A of the national regulation (QCVN 08-MT:2015/BTNMT).

*e). Concentration of N-$NH_4^+$*

Nitrogen is a product of the metabolism of aquatic animals and is also the product of the breakdown of organic matter by microorganisms, forming ammonia nitrogen (N-$NH_4^+$). Some ammonia is used directly by plants, other parts are converted into nitrite and nitrate by bacteria. The presence of N-$NH_4^+$ also indicates the metabolic rate of organic pollutants in a water body. High N-$NH_4^+$ concentrations can cause negative impacts on aquatic animals and microorganisms.

At the sampling sites, the concentrations of N-$NH_4^+$ vary from 0.07 to 0.19 mg/l (see *Figure 2.20*), all the sites meet the column B of the national technical regulation (QCVN 08-MT:2015/BTNMT). The results suggest that the increased N-$NH_4^+$ concentrations present at the low tide come from the N-$NH_4^+$ concentrations in the inland areas. The N-$NH_4^+$ values at the high tide are lower than at the low tide.

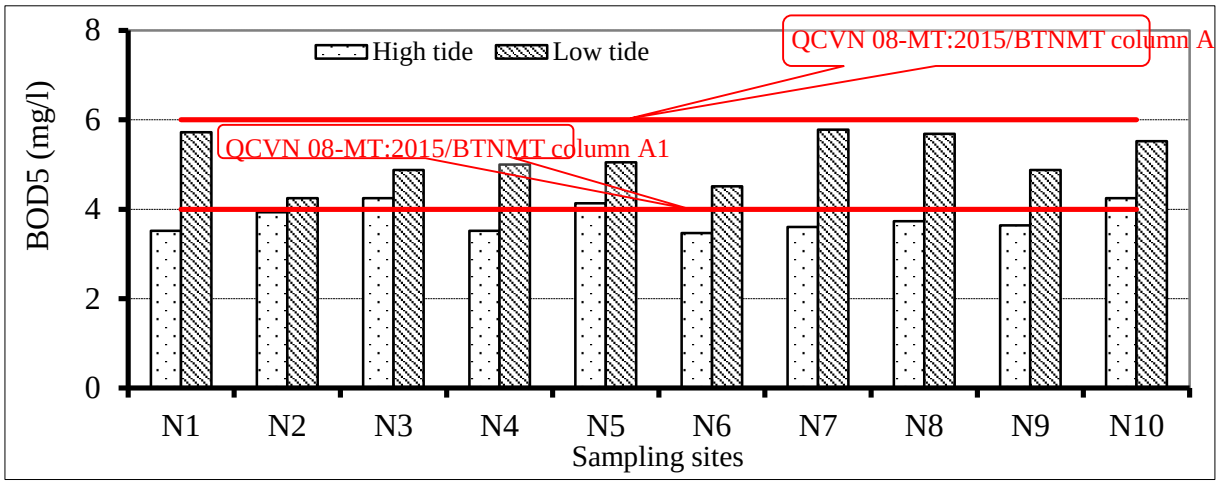



*Figure 2.19: $BOD_5$ values of samples in the construction area of 3 sluice gates*

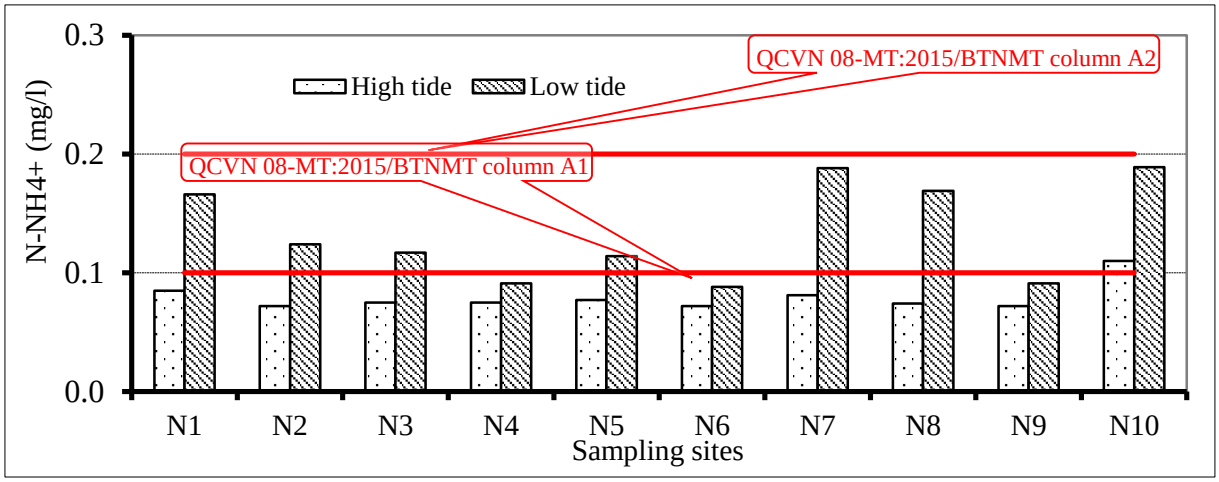



*Figure 2.20: N-$NH_4^+$ contents in the construction area of 3 sluice gates*

*f). Total suspended solids (TSS)*

Results show that the TSS concentrations in the subproject area vary considerably, ranging from 26.6 to 180.0 mg/l (*Figure 2.21*). At the high tide, the TSS contents range from 26.6 to 40.6 mg/l and all the samples meet the column B1 requirement. The TSS levels at the low tide are much lower than at the high tide and range from 45.5 to 180 mg/l. Six of the ten sites that the concentrations that exceed the column B2 guidelines (N1; N3; N7-N10).

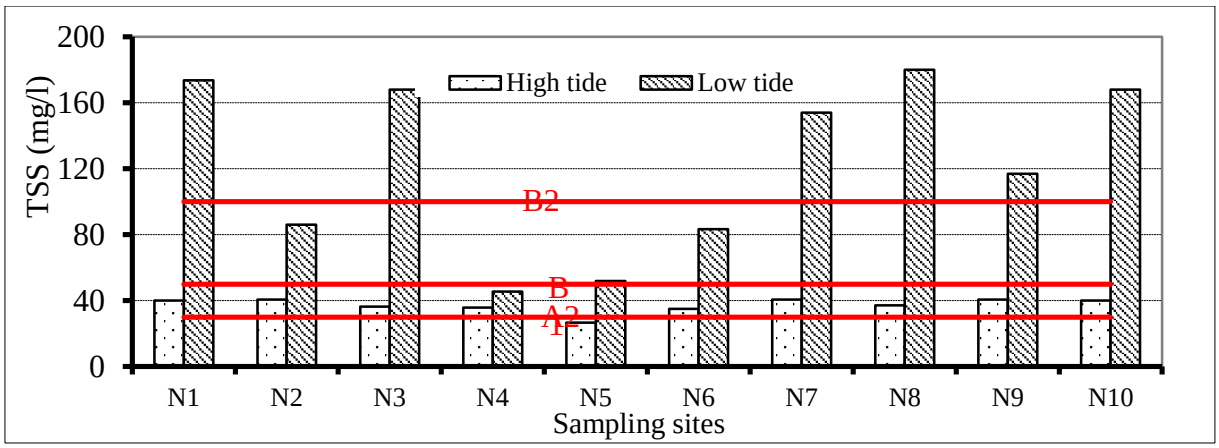



*Figure 2.21: TSS concentrations in the area of 3 sluice gates construction*

*g). Bacterial contamination*

Fecal coliforms are an indicator of water pollution derived from warm-blooded animal feces. It can be used as a reliable indicator of contamination by fecal material from humans and other animals. Fecal coliforms are present at all the sampling sites, ranging from 45 to 540 MPN/100ml (*Figure 2.22*) and most of them exceed QCVN 08-MT:2015/BTNMT column B1. The concentrations of fecal coliforms in areas affected by domestic wastewater are much higher than in other areas. This result highlights inadequate sanitation in this area and the risks of using this water resource without treatment for domestic purposes.

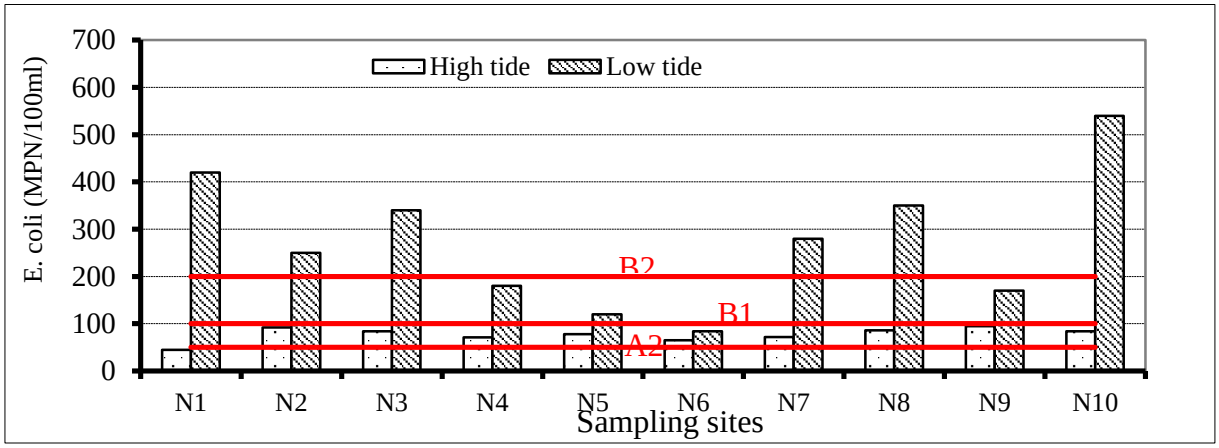



*Figure 2.22: Fecal coliform contents in the construction area of 3 sluice gates*

*h). Residues of pesticides/insecticides in surface water*

Analysis for pesticide residues from chlorinated and phosphorus groups under QCVN 08-MT:2015/BTNMT did not detect these pesticide groups in any of the samples, see detail in Annex 2.

*i). Concentration of heavy metals*

The concentrations of Pb, As, Cu, Ni, Cd, Cr and Zn in the surface water samples are very low and below detection thresholds (Pb <0.05 mg/l; Zn <0.05 mg/l; As < 0.005mg/l; Cu <0.01 mg/l; Ni <0.02 mg/l; Cd <0.002 mg/l and Cr <0.01 mg/l). All concentrations are within the national regulation on groundwater quality (QCVN 09: 2008/BTNMT).

### *2.1.1.13. Goundwater quality*

Using groundwater resources in the region is not much due to part of clean water has been supplied and many households still use surface water as drinking water source especially families living near the banks of the Hau River. In this report, the team has taken five groundwater samples to assess the current state of groundwater quality in the subproject area at depths of 200 – 400 m. Sampling location maps are shown in *Figure 2.23*.

The results show that the ground water in the subproject area is not contaimintated by acid (with pH values ranging from 6.59 to 7.35) and meets the standard on groundwater quality for drinking. However, it is lightly contaminated by Coliforms (with three out of five samples exceeding the permitted national regulation). The total hardness and chloride of the water are within the national regulation for groundwater quality (QCVN 09: 2008/BTNMT) and meets the decision on drinking water quality of the Ministry of Health (Decision No. 1329/2002/BYT/QD). The total iron concentration at most sampling sites is within the permitted national regulation, meeting the requirement for drinking water.

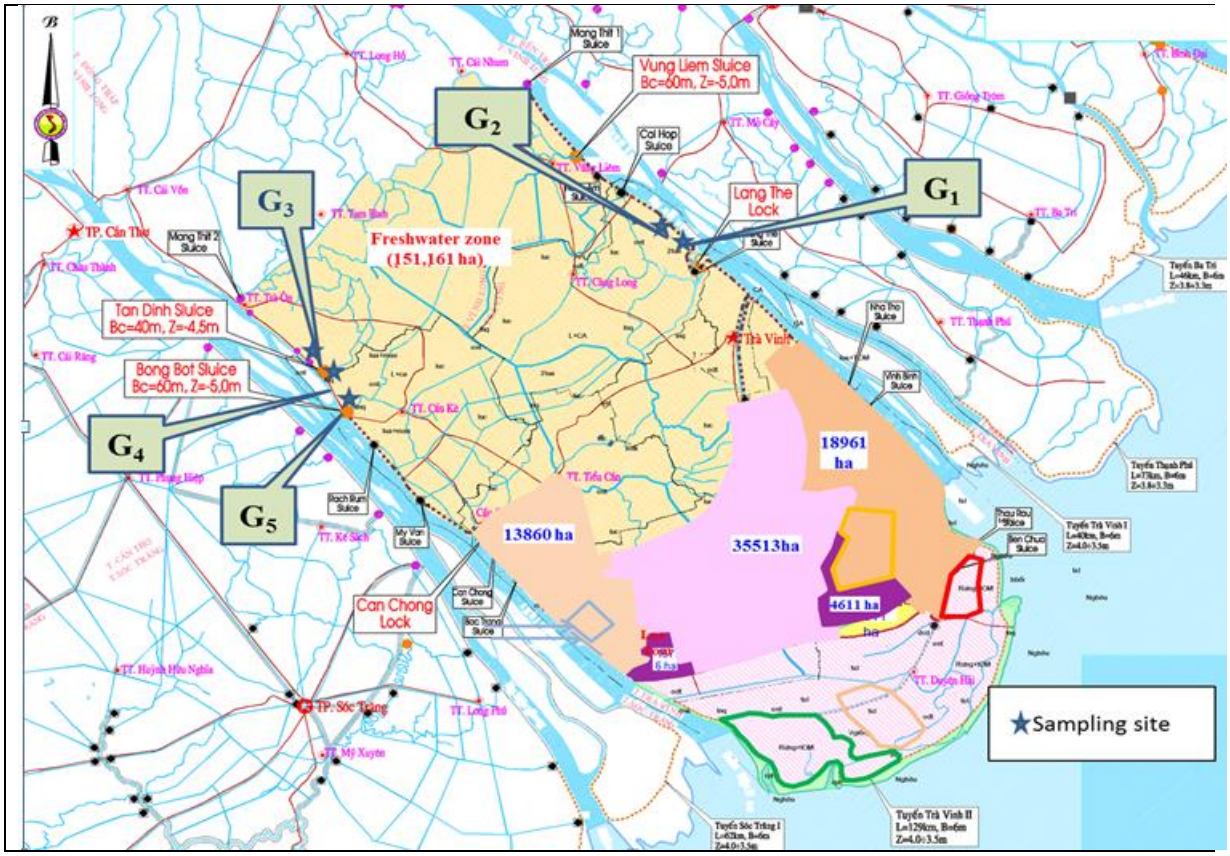



*Figure 2.23: Locations of sampling sites of groundwater*

*Table 2.9: Ground water quality in the construtions area of 3 sluice gates*

| No | Parameter | Unit | Labels of Samples | | | | | QCVN 09:2008/ BTNMT |
|---|---|---|---|---|---|---|---|---|
| | | | G1 | G2 | G3 | G4 | G5 | |
| 1 | pH | | 7.02 | 7.35 | 6.59 | 6.61 | 6.79 | 5.5-8 |
| 2 | Total hardness | mg $CaCO_3$/l | 208.1 | 190.2 | 167 | 283.5 | 224.7 | 500 |
| 3 | $SO_4^{2-}$ | mg/l | 154.9 | 137.6 | 123.8 | 184 | 168.7 | 400 |

| No | Parameter | Unit | Labels of Samples | | | | | QCVN 09:2008/ BTNMT |
|---|---|---|---|---|---|---|---|---|
| | | | G1 | G2 | G3 | G4 | G5 | |
| 4 | $Fe_{TS}$ | mg/l | 1.72 | 1.99 | 0.25 | 0.27 | 0.14 | 5 |
| 5 | $N\text{-}NH_4^+$ | mg/l | 1.52 | 2.68 | 2.53 | 2.63 | 1.67 | 0.1 |
| 6 | $N\text{-}NO_2^-$ | mg/l | 0.02 | 0.04 | <0.01 | <0.01 | <0.01 | 1 |
| 7 | $N\text{-}NO_3^-$ | mg/l | 1.43 | 1.04 | 3.17 | 3.02 | 0.85 | 15 |
| 8 | Cl- | mg/l | 26.99 | 20.99 | 20.99 | 26.99 | 24.99 | 250 |
| 9 | Pb (MLOD=0,01) | mg/l | <0.01 | <0.01 | 0.01 | <0.01 | 0.01 | 0.01 |
| 10 | Hg (MLOD=0,001) | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.001 |
| 11 | Zn (MLOD=0,01) | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 3 |
| 12 | As (MLOD=0,001) | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.05 |
| 13 | Coliform | MPN/100 ml | 2 | 4 | 4.5 | 0 | 4.8 | 3 |
| 14 | E coli | MPN/100 ml | 0 | 0 | 1.7 | 0 | 0 | 0 |
| 15 | Turbidity | NTU | 30.3 | 3.8 | 1.1 | 3.1 | 3.2 | - |
| 16 | EC | µS/cm | 761 | 637 | 592 | 839 | 810 | - |
| 17 | Salinity | ‰ | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 | - |
| 18 | TOC | mg/l | 1.56 | 1.92 | 1.69 | 1.67 | 1.63 | - |
| 19 | $Ca^{2+}$ | mg/l | 29.3 | 24.7 | 23.1 | 30.83 | 30.8 | - |
| 20 | $Mg^{2+}$ | mg/l | 32.37 | 30.83 | 26.21 | 49.54 | 35.45 | - |
| 21 | TSS | mg/l | <2 | <2 | <2 | <2 | <2 | - |
| 22 | TN | mg/l | 3.07 | 3.93 | 5.91 | 5.74 | 2.71 | - |
| 23 | $P\text{-}PO_4^{3-}$ | mg/l | 0.073 | 0.109 | 0.109 | 0.101 | 0.099 | - |

#### *2.1.1.14. Waste water quality*

To assess the impact of this pollution sources, 3 wastewater samples were taken on November 26, 2015 (*Figure 2.23*)

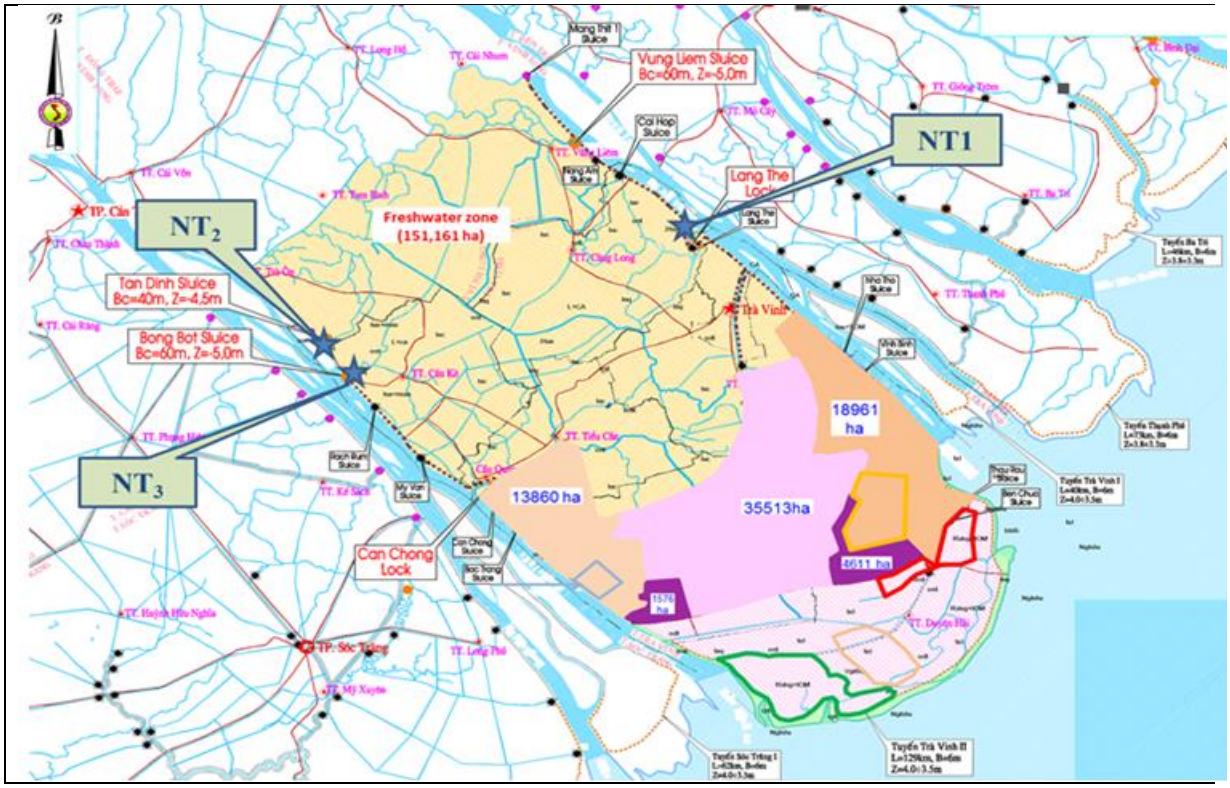



*Figure 2.24: Locations of sampling sites of waste water*

The result of the wastewater quality analysis in *Table 2.10* shows that the wastewater from the residential areas is quite polluted with $BOD_5$ from 129-192mg/l. Remarkably, very high values of Fecal coliform, ranging from 19,000-130,000 MPN/100ml. This indicates that the concentrations of pollutants in the wastewater exceeded the national standard (QCVN 14: 2008 / BTNMT column B) many times.

*Table 2.10: Wastewater quality in the subproject area*

| No | Parameter | Unit | Labels of Samples | | | QCVN14:2008 | |
|---|---|---|---|---|---|---|---|
| | | | NT1 | NT2 | NT3 | A | B |
| 1 | pH | | 7,20 | 6,97 | 7,11 | 5-9 | 5-9 |
| 2 | $BOD_5$ | mg/l | 191,50 | 128,80 | 155,80 | 30 | 50 |
| 3 | TSS | mg/l | 169.00 | 218.00 | 153.10 | 50 | 100 |
| 4 | $N\text{-}NH_4^+$ | mg/l | 3.63 | 3.70 | 4.51 | 5 | 10 |
| 5 | $N\text{-}NO_3^-$ | mg/l | 0.86 | 0.75 | 0.72 | 30 | 50 |
| 6 | $P\text{-}PO_4^{3-}$ | mg/l | 0.09 | 0.16 | 0.08 | 6 | 10 |
| 7 | Total Coliform | MPN/100 ml | 50000 | 37000 | 32000 | 3000 | 5000 |
| 8 | Turbidity | NTU | 65.70 | 93.50 | 62.40 | - | - |
| 9 | EC | mS/cm | 898.00 | 853.00 | 682.00 | - | - |
| 10 | Salinity | ‰ | 0.40 | 0.40 | 0.30 | - | - |
| 11 | Color | TCU | 40.00 | 80.00 | 45.00 | - | - |

| No | Parameter | Unit | Labels of Samples | | | QCVN14:2008 | |
|---|---|---|---|---|---|---|---|
| | | | NT1 | NT2 | NT3 | A | B |
| 12 | DO | mgO2/l | 1.15 | 1.98 | 1.36 | - | - |
| 13 | TOC | | 112.69 | 75.83 | 102.09 | - | - |
| 14 | $Ca^{2+}$ | mg/l | 20.09 | 20.09 | 16.05 | - | - |
| 15 | $Mg^{2+}$ | mg/l | 29.23 | 31.67 | 19.70 | - | - |
| 16 | Total hardness | $mgCaCO_3/l$ | 172.03 | 182.17 | 122.23 | - | - |
| 17 | $SO_4^{2-}$ | mg/l | 80.51 | 82.01 | 54.32 | - | - |
| 18 | TN | mg/l | 5.01 | 4.99 | 5.80 | - | - |
| 19 | $N\text{-}NO_2^-$ | mg/l | 0.40 | 0.34 | 0.43 | - | - |
| 20 | $Fe_{TS}$ | mg/l | 0.24 | 0.37 | 0.43 | - | - |
| 21 | $Cl^-$ | mg/l | 145.90 | 182.40 | 109.40 | - | - |
| 22 | $K^+$ | mg/l | 24.96 | 24.31 | 24.77 | - | - |
| 23 | $Na^+$ | mg/l | 39.32 | 37.96 | 29.43 | - | - |
| 24 | Fecal Coliform | MPN/100 ml | 28000 | 19000 | 130000 | - | - |

## 2.2. SOCIO-ECONOMIC CONDITIONS

### *Economic situation*

**Tra Vinh[10]:**

Overall, in the last few years, economic growth of Tra Vinh province is quite high. Estimated GDP growth in 2014 reach 10.35%, increasing 0.89% to the same period in 2013 (9.46% in 2013). In particular, agriculture, fishery, industry, construction and service increases 4.52%, 28.50%, 10.90%, 8.69% and 12.23%, respectively. Specifically, the production value is estimated 2,619.9 billion, 50.6% of the plan, increasing 10.9% compared to the same period; in which the state sector is 235.5 billion Dong, the non-state sector is 1.474 billion dong, increasing 51.4%; foreign invested sector is 910.4 billion dong, increasing 32.5% (*Table 2.11*).

In 2013, growth rate of the province reach 10.53%, in which agriculture, industry, construction, service increases 1.02%, 3.73%, 11.27% and 17.06%, respectively. In 2014, growth rate target of Tra Vinh province is more than 11%, export target increase 7.1%, social investment mobilization increases 5%, creating 22 thousand employers, reducing 3% number of poor households, particularly Khmer ethnic minority of 4%.

In general, service is primary sector to decide economic growth rate of Tra Vinh province. The secondary sector is industry, however this sector is affected by economic change and not stable. Agriculture is unstable in the 2008-2013 periods with the lowest growth rate of sectors (decrease 1.08% in 2008 and 12.18% in 2012). The highest growth rate of this sector is only 6.42% (2011), however this sector accounts for high ratio among sectors. There is noticeable that there is two decline period of growth rate of the province in 2009 and 2012. The first period causes by industry - construction and services sectors. The second period causes by agriculture; however this sector still creates jobs for a large proportion of workers with 47% of the labor structure.

[10] Socio-economic report of Tra Vinh in 2014

In general, in 2008-2013 periods, agriculture and industry proportion decrease, service proportion increase. Specifically, in 2008 proportion of agriculture, industry and service are 60.3%, 18.38% and 21.32%, respectively. In 2013, proportion of agriculture, industry and service are 47.07% (decrease 13.23%), 15.83% (decrease 2.55%) and 37.1% (increase 15.78%), respectively.

This change shows that economic structure of Tra Vinh province does not change with the trend of industrialization, but also the trend of service. Therefore, economic structure of Tra Vinh province has restricted and backward.

In terms of labor structure, agriculture fell strongly during the period 2008-2011 (from 61.57% to 46.85%), then increased and accounted for 47.95% in 2013. In period 2008-2013, the proportion of labors in agriculture fell 13.62%, the proportion of industrial workers - construction increased from 15.13% to 21.68% (+6.55%), services increased from 23.29% to 30.37% (+7.08%). In terms of labor income (prices in 1994), the labor income of the agricultural and the industrial sectors do not rise much in the period; in 2008 labor income of agriculture, industry, service sector were 9.5 million/labor (million/day), 9.36 million/day, 15.25 million/day, respectively. In 2013, labor income of agriculture, industry service were 11.85 million/day (+2.34 million/day), 13.86 million/day (+4.5 million/ day), 29 million/day (+13, 76 million/day), respectively. Average labor income of agriculture and industry sectors is quite equal. The difference of average labor income of service sector and other sectors is too high. Average labor income of the service sector in 2008 was 1.6 times higher than agricultural sector and 2 times higher the industrial sector and was 2.4 times in 2013. Therefore, investment in this area will bring higher income.

**Vinh Long[11]**:

Economic status of Vinh Long province in 2013: Economy continues grow. Economic structure shifts in the right direction. Total products in the province (GRDP) is estimated to increase 6.21% compared to 2012, in which the agriculture, forestry and fishery products increased by 1.57%; industry and construction increased by 13.1% and service increased 6.73%. Compared to 2012, the agricultural sector fell 2.24%, industry - construction increased by 0.53%, service increased 1.71%. GRDP per capita is estimated at 30.15 million Dong, increasing nearly 3 million Dong compared to 2012.

In 2013, production of agriculture, forestry and fishery (at constant price of 2010) is estimated to 18,979 billion Dong, increasing 1.04% compared to 2012; in which the agricultural sector rise 2.25%, fishery reduces 5.99%. Rice production reaches near 1,064 million tons and if including corn production, grain production in 2013 reaches 1,066,343 tons, decrease 1.52% compared to 2012. The average yield in the form field is above 0.6 tones /ha, costs is 0.97 million/ha lower, income is 3.79 million/ha higher compared to outside the project area. Some models, new ways bring positive results. Resources for new rural investment is maintained, the contribution of people to build new rural areas is increasing.

Industrial production faces many difficulties in capital and goods markets but still improves and continues to grow. Production index of industry rises 12.93% compared to 2012, in which the mining industry increased by 20.69%; processing industries increased by 13.05%; production and distribution of electricity, gas increase up 8%; water supply, sewage, garbage management and treatment rise 7.39%.

*Table 2.11. General information of economy of 2 provinces in 2014*

| Province | GDP growth rate (%) | Average income (mil. VND/year) | Economic structure (%) | | |
|---|---|---|---|---|---|
| | | | Agriculture | Industry | Service |

[11] Socio-economic report of Vinh Long province, 2014

| | | | | | |
|---|---|---|---|---|---|
| Tra Vinh | 9.46 | 16.50 | 83.79 | 8.65 | 7.50 |
| Vinh Long | 6.21 | 21.00 | 46.00 | 18.00 | 36.00 |

*Source: Statistical yearbook, 2014*

## *Social conditions*

### *2.2.1.1. Population*

Population of Tra Vinh and Vinh Long in 2014 was 1,029,300 and 1,040,500 people, respectively. The population density is not high, ranging from 452 to 520 people/km$^2$. The average household size is from 3.7 to 4.4 persons; see the detail in *Table 2.12*. The population distribution is uneven, Duyen Hai district, meanwhile, has the lowest of 246 people/km$^2$. The population in Tra Vinh is sparser from the Northwest to the Southeast. People prefer living in more advantageous districts such as Cang Long, Tieu Can and Tra Cu.

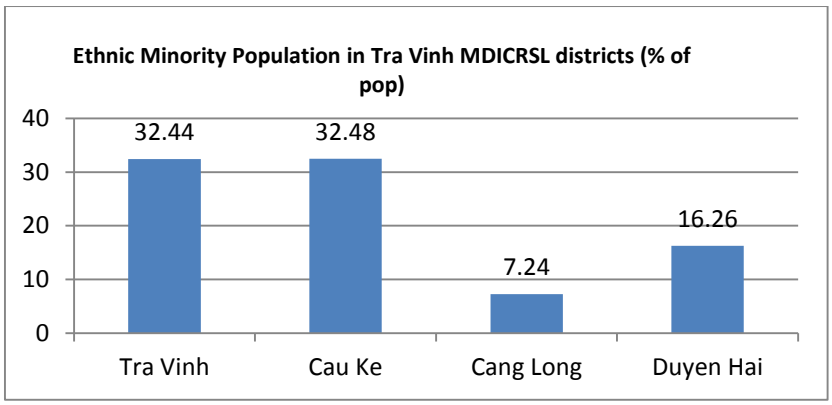
*Table 2.12: Population density in the subproject area*

| No. | Name of district/ province | Natural land area (ha) | Population (person) | Density (persons/km$^2$) |
|---|---|---|---|---|
| **A** | **Tra Vinh** | **234.116** | **1,029,3** | **440** |
| 1 | Tra Vinh city | 6,816 | 106.0 | 1,554 |
| 2 | Cang Long district | 29,409 | 144.9 | 493 |
| 3 | Cau Ke district | 24,662 | 110.7 | 449 |
| 4 | Tieu Can district | 22,675 | 110.7 | 488 |
| 5 | Chau Thanh district | 34,339 | 139.0 | 405 |
| 6 | Cau Ngang district | 31,909 | 133.7 | 419 |
| 7 | Tra Cu district | 36,992 | 180.9 | 489 |
| 8 | Duyen Hai district | 42,007 | 103.5 | 246 |
| ***B*** | ***Vinh Long*** | 2,34,120 | 1,027,5 | 439 |
| 1 | Vung Liem district | 30,957 | 161.1 | 520 |
| 2 | Tra On district | 26,727 | 136.2 | 509 |

*Source: Statistical Yearbooks of Tra Vinh, and Vinh Long, 2015 and data provided by CPCs, 2015*

### *2.2.1.2. Ethnicity*

Tra Vinh has a significant ethnic minority population. Cau Ke district where 3 sluice gates will be built has a high population of ethnic minorities with 32.48% compared to the provincial population of 32.33%, but a small number of households belong to Hoa, Khmer groups living in An Phu Tan, Trung Thanh Tay, Trung Thanh Dong and Tich Thien communes; and Duyen Hai District where mangrove-shrimp investments are proposed has a relatively lower population of ethnic minorities with 16.26 % compared to the provincial population of 32.33% (*Figure 2.25*).




Source: Provincial Ethnicity Board of Tra Vinh, 2015.

*Figure 2.25: Ethnic minority population in Tra Vinh MDICRSL districts*

### *2.2.1.3. Infrastructure for Transportation*

**Road**. Tra Vinh province has 2,111.6 km of road, of which the national road accounts for 10.2%, the provincial road: 21.5%, and the district road: 68.3%. Regarding overland traffic, there are three national roads (NR) no. 53, 54, and 60 which have been upgraded to level 3, connecting Tra Vinh with HCMC and other provinces in the Mekong Delta. NR no. 53 and NR no. 54 connect Tra Vinh with Vinh Long Province (56 km) and Can Tho City (95 km).

**Waterways**. Tra Vinh is bordered the East Sea to the east and surrounded by Tien River and Hau River, thus, waterway transportation is relatively developed. The province has passageways for seagoing ships of 20,000 ton to enter the Hau River (Tra Vinh Canal) and to reach the East Sea via Dinh An Economic Zone. This is a good condition for developing the Tra Cu port system and Dinh An international transshipment port. The main waterways for commodity shipment comprise of vertical and horizontal axes. The ormer is river line of Co Chien River – Tra Ngoa Canal and 3/2, the latter, Nguyen Van Pho line – Can Chong River – Ben Cat River which links the Tien River with the Hau River. It takes from 5 – 7 hours by ship from Dinh An estuary to Con Dao Island (Ba Ria - Vung Tau Province) and about 3 hours to Can Tho City. There are 2 ports in Cung Hau estuary and Dinh An estuary. Two rivers of Co Chien and Bassac can accommodate ships of 3,000 tons. Vinh Long Province also has relatively developed waterway due to its dense river and canal system with major rivers including Co Chien, Ba Ke, Cha Va, Vung Liem, Long Ho, etc. The waterways in Vinh Long are mainly tertiary and secondary waterways.

Due to the topographical characteristics, waterways play an important role in the socio-economic development of the project provinces. From Tra Vinh, and Vinh Long, people can go to the Southeastern and Southwestern provinces as well as other domestic and international links via waterways.

Vung Liem river, Tan Dinh river and Bong Bot canal are the Grade-V inland waterway. Based on the surveyed result showed that (i) in Vung Liem river, the numbers of boats, ships via this river is low (10-20 boats/day); (ii) in Tan Dinh river, there are boats, canoes traveling across the region, the density is high with mostly small boat (40-50 boats/day) with lower 8m wide in transporting fruits and construction materials and in Bong Bot river, local vessel traffic has low density of vessels (15-20 boats/day), including boats, barges carrying construction materials and goods (*Figure 2.24*). Thus, impacts of sluice gates on waterway traffic need to be considered.

*Figure 2.26: Waterway traffic in the subproject area*

### *2.2.1.4. Labor and Employment*

The total population of the subproject communes is 58,604 people, of which approximately 70% are in the working age (from 16 to 60 years old) and 30% are beyond the working age (under 16 and above 60). Among the total population, 30,218 people are female, accounting for 51.8% and 28,386 people are male, occupying 48.2%. Similarly to the sex ratio of the total population, of 70% of population in the working age, 51.8 percent are females while 48.2 percent are males. Data on the labor force of the subproject communes are shown in *Table 2.13*.

In the subproject communes, the proportion of households engaged in agriculture is quite high in the occupational structure of each commune, especially the communes in Cau Ke and Vung Liem districts, accounting for 70-80% of total households in each commune. As the subproject is not located in the area that has forest coverage, there is no household engaged in forestry sector. Detailed proportions of each sector in the project communes are presented in *Table 2.14*.

*Table 2.13: Labor force (people) of the subproject districts*

| No | Name of district/ province | Population | | | In the working age (16-60) | | | Beyond the working age (<16; > 60) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Female | Male | Total | Female | Male | Total | Female | Male |
| 1 | Tra Vinh | 10,675 | 5,443 | 5,232 | 7,472 | 3,810 | 3,662 | 3,203 | 1,633 | 1,570 |
| 1.1 | Cau Ke district | 10,675 | 5,443 | 5,232 | 7,472 | 3,810 | 3,662 | 3,203 | 1,633 | 1,570 |
| 2 | Vinh Long | 18,627 | 9,666 | 8,961 | 10,977 | 5,699 | 5,278 | 7,650 | 3,967 | 3,683 |
| 2.1 | Vung Liem district | 10,206 | 5,351 | 4,855 | 5,858 | 3,089 | 2,769 | 4,348 | 2,262 | 2,086 |
| 2.2 | Tra On district | 8,421 | 4,315 | 4,106 | 5,119 | 2,610 | 2,509 | 3,302 | 1,705 | 1,597 |
| | **Total** | **58,604** | **30,218** | **28,386** | **36,898** | **19,018** | **17,880** | **21,706** | **11,200** | **10,506** |

*Source: Yearly socio-economic report provided by the subproject CPCs, 2015*

*Table 2.14: Occupational structure (%) in the subproject area*

| No. | District | Agri-culture | Industry and Handicraft | Construction | Trade Services | Others |
|---|---|---|---|---|---|---|
| 1 | Tra Vinh | | | | | |
| 1.1 | Cau Ke district | 80.0 | 0 | 0 | 0 | 20.0 | 0 |
| 2 | Vinh Long | | | | | |
| 2.1 | Vung Liem district | 75.3 | 5.4 | 3.0 | 6.8 | 5.8 | 3.7 |
| 2.2 | Tra On district | 80.8 | 0 | 1.9 | 0 | 1.4 | 15.9 |

*Source: Yearly socio-economic report provided by the subproject CPCs, 2015*

#### *2.2.1.5. Income, Poverty, and Gender*

With the proportion of agriculture accounts for the highest in the economic structure, the main income source of the households is from agricultural sector. As most of the districts have salinity-contaminated soil, the area for growing rice is not large. Income from cultivation of the households is mainly from growing fruit trees, especially coconut, orange, pomelo, longan, rambutan, durian, mangosteen, etc. As for freshwater districts such as Tra On, the above listed fruit-trees have been grown broadly. As for the districts with salinity intrusion such as Vung Liem, and Cau Ke, the main fruit tree is coconut. Income from livestock is mainly from cattle, pig, and poultry. Income from aquatic products is primarily from culture of giant freshwater prawn in coconut canals in the districts with high salinity intrusion and from catfish in the districts with large freshwater area.

The living standards of the households in the subproject communes are relatively high and even. Most of the households are classified as above-average, from 40 to 50% of the households in the subproject communes. The poverty incidence is low, mainly below 5 percent. The average income per capita in the subproject districts is relatively high, at around VND 1,700,000 per person per month to VND 2,500,000 per person per month (*Table 2.15*).

Gender issues: the public consultation results show that there is no inequality issue between women and men in the subproject area. Labor division in the family is traditional, that is women mainly do housework including cooking, cleaning house, washing clothes, going to the market, etc. while men are in charge of bigger family issues.

In terms of educational level, the survey results show that women have lower level of education than men. About 30 percent of the communal leaders are women. However, the key and decisive positions with high power are often undertaken by men. Most of the women are member of the Communal Women's Union and participate in the women's movements of the communes.

Most of the household heads are male. However, there is no great difference observed between male-headed and female-headed households in their accessibility to social services such as health, education, credit, loan and household economic development.

Consultation results also show that women have demands to be recruited in the project activities. They can participate in the activities such as mason, cleaning, cooking, and other works depending on the recruitment of the contractors.

*Table 2.15: Living standards of the households in the subproject area*

| No | Name of province/ District/commune | Numbers of HH | Poor HHs | | Average HHs | | Above-average HHs | | Rich HHs | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | HHs | % | HHs | % | HHs | % | HHs | % |
| *1* | *Tra Vinh province* | 2,923 | 147 | 5.0 | 165 | 5.6 | 2,059 | 70.4 | 552 | 18.9 |
| 1.1 | Cau Ke district | 2,923 | 147 | 5.0 | 165 | 5.6 | 2,059 | 70.4 | 552 | 18.9 |
| 1.1.1 | An Phu Tan commune | 2,923 | 147 | 5.0 | 165 | 5.6 | 2,059 | 70.4 | 552 | 18.9 |
| *2* | *Vinh Long province* | 5,327 | 222 | 4.2 | 1,782 | 33.5 | 1,360 | 25.5 | 1,963 | 36.9 |
| 2.1 | Vung Liem district | 2,933 | 123 | 4.2 | 1,557 | 53.1 | 790 | 26.9 | 463 | 15.8 |
| 2.1.1 | Trung Thanh Tay commune | 1,517 | 67 | 4.4 | 762 | 50.2 | 436 | 28.7 | 252 | 16.6 |
| 2.1.2 | Trung Thanh Dong commune | 1,416 | 56 | 4.0 | 795 | 56.1 | 354 | 25.0 | 211 | 14.9 |
| 2.2 | Tra On district | 2,394 | 99 | 4.1 | 225 | 9.4 | 570 | 23.8 | 1,500 | 62.7 |
| 2.2.1 | Tich Thien commune | 2,394 | 99 | 4.1 | 225 | 9.4 | 570 | 23.8 | 1,500 | 62.7 |

*Source: Yearly socio-economic report provided by the subproject CPCs, 2015*

#### *2.2.1.6. Access to services, communications, and clean water*

Currently, clean water system has not covered all households in the communes in the subproject area. In the communes where not many households can use clean water, most of the households, equivalent to above 60% of household in each commune use water from rivers and rainwater. Water sources from canals and rivers are important for households to use for cooking, drinking and other domestic purposes. A small number of households use rainwater for daily cooking and drinking (*Table 2.16*). 100% of the households are using electricity from national grid.

*Table 2.16: Water sources for domestic use of the households in the subproject area*

| No. | District/Commune | Tap water | Drilled well | Dug well, earth well | River, stream, lake, pond | Rain water | Others |
|---|---|---|---|---|---|---|---|
| *A* | *Tra Vinh province* | *723* | *0* | *1,921* | *0* | *0* | *279* |
| 1 | Cau Ke district | 723 | 0 | 1,921 | 0 | 0 | 279 |
| 1.1 | An Phu Tan commune | 723 | 0 | 1,921 | 0 | 0 | 279 |
| *B* | *Vinh Long province* | *1,053* | *1,600* | *0* | *2,378* | *296* | *0* |
| 2 | Vung Liem district | 563 | 0 | 0 | 2,109 | 261 | 0 |
| 2.1 | Trung Thanh Tay commune | 313 | 0 | 0 | 943 | 261 | 0 |
| 2.2 | Trung Thanh Dong commune | 250 | 0 | 0 | 1,166 | 0 | 0 |
| 3 | Tra On district | 490 | 1,600 | 0 | 269 | 35 | 0 |
| 3.1 | Tich Thien commune | 490 | 1,600 | 0 | 269 | 35 | 0 |

*Source: Yearly socio-economic report provided by the subproject CPCs, 2015*

*Duyen Hai Thermal Power Plant.* The beach in Tra Vinh is adjacent to the under-construction Duyen Hai Thermal Power Plant --- 2x 622 MW. Sub-critical coal-fired units will be installed for Phase I of this subproject; the jetty built for the coal terminal will have impacts on hydrological flows in the project area. Residents in the area have already claimed that construction of the plant has resulted in soil loss and erosion. The positioning and design of the marine outfall from the cooling water recirculation system of the plant is a valid concern

depending on the temperature differential at the edge of the mixing zone. If it is too high, this will have an effect on marine life in the area, and may impact livelihoods of fishermen in the area, as well as having detrimental effects on the marine ecosystem. However, neither the Power Plant nor its associated facilities are supported by the subproject. The Power Plant is located on the coastal area about 70 km downstream of the proposed sluice gate locations. These factors will be taken into consideration when designing any climate resilience or livelihood restoration subprojects in the vicinity of the plant. Fortunately, demonstration sites of the subproject are far away for the Power Plant, ranging from 8.07 to 16.29 km.

#### *2.2.1.7. Health*

Averagely, each commune has a solid or semi-solid health center. All of the centers have at least one doctor, one physician, two to three nurses, one nurse's aide, one pharmacist, etc. The average patients who treated in these centers are ranging from 10,000 to 20,000 people per year. The common diseases in the area are flu, dengue fever, hand-foot-mouth, digestive diseases, pinkeye, and scarlet fever due to the characteristics of the hot and wet tropical climate area where epidemics easily occur.

#### *2.2.1.8. Education*

There is no high school in the subproject area. All schools have relatively good infrastructure (solid or semi-solid). Averagely, each school has from 10 to 15 classrooms. The number of primary school students in the project communes is 11,538; the number of secondary school students is 7,965 while the number of high school students is 833. The drop-out rate is low, 0.4 percent of the total students in each commune.

#### *2.2.1.9. Culture, Religion, and Belief*

Tra Vinh, and Vinh Long provinces lie in Southern region, the inhabitation of many groups. The largest is Vietnamese, followed by Khmer, Hoa (Chinese), and Cham ethnic groups. During the coexistence process, cultural exchanging relations have been shaped among the ethnic communities mentioned above. The relations are clearly observed especially in religion and belief. Most of the popular religions in Mekong River Delta are present in Ben Tre, Tra Vinh, and Vinh Long including Buddhism, Catholicism, Protestantism, Caodaism, Hoa Hao, Coconut Religion, etc. In terms of influence as well as number of followers, the most notable religions are Buddhism, Catholicism, and Caodaism.

Regarding traditional festivals, in addition to the major holidays of the country, in the subproject districts, there are traditional festivals of Khmer people such as fruit festival, Golden Rice Fair, etc. In Tra On district, the major annual festivals that attract several people from other areas are Tomb of Nguyen Van Ton (Lăng Ông Tiền quân Thống chế) in Thien My Commune took place on January 4 according to Lunar Calendar with around 2,400 visitors and Khmer Festival took place in lunar October, March, and August.

#### *2.2.1.10. Results of baseline household survey in the affected communes and households in the area of 3 sluice gate construction*

*a). General social information of affected communes*

The total of natural area of 4 communes affected by construction is 53.43 $km^2$, and the total of population is 29,302 people (density of 548 people/$km^2$). The ratios of males and females are not much different (14,084 males compared with 15,218 females), see detail in *Table 2.17*.

*Table 2.17. Area, population and living standard of subproject's affected communes*

| Commune | Natural area ($km^2$) | Population | Population by gender | | Poverty ratio (%) |
|---|---|---|---|---|---|
| | | | Male | Female | |
| An Phu Tan | 15.96 | 10,675 | 5,445 | 5,230 | 5.0 |
| Tich Thien | 18.09 | 8,421 | 3,582 | 4,841 | 4.1 |
| Trung Thanh Dong | 11.17 | 4,858 | 2,331 | 2,525 | 4.0 |
| Trung Thanh Tay | 8.21 | 5,348 | 2,726 | 2,622 | 4.4 |
| **Total** | 53.43 | 29,302 | 14,084 | 15,218 | |

According to socio-economic statistic data provided by CPCs, the poverty ratios of communes range from 4% to 5%. Compared to poverty ratios of Tra Vinh and Vinh Long provinces with 10.67% and 6.24%, respectively, so these rates are lower.

All communes have health centers and primary, secondary schools, but no high school. People in all communes have already used electricity from national network. Otherwise, some HHs also use electricity source from biogas. As for domestic water, currently, water sources using for domestic and production needs are various. Majority of people use water from ponds, lakes, rivers, streams, drilled wells and dug wells. Only some use tap-water, some HHs have rain-water tanks to use in domestic use.

*Table 2.18. Health facilities, education and living facilities*

| Commune | Health Center | School | | Electricity | Domestic water |
|---|---|---|---|---|---|
| | | Primary and secondary school | High School | | |
| An Phu Tan | 1 | 5 | 0 | 100% | Mainly use dug well, drilled well (66%), tap-water (25%), remains are other types with small proportion |
| Tich Thien | 1 | 3 | 0 | 100% | Mainly use drilled well (67%), tap-water (20%), water from ponds, lakes, rivers, streams (11%), and rain water with small proportion |
| Trung Thanh Dong | 1 | 2 | 0 | 100% | Mainly use water from ponds, lakes, rivers, streams (72%), tap-water (19%), remains use rain water (9%) |
| Trung Thanh Tay | 1 | 2 | 0 | 100% | |
| **Total** | **4** | **12** | **0** | | |

*b). Results of household survey in the area affected by land acquisition*

After the household survey in 4 communes of the subproject, consultants identified 13 affected households (AH) of the subproject due to land acquisition. Each household has the average of 3000-5000 $m^2$ production land, and a ratio of lost area portions of HHs is negligible. The following data is the result of surveys with 13 AHs of the subproject.

- **Population, ethnic.** In the total of 13 AHs of the subproject, the number of households which were surveyed on socio-economic situation is 13 HHs with the total of 41 members. All AHs are Kinh people, the ethnic majority in Vietnam. At the construction site of the project, there

are no ethnic minority people. In 13 AHs, the number of male and female in HHs is not much different. The percentages of male and female are approximately 50% of each (*Table 2.19*).

*Table 2.19. Number of affected households*

| District/Commune | No. of AHs | No. of HH surveyed | No. of people | By gender | | Ethnic | |
|---|---|---|---|---|---|---|---|
| | | | | Male | Female | Kinh | |
| | | | | | | HH | No. of people |
| **Cau Ke** | **4** | **4** | **15** | | | **4** | **15** |
| An Phu Tan | 4 | 4 | 15 | 8 | 7 | 4 | 15 |
| **Tra On** | **4** | **4** | **9** | | | **4** | **9** |
| Tich Thien | 4 | 4 | 9 | 3 | 6 | 4 | 9 |
| **Vung Liem** | **5** | **5** | **17** | | | **4** | **17** |
| Trung Thanh Tay | 3 | 3 | 12 | 7 | 5 | 3 | 12 |
| Trung Thanh Dong | 2 | 2 | 5 | 3 | 2 | 2 | 5 |
| **Total** | **13** | **13** | **41** | **21** | **20** | | |

- **Age, education.** In the total of 41 members of AHs, the number of people under 6 years old is 3 (ratio of 7.3%), the number of people in the age group at schools (6-17 years) is 7 (ratio of 17.1%) and number of people in the working age group (18-60 years) is 105 (ratio of 56.1% - the quite high ratio of people in working age group). The number of people over 60 years is 8 (accounts for 19.5%), see in *Table 2.20.* The number of people finished secondary schools accounts for highest ratios among members of AHs with the proportion of 26.8; 14.6% finished high schools, 7.3% are in qualification of college, university. All of 3 illiterate people are elder, account for 6.8% (*Table 2.21*).

*Table 2.20. Percentage of population in age groups*

| District | Age groups | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Under 6 years | | 6-17 years | | 18-60 years | | Over 60 year | | | |
| | N | % | N | % | N | % | N | % | N | % |
| Cau Ke | 2 | 4.9 | 3 | 7.3 | 9 | 22.0 | 1 | 2.4 | **15** | 36.6 |
| Tra On | 0 | 0.0 | 2 | 4.9 | 2 | 4.9 | 5 | 12.2 | **9** | 22.0 |
| Vung Liem | 1 | 2.4 | 2 | 4.9 | 12 | 29.3 | 2 | 4.9 | **17** | 41.5 |
| **Total** | **3** | 7.3 | **7** | 17.1 | **23** | 56.1 | **8** | 19.5 | **41** | 100.0 |

*Table 2.21. Education level of APs*

| District | Illiteracy | | Nursery school | | Primary School | | Secondary school | | High School | | College – University | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| Cau Ke | 2 | 4.9 | 0 | 0.0 | 9 | 22.0 | 3 | 7.3 | 0 | 0.0 | 1 | 2.4 | **15** | 36.6 |
| Tra On | 0 | 0.0 | 0 | 0.0 | 6 | 14.6 | 2 | 4.9 | 0 | 0.0 | 1 | 2.4 | **9** | 22.0 |
| Vung Liem | 1 | 2.4 | 2 | 4.9 | 1 | 2.4 | 6 | 14.6 | 6 | 14.6 | 1 | 2.4 | **17** | 41.5 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **3** | **7.3** | **2** | **4.9** | **16** | **39.0** | **11** | **26.8** | **6** | **14.6** | **3** | **7.3** | **41** | **100** |

- **Occupation and income.** Members of AHs have different occupations, 10 out of 41 people works in agricultural activities (including horticulture and livestock raising), accounting for 24.4% of the total. Other occupations with many people are students (17.1%) and trading (12.2%). The remaining people belong to worker, state or private employee, driver, part-time labor, housewife, retiree (*Table 2.22*). The survey on income rate of AHs indicates that majority of AHs have average monthly income from 2 to 3 mil.VND/HH/month, accounting for 46.2%. There are 3 AHs with income rate from 2 to 3 mil.VND/HH/month, accounting for 23.1%. This income rate is nearly similar with poverty line promulgated by Ministry of Labor, Invalids and Social Affaires (MOLISA) (calculated for scope of 4.14 people/HH). Number of AHs with income from 3 to 5 mil. VND and over 5 mil.VND are the same of 2 HHs, accounting for 15.4% of each (*Table 2.23*).
- **Domestic water and electricity**. Regarding drinking water sources, most of AHs in Cau Ke and Tra On district use tap water for drinking with 6 HHs, accounting for 46.2%. Whilst, 4 AHs in Vung Liem district use rain water for drinking, accounting for 38.5%. Percentage of lake/river water is only 15.4%. Majority of AHs use water from river for washing, accounting for 69.2% because they are living near the rivers. The others use tap water or wells for washing purposes (*Table 2.24*). Regarding power usage, all 13 AHs use electricity source from national power network. Otherwise, a few HHs also use energy source from biogas of livestock raising.

*Table 2.22. Occupations of affected people*

| | **Cau Ke** | | **Tra On** | | **Vung Liem** | | **Total** | |
|---|---|---|---|---|---|---|---|---|
| **Occupation** | N | % | N | % | N | % | N | % |
| Agriculture | 4 | 9.8 | 6 | 14.6 | 0 | 0.0 | 10 | 24.4 |
| Trading | 1 | 2.4 | 2 | 4.9 | 2 | 4.9 | 5 | 12.2 |
| Worker | 0 | 0.0 | 2 | 4.9 | 0 | 0.0 | 2 | 4.9 |
| State employee | 0 | 0.0 | 1 | 2.4 | 0 | 0.0 | 1 | 2.4 |
| Employee of private companies | 1 | 2.4 | 0 | 0.0 | 0 | 0.0 | 1 | 2.4 |
| Driver | 0 | 0.0 | 0 | 0.0 | 1 | 2.4 | 1 | 2.4 |
| Housewife | 1 | 2.4 | 0 | 0.0 | 2 | 4.9 | 3 | 7.3 |
| Retiree | 0 | 0.0 | 2 | 4.9 | 1 | 2.4 | 3 | 7.3 |
| Student | 1 | 2.4 | 3 | 7.3 | 3 | 7.3 | 7 | 17.1 |
| Part-time labor | 0 | 0.0 | 0 | 0.0 | 2 | 4.9 | 2 | 4.9 |
| Other | 1 | 2.4 | 1 | 2.4 | 4 | 9.8 | 6 | 14.6 |
| **Total** | 9 | 22.0 | 17 | 41.5 | 15 | 36.6 | 41 | 100 |

*Table 2.23. Monthly income of affected households*

| **District** | **Under 2 mil.VND** | | **From 2-under 3 mil.VND** | | **From 3-5 mil.VND** | | **Over 5 mil.VND** | | **Total** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **HH** | **%** | **HH** | **%** | **HH** | **%** | **HH** | **%** | **HH** | **%** |
| Cau Ke | 1 | 7.7 | 2 | 15.4 | 0 | 0.0 | 1 | 7.7 | 4 | 30.8 |
| Tra On | 2 | 15.4 | 2 | 15.4 | 0 | 0.0 | 0 | 0.0 | 4 | 30.8 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Vung Liem | 0 | 0.0 | 2 | 15.4 | 2 | 15.4 | 1 | 7.7 | 5 | 38.5 |
| **Total** | **3** | **23.1** | **6** | **46.2** | **2** | **15.4** | **2** | **15.4** | **13** | **100** |

*Table 2.24. Water sources of affected households*

| District | Drinking water source | | | | | | | | Washing water source | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tap | | Wells | | Lake/river | | Rain | | Tap | | Wells | | Lake/river | | Rain | |
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| Cau Ke | 3 | 23.1 | 0 | 0.0 | 1 | 7.7 | 0 | 0.0 | 1 | 7.7 | 1 | 7.7 | 2 | 15.4 | 0 | 0.0 |
| Tra On | 3 | 23.1 | 0 | 0.0 | 0 | 0.0 | 1 | 7.7 | 0 | 0.0 | 0 | 0.0 | 5 | 38.5 | 0 | 0.0 |
| Vung Liem | 0 | 0.0 | 0 | 0.0 | 1 | 7.7 | 4 | 30.8 | 1 | 7.7 | 1 | 7.7 | 2 | 15.4 | 0 | 0.0 |
| **Total** | **6** | **46.2** | **0** | **0.0** | **2** | **15.4** | **5** | **38.5** | **2** | **15.4** | **2** | **15.4** | **9** | **69.2** | **0** | **0.0** |

In addition, the construction of 3 sluice gates can also affect the livelihood of the households who rely on the Tan Dinh, Vung Liem rivers and Bong Bot canal, such as: fishing households, household of aquaculture rasing and household of operation of ferries. The surveyed results showed that due to over fishery exploitation in recent years (even baby fishes) so fishes in the Vung Liem, Tan Dinh rivers and Bong Bot canal are relatively poor, only normal species of low economic and fishing by electrical gear in these rivers and canal is prohibited, but there still have some households illegally catch fish by gill and cast nets on their boats (5-10 households each sluice gate) and some households (3-5 households each sluice gate) using trap to catch fish along these rivers and canal for their daily lives. There are no aquaculture activities on these rivers and canal.

In addition, there have 2 ferry terminals in the construction area of 3 sluice gates, namely Bong Bot and Tan Dinh (*Figure 2.27*). The number of people are now using Bong Bot ferry are about 400-500 people with 200 motorbikes and and number of people are now using Tan Dinh ferry are about 500-700people with 400 motorbikes. These ferries are operated by 2 households, with the price for using the ferries is 1000VND/person and 2000VND/motorbike, they can earn from 1.2-1.5 mil VND/day and the subproject implementation will impact on them.

*Figure 2.27: (a) Bong Bot ferry and (b) Tan Dinh ferry*

### *Current livelihood models in the subproject area*

#### *2.2.1.11. Shrimp aquaculture*

There are several models farming systems, namely, Extensive Shrimp Farming, Improved Extensive Shrimp Farming, Intensive Shrimp Farming, and Mangrove-Shrimp that can be differentiated as follows[12]:

*a). Extensive Shrimp Farming*

This farming system relies entirely on natural feed. The shrimp seeds are recruited entirely from the wild, thus the stocking density is low. The area of the shrimp farm is typically large.

Advantage: This system is low cost, without spending on seeds and feeds. The size of the grown shrimp is bigger than in other farming systems and so the shrimps can fetch better prices. The labor requirement is also low as not much care is required. The growth period of the shrimps is short as the recruited shrimps from the wild are already grown up.

Disadvantage: the yield and profit per unit of land is low. The land area must be large enough to make significant income while land price is increasing.

*b). Improved Extensive Shrimp Farming*

This farming system is based on the extensive farming system with additional shrimp stocking at low density (0.5-2 shrimps/$m^2$) and additional feeds on weekly basis.

Advantage: This system has low cost. Seeds can be partly recruited from the wild. The sizes of grownup shrimps are also larger than intensive shrimps and thus fetch better prices.

Disadvantage: as in extensive system, the profit from this system is also low. A large piece of land is required.

*c). Semi-Intensive*

This system where an organic fertilizer applies to create natural feeds (plankton blooms). Additional feeds such as rice bran and rice are required. The stocking density in this case (10-15 shrimps/$m^2$) is higher than in the extensive system. A medium sized piece of land (2000-5000$m^2$) can be used in this system.

Advantage: the pond is constructed with complete dykes and is small in size, this it is easier to manage. The sizes of grown-up shrimps in this system are also large, fetching high prices. The cost is also low as stocking dentisy is lower than in the intensive system while natural feeds can also be used.

Disadvantage: The yield is lower than in the intensive system.

*d). Intensive Shrimp Farming*

This shrimp farming system relies entirely on added feeds (pellets and fresh feeds). The stocking density is high at 15-30 shrimps/$m^2$. The pond size ranges 1000-10,000$m^2$, optimally at 5000$m^2$.

Advantage: The pond is constructed so water supply and drainage can actively be controlled.

[12] http://khoahocchonhanong.com.vn/CSDLKHCN/modules.php?name=News&op=viewst&sid=221

Disadvantage: The sizes of grown up shrimps in this system are small (30-35 shrimps per kilogram), fetching lower prices than shrimps from other systems. The cost is high, thus the profit margin is lower than in other systems. The system carries a high risk of failure from disease if water management is sub-optimal.

*e). Mangrove-Shrimp*

This system is a mixture of shrimp and mangrove forest where forest area accounts for 30% to 70% of the land area.

Advantage: the environment is near natural. The mangroves take up organic pollution from the shrimp. The sizes of mature shrimps are large, fetching good prices. This system is considered the most sustainable system.

Disadvantage: The yield is relatively low per unit of land.

### *2.2.1.12. Alternating rice and brackish water shrimp*

The brackish water alternating rice-shrimp system includes one crop of saline tolerant rice alternating with one crop of brackish water shrimp (commonly black tiger) per year has been practiced in the Mekong Delta in general and in Tra Vinh in particular since the early 1990s. The typical calendar of the system is shown below.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shrimp | | | | | | | | | | | | |
| Flushing salinity | | | | | | | | | | | | |
| Rice cultivation (fish can be added to the rice field) | | | | | | | | | | | | |

The site for the alternating shrimp-rice farming system must have a pH above 5.5, salinity ranging between 8 and 20‰, good water supply and drainage, and unpolluted input water. The soil must be kept moist at all times, especially during breaks in between the crops to avoid oxidation of the potentially acidic soil.

A poldered dyke system is required for the land plot with the top of the dyke about 0.5 meters higher than the annual flood peak. The canal parallel to and inside the polder dyke is 3-4 meter wide, 1.2 meters deep. A nursery pond and the main pond should be about 40% of the area of the land plot.

In this alternating rice-shrimp system, natural feeds account for a large part of the nutrients of the shrimp, so fertilizers must be applied during the first 10-15 days to foster algal growth to create a source of feed for the shrimp. During the second month, industrial feeds are added twice per day. Technical knowledge is very important for the success of shrimp farming. After 4 months, when the shrimps reach the size of 30-35 shrimps per kilogram, they can be harvested by draining all water out from the land.

The alternating shrimp-rice farming system is widely claimed to be an effective adaptation to salinity intrusion and sea level rise (Renaud *et al*, forthcoming; Nhan *et al*, 2014; Nhan *et al*, 2015). The rice and the shrimp support each other in that the shrimp farming add nutrients to the soil, while the rice helps cleansing the environment for the next shrimp crop. The rice varieties suitable for this farming system are those tolerant to acidity and salinity such as OM 9915, OM 9916, OM 9921, OM 10636, OM 9577-1, OM 9584-4, MTL 580 và MTL 689.

# CHAPTER 3. ALTERNATIVES ANALYSIS OF SUBPROJECT

This chapter aims to provide justification on how and why this subproject is selected based on the approach recommended by the Regional Environmental Assessment (REA) and the Resional Social Assessment (RSA) for the MDICRSL project for the transition zone to the estuary region (Section 3.1) as well as the alternative analysis considered during the design of the subproject (Setion 3.2). The ESMP (Chapter 6) has explicitly incorporated a technical assistance to ensure that extensive consultation is made during the development of the sluice operational manual and that DARD will have adequate capacity to manage and control future development of aquaculture farming including possible scale up of the proposed livelihood models. These measures are intended to prevent and/or mitigate potential negative impacts on land and water uses due to operation of sluice gates as well as possible expansion of aquaculture activities in the subproject and nearby areas. The technical assistance will plan and implement the mitigation measures to address the potential impacts during operation phase of the subproject.

## *3.1. Need for the Subproject*

Need for implementation of the subproject has been identified in the REA and RSA prepared for the MDICRSL Project. It has been concluded that overall the proposed subprojects are designed to have positive environmental and social impacts and monitoring changes during construction and operation of water control infrastructure and livelihood models is required. The additional surface and groundwater monitoring and assessing changes in coastal and riverbank erosion under Component 1 of the MDICRSL Project will be important for measuring and managing the long term regional impacts of the Subprojects 2, 3 and 4 and the implementation of subprojects in Phase I will provide important insights into the design and safeguard instruments for the Phase II subprojects.

The proposed subproject will be implemented under Component 3 of the MDICRSL Project. Below highlights justification for the subproject and measures to mitigate potential negative impacts as recommended in the REA and RSA and they have been considered during the preparation of Chapters 4, 5, and 6.

***a) Impacts of installing water/salinity control structures in the transition to estuary***

Recently, the function of salinity-control structures has been modified from a control oriented to adaption-oriented approach. For instance, shrimp culture relying on saline water in the dry season is followed by rice culture depending on rainwater in the wet season through proper adjustments in the design and operation of existing water structures and additional investments in small-scale infrastructure. The MD-ICRSL project builds on this approach and the infrastructure will support the transition to more sustainable brackish water activities such as mangrove-shrimp, rice shrimp and other aquaculture activities, adapting to further challenges of salinity intrusion.

Changes in the ecological flow of the Mekong River may result due to the installation of flood/salinity control measures; leading to a reduction in the diversity and quantity of fish populations. Overfishing and loss of habitat and spawning sites due to changes in the river threaten fish species in the Mekong Delta. Efforts should be taken to limit impacts on aquatic fauna.

The issue of surface water quality and operation of sluices needs to be managed. Surface water pollution comes from the residues of agro-chemicals (i.e. pesticides and fertilisers) and organic matter from agriculture and aquaculture when flushing water from canals and embankments. However, the proposed project would only include construction of secondary and tertiary sluices, and the environmental impacts would be mainly local, and mitigation measures can be implemented at the subproject level. The operation of sluices also needs to consider the impacts

to local waterway transportation for fishers and farmers. The operating rules of sluice gates should be developed in consultation with all stakeholders, including local waterway users.

***b) Impacts of piloting sustainable livelihood models in the transition to estuary and peninsula***

The livelihood models in the delta estuary and peninsula will support to farmers to transition (where suitable) to more sustainable brackish water activities such as mangrove-shrimp, rice-shrimp, and other aquaculture activities and to implement climate smart agriculture by facilitating water use efficiency in the dry season. Livelihood programs are very important in the delta estuary and coastal provinces ashouseholds in the transition between fresh and brackish water had lower income than those in other zones. Livelihoods of people in this zone are more vulnerable to freshwater availability from the upstream, to salinity intrusion from estuaries and/or adjacent shrimp farming areas and to extreme dry season freshwater shortages.

Providing livelihoods support measures to farmers to adapt to salinity intrusion and transition to brackish aquaculture is an important initiative. Salinity issues in the estuary areas have caused production losses to rice and high value agriculture. The transition to high value agriculture will provide many social benefits to local communities and households involved in the livelihood models. Construction of salinity control infrastructure in the past has been inflexible and locked farmers into development pathways. A high number of Khmer people are living in Soc Trang and Tra Vinh, the Khmer are some of the poorest households in the Mekong Delta. It is important that support and livelihood programs are provided to Khmer and other ethnic groups. The transition to aquaculture in the estuary areas will be complex as currently high value crops provide more farm-based income than aquaculture and supports employment opportunities for local people.

The mangrove-shrimp and rice-shrimp are more sustainable options for aquaculture. The development of livelihood models will need to consider the potential environmental impacts of aquaculture and shrimp farming including the release of organic wastes, agro-chemicals, antibiotics, the transmission of diseases and the ecological impact on freshwater and coastal fisheries in the Mekong Delta. In order to mitigate these environmental impacts, an integrated pest management plan (IPM) program will be implemented for each applicable subproject as a part of the ESMP. In order to mitigate these environmental impacts, an integrated pest management plan (IPM) program will be implemented for each applicable subproject as a part of the ESMP. The PMF stipulates: prohibition of the use of very toxic chemicals, and provides directions and approach for Integrated Pest Management (IPM).

## 3.2. ASSESSING "WITHOUT SUBPROJECT" AND "WITH SUBPROJECT"

This section analyses "without subproject" and "with subproject" alternatives in terms of environmental and social issues, based on the following conditions:

- "Without subproject": When the subproject will not be implemented. In the case of not doing this subproject, water scarcity is expected for production, livelihoods and domestic purposes, especially in the dry season; there are expected difficulties in travelling and impacts from climate change on the local people will occur.
- "With subproject": When the subproject will be implemented There would be construction of 3 sluice gates and piloting for moving to a brackish economy, which includes planting additional mangrove trees for ponds under the raising shirmp - forest model and conducting training and capacity building for local people on climate change and methods of sustainable production.

Results of the analyses are shown in *Table 3.1*.

*Table 3.1: Analysis of social and environmental issues under the "without subproject" and "with subproject" alternatives*

| Environmental and social issues | Alternatives | |
|---|---|---|
| | **Without subproject** | **With subproject** |
| **Environmental issues** | | |
| Water quality | Poor water quality caused by discharge of contaminated freshwater from rice paddy fields and agriculture production. | - Improved water quality through support to gain organically shrimp - mangrove certification, one of the requirements for the remaining uncertified area to meet standards for certification is the environment must be better protected.<br>- Improved water quality because the operation of 3 sluice gates will facilitate flood, acidity and alum drainage for the subproject area. |
| Impact on aquatic life | There is no migration of fish and endangered or protected species reported in the subproject area. Only normal species of low economic value are observed such as: Snakehead fish Channa micropeltes fish, Anabas, Snakeskin gourami, Philippine catfish, Pangasius catfish, etc. in the subproject area | The sluice gates will be closed for a very short period, and therefore there will not be enough time for a change from saline/brackish water to fresh water species and from open to closed ecological systems to occur. Aquatic life in the subproject area is not highly diverse, fisheries resources are of relatively low economic value, and no migratory species are present. This shows that the subproject construction will not affect or only slightly affect aquatic life and fisheries resources. |
| Change in salinity content of water resources | Saltwater will intrude very far inland, making it difficult for for the local people to cultivate rice and fruit trees, especially in the dry season. | Saltwater intrusion will be controlled for sustainable agriculture and aquaculture production in the subproject area. |
| Climate change adaptation | - The subproject is located in the coastal area that is expected to be severely affected by saltwater intrusion in the context of climate change, leading to scarcity of fresh water resources.<br>- Awareness of local people about climate change is still low.<br>- Current livelihoods are not sustainable in context of climate change. | - Local community awareness about climate change will be raised through establishment and functioning of the Commune Climate Change Response Teams.<br>- Gradual transition to sustainable livelihoods (brackish water economy) for climate change adaptation will be ensured. |

| **Social Issues** | | |
|---|---|---|
| Increase income for the local people | Income of the local people may decrease due to low water quality in the aquaculture area and lack of fresh water, and saline soil contamination in the areas of rice and fruit tree plantings. | Income of the local people increase due to:<br>- Water regulation for will help reduce losses for fruit tree areas due to salinity intrusion.<br>- Faster transportation of goods and products through the bridges over the sluce gates reduces the state of decay and/or retains freshness of the product.<br>- Mangrove-shrimp to be certified organically grown mangrove-shrimp will help increase of economic value of the product. |
| Supply freshwater for production, livelihoods, and domestic purposes | A lack of fresh water for domestic and argicultural uses in the southern part of the subproject area is expected. | Adequate fresh water will be provided by operation of the sluice gates for agricultural production, livelihoods, and domestic purposes for 300,000 people in the subproject area. |
| Filling the current land transportation gap | Transportation infrastructure in some parts of the subproject area has not been completed yet. | Construction of 3 bridges over the sluice gates will partly help fill the current land transportation gap. |
| Land acquisition and resettlement | No household will be affected by land acquisition and resettlement. | 33,997$m^2$ of land will be acquired from13 HHs including 12 HHs to be physically displaced. |
| Navigation disruption | None. | Navigation will be disrupted when the sluice gates are closed. However, the sluice gates will be open most of the time and the closing schedule for the sluice gates will be made in close consultation with local communities and the agencies responsible for waterway management. Thus, the impact of the subproject on water transportation will be low. |

## 3.3. ANALYSIS "WITH SUBPROJECT" ALTERNATIVES

*Table 3.2* presents a comparison of structure options for sluice gate design. The result shows that: (i) ***for the structural form of the sluice gates***, Alternative 1 for the technical designs would have higher adverse social and environmental impacts than Alternative 2; and (ii) ***for the structure type of the sluice gates***, Alternative 1 for the technical designs would have lower adverse environmental and social impacts than Alternative 2. Given the high cost of Alternative 2 and the fact that the negative impacts under Alternative 1 ***for the structural form of the sluice gates*** are not significant and can be mitigated, Alternative 1 should be selected. The subproject

owner will implement mitigation measures to minimize the impacts on local people and environment.

*Table 3.2: Alternatives for selecting engineering and technology options for construction of 3 sluice gates*

| No | Technical issues | Alternatives | |
|---|---|---|---|
| | | **Alternative 1** | **Alternative 2** |
| **1** | ***Structural form*** | ***In-situ reinforced concrete structures: use a steel sheet pile wall system to block water flow out of foundation pit*** | ***Precast reinforced concrete structures:piers and gate shaft (divided into segments of 2-3m) are precast reinforced concrete structures*** |
| | Advantages | - Concrete task is simple, technical and machinery requirements are at average level.<br>- Materials supply conditions are abundant. The works are not far away from the material supplies (sand, stone, cement, and steel), about 15 to 20km.<br>- Transportation conditions are convenient; it is able to carry out by means of roads or waterways. | - Construction time is short<br>- Quality of reinforced concrete members is ensured.<br>- Fabrication of the members does not depend on the weather. |
| | Disadvantages | - It is difficult to create a dry foundation pit. Water column is high (H = 6-8 m), it is required to drive steel piles to make a sheet pile wall system.<br>- Construction time is long.<br>- It is more difficult to control quality than pre-cast members in factories. | - Necessary to provide with modern construction machinery and equipment<br>- Required to have skilled workers and highly qualified technical staff<br>- Transporting and connecting the components in large amount of up to 100 tons from factories to the construction site is very difficult, required to have specialized equipment. |
| | Impacts on social and environment issues | - Construction depends much on the weather, so it is difficult to control negative impacts<br>- More negative impacts during construction phase because time and land aquisition of construction phase are more than Alternative 2 | - Less negative impacts in construction phase because time of construction period and land aquisition are less than Alternative 1 |
| | Economic issue | Low cost | High cost |
| | *Conclusion* | *Selected* | *Not selected* |

| | | | |
|---|---|---|---|
| **2** | Structure type | ***Flexible structure: Non-monolithic RC, flexible connection between Piers and bottom slab (bottom beam)*** | ***Rigid structure: Monolithic RC between Piers and Bottom slab*** |
| | Advantages | - Appropriate for designing sluices with the width of more than 20m.<br>- Ability to combine as a high load bridge is higher than Alternative 1.<br>- The volume required to construct at the same time is small and able to arrange flexibly. | - Tasks of construction, supervision, and quality control have much been experienced.<br>- It is safe in designing, managing, and operating the gates. |
| | Disadvantages | - Jointed members are required to appropriate for gate activities and to limit differential settlement.<br>- Tasks of construction, supervision, and quality control have not much been experienced for the irrigation sector, but have commonly been applied for the transport sector in Vietnam. | - Only appropriate for designing sluices with the bay width of up to 20m<br>- Ability to combine as a high load bridge is lower than alternative 2<br>- The volume required to construct at the same time is so large and not flexible. |
| | Impacts on social and environment issues | - Land aquisition of construction phase is lower than Alternative 1<br>- Lesser influence on water traffic and drainage capacity during construction than alternative 1 | - Higher impact on water traffic and drainage capacity during construction than alternative 2<br>- Higher land aquisition of construction phase is than Alternative 2 |
| | Economical issue | Investment cost is feasible. | For sluices with bay width ≥ 20m, the investment cost will be high. |
| | *Conclusion* | *Selected* | *Not Selected* |

# CHAPTER 4. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

To assess the impacts of the subproject on each biophysical component of the study area, the interactions between the subproject and biophysical components were identified, measured against baseline conditions, and characterized to determine the extent of the impact. Issue and site-specific mitigation measures to reduce impacts were also identified. Potential impacts of the subproject on each biophysical component were assessed for each phase of the subproject, including the potential for accidents and malfunctions. Impacts were assessed as significant, moderate, minor, and insignificant or negligible based on their perceived importance. Impacts on each biophysical component were characterized using the following eight descriptors:

*Direction* – refers to whether an effect on a population or resource is considered to be positive, adverse or neutral.

*Magnitude* – refers to the intensity or severity of an effect and is described as the amount of change in a measurable parameter or variable relative to baseline conditions. Magnitude is described as negligible, low, moderate or high.

*Geographic extent* – refers to the spatial area affected by an activity and is identified as site specific, local or regional.

*Duration* – refers to the length of time over which an environmental effect occurs. Duration considers the various phases of the subproject and is divided into four classifications: short term, medium, long term or far future.

*Frequency* – refers to the number of times an effect occurs over the identified phase and is described as once, intermittent or continuous.

*Reversibility* – refers to the potential for an environmental effect on a measurable parameter to be restored to the conditions that existed before the subproject. An effect is defined as irreversible if the resource element cannot be restored to the conditions that existed before the subproject, within the long term, as defined under duration.

*Seasonal timing* – refers to the specific times of year that an effect might be present or persist.

*Uncertainty* – refers to the level of understanding of the effect on the biophysical component. Uncertainty is identified as low, moderate or high.

It is noted that although the potential negative impacts of works (sluice gates) to be conducted under Components 3 of this subproject is in line with the key findings of the REA for the MDICRSL 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 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 4.4.2. As suggested by the REA, these impacts will be mitigated through the application of the Environmental Code of Practices (ECOP) which has been prepared in lien with the ESMF.

Potential negative impacts of the subproject activities during operation of sluice gates and application of the livelihood models have also been found to be moderate and they can be mitigated through a technical assistance to be provided during the preparation and implementation of the livelihood development models (Componement 1 of this subproject). The technical assistance will also address the need for extensive consultation with water users

and key staekholders during the development of sluice operations and possible impacts due to expansion of aquaculture faring and the livelihood model without adequate management and control.

## 4.1. POSITIVE IMPACTS

### *Positive impacts from construction 3 sluice gates*

Building 3 sluice gates will bring positive impacts for the subproject areas as follows:

***Improving regulation of freshwater supply and salinity intrusion.*** When the subproject is completed and put into operation, the effects on saltwater intrusion and inundation due to flood tide controls are positive. Under the regulatory activities of the sluice gates, the intrusion of salinity into inland canals and rivers will be limited. In addition, when the sluice gates supply adequate freshwater for usage, they will reduce the salinity in the rivers and canals in the subproject area.

***Enhancing biological resources and biodiversity.*** When the in-field canal system is supplied with adequate freshwater and suitable farming methods are applied, there will a contribution to the growth of freshwater species (eg. Snakehead fish, Channa micropeltes fish, Anabas, Snakeskin gourami, Philippine catfish, Pangasius catfish, etc.) and agricultural biological diversity (e.g. diversity of crops and livestocks). There also will be reduced use of fertilizers and pesticides as well as chemicals used in aquaculture. As such, the quality of the environment is expected to improve. Improved biological resources and biodiversity also enhance the livelihood solutions for people shifting to sustainable farming methods.

***Contributing to economic development.*** Salinity control and irrigation will be provided for 225,682 ha of land (including 49,020 ha in Vinh Long and 176,662 ha in Tra Vinh). This scenario will help to provide water, drainage, alluvium, deacidification, and alkaline wash to serve agricultural and aquaculture production for 171,662 ha of arable land of Vinh Long and Tra Vinh provinces. Furthermore, diversification of crops and livestock would lead to creation of more jobs and an increase in income for the people in the subproject area.

***Ensuring social development.*** Subproject implementation will include development plans to help the population in the subproject area, including: (i) Building bridges over the sluice gates to improve the road network of the suproject communes and districts. Particularly, in the Tan Dinh and Bong Bot area, people often travel across the river by ferry, which is time-consuming. When the bridges over the Tan Dinh and Bong Bot sluicegates are completed, travel from Vung Liem district to Cau Ke district and vice-versa as well as to other districts of Tra Vinh and Vinh Long provinces will be more convenient. Freight transportation also will be faster which will result in cost reductions. For example, in the Mekong Delta, fruit growing and trading are important agricultural activities and reduced transport time will result in fresher fruits arriving at the market and these will command a better price for the farmer; (ii) improving people's access to services such as health care and schools due to improved transport conditions. Hence, people can take advantage of healthcare services, schools, and markets easier, particularly children and women; (iii) Contributing to the connection of the geographical regions, facilitating the exchange of cultural activities, participation in the great festivals of the people in the region' and (iv) More than 60% of the subproject communes still use river water for cooking and other domestic purposes, so the freshwater reserves will supply water and improve drinking water for the people;

### *Positive impacts from supporting to organically certified mangrove-shrimp, raising aquaculture toward bio-diversity and other non-strutural measures*

***Increasing capacity of climate change adaptation***. The subproject objective of up-scaling organically certified mangrove-shrimp in Tra Vinh is to simultaneously raise capacity of

climate change adaptation outcome through a market driven sustainable livelihood. It does this by increasing farmer incentives to invest in increasing mangrove cover to a minimum of 50 % of tree cover on their farms. In addition, establisment of Climate Change Response Teams and conducting campain to raising awareness of local people on impact of climate change will contribute to increasing capacity of climate change adaptation.

***Increasing income of local people***. In Tra Vinh province, profits from non-certified mangrove-shrimp systems are approximately 21 million VND/ha and by obtaining organic certification, similar farms are able to increase profits by between 7 and 10 million VND/ha, representing a 20% increase. In addition, forming new cooperatives, or implementing through existing cooperatives, will help to instill farmer confidence through collective risk sharing, particularly with risk-averse farmers that are unwilling to adopt the new adaptation models. Cooperatives can play an important role in helping farmers to manage production, post-harvest, and market risks. For example, the cooperative can bulk buy high quality seed at discount prices which an individual farmer may not have the knowledge or financial capacity to do so. Post harvest risks can be reduced by sharing post harvest equipment such as refrigeration for aquaculture products which would not be available to individual farmers. Market risks can be better managed through better access to market prices, collective bargaining, bulk/contract selling, etc.

## 4.2. POTIENTIAL NEGATIVE IMPACTS

Based on the screening using the forms provided in the ESMF, analysis of baseline data, field visits, and discussions with key officials and stakeholders and the affected people, the potential negative impacts on the physical, biological, and socio-economic environment caused by the subproject are assessed as small to moderate (*Table 4.1*). In particular, the subproject does not have any direct impact on historical and cultural monuments, religious, school and health facilities during the land acquisition and construction and operation processes.

In the construction areas of 3 sluice gates, there are few houses surrounding Vung Liem and Bong Bot sluice gates (*Figure 1.7, Figure 1.8, Figure 4.1* and *Figure 4.2*), especially there are no houses at Tan Dinh sluice gate site (*Figure 1.6* and *Figure 4.3*). There are also no important historical and cultural sites identified in the subproject construction sites. There are two sites, An Tinh and Hung Giao temples located about 280 meters to Bong Bot sluice gate. As stated above, Vung Liem, Tan Dinh River, and Bong Bot canal are used for the purpose of agriculture, waterway transport activities. Fishing is prohibited in the rivers and canal, however, there are some fishermen still use nets to catch fish and some place traps along the two river/canal banks to catch fish for their daily lives. Therefore, building 3 sluices on these rivers and canal will affect the activities listed above.

At the locations of mangrove - shrimp models for additional mangrove planting to achieve requirements of ecofarming certification, there are mainly water surface land and agricultural land, and few houses. Reforestation will take place in the existing aquaculture ponds, and mangrove trees (*Rhizophora*) will be planted by putting about one-third of the seed length into the mud. Therefore, the impact of reforestation is very low.

The demonstration sites will be located at the existing ponds, so there is no need to dig new ponds or build new infrastructure for the demonstrations, only cleaning out the mud layer on the bottom of the ponds. Given that very few people live around the demonstration sites, impacts on the local environment and people in this phase is low.

Type and scale of impacts due to subproject implementation are identified and assessed in detail in the following sections.


*Figure 4.1: Landscape around the construction area of Vung Liem sluice gate*

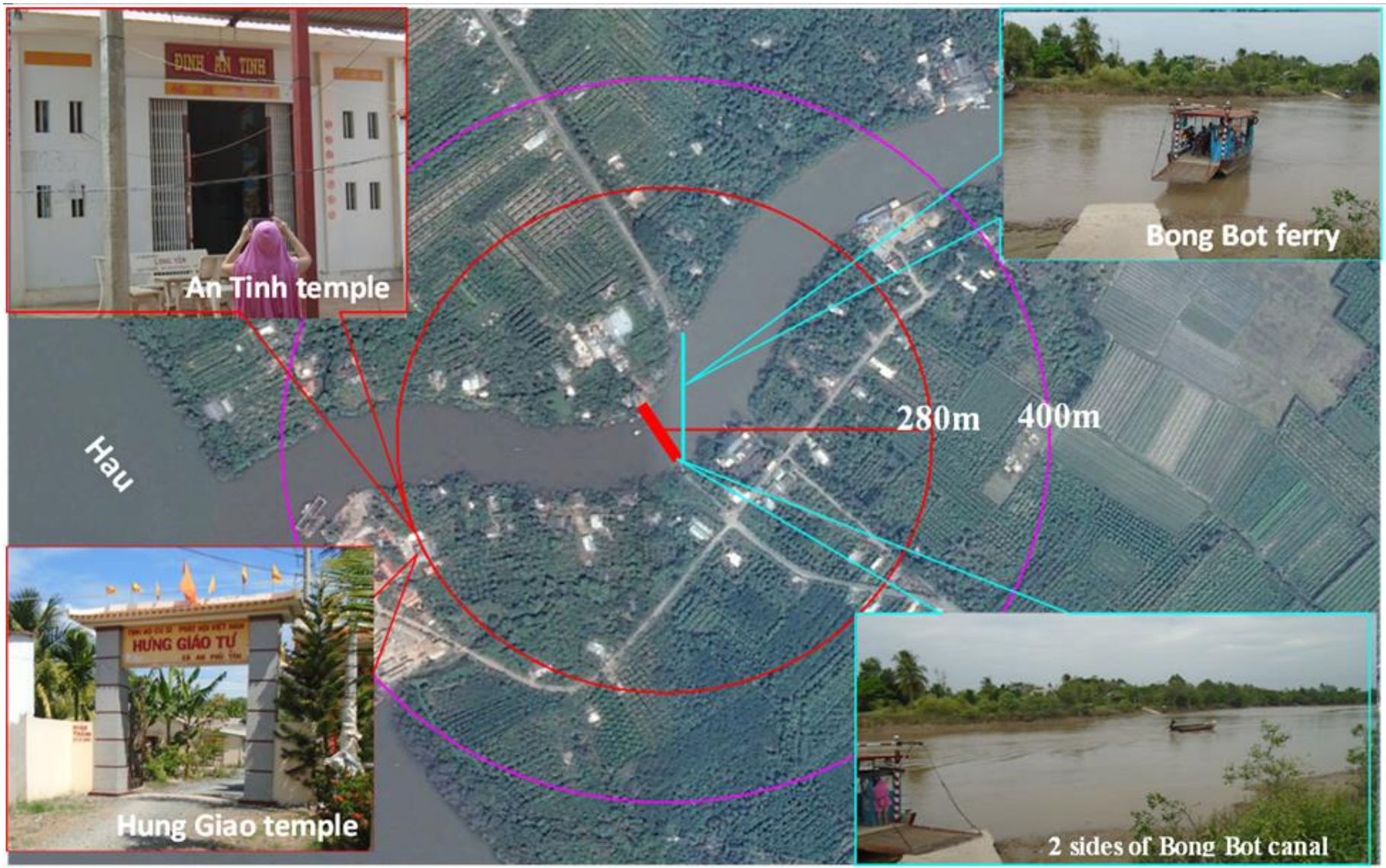



*Figure 4.2: Landscape around the construction area of Bong Bot sluice gate*

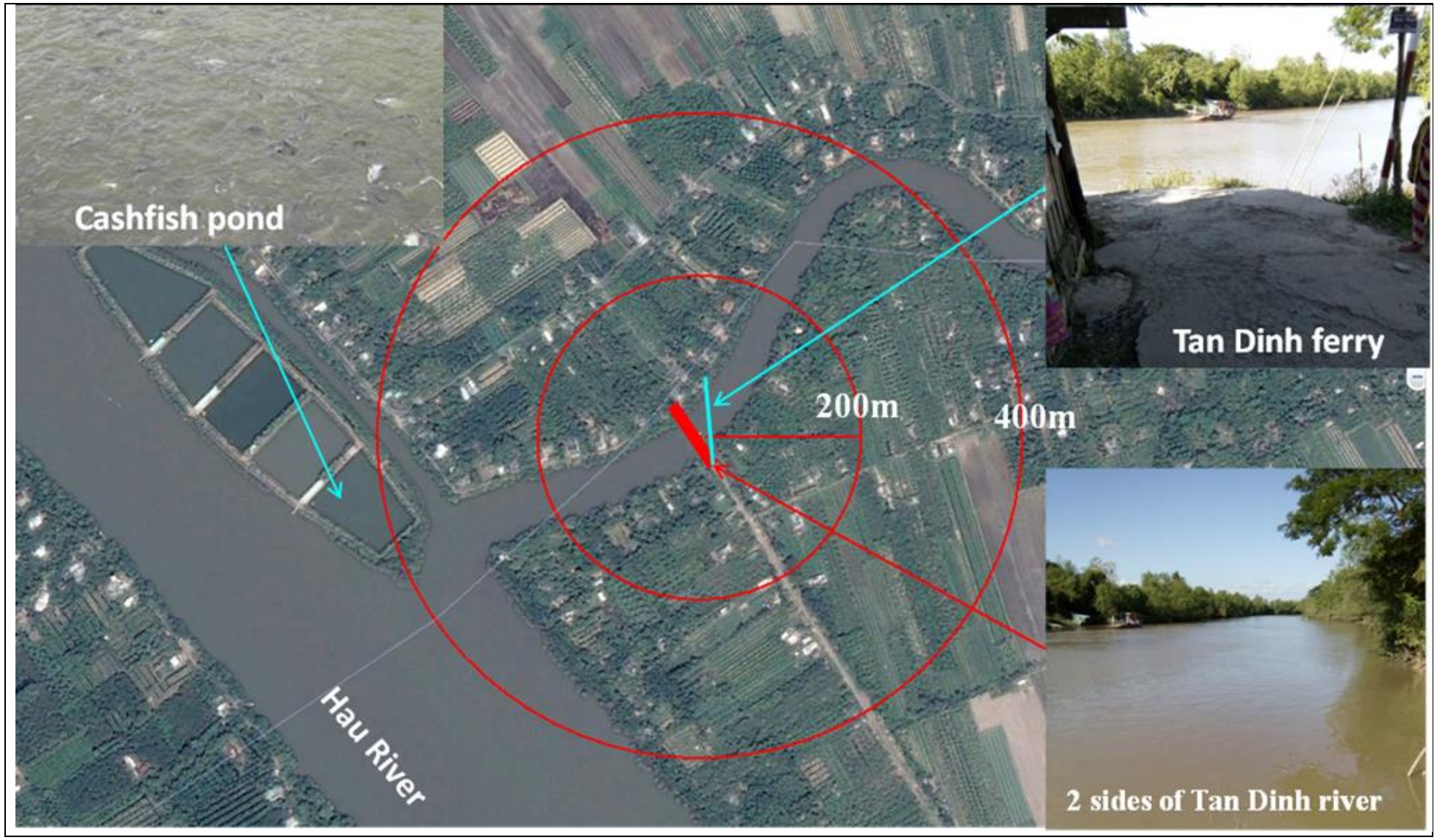



*Figure 4.3: Landscape around the construction area of Tan Dinh sluice gate*

*Table 4.1: Matrix of impacts of the subproject*

| Stage of the project | Physical Environment | | | Biological Resources | | Socio-Economics Environment | | | | Others* | | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Air, noise and vibration | Water and soil | Solid and sludge wastes | Natural forest ecosystem | Fisheries and aquatic organisms | Land acquisition and resettlement | Indigenous People | Physical Cultural Resources | Livelihoods | Waterway Transportation | Impacts due to work site | |
| **Construction of 3 sluice gates** | | | | | | | | | | | | |
| **Pre-construction stage** | L | L | L | L | N | M | N | N | L | L | M | Causes of the impacts include: preparation of materials yard, worker camp and space for construction including land acquisition and relocation of 12households. |
| **Construction stage** | M | M | M | L | M | L | N | N | L | M | M | Construction activities may increase level of air, noise, vibration, wastes, and water/sediment and disturbance to local residents and disruption of waterways transport. |
| **Operation stage** | L | L | L | L | L | N | N | N | L | M | N | Impacts on water environment and/or waterways transportation may occur if sluices are not operated effectively and/or local peoples are not aware of its closing schedule. Provincial actions on road safety will help reduce road accidents. |
| **Piloting Mangrove shrimp to certified organically mangrove shrimp** | | | | | | | | | | | | |
| **Pre-construction stage** | N | N | N | N | N | N | N | N | N | N | N | |
| **Construction stage** | N | L | N | L | N | N | N | N | N | N | N | |
| **Operation stage** | N | L | L | N | N | N | N | N | N | L | L | |
| **Piloting climate resilience sustainable aquaculture models** | | | | | | | | | | | | |
| **Pre-construction stage** | N | N | N | N | N | N | N | N | N | N | N | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction stage** | N | N | L | N | L | N | N | N | N | N | N | |
| **Operation stage** | N | M | M | M | N | N | N | N | M | L | L | |
| Notes (1): * means other impacts on local residents; (2) N =No impact; L =Small (very small- scale, localized and temporary impacts); M= Moderate impacts (Medium-scale, reversible impacts that can be solved by applying prevention and management measures; and H = Significant Impact (large scale, irreversible, unprecedented). | | | | | | | | | | | | |

## 4.3. IMPACT OF CLIMATE CHANGE AND CHANGE IN UPSTREAM AREA TO THE SUBPROJECT

Salinity in the main rivers mainly depends on tide and flow in the upstream area. According to the simulation scenarios with the MIKE model, salinity will significantly change and intrude when sea level rises, reducing the upstream flow, as follows:

- Salinity intrusion will be higher in the case of changes to the upstream conditions. Impacts of climate change on salinity of the estuaries are almost the same. However, should the upstream flow change, it will cause significant impacts on the Hau River due to salinity intrusion where the Bong Bot and Tan Dinh sluice gates are expected to be constructed.
- Under the current conditions, the system in Tra Vinh is controlling salinity intrusion quite well. In the context of climate change to 2100, the salinity control system of Tra Vinh province will also be affected; salinity will pass the expected sluice gates and enter the subproject area, particularly at the Bong Bot sluice gate.
- When taking into consideration both climate change and reduced upstream flow, the sluice gate system of the subproject is still effective in preventing salinity intrusion, except for the area of the Hau River. If upstream flow decreases quickly, the area surrounding the Hau River will be affected most significantly; salinity can pass the Tan Dinh sluicegate and enter the northern part of the project area through open canals.

## 4.4. IMPACT ASSESSMENT FOR THREE SLUICE GATES (ZONE 3b)

### *During pre-construction phase*

The activities in the pre-construction phase includes: (i) land acquisition; and (ii) land clearance. *Table 4.2* presents impacts and sources of impacts, as well as the scale of impact which may occur in the pre-construction period.

*Table 4.2. Impacts during pre-construction phase*

| No | Source of impacts | Impacts | Affected objects | Significance and duration of impacts |
|---|---|---|---|---|
| *1.* | *Impact sources related to waste* | | | |
| 1.1 | Clearance | – Dust generated from land clearance.<br>– Emissions generated from construction vehicles.<br>– Risks of UXO | Air, soil, surface water in the area of land acquisition.<br><br>Workers and local people | Low, short term, can be mitigated<br><br>Moderate, short term and can be mitigated |
| 1.2 | Worker activities | – Domestic waste water.<br>– Domestic solid waste. | Air, soil, surface water in the workers' camp. | Low, short term, can be mitigated. |
| 1.3 | Maintenance of vehicles and machinery | – Waste water.<br>– Used oil. | Air, soil, surface water in the area of land acquisition. | Low, short term, can be mitigated. |
| 2 | *Impact sources not-related to waste* | | | |
| 2.1 | Clearance | – Affect on the lives of displaced people.<br>– Conflicts between people in the | - Affected people<br><br>– Local community in the subproject area | – Moderate, long term, can be mitigated.<br>– Low, long term can be mitigated. |

| | | | | |
|---|---|---|---|---|
| | | construction area and investors.<br>- Noise, vibration from machinery | - Workes and local people | - Low, short term can be mitegated. |
| 2.2 | Vehicles, machinery | Noise and vibration from machinery, vehicles | Workers and local peole | Low, short term can be mitigated. |
| 2.3 | Concentration of workers at the subproject site | - Affect on local economic – social condition.<br>- Possibility of generating a number of diseases and social problems caused by the workers. | Local social and economic environment<br><br>Local people | Low, long term can be mitigated. |

#### *4.4.1.1. Impact assessment of land acquisition*

There are two types of land acquisition to serve the subproject, being permanent and temporary acquisition. Permanently acquired land is the area required for the sluice gate system. Temporarily acquired land is the area that will be used for the purposes of (i) construction material storage; (ii) waste storage area, (iii) equipment storage and (iv) small workers' camp. After completion of the works, the temporarily acquired area shall be returned to the local people/ communities.

Only construction of the 3 sluices Bong Bot, Tan Dinh, Vung Liem requires land acquisition that affects the residents around the construction sites. According to the inventory of losses, there are 13 affected household (AH)s including 12 household (HH)s to be physically displaced; none of them belongs to ethnic minority people. Permanently acquired land is about 17,734 $m^2$ of production land and 3,190 $m^2$ of residential land. The area of temporary land acquisition is 16,243 $m^2$ (*Table 4.3*).

*Table 4.3. Summary of estimated land acquisition impacts of 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 ($m^2$) | Residential land acquisition ($m^2$) | No. of affected graves | No. of AH | Land acquisition ($m^2$) |
| 13 | 0 | 13 | 12 | 17,734 | 3,190 | 5 | 2 | 16,243 |

- Impacts on land: the subproject will permanently acquire 17,734 $m^2$ of production land and 3,190 $m^2$ of residential land; and will temporarily acquire 16,243 $m^2$ of production land in 4 communes of the subproject. The total of land acquired permanently of the whole subproject is 20,924 $m^2$. The types of land affected include residential land, garden land, and aquaculture land. Details of the affected land types is showed in *Table 4.4*. Of the total 20,924 $m^2$ of land permanently acquired, as noted, 3,190 $m^2$ is residential land (accounting for 15.2% of the total of permanent land acquisition) and 17,610 $m^2$ is garden land. The area of aquaculture land is very small in comparison with the total of permanent land acquisition, accounting for only 0.6%.
- Impacts on structures and assets on acquired lands: 12 HHs must be physically displaced due to the loss of their houses and their remaining land is not large enough for resettlement. The types of affected houses are houses that have brick walls and concrete roof, houses with

brick walls and tile roof, and temporary houses constructed of bamboo and leaves. The total house area is 1,185 $m^2$ (

- *Table 4.5*). Besides, AH structures, including kitchens, bathrooms, toilets, livestock raising facilities, concreted yards, and tanks also are affected. Details of the affected structures are shown in *Table 4.6*.
- Impacts on trees: A large number and variety of trees, including fruit trees, timbers, and ornamenetals, that are located on the garden land areas of HHs would be impacted by construction activities. Details of the affected trees by types and locations are shown in
- *Table* 4.7.
- Impact on cultural, historical and public works in the subproject area: The subproject does not have any direct impacts on historical and cultural monuments, religious, school and health facilities in association with the land acquisition process.
- Psychological impacts on subproject affected people: apart from land loss and relocation as described above, 5 graves may also be displaced, which would cause negative reactions from the affected households. According to Vietnamese customs, it is a taboo to relocate the graves of their grandparents, parents and relatives, etc.

Conclusion: Land acquisition for the implementation of the subproject is expected to cause some adverse impacts on the lives of people in the area which can be assessed as *moderate*. Permanent loss of land will qualify under the appropriate compensation policy to support a stable livelihood. After completion of the works, the temporarily acquired area shall be returned to the people/local communities.

***Impacts of grave relocation:*** According to the survey, to provide land for the subproject, there are 5 graves will be relocated. To Vietnamese people, grave is the spiritual matters which should be respected carefully. Household and individual graves are considered physical cultural resources (PCR), and the Bnak's OP/BP 4.11 applies for this subproject. However, this is not a very big problem, people are still willing to move the graves to another location to give land for construction if the subproject owner supports sufficiently to ensure the grave relocation. The level of this impact caused by this activity is only small and localized.

*Table 4.4. Scope of land acquisition*

| No. | Province | District | Commune | No. of AHs | Permanent production land acquisition ($m^2$) | Permanent residential land acquisition ($m^2$) | Temporary production land acquisition ($m^2$) |
|---|---|---|---|---|---|---|---|
| 1 | Tra Vinh | Cau Ke | An Phu Tan | 4 | 3,900 | 1,200 | 6,500 |
| 2 | Vinh Long | Tra On | Tich Thien | 4 | 4,500 | 690 | 1,128 |
| 3 | Vinh Long | Vung Liem | Trung Thanh Dong | 2 | 4,675 | 400 | 3,715 |
| 4 | Vinh Long | Vung Liem | Trung Thanh Tay | 3 | 4,659 | 900 | 4,900 |
| **Total** | | | | **13** | **17,734** | **3,190** | **16,243** |

*Table 4.5. Condition of affected houses*

| No. | Province | District | Commune | House with brick wall, concrete roof | House with brick wall, tile roof | Temporary house by bamboos, leaves | Total | Area |
|---|---|---|---|---|---|---|---|---|

| | | | | HH | m² | HH | m² | HH | m² | HH | m² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Tra Vinh | Cau Ke | An Phu Tan | 1 | 210 | 2 | 150 | 1 | 50 | 4 | 410 |
| 2 | Vinh Long | Tra On | Tich Thien | 0 | 0 | 2 | 220 | 1 | 90 | 3 | 310 |
| 3 | Vinh Long | Vung Liem | Trung Thanh Dong | 0 | 0 | 2 | 240 | 0 | 0 | 2 | 240 |
| 4 | Vinh Long | Vung Liem | Trung Thanh Tay | 1 | 35 | 2 | 190 | 0 | 0 | 3 | 225 |
| | | **Total** | | **2** | **245** | **8** | **800** | **2** | **140** | **12** | **1185** |

*Table 4.6. Affected structures of households*

| No. | Structure | Unit | Commune | | | |
|---|---|---|---|---|---|---|
| | | | An Phu Tan | Tich Thien | Trung Thanh Dong | Trung Thanh Tay |
| 1 | Kitchen | m² | | 50 | 30 | |
| 2 | Electricity meter | set | 4 | 2 | 2 | 3 |
| 3 | Water meter | set | 2 | 40 | 1 | |
| 4 | Fence | m² | 150 | | | |
| 5 | Toilets | m² | 20 | | 4 | |
| 6 | Concreted yard | m² | 40 | | 20 | 35 |
| 7 | Livestock cages | m² | | 40 | 20 | 30 |
| 8 | Fish pond | m³ | | | 42.5 | 30 |
| 9 | Soil graves | set | | | | 5 |
| 10 | Water tank | set | | | | 16 |

*Table 4.7. Affected trees of households*

| No. | Structure | Unit | Commune | | | |
|---|---|---|---|---|---|---|
| | | | An Phu Tan | Tich Thien | Trung Thanh Dong | Trung Thanh Tay |
| 1 | Coconut | tree | 50 | 200 | 67 | 100 |
| 2 | Banana | tree | 180 | 300 | 105 | 130 |
| 3 | Longan | tree | 80 | 70 | | |
| 4 | Mangosteen | tree | | 120 | | |
| 5 | Mango | tree | | 50 | 40 | 4 |
| 6 | Jackfruit | tree | | 50 | 26 | |
| 7 | Mulberry | tree | | | 80 | |
| 8 | Hopea odorata | tree | | | 180 | |
| 9 | Ornamental tree | tree | | | 50 | |
| 10 | Apricot | tree | | | 40 | 10 |
| 11 | Bamboo | tree | | | | 2 |

#### *4.4.1.2. Impact assessment of dust, gaseous emissions and solid waste generation*

Using equipment and workers to demolish the existing houses, other assets, cutting trees, plants and removing graves will cause some impacts on environmental quality due to: (i) noise, vibration, air emission and waste from demolition; and (ii) wastes from the workers.

It is estimated that demolition of houses and other structures for the subproject will generate about of 30m$^3$ of demolished materials of concrete, bricks, wood, tiles, etc and a biomass of 1934 trees, spreading over 4 communes during 15 days in total (be done in form of “rolling”).

The number of workers in this acitvity is only 3-4 people and these are local people. Engine saw, boat, truck and bulldozer will be used for this activity.

Most of the 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.

These conditions result in the subproject having minor land clearance activities and therefore the emission of dust, gases as well as solid waste generation during this pre-construction phase will be limited.

Conclusion: Impacts of pollution caused by the subproject during the construction phase should lead to a *small negative impact*, because the subproject requires little land acquisition or clearance and in addition the construction area is rural with a small population.

#### *4.4.1.3. Impacts due to unexploded ordnances (UXOs)*

Because the subproject is located in an area that was affected by military operations during the war period, it is necessary to clear any remaining UXOs to avoid the potential threat to the works and safety for local people and workers. For the subproject components, UXOs need to be carefully considered and removed before construction activities can commence.

Conclusions: The risk of UXOs in the project area is *moderate* if mitigation measures are not applied, with high risk to human health, life, and also infrastructure. UXO removal must be completed before starting civil works.

### *During construction phase*

#### *4.4.1.4. Identifying source of impacts*

As described in Section 1.4.5, the subproject does not require opening of new borrow pits or quarries but rather, brings in construction materials from Tra Vinh, Can Tho and Tien Giang provinces by waterway transportation; therefore, the main activities in the construction phase include: (i) soil excavation; (ii) transportation of construction materials, vehicles, equipment, machinery; (iii) construction of sluice gates, sluice gate management houses and bridges over the sluice gates; (iv) construcion of approach roads and worker camps on the construction sites.

During construction phase, potential negative impacts on the local environment and the community will include increases in air pollution, noise, vibration, water pollution, waste generation, land and waterway transport traffic safety, safety risks, and potential disturbance to local residents and other social impacts. The main sources of impacts will be due excavation of soil, rock and concrete; construction of sluice gates; transportation of materials and construction equipment; installation of structural bridges and sluice gates; and activities of contractor officers and workers at the work site and/or work camp. However, these impacts are considered moderate and most of them are temporary, localized and can be mitigated through effective implementation of good construction management practices (*Table 4.8*).

*Table 4.8: Impacts during construction phase*

| No | Source of impacts | Impacts | Affected objects | Scale of impacts |
|---|---|---|---|---|
| *1.* | *Impact sources related to waste* | | | |
| 1.1 | Material transportatation | Dust, emissions from embanking, material Transportation and machinery. | Air, soil and water resources and local people along the transportation route. | Moderate, temporary, can be mitigated via good management and construction practices. |

| | | | | |
|---|---|---|---|---|
| 1.2 | Worker activities | - Domestic waste water.<br>- Domestic solid waste. | Air, soil, water resources, and local people near worker camps. | Low, temporary, can be mitigated via good management and construction practices. |
| 1.3 | Operation of vehicle and machinery | - Construction waste water.<br>- Construction solid waste and hazardous waste. | Air, soil, water resources of Vung Liem, Tan Dinh rivers and Bong Bot canal and local people near construction sites. | Moderate, temporary, can be mitigated via good management and construction practices |
| 1.4 | Maintenance of vehicle and machinery | Waste oil. | Soil and water near construction sites. | Low, short term, can be mitigated. |
| 2 | *Impact sources not-related to waste* | | | |
| 2.1 | Soil excavation | - Disturbance of bottom habitats in Vung Liem, Tan Dinh rivers and Bong Bot canal<br>- Increase suspended solids | - Water quality of Vung Liem, Tan Dinh rivers and Bong Bot canal<br>- Aquatic life of Vung Liem, Tan Dinh rivers and Bong Bot canal | Low, short term, can be mitigated. |
| 2.2 | Vehicles, machinery | Noise and vibration from machinery, vehicles. | Air and local people near construction camps | Low, short term, can be controlled |
| 2.3 | Concentrated workers at the subproject site | - Affect on local economic – social condition.<br>- The ability in generating a number of diseases and social problems caused by the workers.<br>- Disturbance to local people. | Local people and authorities near worker camps. | Moderate, short term, can be mitigated. |
| 2.4 | Drainage and traffic | - Drainage issue due to rainwater runoff.<br>- Navigation due to water diversion during construction. | Soil, water resources and local people near construction sites. | Moderate, short term, can be mitigated. |
| 2.5 | Risks | - Oil and harzadous spills.<br>- Waterway accidents, accidents in construction site.<br>- Occupational safety and health for workers. | Soil, water resources and local people near construction sites and along the material transportation route. | Moderate, short term, can be mitigated. |

#### *4.4.1.5. Impact assessment with impact sources not related to waste*

*a). Noise and vibration pollution*

Noise generated from the construction activities includes noise from operation of equipment, machines, as well as transportation vehicles. The main construction machinery and equipment to be mobilized include excavator, dozer, tamping machine, bucket excavator, concrete mixing machinery, and trucks.

The level of noise depends on the kinds machinery and particular construction activities on the sites. In fact, mobilization of noise generation equipment will deeply rely on the construction activities undertaken on the site, which means that all above equipment will not be mobilised at the same time. Results from baseline monitoring show that ambient noise levels were lower than permitted levels as stated in QCVN 26/BTNMT – national technical regulation for noise pollution (see section 2.1.5.1). Therefore, impacts of noise from construction activities should take into account the resonance from different sources.

Noises generated from machines working independently are listed in *Table 4.9*. However, noise levels at construction sites are usually generated at least from two types of equipment operating at the same time. The noise level is identified as following [*Pham Ngoc Dang, 2003*]:

$$L_{\sum} = 10 \lg \sum_{i}^{n} 10^{0,1.Li}$$

In which:

- ΔL : reduction of noise at distance $r_2$ compared with source $r_1$;
- distance for noise source normally considered as $r_1$= 8 m;
- a: noise absorbtion of area

*Table 4.9: Noise levels (dB) from construction equipment at a distance of 8 m*

| ***Equipment*** | ***Noise Level*** | ***Equipment*** | ***Noise Level*** | ***Equipment*** | ***Noise Level*** |
|---|---|---|---|---|---|
| Bulldozer | 80 | Welding Machine | 74-88 | Concrete Pump | 82 |
| Excavator | 72-93 | Vertical drilling | 88 | Trucks | 88 |
| Concrete Mixer | 81-84 | Jack Hammer | 80-93 | | |
| Steel cutting | 84 | Steel bending | 84 | | |

Source: USA EP, noise levels of construction machines, p. 300, 1, 1971

However, given the number of machines mobilised at the same time will be limited, calculated results of noise during the construction phase are shown in *Figure 4.4* and *Figure 4.5*. For the noise sources, the biggest noise source is from pile driving. Noise levels at a location 100 meters from this source is less than the limit.

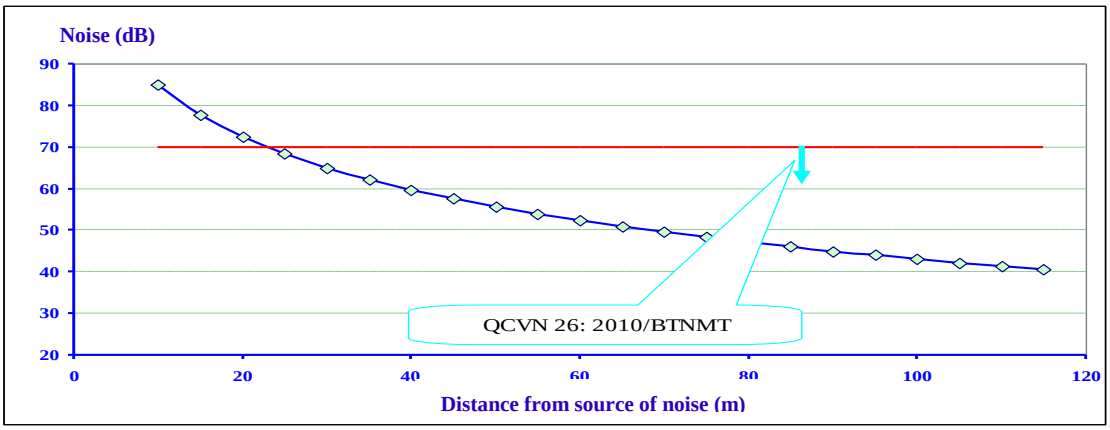



*Figure 4.4: Attenuation of construction noise from concrete mixing over distance*

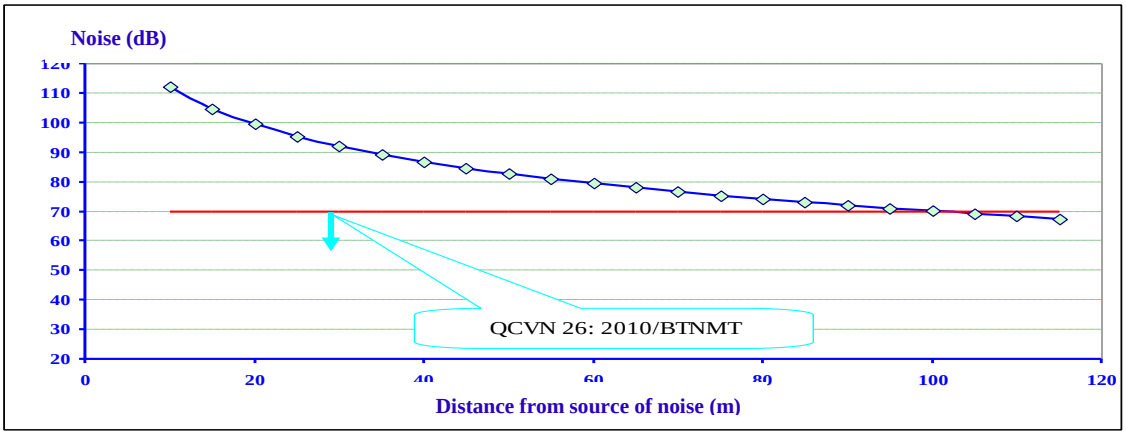



*Figure 4.5: Attenuation of construction noise from pile driving over distance*

As metioned above, no houses are located within 100m from the construction sites of Tan Dinh sluice gate, and there have sparsely only 10 and 17 houses within 100m from the construction site of Vung Liem and Tan Dinh sluice gates, perspectively (*Figure 4.6* and *Figure 4.7*), the impact is moderate but construction occurs only for a short time and contractors need to consider several noise mitigation measures to control noise, especially from pile driving.

Conclusions: The impacts of noise caused by construction of the subproject are considered as *moderate negative impacts*, and there needs to be strict compliance with proposed mitigation measures during the construction phase.

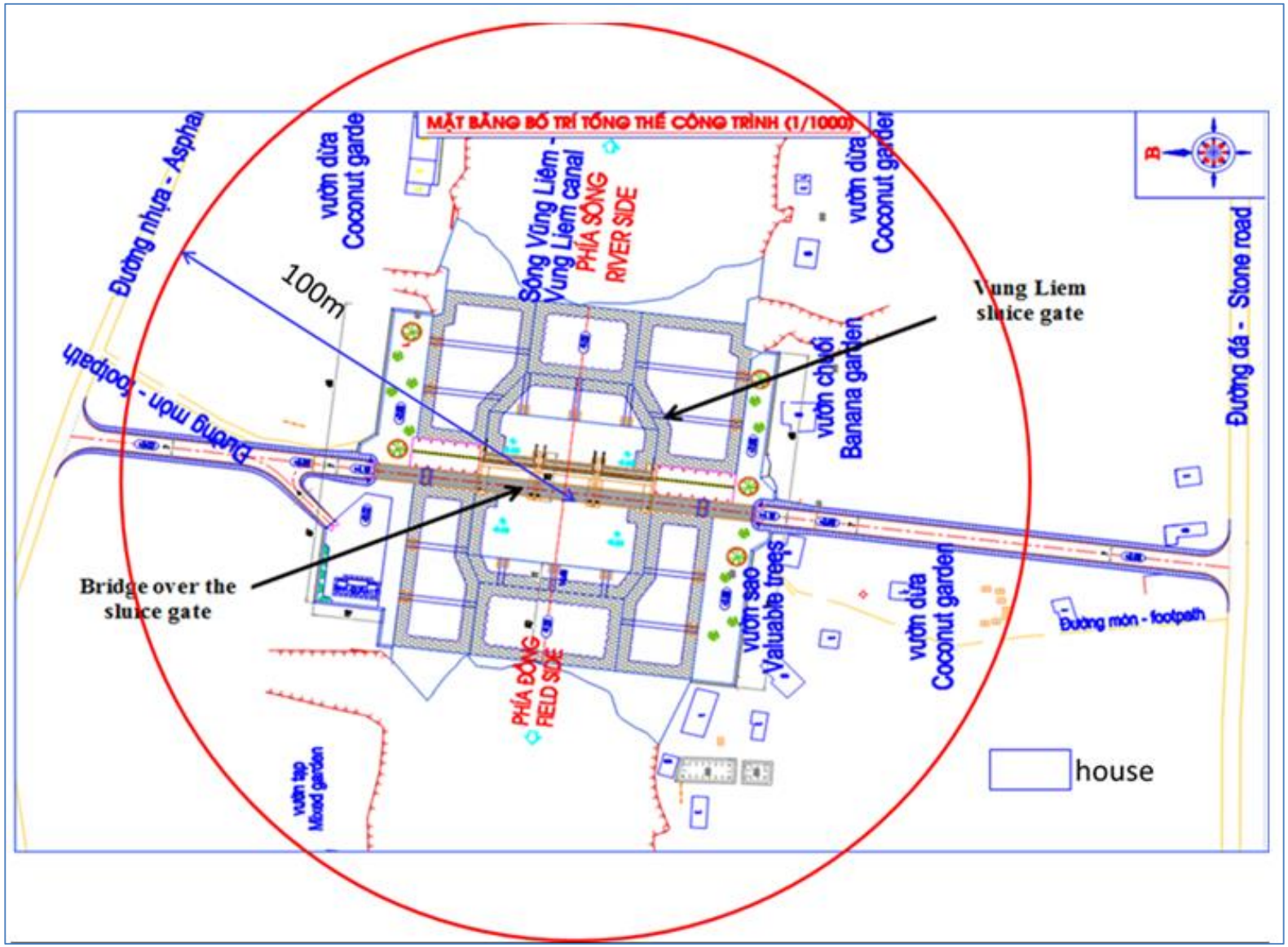



*Figure 4.6: Houses within 100m from the construction site of Vung Liem*

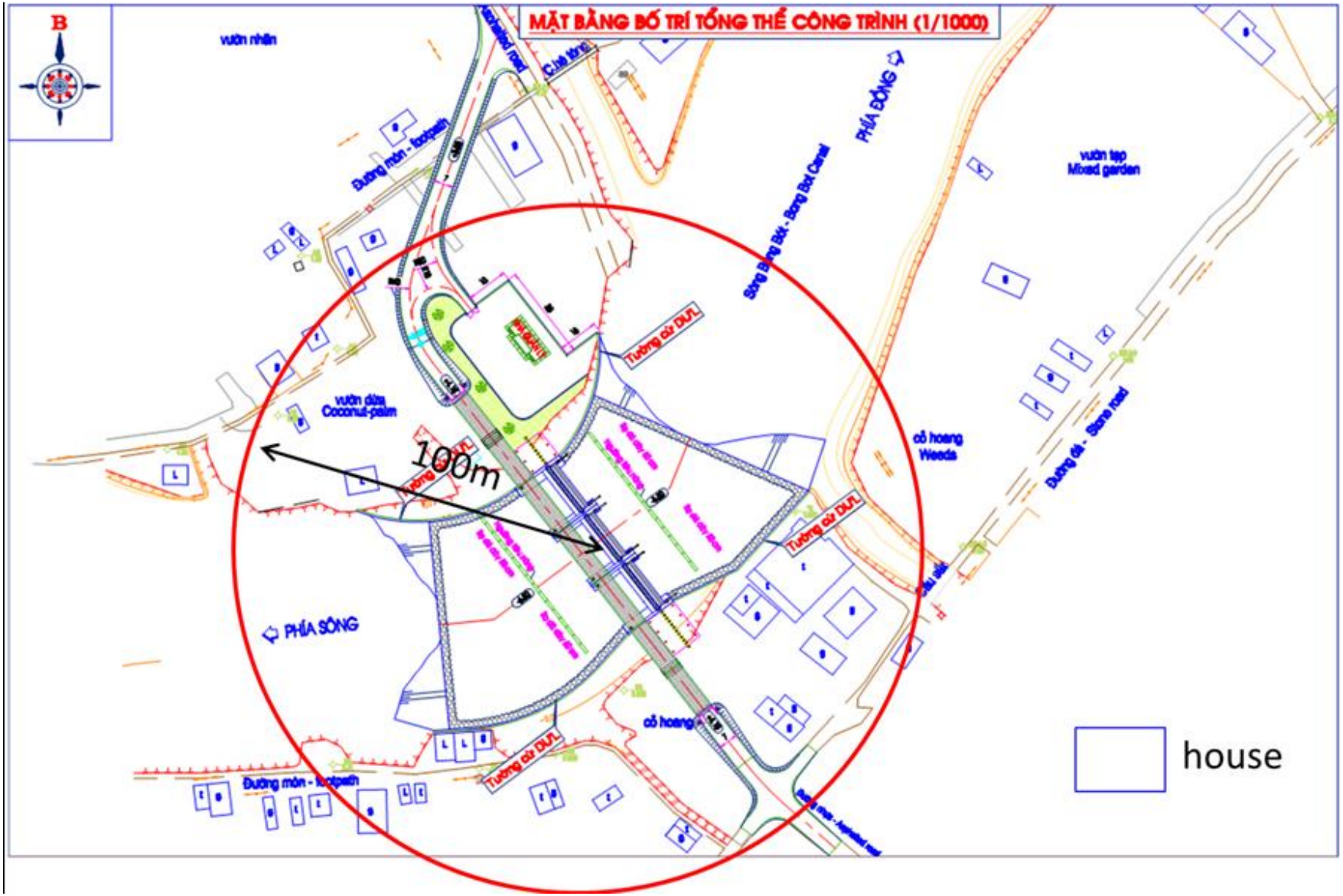



*Figure 4.7: Houses within 100m from the construction site of Bong Bot*

*b). Economic and social conditions*

**Impacts due to worker concentration**. It is estimated that there will be three worker camps established with 65 - 80 workers each during the peak periods. The main social problems could be listed as: (i) potential impact of spreading infectious disease from employees to local communities and vice versa; (ii) potential impact of prostitution, drugs and gambling; (iii) potential conflict between workers and local communities because of differences of culture, behavior; (iv) communities could be at risk if they travel around or are close to the construction sites and potentially exposed to accidents. However, with the shortage of labor for the construction, local workers in the city will have the opportunity to participate in the construction. The vendors and supermarkets near the construction will also benefit during subproject implementation.

Conclusions: It is considered that there will be *moderate negative impacts* to local communities, and the subproject requires appropropriate management at construction sites to avoid undesirable impacts.

**Impact on waterway navigation.** Inland water network/navigation is one of the strengths of Tra Vinh and Vinh Long province with system of the Mang Thit river and the Hau river contributing to create trade opportunities within the nation and more specifically, the entire Mekong River Delta region. The canal systems, from primary canals to tertiery cannals, are equally distributed in Tra Vinh and Vinh Long province and facilitate inland waterway transportation. Therefore, during the construction phase, acitivies of material transport by boats and construction on the Vung Liem river, Tan Dinh river and Bong Bot canal will lead to disturbances of inland waterway activities.

As mentioned above, with the soil for filling and other materials for the subproject construction, the total material shipments will be about 200 trips over 2 month period, or about 3-4 trips per day on average. Given this average increase of 3-4 trips per day, increasing 200 trips of vessels for the entire construction period would not be a major issue affecting the environment and/or existing waterways traffic. Transportation of construction materials will be minimized as much as possible.

The sluices will have two to three gates, and the construction activities will be carried out within steel sheet walls in the river/canal bed. Sluicegate construction is divided into two to three batches; therefore, when the later batch is carried out, flow is led through the construction work that has been completed in the previous batch. This activity will partly narrow Bong Bot canal, Tan Dinh and Vung Liem cross sections. In addition the concentration of a number of vehicles and equipment on the rivers and canal to serve the construction will increase, and the waterways will be affected. The speed of vehicles passing through the rivers and canal during the construction period will be limited and at times, these vehicles may have to travel by other rivers and canals.

**Impact on operation of 2 ferries of Tan Dinh and Bong Bot**. During the construction, the brigdes over these sluice gates have not been finished yet, so the local people will need to use the 2 ferries for their travel, so there no need to remove these ferries. However, construction of the 2 sluice gates and the bridge will impact on safety of the operation of these ferries due to construction activites requiring relocation of one terminal of each ferry to new locations.

Conclusion: As metioned above, there have about 400 - 700 people/day using each ferry. Unsafety of ferries operation will impact on local people's lives and travel. These impacts are *considerate moderate*. The contractors should set up 2 new terminals of 2 ferries for local travel and arrange the speedboat control to ensure safety for the 2 ferries operation.

**Impact on fishermen**. Construction sluice gates will partly narrow the cross sections of Bong Bot canal, Tan Dinh and Vung Liem rivers. The remaning cross sections are till spacuous enough for fishing boats to pass through. However, fishing activities in these rivers and canal are frobidden. There are only 1-2 fishing boats using gill and cast nets everyday at each sluice gate, and thus the impact on fishermen' fishing activities is *assessed as small*.

*c).* Conclusion: Vung Liem, Tan Dinh rivers and Bong Bot canal are Grade-V inland waterways, and the number of boats using these rivers and canal now is about 10-50 boats/day. The adverse impact on the waterways therefore is moderate, and there is a need to inform local people on the construction plan.*Impacts on physical cultural resources*

Construction activities may affect religious and cultural structures such as pagodas or temples by dust, noise, and vibration, disturbing traffic or access to these works, or cause visual impacts or nuisance if construction materials and wastes are loaded improperly. Loud noise may also affect religious procedures.

There are also no important historical and cultural sites identified in the subproject construction sites. There are two sites, Hung Giao and An Tinh temples located about 280m to Bong Bot sluice gate. The temples are used regularly, particularly when offerings are made every 15$^{th}$ day, on the first day of the lunar month, and during festival days. No direct impacts on the temples are expected, but there may be indirect impacts (noise) on people visiting them.

Conclusion: There is likely *small negative impact* on Hung Giao and An Tinh temples and to mitigate potential noise impacts, equipment with low noise signatures will be used, work activities will avoid days of worship, and if necessary, noise barriers will be installed. No adverse impacts on other historical and cultural heritage features are expected during the construction phase of the subproject. However, during execution of the works, the construction there might be chances that some historical and cultural objects or remains might be found. The process for treatment of these cases is presented under the Chance Find Procedures presented in Chapter 6.

#### *4.4.1.6. Impact assessment with impact sources related to waste*

*a). Air pollution*

Air pollution from construction activities/sites has many sources: (i) Emission generated from the material transportation; (ii) Odor from soil excavation; (iii) construction activities.

**Dust, gas emission from means of transportation, emission of materials into the environment during transportation.** Based on a design land filling volume of about 3,636m$^3$ and 66,000 tonnes of other construction materials (see *Table 1.8*), the number of boats and barges trips carrying materials in and out of the subproject area would be 200 trips (for barges and boats of 400 tons). The construction materials would mainly be purchased from companies in Tien Giang, Can Tho province and transported to the construction site with an average distance per trip of 70 km and the time for transportation is of 60 days. Using emission factors of boats and barges presented in *Table 4.10*, the emissions calculated for the transportation of materials is shown in *Table 4.11*.

The mass of waste generated during materials transportation as calculated in *Table 4.11* will result in increased levels of environmental pollutants in air and water, particularly along the transportation route. However, a relativley small number of boats and barges trips will be used in association with this activity. Furthermore, since the transportation will take place at the start

of construction and over a very short time, the impact is expected to be localized and small. In addition, use of water transportation for bulk materials often is more efficient and can generate less pollution than transport by truck.

*Table 4.10: Pollution emission factor of boats and barges using diesel*

| | **Dust** | **$SO_2$** | **$NO_x$** | **CO** | **VOC** |
|---|---|---|---|---|---|
| Emission factor (kg/1,000km) | 6.8 | 136S | 90.7 | 0.036 | 4.1 |

*Source: WHO, 1993.*

*Note:* S – *is the weight percent of sulfur in the fuel* (S=a%).

*Table 4.11: Dust load emission from materials transportation*

| | **Dust** | **$SO_2$** | **$NO_x$** | **CO** | **VOC** |
|---|---|---|---|---|---|
| Total load (kg) | 356.2 | 71.3 | 4,750.9 | 1.9 | 214.7 |
| Average daily load (kg/day) | 11.9 | 2.4 | 158.3 | 0.1 | 7.1 |

Conclusion: Air pollution caused by transporting materials is small, but it will happen, and using water transportation for bulk goods will reduce the amount of dust generated. Technical measures and management to minimize pollution from dust will be applied strictly in the process of implementing the subproject as per Chapter 6.

**Dust emission from soil excavation**: Based on the environmental assessment sourcebook, Volume II, Sectoral guidelines, environment, World Bank, Washington D.C8 / 1991, dust emission from soil excavation is calculated by the emission coefficient (E) as follows:

$$E = 0{,}0016 \times k \times \frac{(\frac{U}{2{,}2})^{1,3}}{(\frac{M}{2})^{1,4}}$$

Among them:

E: Pollution factor (kg/ton)

k: Average grain structure value (0.35)

U: Average wind speed in construction area (3 m/sec)

M: Average soil moisture (20%)

Thus $E = 0.35x\ 0.0016x \left(\frac{3.6}{2.2}\right)^{1.4} / (\frac{0.2}{2})^{1.3} = \mathbf{0.0188}$ kg of dust/ton of soil

The volume of dust coming from soil excavation and filling is calculated by the following formula:

$$W = E \times Q \times d$$

In which:

W: Amount of dust (kg);

E: Pollution factor (kg/ton);

Q: volume of soil excavation and filling ($m^3$);

d: soil density (d = 1,5 ton/$m^3$).

The total volume of soil excavation (54,093m$^3$) and filling (3,636m$^3$) is expected to be 57,729m$^3$ and the time for soil excavation and filling activities is estimated to be about 90 days. As such, the total and daily dust loads are shown in *Table 4.12*.

*Table 4.12: Load of dust in the area due to soil excavation and filling activities (within 03 months)*

| Source of dust | Total load of dust (kg) | Daily average load of dust (kg/day) |
|---|---|---|
| 57,729 x 1.5 x 0.0188 | 1,627.96 | 18.09 |

According to the analysis of air quality in the subproject area, the highest concentration of dust was recorded at 41µg/m$^3$, equivalent 0.000041g/m$^3$ air. Therefore, the load of dust generated during soil excavation is expected to increase the ambient dust concentration in the region. However, because the construction will be carried out in sequences, dust emission levels will be relatively low.

Conclusion: Air pollution caused by soil excavation is *moderate* but the construction will be on the river, canal, in sequences, which will help to minimize dust generation issues. Technical measures and management to minimize pollution from dust also will be applied strictly in the process of implementing the subproject as per Chapter 5.

**Dust generated from concrete mixing station.**

Within the subproject activities, 3 concrete mixing stations, with the capacity of 30m$^3$/h will be used. The stations mostly mix the construction material to create concrete at the stations. Based on experience, the main impacts of a 30m$^3$/h concrete mixing station could be dust generation exceeding the permitted standard in QCVN 05: 2013/BTNMT at a distance of 20m from the station when operating.

Conlusion: Air pollution caused by operation of concrete mixing stations is *small* because small concrete mixing plants will be used. There are only few people reside within 100m of this process, and 2-3 workers for operation of a concrete mixing station and the activity takes place over a short time. However, contractors need to strictly follow dust and noise pollution during operation of concrete mixing stations.

*b). Domestic and construction-generated solid waste*

Solid wastes during construction phase are generated from: (i) Workers' facilities; and (ii) Construction activities (non-hazadous and hazadous solid wastes).

**Domestic solid wastes generated from workers' facilities** include paper, plastics, cartons, food waste, etc. A worker produces about 0.3 kg of waste per day. If there are three worker camps with total of 245 workers, the daily solid waste generation caused by this project during construction phase is 74 kg/day. This solid waste contains 60-70% organic ingredient and 30-40% other substances, and may contains bacteria and pathogens. These solid wastes would be collected and processed in order to limit the negative impact on human health and the local environment. The number of workers in the construction phase is relatively small, so the amount of solid waste generating from the construction area is low. However, some measures to collect and ensure environmental hygiene of the working areas are needed to avoid inappropriate waste disposal.

**Construction solid wastes** generated from construction activities include sand, rock and soil from excavation. As mentioned above, the total volume of soil excavation is 54,093m$^3$ of which 14,514m$^3$ will be reused for the subproject. The remaning volume of 39,579m$^3$ will be

reused for other purposes or gathered and transported to the designated sites as permitted by the local authorities (see detail in *Table 1.5*). The local authorities will have plans to use this volume for canal embankment and land backfilling, etc.

**Hazardous waste**: are mostly oil contaminated materials. As regulated in the Circular No.36/2015/BTNMT issued on 30 June 2015 of MONRE, they include emply fuel and lubricant boxes, cans, asphalt, petrol, fuels, paints etc. The volume of hazardous waste depends on the number of mobilized equipment/machinery and based on monitoring experience from many construction sites it is expected that only a small amount of hazardous waste will be generated. Other kinds of hazardous waste include batteries, wastes contaminated by printing inks etc. with a small amount (about 5 kg/month) expected. However, these are not be generated at the construction sites but in operational offices and maintenance areas. Discharged oil and oily contaminated waste from regular maintenance also is identified as hazardous wastes. The amount of generation is estimated as: i) the amount of oil discharged from equipment oil change for one time is 7 liters; and ii) frequency of maintenance is 600 work shifts. Hazardous waste is expected to be of small volume, but it could create serious negative impacts on environment, and therefore will be collected, transported and treated by a licensed agency according the provisions of the Hazardous Waste Management.

Conclusions: The impacts of domestic and construction solid waste, and hazardous waste, represent moderate negative impacts during the construction phase of the subproject. It requires the subproject to implement mitigation measures to reduce negative impacts during the construction phase.

*Table 4.13: Summary of solid and hazardous wastes generated from construction activities*

| No. | Activities | Waste generation | | | | |
|---|---|---|---|---|---|---|
| | | Type | Volume | Contents | Location | Duration |
| 1 | Surface excavation | Construction solid waste | 39,579 $m^3$ | Non-hazardous solid waste | Construction sites | 6 months |
| 2 | Operation of worker camps | Domestic solid waste | 1332kg | Degradable, organic solid waste content | 3 worker camps | 18 months |
| 3 | Maintenance and others | Hazardous waste | 90kg | Discharged oil, paint boxes; battery etc. | Construction sites and offices | 18 months |
| 4 | Discharged oil | Hazardous waste | 4200l | Discharged oil | Construction sites | 18 months |

*c). Waste water from work camps and drainage from equipment and truck maintenance*

**Wastewater from worker camps.** Per capita worker's water demand is prescribed in QCXDVN 01:2008/BXD at about 45 liters/person/day including water for washing, cooking and personal hygiene. The amount of wastewater generated is calculated as 80% of the water used daily. Thus, the amount of domestic wastewater generated is about 8.82$m^3$/day for 245 workers.

Content of wastewater includes suspended solids, oil, and grease, high concentrations of organic matter, residue, dissolved organic matter (through the $BOD_5$, and COD indicators), nutrients (Nitrogen, Phosphorus) and microorganisms. World Health Organization (WHO) pollutant emission estimates for developing countries are shown in *Table 4.14*. The estimated

average concentration of pollutants in the domestic wastewater before treatment through septic tanks are listed *Table 4.15*.

Based on the pollution load, number of workers and wastewater flow, we calculate the pollutants concentration in wastewater by the following formula:

$$C = \frac{C_0 \cdot}{Q}$$

In which:

- C: Pollutant concentration, (mg/L)
- $C_0$: Pollutant load, (g/day)
- Q: Wastewater flow, ($m^3$/day)

Comparing the pollutant concentrations in untreated domestic wastewater with the QCVN 14:2008, Column B, most of the parameters exceed the standard (*Table 4.16* and *Table 4.17*). To minimize the impact, the investor should requires the contractor installing mobile toilets inside the construction area to serve the needs of the labor activities. Therefore, the amount of domestic wastewater is collected and be treated by the local treatment system, hence, the impact is low.

**Wastewater from barges.** Barges will be used to transport materials for the subproject construction andwastewater coming from the barges is estimated at about 8-10 $m^3$/day (3 barges including 200T, 250T, 400T). Factors causing water pollution of waste water is grease, suspended solids, organic matter, nutrients (N, P) and microorganisms.

*Table 4.14: Pollutants loads of domestic wastewater (untreated)*

| No | Pollutants | Pollution factor (g/person.day) | |
|---|---|---|---|
| | | In developing countries like Vietnam | Vietnam |
| 1 | $BOD_5$ | 45 - 54 | 50 |
| 2 | COD | 72 - 102 | 85 |
| 3 | TSS | 70 - 145 | 100 |
| 4 | Total N | 6 - 12 | 9 |
| 5 | Total P | 0,8 - 4 | 2.5 |

*Source: WHO, 1993.*

*Table 4.15: Pollutants concentrations of domestic wastewater*

| TT | Pollutants | Concentration (mg/l) |
|---|---|---|
| 1 | $BOD_5$ ($20^0$ C) | 450 - 540 |
| 2 | TSS | 700-1450 |
| 3 | TN | 60-120 |
| 4 | TP | 20 |
| 5 | Microorganism<br>Total Coliform<br>Fecal coliform | (MPN/100ml)<br>$10^6$-$10^9$<br>$10^5$-$10^6$ |

*Source: Hoang Van Hue, 2012.*

*Table 4.16: Performance of treatment of pollutants on septic tanks or similar works*

| TT | Pollutants | Performance of treatment (%) |
|---|---|---|
| 1 | $BOD_5$ | 50 |
| 2 | COD | 45 |
| 3 | TSS | 65 |
| 4 | Total N | 70 |
| 5 | Total P | 75 |

*Source: Institute of Natural Resources and Environment, 2005.*

*Table 4.17: Pollution loads due to subproject construction*

| TT | Pollutants | Pollution load (kg/ngđ) | |
|---|---|---|---|
| | | Untreated | Treated by septic tank |
| 1 | $BOD_5$ | 12.25 | 6.13 |
| 2 | COD | 20.83 | 11.45 |
| 3 | TSS | 24.50 | 8.58 |
| 4 | Total N | 2.21 | 0.66 |
| 5 | Total P | 0.61 | 0.15 |

**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, inludes: i) machine maintenance (about 2 $m^3$/day); ii) machine cleaning (about 4$m^3$/day); iii) machine cooling (about 2$m^3$/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 (*Table 4.18*). To prevent drainage from reaching water bodies, equipment and truck maintenance areas will be captured and treated.

*Table 4.18: Pollutants generated from operation and maintenance of construction equipment and machinery*

| Source of wastewater | Volume ($m^3$/day) | Concentration of pollutant | | |
|---|---|---|---|---|
| | | COD (mg/l) | Oil and grease (mg/l) | SS (mg/l) |
| From maintenance | 2 | 10-15 | - | 25-40 |
| From cleaning | 4 | 20-32 | 0.4-0.8 | 60-80 |
| From cooling | 2 | 2.5-5 | 0.1-0.25 | 2.5-12.5 |
| QCVN08-MT:2015/BTNMT (column A) | | 10-15 | 0.1-0.2 | 20-30 |
| QCVN08-MT:2015/BTNMT (column A) | | 30-50 | 0.1-0.3 | 50-100 |

*d). Storm water runoff*

Rain water passing through the construction sites could introduce pollutants to the surface water environment. Runoff of materials, sand and rock into water is expected to be the main source of pollution and would increase water turbidity. Additionally, runoff water may be contaminated by leakage of oil and lubrication from machines but the concentrations are expected to be low. A study by WHO showed that SS, COD and oil contaminants in runoff water are 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.

As decribed above, the local people use water resource in Vung Liem, Tan Dinh rivers and Bong Bot canal for irrgation, and 60% of the population in the subproject area use river/canal water for their domestic purposes after temporary treatment (by alum). However, this effect can be minimized if the construction meets the construction schedule and through implementation of good drainage.

Conclusion: Despite the use of advanced construction technologies such as steel coffer dams, and onsite management, there is a risk of increasing turbidity in the receiving waters which could affect domestic and agirculture activities of the local people, but the impacts would *be low*.

*e). Site specific impacts on aquatic life*

Construction activities on Bong Bot canal, Tan Dinh, and Vung Liem rivers would cause loss and disturbance of benthic habitats due to construction of the sluice gate foundations and an increase in suspensed solids in the water column due to excavation activities. Increased water turbidity results in a decrease in light penetration, adversely affecting phytoplankton productivity. The zoobenthos at the sluice gate foundatations will be revoved due to excavation, and their habitats will be lost. These impacts in turn will affect food availability for other secondaty consumers in the areas such as fish. However, excavation and construction of the sluice gate foundations will be conducted in temporary steel coffer dams which limit habitat loss and reduce suspended solids in water. However, this habitat loss and disturbances are very small compared to the whole natural benthic habitats in the area. In addtion, construction will be localised in space and time. The zoobenthos can recolonize in 3 months[13] after the construction phase, and thus impact on the aquatic life could be considered low.

Nevertheless, the 3 sluice gates are about 500 - 600m from the intersection areas with Hau and Mang Thit Rivers, so wastewater, solid waste, spoil should be controlled to avoid effect on surface water sources by pollution causing impacts on aquatic life (*Figure 4.8*).


*Figure 4.8: Locations of 3 sluice gates to Hau and Co Chien Rivers*

Conclusion: Overall the significance of the impact on the aquatic life during construction is assessed as *low* (about 20m upstream and 50m downstream from the pile position) and the duration of impacts is short term during the bored pile construction process.

*f). Site-specific impact of water pollution on rice fields and aquaculture ponds*

There are no irrigation canals and rice fields adjacent to the three sluice gates, and thus no related impact is expected. There have no aquaculture ponds in the Vung Liem river and Bong Bot canal, but there is a catfish pond about 350m far from Tan Dinh sluice gate site (*Figure*

[13] Bolam,S.G., Schratzberger, M. and Whomersley, P. (2006). Macro- and meiofaunal recolonization of dredged material used for habitat enhancement: Temporal patterns in community development. Mar. Pollut. Bull. 52: 1746-1755

*4.9*). Water pollution from unproper management of wastewater, solid waste, spoil can cause impact on the pond.

Conclusion: This impact will *be low* because the ponds are closed and located quite far from the impact area of piling activity, and all activities will be happened in steel sheet coffer dams. However, contractor still needs to comply strictly with mitigation measures to management the wastes from construction activities.


*Figure 4.9: Catfish pond near Tan Dinh sluice gate*

#### *4.4.1.7. Environmental risks and emergencies*

**Occupational safety and worker health**. Construction activities incur occupational risk of employee injury or mortality. The following sources could create high risk of accident: UXO at construction sites; electric shock and electrocution while conducting excavations such as from encountering power cables. Common diseases in the subproject areas includes flu, dengue fever, hand-foot-mouth, digestive diseases, pinkeye, and scarlet fever to be recognized frequently. The worker may get the risk of being affected by these diseases. Besides that, if workers get infected, their illness may be spread to others including the local people. In addition, workers may get sick because of unsafe living conditions, unsafe food and inappropriate personal protection equipment (PPE).

Conclusions: Impacts caused by unsafe working conditions are considered as moderate negative impacts during the construction phase. It is important to implement mitigation measures to ensure safety for all workers, local communities and ensure planning of emergency responses if accidents happen.

**Fire and explosive emergencies**. Emergencies of fire and explosion could be incurred through fuel storage and unsafe use of electrical equipment. The consequences are extremely adverse and could cause injuries, disabilities and loss of life. The reasons of fire and explosion are (i) unsafe or inappropriate firefighting systems and management at fuel storage areas on construction sites; (ii) electric generator supplying energy for machinery, equipment could cause electrical incidents resulting in fires; (iii) use of heating equipment could cause fire or occupational accidents such as burns.

Conclusion: The emergencies are moderate negative impact. Because these emergencies could occur any time thus it requires a specific emergency preparedness and response plan to be in place at the construction site as well as appropriate equipment to minimize the probability of these emergencies.

**Waterway incidents**. Because almost all the materials will be transported by water, 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 river and canal bed on contact or through oil spills from engine damage.

Conclusions: The emergencies are moderate negative impact because there likely is a low frequency of occurrence. However, if an accident happens during the construction phase it could create a significant impact on habitat, people and properties. Therefore, an appropriate rapid response plan is needed to ensure management of emergencies.

### *Impacts during operation phase*

During operation phase, the sluice gates will be closed for to functions, prevention of salinity intrusion and control of flooding. The sluice gates are expected to be closed in a short time, specifically 4-5 hours in 2-3 days in March and April of the lunar calendar to prevent saline intrusion, and in 4-5 days during November and December of the lunar calendar to control flooding to the area.

The main potential negative impacts due to operation of the sluice gates include disruption to waterway transportation, increased water pollution near the sluice gate, a change in water quality, and blockage of fish migration. Most of these impacts *are considered low and/or moderate* and can be mitigated through proper sluice gate operations and coordination with the local authorities and communities.

#### *4.4.1.8. Impact on waterway traffic*

As discribed in the above paragraph that the sluice gates will be opened most of the time; therefore, potential impacts on waterway transport will be temporary and can be mitigated through effective operation and close consultation with local authorities and communities as well as public information disclosure. The impacts on waterway traffic is considered moderate.

#### *4.4.1.9. Impacts of closing the sluice gates on water quality*

Due to inadequate sanitation in this area, some households live along the rivers and canal still discharging their domestic wastewater directly into the rivers and canal so closing of the sluice gates will reduce water exchange in the subproject area to Hau and Tien rivers and the risk of water pollution may be increase. However, given that the sluice gates will be closed only in short times when there is a risk of high salinity intrusion and flood. The simulation results of BOD under “with and without subproject” using MIKE shows that if sluice gate is closed for a short time, the level of impact on the environment will be low, BOD contents only increase about 5 - 10% compared with open the sluice gate (*Figure 4.10*) and still meet the nation regulation (QCVN 08-MT:2015/BTNMT). Therefore, negative impacts on water pollution are expected to be low and no mitigation measures are required.

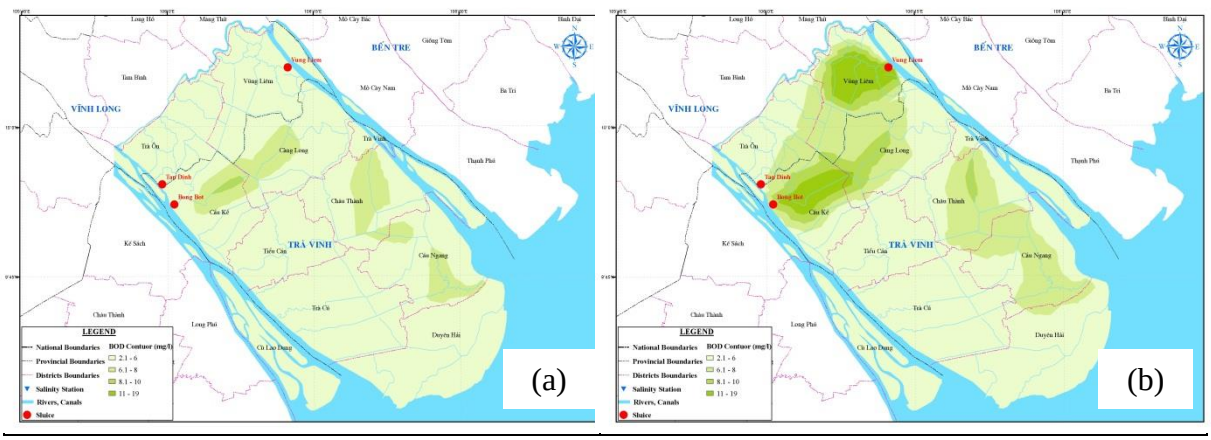



*Figure 4.10: BOD content (a) with the subproject and (b) without subproject*

#### *4.4.1.10. Changes in water salinity contents*

On the Co Chien and Hau rivers, salt concentration tends to be lower when building the sluices although the impact should not be significant. At the Bong Bot sluice, salinity content is projected to decrease by about 0.4 g/l and at the Vung Liem sluice, salt concentration is projected to decrease by about 0.22 g/l (Figure 4.11).

Hence, it is expected that the impact of the 3 sluices on the salinity in the major rivers is low. The salinity intrusion boundary does not change remarkably.

During sluice operation, salt water will be prevented from entering the inside canal areas and the salinity in the fields will be reduced. Salinity should decrease by 95.4% (in the Bong Bot sluice) and thus will be low enough to ensure agricultural production (0.04 to 1.07‰) as seen in *Table 4.19*. It will be possible to even plant low salt-tolerant trees such as durian, rambutan, mangosteen, etc. (when watering salt-contaminated water 1‰, it will stunt growth and cause leaf burn), in the subproject communes after the construction is completed.

#### *4.4.1.11. Impact on aquatic life*

*a). Temporary blockage of fish passage*

When closing the sluice gates, fish can not pass from Hau river to Bong Bot canal and Tan Dinh river, Vung Liem river to Mang Thit river and vice versa. It is expected that the 3 sluice gates will be fully closed for approximately 4-5 hours on 2-3 days in March and April of the lunar calendar (during the highest tides in the dry season) to regulate salt water intrusion; and 4-5 days in November and December to control flooding during high tide for the subproject area. Given that the sluice gates will be closed in short times, the impact on fish migration can be assessed as minor, no mitigation measures are required.

*b). Impacts on biodiversity*

For most projects of sluice gate construction, given that alteration of water quality and water flow regime due to closing of sluice in long time would result in significant impact on aquatic creatures (changing from saline/brackish water to fresh water and from open to closed ecological systems). For this subproject, the sluice gates will be closed in very short period, which is not long enough to change from species of saline/brackish water to fresh water species and from open to closed ecological systems. As discussed above, biodiversity in the subproject area is not high (*Gray eel-catfish, Silver carp fish, Silver barramundi fish, Banana prawn, Giant freshwater shrimp*), and fisheries resources area not much. This shows that impacts on biodiversity and fisheries resources of the subproject is assessed as low.

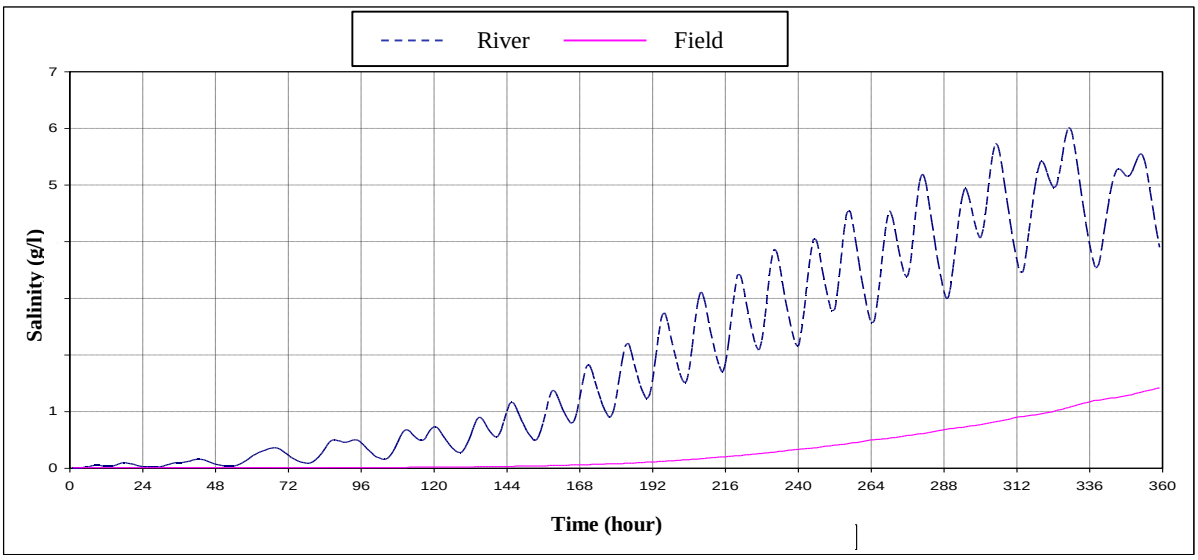



*Figure 4.11: Salinity content at the Vung Liem sluice gate with and without subproject*

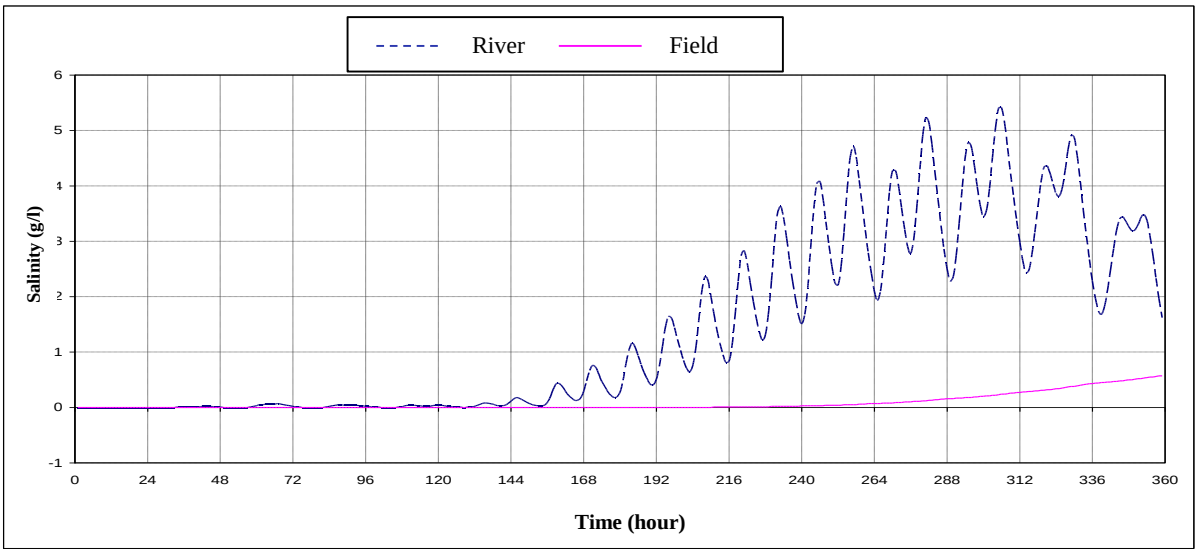



*Figure 4.12: Salinity content at the Tan Dinh sluice gate with and without subproject*

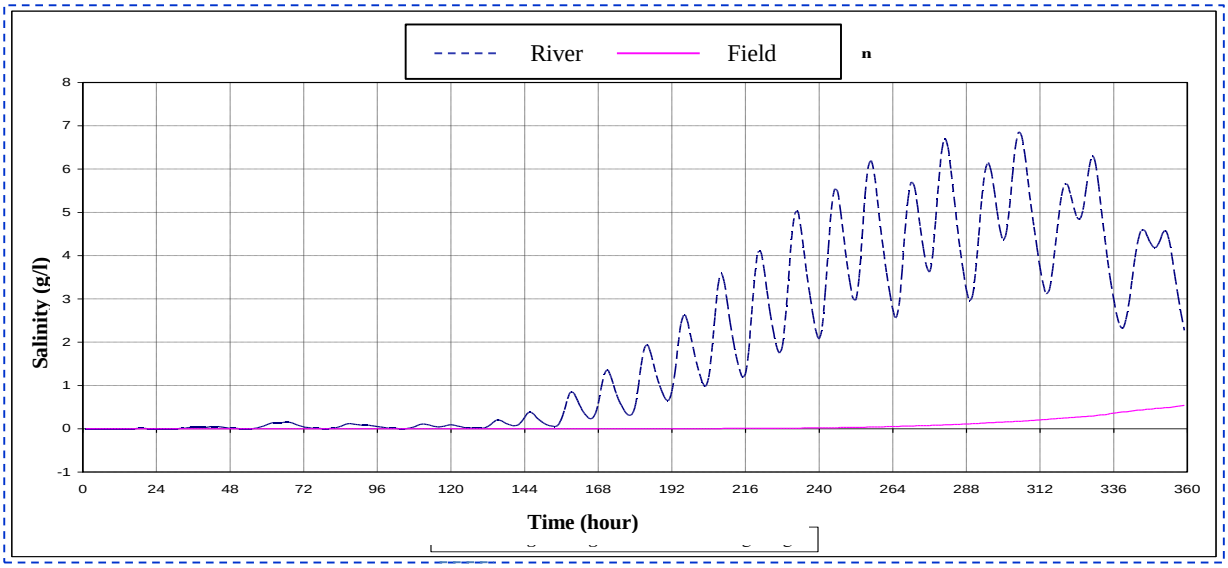



*Figure 4.13: Salinity content at the Bong Bot sluice gate with and without subproject*

*Table 4.19: Salinity levels (‰) in fields, canal, rivers with and without subproject*

| No | Sluice gate | Without subproject | | With subproject | | Difference | |
|---|---|---|---|---|---|---|---|
| | | River | Field | River | Field | River | Field |
| 1 | Vung Liem | 1.94 | 1.46 | 1.72 | 0.10 | -11.3% | -93.2% |
| 2 | Tan Dinh | 0.99 | 0.64 | 0.73 | 0.13 | -26.3% | -79.7% |
| 3 | Bong Bot | 2.04 | 1.51 | 1.57 | 0.07 | -23.0% | -95.4% |

#### *4.4.1.12. Impact of saline and/or brackish water on construction material*

Given that the 3 sluice gates will be built at the rivers and canal which impact by saltwater, saline/brackish water would impact on construction materials, so the design stage, salt-tolerant construction materials would be chosen.

#### *4.4.1.13. Impact of removal of the ferry services*

There have 2 ferry terminals in the location of Tan Dinh and Bong Bot sluices. When the 2 bridges over these sluice gates are completed, local people will use the 2 bridges for their travel causing removal of the 2 ferries and this will impact negatively on livelihoods dependent on the ferries operation. The subproject owner will allowance equivalent to the minimum salary as per the regulations during the transition period which can be for a maximum of 6 months and train occupation change and facilitate job searching to the 2 ferries owners. .

#### *4.4.1.14. Impacts due to risks and incidents during operation*

During subproject implementation, the environmental risks and incidents that may happen include the following types: (i) Damage to sluicegate; (ii) Damage to road; (iii) Road accident.

*a). Damage to sluicegate*

As analyzed above, risks and incidents that may arise are the concerns of the subproject. Risks and incidents happening during operation are mainly derived from subjective causes; sometimes there are objective reasons. The reasons that might lead to risks and incidents are: (i) Technical quality of the works is not guaranteed from the beginning; (ii) Operation of these sluice gates does not follow the regulations; (iii) Regular maintenance activities do not comply with regulations; (iv) People lacking awareness of protection of the sluice gates and the bridges.

If a sluice gate is damaged, the salinity from the main rivers will quickly enter into the water environment of the fields. Salt water will immediately interact with every aspect of the environment, leading to severe consequences, including damage of rice, fruit trees, and other crops; depletion of freshwater aquatic sources in the area, directly affecting aquaculture in the area; salinity intrusion into surface water, contaminating the soil environment.

#### *4.4.1.15. Induced impacts due to sluice gate operation*

More sustained fresh water supply will be provided for rice cultivation leading to more use of pesticides. Pesticides are toxic chemicals designed to be deliberately released into the environment. Although each pesticide is meant to kill a certain pest, its excessive use will lead to contamination the air, soil and water when they run off from fields, escape storage tanks, are not discarded properly and especially when they are sprayed aerially.

Animals such as birds may be poisoned by pesticide residues that remain on food after spraying. An application of pesticides in an area can eliminate food sources that certain types of animals need, causing the animals to relocate, change their diet, or starve. Fish and other aquatic biota may be harmed by pesticide-contaminated water. Application of herbicides to bodies of water can cause plants to die, diminishing the water's oxygen and suffocating the fish.

Community health and safety issues during the production of annual crops may include the following: i) Potential exposure to pesticides 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; and iii) Potential exposure to air emissions from open burning of crop waste.

Pesticides 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).

## 4.5. IMPACT ASSESSMENT FOR PILOTING SUSTAINABLE LIVELIHOOODS MODELS (ZONE 2)

### *Impact of additional planting mangrove trees and supporting from mangrove-shrimp to organically certified mangrove-shrimp*

#### *4.5.1.1. During preconstruction phase*

The areas of mangrove-shrimp ponds proposed piloting mangrove-shrimp livelihood model are mainly water 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 is negligible.

#### *4.5.1.2. During construction phase*

*Rhizophora apiculata* is often used for mangrove silviculture because: i) it has a fast growth rate; ii) it is easy to grow and manage and iii) it has a higher economic value than many other species. The sequence for mangrove trees (*Rhizophora*) planting is follows (*Figure 4.14*): i) Site selection: *Rhizophora apiculat*a should be planted on sites that are flooded for 10-20 days per month; ii) Seed selection: Select seed from big, healthy trees; iii) Storage: Store seeds in a shady, cool place. Prevent them from drying out. Do not store for more than 2 month and iv) Planting density: 10,000 trees/ha (a spacing between trees of 1.0m); and v) Put about one-third of the seed length into the mud.

*Rhizophora* will be planted by putting about one-third of the seed length into the mud. Given that mangrove trees will be planted on the existing shrimp ponds, the impact of mangrove reforestation during this phase is negligible.

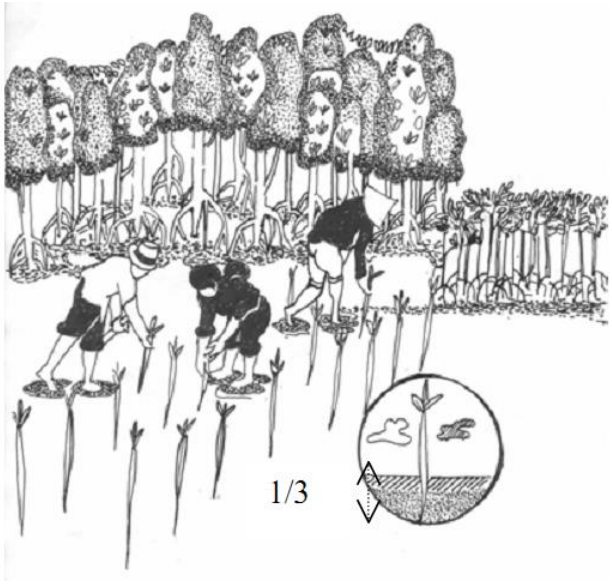



*Figure 4.14: Planting Rhizophora*

#### *4.5.1.3. During operation phase*

**Positive economic and environmental impacts**. Planting additional mangrove trees to meet requirement of organically mangrove-shrimp certification would bring significant economic and environmental benefits, including: (i) Mangroves protect the ponds and positively influence considerably the water quality in shrimp farming areas; Mangroves may remove nutrients, heavy metals, suspended solids, and toxic hydrocarbons[14], and "clean up" shrimp pond effluents; and (ii) increase income of farmers: The findings of Regional Social Assessment for the MD-ICRSL showed that in Tra Vinh province, profits from non-certified mangrove-shrimp systems are approximately 21 million VND/ha and by obtaining organic certification, similar farms are able to increase profits by between 7 and 10 million VND/ha, representing a 20% increase.

**Employment opportunity.** The employment opportunities for poor laborers provided by mangrove shrimp systems are not significant. The low intensity of production and small scale harvesting at regular intervals during the year means that farmers can rely on themselves or the labor available within their households.

**Social Structures and Cooperatives to support Livelihoods, and Credit Access.** There are no formal cooperatives supporting the mangrove-shrimp communities. Traditionally, farmers here have worked individually as their farms are often remote and there is little community structure.

The subproject proposes the formation of formal farmer cooperatives. While this may be fine in theory, and may provide more bargaining power to farmers, it is an ambitious objective given that there is the lack of farmer experience and familiarity with cooperatives in the area. A preferred approach may be to implement less formal collective groups which would build on the SNV/IUCN experience of farmer groups as a starting point.

**Negative impacts.** Shrimp survival and biomass decreased significantly when the shrimp were cultured at the relatively higher concentrations of *Rhizophora* leaves and leachates (10-15g/l);

[14] Landers JC, Knut BA. 1991. Use of wetlands for water quality improvement under the US EPA Region V Clean Lakes Programme. Environ. Manage. 15: 151-162.

in contrast, moderate amounts of *Rhizophora* leaves or their leachates had positive effects on shrimps (2.5-5g/l)[15]. 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.*

### *Impacts of raising aquaculture towards biosecurity*

Over the past decade, a number of important disease outbreaks caused by viruses, bacteria, fungi and toxic algae that present a major threat to profitable aquaculture production in the MD aquaculture This has increased the industry's awareness of the importance of biosecurity. Biosecurity is a set the measures and methods adopted to secure a disease free environment in all phases of aquaculture practices (i.e. hatcheries, nurseries, growout farms) for improved profitability'. Biosecurity protocols are intended to maintain the "security" of a facility (i.e., prevent entry of, or reduce overall numbers prior to entry) with respect to certain disease causing organisms (parasites, bacteria, viruses and fungi) that may not be present in a particular system.

Major biosecurity goals are: i) animal management - obtaining healthy stocks and optimizing their health and immunity through good husbandry; ii) pathogen management - preventing, reducing or eliminating pathogens; and iii) people management - educating and managing staff and visitors.

#### *4.5.1.4. During pre-construction phase*

These activities require no land acquisition and resettlement, as well as public infrastructure encroachment because they are developed on the existing ponds.

#### *4.5.1.5. During construction phase*

Implementation of the proposed pilot biosecurity aquaculture models, incuding the pilot models to change from monoculture shrimp to shrimp - rice, shrimp - Oreochromis niloticus, shrimp - crab farming, may require some improvement of on-farm systems to ensure achievement of good production practices. However, potential impacts of these works will be low, localized, and limited to each farm and it will be made with technical assistance to be provided by the subproject to ensure that the system has the right design to implement the demonstration activities.

#### *4.5.1.6. During operation phase*

Aquaculture wastes not only affect on water quality due to risk of pollution from feeds and waste but also from chemical application to prevent and control the desease for raised animals, mange the quality of feeding water and soil and create the favourable conditions for raising and harvesting. The potential used chemicals are listed as following:

- Soil and water treatment (EDTA, lime, Zeolite);
- Disinfection chemicals (Natrium or Cansium hypochloric, chloramine, Benzalkonium chloride (BKC), Formalin, Iốt, Ozone);

[15] 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

- Pesticides and herbicides (Saponin, Sotenone, Amoniakhan, Gusathion, Sevin, Organophosphates, Organotins);
- Antibiotics (Nitrofuran, Erythromycin, Chloramphenicol, Oxolinic axit, Sulphonamides, Oxytetracycline);
- Others (Formalin, Acriflavine, Green or Blue Malachite,Kali permanganat, Trifluralin);
- Feed indegrients (Immunostimulants, protective and conservative chemicals and anti-oxidants and feed attractive components, Vitamin);

Thus, if the aquacultural activities are not managed well enough, it will cause significant environmental pollution. Those impacts must be controled and mitigated during the operation by applying the environmental management plan to ensure that the aquaculture do not pollute or has adverse impacts on environment.

*a) Impact of shrimp – rice model*

In the shrimp/rice rotation systems, the 3-4 month shrimp crop is cultured in the dry seasonat low stocking densities (3 to 5 prawns per square meter) and rice is planted during the rainy season. Due to enhanced soil fertility after the shrimp crop, very limited fertilizer is used for rice cultivation. Due to the lower density so the negative impact from shrimp farming activities on the environment is considered low.

*b) Impact of shrimp (Penaeus monodon) with other targeted animals (fish, crab,etc.)*

This model in which low stocking density of shrimp (5 frys/$m^2$) will be applied while adding crabs and fish. Due to the low stocking density, impacts of this model on environment are not expected to be significant. Adding crabs and fish in this model will generate continuous food chain in the pond. The waste from the shrimp will be the source of food for fish and fish in this case contribute partially treated waste from shrimp. The impact of this model on the environment is considered moderate.

*c) Impact of livihood demonstration activities*

Currently, ponds for demonstration are now raising intensive shrimp, the impacts of this method on the environment mainly from organic wastes water and solid waste. However, in case of "without subproject", these impacts still occur, and when implementation of the subproject, objectives will be diversified not only shrimp-rice but also shrimp-oreochromis niloticus, shrimp -crab and farming will be done in form of cleaner production, the impact on the environment will reduced; however the problem of concern is the spread of disease. When outbreaks occur, the government offers free treatment of ponds when disease appears. If the shrimp are older than one month when they become infected, shrimp farmers will not notify authorities but try to salvage their investment by releasing water to harvest the shrimp to sell. However, these modes use for demonstration purposes only and its impacts will be localized and minimized through increasing farmer awareness on the impacts of the diseases and develop good quality seeds.

*a). Induced impacts due to scaling up of livelihood models*

**Change on land use when scaling up livelihood models**. The pilots of models from monoculture shrimp to shrimp - rice, shrimp - Oreochromis niloticus, and shrimp - crab farming will be carried out in the existing intensive aquaculture areas. The pilot models have an advantage over the current intensive aquaculture model in this area in terms of fewer impacts on the environment because of their less waste generation due to application of GAP and biosecurity. From the environmental perspective scaling up of these models would bring more

benefit than harm. However, there would be risks of model failure forcing farmer revert back to the intensive shrimp aquaculture. Therefore, risk could be assessed as moderate.

**Impact on water pollution**. The subproject will promote livelihoods models that are considered to be more environmentally sustainable aquaculture because it is extensive and uses less agro-chemicals (i.e. fertilisers, antibiotics). Applying sustainable aquaculture model using VietGap standard and biosecurity to develop operational guidelines for water management and desease control systems in the subproject area will lead to more sustainable shrimp farming in the estuary. Nevertheless, there are some environmental concerns relating to the current rice-shrimp farming systems. First, the current shrimp farming method is based on high water exchange, which would result in high accumulation of sediment in the rice farms in the long-term. Many farmers reportedly dispose of accumulated sediment back into the canals or nearby river, which would induce negative environmental impacts. Furthermore, recent introduction of exotic species and introduction of more intensive shrimp aquaculture may also lead to more pollution in the effluent of the wastewater from the shrimp farming. This impact is assessed as moderate.

### *Regional impacts*

A Regional Environmental Assessment (REA) has been prepared for the whole MDICRSL project. The REA analysed the regional impacts of the subprojects under Components 3 of the MDICRSL project are summarized in Table 20. Most of the regional impacts of the subproject are positive including: Reduced coastal erosion; Reduced damage from storm surges and sea level rise; Improved resilience of farmers; Increased income from high value aquaculture; Improved surface water quality from reduced intensive shrimp; Reduced use of groundwater; and increased mangrove forest areas and biodiversity. The REA indicates that the subproject may have negative regional impacts due to construction of the infrastructure to control spring tide and salinity to support agricultural activities and adapting to climate change and implementation of the livelihood models. The key regional adverse impacts include:

- *Impactd due to installing water/salinity control structures in the delta estuary and peninsula:* Salinity intrusion affects existing freshwater agriculture areas; Barrier to fish migration and ecosystem connectivity; Conflict between freshwater and aquaculture water uses; Surface water quality impacts when opening sluice gates; Groundwater aquifers impacted by salinity intrusion;
- *Impacts due to development of livelihood models in delta estuary and peninsula:* Livelihood programs not provided to Khmer, other ethnic minorities and women; Surface water quality issues of aquaculture and shrimp farming;
- *Impacts due to expanding aquaculture and shrimp farming:* Reduced income for intensive shrimp farmers; Conflict between fresh and brackish water uses.

The REA, however, suggests that these impacts can be mitigated at the subproject level by implementation of the subproject ESMP, and 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.

The regional negative impacts of the subproject activities during operation of sluice gates and application of the livelihood models can be mitigated through a technical assistance to be provided during the preparation and implementation of the livelihood development models (Componement 1 of this subproject). The technical assistance will also address the need for extensive consultation with water users and key staekholders during the development of sluice

operations and possible impacts due to expansion of aquaculture farming the livelihood model without adequate management and control. In addition, the water resources monitoring program and MARD real time operations system for hydraulic infrastructure under Component 1 of the MDICRSL project will informed information for management of these regional impacts.

*Table 20: Summary of regional impacts for Components 3 of the MDICRSL Project*

| Activity | Demand on natural resources | Significant impacts<br>Intensity/Extent/Duration | Impact<br>Rating |
|---|---|---|---|
| **Installing water/salinity control structures in the delta estuary and peninsula** | Changes hydrological flow and land use. | • Salinity intrusion affects existing freshwater agriculture areas ***M/Sr/Lt*** | **Moderate** |
| | | • Barrier to fish migration and ecosystem connectivity ***H/R/Lt*** | **Minor** |
| | | • Conflict between freshwater and aquaculture water uses ***M/Sr/Mt*** | **Moderate** |
| | | • Surface water quality impacts when opening sluice gates ***M/Lo/St*** | **Minor** |
| | | • Groundwater aquifers impacted by salinity intrusion ***M/Sr/Lt*** | **Moderate** |
| | | • Reduced coastal erosion ***H/R/Lt*** | **Moderate** |
| | | • Reduced damage from storm surges and sea level rise ***M/Sr/Mt*** | **Moderate** |
| | | • Improved resilience of farmers ***H/Lo/Mt*** | **Moderate** |
| **Development of livelihood models in delta estuary and peninsula** | Pilot areas of land (ha) for brackish aquaculture. | • Increased income from high value aquaculture ***M/Lo/Mt*** | **Moderate** |
| | | • Livelihood programs not provided to Khmer, other ethnic minorities and women ***M/Lo/Mt*** | **Moderate** |
| | | • Surface water quality issues of aquaculture and shrimp farming ***M/Sr/St*** | **Moderate** |
| **Expanding aquaculture and shrimp farming** | Conversion of land for sustainable shrimp farming. | • Reduced income for intensive shrimp farmers ***M/Lo/St*** | **Moderate** |
| | | • Conflict between fresh and brackish water uses ***M/Lo/St*** | **Minor** |
| | | • Improved surface water quality from reduced intensive shrimp ***M/Sr/Lt*** | **Moderate** |
| | | • Reduced use of groundwater ***M/Sr/Mt*** | **Moderate** |
| **Protecting mangrove forests in coastal areas** | Increased area of mangroves in coastal areas. | • Increased mangrove forest areas and biodiversity ***H/Sr/Mt*** | **Major** |
| | | • Increased protection from coastal erosion and sea level ***H/Sr/Mt*** | **Moderate** |
| | | • Establish mangrove-clam farming systems ***M/Lo/Mt*** | **Moderate** |

**Note:**

- **Impact intensity is** evaluated as high (H), medium (M), or weak (W)
- **Spatial extent** is evaluated as regional (R), subregional (Sr), or local (Lo)
- **Duration** is evaluated as long-term (Lt), medium term (Mt), or short term (St)
- **Color codes:** Blue for positive regional impacts; Grey for negative regional impacts

## 4.6. DETAILS AND REALIABILITY OF ABOVE ASSESSMENTS

### *Assessment of Reliability of Methods Applied in the ESIA*

- Statistical and comparative methods: In completing the ESIA, the environment team has taken many observations, and done data collection in the subproject corridor. Those data

have been updated and include time series of years. Therefore, such methods could give reliable and accurate results.

- Field observation, measurement and sampling, sample analysis in the laboratory and social survey are methods used in this ESIA. Personnel who are trained, experienced, and have worked with such technique for years, conducted the evaluations. The data from such methods could ensure accuracy and reliability about environmental quality.
- Environmental rapid assessment method: the application follows guideline of WHO in quantifying pollutants that depends on pollutant coefficients. This method could quickly give outputs that are used for other assessments.
- Integrated analysis and assessment methods: this method was used to synthesize environmental impacts caused by the subproject. Based on the projected impacts, mitigation measures were proposed. Although these methods are subjective assessments it is still reliable if it is done by environmental experts who are experienced with those impacts. The impacts will be assessed depending on realities of local contexts as well as subproject designs before proposed mitigation measures that should be appropriate and feasible.
- The characteristics of impacts were identified according to the experiences of experts, secondary data as well as quantification of impacts that are caused by subproject activities. The impacts were quantified through secondary sources, including emission coefficients from reliable sources such as Assessment of Sources of Air, Water and Land pollution by WHO (1993), Environmental Impact Assessment by Larry W. Canter (1997).
- Determining the spatial scale and time scale of impacts that included expert consultation, and analyzed the current characteristics of the system in terms of scale, scope and construction plans in considerations of local climate conditions, infrastructures, as well as environmental management regulations.
- Impact assessments considered the spatial and temporal scale of impacts as well as sensitivity of recipients. The actual experiences are very important in assessing the impacts and proposed mitigation measures. It requires an understanding of local social and environmental context as well as local environmental regulations.

***Reliability of the Assessment***

- All impact assessments were conducted by experienced experts as well as useful tools that give reliable and accurate results. Impacts type and impacts scope were assessed for different phases of project implementation so that they reflect reality. Therefore, investor has committed to mitigate negative impacts as well as pollution control, which are detailed in later sections.
- The quantifying pollutions assessed based on the fuel consumption and emission norms documents. For example, the application of emission norms of vehicle WHO 1993; or calculation of noise level applied guideline of Pham Ngoc Dang 1997.
- The assessments were analyzed by experts who experience in practices and scientific researches as well as participate in many EIAs therefore their opinions or analyses and solutions that are determined.

# CHAPTER 5. IMPACT PREVENTION AND MITIGATION MEASURES

The impact analysis conducted in Chapter 4 suggested that the potential negative impacts of the subproject are considered low to moderate and most of them would be localized, temporary, and reversible. These impacts can be prevented and/or mitigated through the application of the Environmental Code of Practice (ECOP) that has been developed as part of the ESMF as well as the site-specific measures that have been developed to address site-specific issues during the preparation of this ESIA. In this context, this chapter presents the measures to mitigate the site-specific impacts of the subproject activities while the Environmental and Social Management Plan (ESMP) covering the ECOP and site-specific measures is presented in Chapter 6.

## 5.1. ENHANCING POSITIVE IMPACTS

To enhance environmentally friendly development and climate change adaptive capacity, as well as ensure the achievement of the subproject's goals, several principals should be taken into account during the design phase:

- Minimize land acquisition;
- Adopt good international aquaculture practices;
- Sustainable construction materials: Selection of sustainable construction materials will be important in ensuring the sustainable operation of the subproject in the context of climate change and in the natural conditions of the subproject area.
- The main technical items that need to be carefully considered to ensure sustainable operation of the 3 sluice gates is an operational schedule for proposed sluice gates should be developed with community input.

## 5.2. MEASURES TO MITIGATE IMPACTS MEASURES TO MITIGATE IMPACTS FOR THE THREE SLUICE GATES

### *During preconstruction 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 in additiona to the general requirements described in ECOP. To prevent and/or mitigate these impacts, the subproject owner will perform the following tasks:

#### *5.2.1.1. Land acquisition*

Land acquisition and resettlement will be compliance with the approved Resettlement Policy Framework (RPF), which was prepared in order to establish the resettlement principles, eligibility requirements for compensation, valuation methods, describe the legal and institutional framework, organizational arrangements, funding mechanisms, and community consultation and participation, and grievance redress mechanism to be applied to the subproject during the subproject implementation. The Resettlement Action Plan (RAP) for this subproject has been prepared in compliance with the approval RPF and submitted to and cleared by the

World Bank. The RPF has been prepared in compliance with the World Bank's Operational Policy on Involuntary Resettlement (OP/BP4.12) and the Vietnam's laws and regulations.

The principles of resettlement policies of the subproject include:

- All those affected, regardless of ownership status or socio-economic status will be provided with compensation and support for the loss of property, income and production-business activities at replacement cost and restoration of living standards, income and production capacity to the subproject level.
- Land prices to calculate compensation (compensation, assistances) are determined close to the land use right transfer cost in the market under normal conditions. When there is a difference compared to the actual price of land use right transfer in the market, it must be adjusted accordingly.
- Land will be compensated "land for land", or in cash, according to PAP's choice whenever possible. The choice of land for land must be offered to those loosing 20% or more of their productive land. If land is not available, Project Management Unit (PMU) must assure itself, that this is indeed the case. Those loosing 20% or more of their land will have to be assisted to restore their livelihood. The same principles apply for the poor and vulnerable people losing 10% or more of their productive landholding.
- PAPs who prefer "land for land" will be provided with land plots with the equivalent productive capacity for lost lands or a combination of land (a standard land plot) in a new residential area nearby for residential land, and cash adjustment for difference between their lost land and the land plots provided.
- PAPs who prefer "cash for land" will be compensated in cash at the full replacement cost. These PAPs will be assisted in rehabilitating their livelihoods.
- Compensation for affected houses and structures at the value of new construction of houses and structures that have technical standards equivalent to the affected houses

- To disseminate broadly about the economic development and compensation policies of the government to local communities. Disseminate about the subproject implementation in accordance with rights and duties and laws. Disclose compensation rates (details of each affected asset) to the affected people. Disclose and inform accurately the compensation amount of each household.
- To support vocational training for members of the severely affected households due to land acquisition for the project.

### *Mitigation measures for impacts on Physical Cultural Resources*

Compensation for the removal of the 5 graves is included in the RAP of the subproject and will include the cost for buying of land for re-burial, excavation, relocation, reburial and other related costs which are necessary to satisfy customary religious requirements. Compensation in cash will be paid to each affected family or to the affected group as a whole as is determined through a process of consultation with the affected community. The level of compensation will be decided in consultation with the affected families/communities. These mitigation measures will be included the Environmental and Social Management Plan (ESMP) of the subproject and enforced by the subproject owner during implementation. All costs of excavation, relocation and reburial (3,000,000 VND/grave) will be reimbursed in cash. Graves to be exhumed and relocated in culturally sensitive and appropriate ways.

During implementation the Subproject Owner will make early announce to the households whose graves are affected so that they can arrange their embodiment in consistence with the spiritual practices of the people and compensate to the affected household as required in the subproject RAP and ESMP.

#### *5.2.1.2. UXO risk*

To address safety risks associated with unexploded ordnances, the subproject will fund mine clearance at the sluice gate construction areas. The subproject owner will sign the contract with the specialized unit or the military headquarter of Tra Vinh to carry out mine clearance at the construction sites. This task will be implemented right after completing land acquisition and compensation and BEFORE any dismantling, demolition or ground levelling takes place.

#### *5.2.1.3. Land clearance*

- Gathering and collection of waste due to demolition of works, structures and clearance of trees around the construction sites.
- Providing regulation on demolition time and transport of demolished materials to avoid the resting time of local communities (allowed time is from 6AM to 6PM).
- Measuring accurately the scope of site clearance to minimize the number of trees to be cut down;
- It is strictly forbidden for the contractor to dispose waste including waste soil, plant materials into the flow, especially Vung Liem, Tan Dinh rivers and Bong Bot canal.

### *During construction phase*

As discussed in Chapter 4, construction of sluice gates can increase the level of air, noise, vibration, local traffic, wastes, water pollution, etc. and these impacts could be mitigated through the application of ECOP in general. However, in order to minimize negative impacts, the subproject owner will also require the contractor to implement the following site specific measures:

#### *5.2.1.4. Ferries operation mitigation measures*

- Setting up a new ferry terminal about 200m compare to the old terminal toward infield for Tan Dinh ferry (at the right hand side) and about 300m compare to the old terminal toward infield terminal for Bong Bot ferry (at the right hand side), see detail in *Figure 5.1*.
- Arranging a speedboat to regulate, control, and guide waterway traffic for the ferries operation.

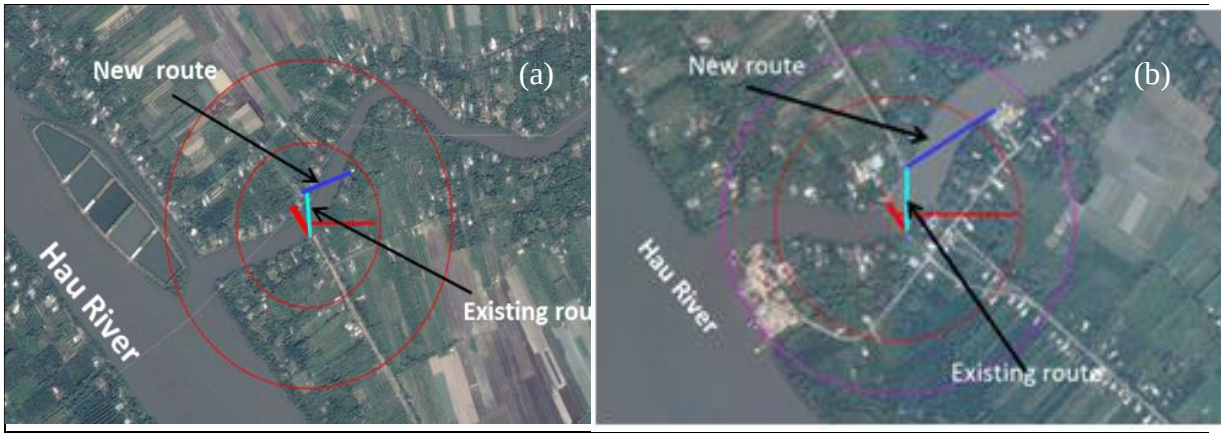



*Figure 5.1: New terminal (a) Tan Dinh ferry; (b) Bong Bot ferry*

#### *5.2.1.5. Dust and exhaust mitigation measures*

**Description of mitigation measures**. The main objectives are negative impact control on ambient air quality from dust and exhaust generated from sluice gates construction activities as: i) soil excavation; ii) emissions from construction equipment and machinery; iii) transport of construction materials, equipment and machinery.

*a). From soil excavation activity*

- Storing the excavated soil storage areas must be placed in the designed areas far from residential clusters near the construction sites of Vung Liem and Tan Dinh sluice gates, orchard land around, keeping a distant to the Bong Bot canal and Tan Dinh and Vung Liem rivers and not allow to stay on site over 24 hours.
- Covering the construction site (it could be use fence or canvas) to avoid the release of dust, the height of fence must be at least 2 m, especially in the construction sites of Bong Bot and Tan Dinh sluice gates.

*b). From equipment emissions*

- The construction machinery/ equipment and heavy vehicles have to comply with the Decision No. 249/2005/QĐ-TTg of the Prime Minister, Regulation on Emission Roadmap dated 10 October 2005 for road transportation vehicles.
- Regular maintenance and clean construction machinery/ equipment;
- Construction machinery and equipment will not allow to place out of the Right of way.

*c). Transport of construction materials*

- Setting up appropriate schedule of material mobilization to the site to avoid material obstruct.
- Boats and barges carrying constrution materials must be covered. All boats and barges should not be overloaded and fix with its body.
- Loading and unloading construction materials, waste need to schedule to avoid the rush hours and forbit during the nightime (from 22pm to 6am) at the section nearby the residential clusters from the provider of construction materials and residential clusters in Vung Liem and Bong Bot construction sites.

*d). Concrete mixing stations*

- The location of concrete mixing plant on the site must be away from two sides of Bong Bot canal, Vung Liem and Tan Dinh rivers and residential clusters as well as Hung Giao and An Tinh temples.
- The watering activities have been proposed at least once per day during the rainy season and twice a day during the dry season in the concrete mixing plants.
- Operation schedule of the plan must be carefully considered to avoid rest times of local people.
- In case that, the subproject will purchase the hot concrete from nearby mixing stations, the contractors and PMU need to check the environmental permission certificates of these stations.

**Location and time frame**: At high air pollutant and dust sensitive recipients around the construction site as stated above for specific mitigation measures, during the construction phase.

**Remarks**: Above proposed mitigation measures to control dust and exhaust generation impacts on ambient air quality is practicable, suitable to subproject's resources and implementing capacity of the Vietnam's contractors. Controlling the dust generation from sources will result in reducing dust release from the construction sites and transport vehicles. Since all proposed mitigation measures are fully complied, the dust concentration could minimize to within the permission level regulated on QCVN 05/2013-BTNMT is 0.2mg/$m^3$.

All proposed mitigation measures need to include into biding documents and will be an environmental clause on civil work contracts to ensure the strictly compliance of contractors. The effectiveness of mitigation measures is strongly relied on the compliance level of contractors on the sites.

#### *5.2.1.6. Noise and vibration*

**Description of mitigation measures**. According to monitoring results in Chapter II, the noise and vibration levels in the subproject area are within the permission standard. However, the noise generated from construction equipment could be higher than standard, the following measures are proposed to control noise and vibration from construction activities:

*a). Setting up appropriate operational schedule of noise generate equipment*

- Use modern and new construction machineries and equipment which generate lower noise level and strickly carry out equipment maintenance as regulated by the Government.
- Turn off the interrupted machines wherever possible to avoid resonant frequency.
- Usage of machines generate noise level over >55 dBA at night (from 22:00 to 6:00) is strictly prohibited at the location nearby residential clusters in Vung Liem and Bong Bot sluice gate.
- Boat and barges, loading/unloading shall not allow operating at night (from 22:00 to 6:00).
- Provision noise protection equipment for workers.

*b). Usage of lower noise generating equipment*

- Selecting the lower noise generate equipment which could be result in noise level reduction from 6 dBA to 12 dBA.

*c). Limit concurrent usage of multiple noise generating equipment*

- Limit concurrent usage of several noise generate equipment apply for construction activities near by the noise and vibration sensitive receptors.

**Location**: Location shall be based on the noise level allowed around the noise and vibration sensitive receptors.

**Remarks**: All proposed mitigation measures need to include into the biding documents and will be an environmental clause on civil work contracts to ensure the strictly compliance of contractors. The mitigation measures are proposed to manage the noise from generating sources. The effectiveness of mitigation measures is strongly relied on the compliance level of contractors on the sites.

#### *5.2.1.7. Water pollution management*

**Description of mitigation measures:**

- Undertake earthworks where possible during dry season, to reduce the run off water from the construction site which lead to increase content of suspended solids and pollutants in surrouding water bodies.

- Construction sites must be designed so that all temporary works serving construction, temporary material containing areas, machinery areas, equipment maintenance areas, and worker camps areas must be far away from the Tan Dinh and Vung Liem rivers, Bong Bot canal at least 150 meters.
- Provide the facilities in the site including latrines, holding areas, garbage bins. Waste from latrines will be collected and treated properly through an economic contract with local environmental companies.
- 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.
- All equipment shall be kept in good working order and serviced regularly. Leaking equipment shall be removed immediately from site and repaired.
- Washing instruments/vehicles next to the water bodies is forbidden to avoid leaching of waste, sludge, soil, oil contaminated water.
- All in-river construction activities should be in steel sheet pile coffer dam (*Figure 5.2*).

*Figure 5.2: Steel sheet pile coffer dam for in-river construction activities*

- Minimize the risk of water pollution and sediment from operation and maintenance of facilities and equipment on the floating rigs involved construction of 3 sluices and 3 bridges over the sluices:
  - Wastewater generated from operating and maintenance areas of machinery and equipment is not discharged directly into the Vung Liem, Tan Dinh rivers and Bong Bot canal, which is given through a partition system has to collect the oil scum before flowing down these rivers and canal.
  - The partition made of geotextile layer which allow water through only and keep oil scum. Regular maintenance in order to operation of the partitions is effective.
  - Oil scum collected store in drums for disposal according to Circular 36/2015/TT-BTNMT.
- Reduce the risk of solid waste pollution from barge in the bridges construction:
  - No direct discharge of waste into the flow of Vung Liem, Tan Dinh rivers and Bong Bot canal, put the floating pontoon surrounded rigs to facilitate the collection of solid waste, floating objects accidentally falling flow.
  - Arrange 2 different kinds of trash on each floating rigs for containing oil rags and other solid wastes.
  - Oil debris will be collected and processed according to Circular 36/2015/TT-BTNMT.
  - The different types of waste will be collected and treated as normal waste according to

treatment contract with the local garbage disposal units.

- Reduce the risk of rivers and canal water pollution by solid waste not collected after bridges and sluice gates construction by clearance work of the riverbed must be applied after construction phase. Contents of clearance work include:
  - To remove all temporary works.
  - Take away the spilled material.
  - Stable bed, recovery flow as the initial state.
- Water run off in the construction site need to flow to manholes to deposit sediment before discharging into environment,
- Provide the facilities in the site including latrines, holding areas, garbage bins. Waste from latrines will be collected and treated properly through an economic contract with local environmental companies.
- 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.
- Washing instruments/vehicles next to the water bodies is forbidden to avoid leaching of waste, sludge, soil, oil contaminated water.

**Remarks:** The proposed mitigation measures are practicable, suitable to project's resources and implementing capacity of the Vietnam's contractors. Strictly, compliance with above measure could help to manage water pollution from the subproject activities. They need to include into biding documents and will be an environmental clause on civil work contracts. The effectiveness of mitigation measures strongly relies on the compliance level of contractors on the sites. Thus from the result of environmental supervision activities, additional mitigation should proposed for any outstanding issues to manage impacts on water quality in the subproject area. Moreover, public monitoring mechanism also needs to promote through public consultation meetings, interview etc. to seek for strictly compliances of contractors and identify any outstanding issues.

#### *5.2.1.8. Solid waste management*

**Description of mitigation measures**

- Garbage:
  - Domestic waste generated on the site shall be managed as the following steps: i) provide dustbins at work site; ii) waste category for reuse; iii) domestic waste and garbage from worker camps need to be collected by hygienic manner through service provision of local companies.
  - Garbage bins: need to meet the requirement of Ministry of Construction QCVN 07:2010/BXD as detail: i) vollume of garbage bin will be 100 litters and no exceed $1m^3$; ii) garbage bin with coverage; iii) location of garbage bins will be every 100 meters; iv) waste standing on garbage bin will not allow to over 24 hours; and v) daily clean the bins is required.
  - Provide dustbins and mobile septic tanks at work sites.
  - Disposal of solid wastes into the Vung Liem, Tan Dinh rivers and Bong Bot canal, other water courses, orchard land surrounding the construction sites is prohibited.
- Construction waste:

- Wherever possible, materials used or generated by construction shall be recycled such as excavated soil could be reused for backfilling purpose on the sites.
- Construction waste will be temporary storage on the site before transporting to waste disposal, the contractors must ensure the following i) must keep the safety distance of 250m from any irrigation canals, water bodies; ii) must keep the safety distance (200 m) from any sensitive residential areas; iii) located within the RoW of the subproject; iv) covering storage areas during rainy times and v) temporary storage on the sites will be no longer than 48 hours.
- Construction wastes will be disposed the aproved site of waste disposal.
- Waste transport vehicle also need to comply with mitigation measures for transport vehicles stated in item of dust and exhaust generation.

- Hazardous wastes: They are included boxes, cans contain asphalt, petrol, fuels, paints etc. These types of waste need to be collected transported and treated by a company, which has a work permit to treat hazardous waste according to MONRE's Circular No. 36/2015/TT-BTNMT dated 30 June 2015, the detail requires as bellowing:
  - The storage area for all hazardous substances is located away from any water bodies such as Vung Liem, Tan Dinh rivers and Bong Bot canal.
  - Storage of hazardous substances must in the places, which are facilitated with: i) roof; ii)concrete ground and water resistant; iii) edge around the storage areas; iv) away from water bodies and high fire risk areas.
  - Weekly records on volume of generated hazardous substances.
  - Sign contract with company which has a work permit to treat hazardous waste for transport and treatment.

**Location**: on the construction sites, worker camps, waste storage areas on the sites.

**Remarks**: the proposed solid waste management manners follow the regulation on Decree No. 38/2015/ND-CP on solid waste management and Circular No. 36/2015/TT-BTNMT on stipulating hazardous waste management. The feasibility of the mitigation measures rely on the capacity of local waste service companies and the compliance of contractors, they need to include into biding documents and will be an environmental clause on civil work contracts.

#### *5.2.1.9. Occupational safety and health for worker*

**Description of mitigation measure:**

- Establish safety measures as required by law and by good engineering practice, provide first aid facilities that are readily accessible by workers;
- Workers shall be provided with appropriate personal protective equipment (PPE) such as safety shoes, hard hats, safety glasses, ear plugs, gloves, etc, at no cost to the employee;
- The Contractor shall ensure safety for people who are permitted to enter the sites. The construction sites shall be kept clean and tidy to avoid dangers caused to these people;
- Contractors ensure to provide safe drinking water to workers for daily uses;
- Construction site shall be provided with toilet/sanitation facilities/cooking areas and clean camps;
- Contractor shall readily provide and maintain lights, protection fences, signboards and wardens where necessary to prevent local people access the sites;

- Provision periodic health care check for workers (every 6 months as regulated).

**Location:** every construction sites

**Remarks:** The effectiveness of mitigation measures strongly relies on the compliance level of contractors and awareness of workers on the sites. They need to include into biding documents and will be an environmental clause on civil work contracts.

#### *5.2.1.10. Mitigation measures for traffic accidents and people's safety*

**Description of mitigation measure:**

In order to ensure traffic safety for the vehicles on the Bong Bot canal, Vung Liem and Tan Dinh rivers during the construction, the following measures should be taken:

- Setting up a station to regulate the waterways in the upstream and downstream areas of the construction area.
- Arranging speedboat to regulate, control, and guide waterway traffic.
- Arranging rescue stations.
- Placing guide posts on the rivers, canal for the waterway vehicles passing the construction sites.

**Location:** every construction sites.

**Remark**: The effectiveness of mitigation measures strongly relies on the compliance level of contractors and awareness of workers on the sites. They need to include into biding documents and will be an environmental clause on civil work contracts. The supervision consultant needs to supervise the compliances of contractors and enhance the cooperation among relevant agencies in traffic management.

#### *5.2.1.11. Impacts on aquatic life*

**Description of mitigation measures:**

- 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.
- Forbid to discharged construction waste, domestic waste, waste water and runoff water into the surrounding areas as well as cut the trees outside the subproject's corridor.
- Before the construction activities completed, contractors have to carry out site clearance and environmental recovery such as: (i) Transporting all unused materials from the construction sites; (ii) Removing all construction machineries and equipment, temporary facilities, worksite, etc; (iii) Recovering environment at the site.
- Use coffer dams using steel piling construction method to mimize loss of bentic habitats, limit distrubances to the bentos, and reduce the amount of suspended solids in the water column at the construction sites.

**Location**: All construction sites.

**Remarks**: They need to include into biding documents and will be an environmental clause on civil work contracts for compliance by contractors.

#### *5.2.1.12. Social disturbance*

**Description of mitigation measures:**

- Severely affected and vulnerable households will be prioritized for hiring for the site works;

- Barriers will be installed (temporary fence) at construction areas to deter people from entering the site;
- The local residents shall not be allowed in high-risk areas (excavation sites and areas where heavy equipment is in operation) and such sites have a watchman to keep public out;
- The lighting will be provided at the construction site at night;
- Borrow areas will be backfilled or fenced upon completion of construction work;
- Construction workers who are not local people must register temporary residents and obtain temporary residential certificate from local authority;
- Workers will be educated on appropriate behavior for interactions with local community and risks of communicable diseases.

**Location**: All construction sites

**Remark**: The proposed mitigation measures will not require high technical skills and suitable with Vietnam's condition, thus all mitigation must be implemented by constrictors to minimize the social risks.

#### *5.2.1.13. Implementation of "Chance Find" Procedures*

**Description of mitigation measures:**

When grave or cultural objects are found during the construction phase, the subproject owner needs to coordinate with local authorities to arrange the relocation and mapping the location of the graves before and after relocation.

If the Contractor discovers archeological/historical sites, monuments and objects, including graveyards and/or individual graves unearthed during construction, the contractor will be responsible for:

- Stoping the construction activities in the chance find area;
- Delineating the location or found area;
- Protecting the area to prevent the object from being damage and lost. For artifacts or remains, the night guard will be allocated directly until the local government has the responsibility or the Department of Culture and Information takeover;
- Informing the Investor to notify for the local government or the nations undertaking the cultural heritage of Viet Nam (within 24 hours).
- Relevant local/central authorities will be responsible for the area protection and conservation before providing the decision on the later appropriate procedures. Then they will implement the preliminary evaluation on the excavated findings. The significance and importance of these findings should be evaluated according to various criteria relevant to cultural heritage, including aesthetic value, historical or scientific research, economic and social values.
- The decision of findings treatment will be made by the responsible agency. This decision covers the layout (such as in case of detecting the rest of the cultural or archeological importance cannot be moved) conservation, preservation, restoration and salvage.

**Location:** where ever the cultural objects are found.

**Remarks:** The proposed mitigation measures are suitable with Vietnamese believes.

#### *5.2.1.14. Environmental accident management*

**Description of mitigation measures**:

- Providing of the fire and explosion prevention and management on the construction sites;
- Applying the fire and explosion prevention and management standards in constructing temporary sites, storage areas on the sites, etc.;
- Facilitating the fire and explosion prevention equipment on the site and providing training for workers on fire and explosion prevention and management.
- Provision with personal protective equipment for worker: Workers shall be provided with appropriate personal protective equipment (PPE) such as safety shoes, hard hats, safety glasses, ear plugs, gloves, etc, at no cost to the employee;
- Ensure the safety of electricity supply at the construction sites…;
- Educating the workers on personal protective equipment users, and imposing strictly penalization for the violence;
- Providing periodic health carry checking for workers, every 6 months and complying with any labor duties such as health care insurance, social insurance and body insurance…;
- Emergency rapid response plan: The contractors must prepare an emergency rapid response plan in case of accidents, work collapse, hazardous substance/ waste leak out to surrounding areas, etc.

**Location**: in all construction sites;

**Remarks**: The proposed mitigation measures will not require high technology, but could help to set up an emergency rapid response to curb with any arising accidents on the site thus also could help to reduce the risk and social cost burden. The contractors must strictly comply with the approval plan, and the requirement need to include into biding documents and will be an environmental clause on civil work contracts. PMU needs to monitor the performance of contractors and seeking for feedbacks from local people for further improvement and effectiveness.

**Environmental monitoring:** To ensure that the construction of sluice gates will not create significant impacts on local environment and local people/activities, an environmental monitoring program (air, noise, vibration, water quality) will be conducted at the construction site as well as at critical location that may have significant impacts and details are presented in Chapter 6.

### *During operation phase*

As discusses in Chapter 4, operation of the sluice gates can result in both positive and negative impacts but all impacts will be low to moderate and can be mitigated through consultation and agreement among local agency responsible for sluice operations, water users, and local people. To mitigate the potential impacts the following measures will be carried out by the subproject owner:

- *Preparation and operation of an operational plan:* During implementation of the subproject, a consultation process will be conducted with all key stakeholders to establish an operations plan for these sluice gates and the final plan will be publically disclosed. It is expected that the draft plan will be available for the first consultation in 2017 so that the final plan can be available for public consultation and finalization in 2019. A budget will be allocated for the activities (see Chapter 6).

- *Planning and undertaking water quality monitoring:* To ensure that operation of the sluice gates will not create significant impacts on local environment and local people/activities, a water quality monitoring program will be conducted upstream and downstream. The water quality monitoring will include some selected biological parameters and the plan will be finalized in consultation with key stakeholders. Chapter 6 presents a draft plan for water quality monitoring to be conducted during the implementation of the subproject.
- During implementation a Technial Assistance (TA) will be implemented to support for real time operation of hydrolics system monitoring in the MD. The purpose of this monitoring system is to enhance the reliability and proactive real-time prediction of water information supporting to operation of hydraulic structures in the MD to improve the effectives of irrigation systems in managing the water, mitigating flood risks, water supply, drought and salinity intrusion control. The subproject will be benefit from this TA for optimal operation of the sluices.

#### *5.2.1.15. Site-specific measures to mitigate impacts due to sluice gates operations*

*a). Mitigation for impact on waterway traffic*

Although the sluice gates will be closed for short times, mitigation measures should be carefully devised. To facilitate waterway tranffic during the closure of the sluice gates, the project owner need to (i) consult closely with the local comminities and authorities to (ii) develop an effective operation procedures for the sluice gates taking into account waterway travel need, (iii) putting waterway traffic signs at the sluice gates sites, (iv) communicate the sluice gate opreration procudures with the local communities and authorities, and (v) disclose the sluice gate closure times at least 1 month in writing and local mass media before the events.

*b). Mitigation for impact of removal of the ferry services*

During operation the 2 ferries at the location of Tan Dinh and Bong Bot sluices will stop functioning, and local people will use the 2 bridges for their travel causing job loss of the ferry owners negatively affecting their livelihoods. The subproject owner needs to adequately compensate for this impact by financial compensation equivalent to the minimum salary as per the regulations during the transition period which can be for a maximum of 6 months and train occupation change and facilitate job searching.

*c). Induced impacts due to sluice gate operation*

More sustained fresh water supply will be provided for rice cultivation leading to more use of pesticides. Pesticides 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). DARD and the subproject will develop and promote integrated pest management in accordance witth the IPM Framework in the project ESMF.

#### *5.2.1.16. Measures to mitigate impacts due to bridge operations*

Before operation, DWR and transportation agency will prepare an Emergency Contingency Plan to include: emergencies involving people, potential spills of oil, diesel and hazardous materials and their clean-up, medical evacuation, etc. The objective will be to minimize risk and accidents and to respond quickly and competently should an accident occur and effort has been made during design of the subproject to incorporate all road safety infrastructures (light, signs, etc.) to reduce road safety risks.

#### *5.2.1.17. Measures for responding and handling sluice gate incidents*

Incidents involving damage to the sluice gate or dyke rupture may result in salinity intruding into the fields. When a salinity inflow incident occurs at a large scale due to dyke rupture or damaged sluice gate valves, the following steps should be carried out:

- Timely covering and shielding plants with earth bags and closing the sluice gate to prevent saltwater from entering the fields.
- Timely mobilization of equipment and rescue teams to the scene to embank and reinforce the damaged dyke section.
- Promptly repairing or replacing malfunctioning valve gate

## 5.3. FOR ADDITIONAL PLANTING MANGROVE TREES AND SUSTAINABLE LIVELIHOOODS MODELS (COMPONENT 1: ZONE 2)

- As discussed in Chapter 4 that implementation of this component could create both positive and negative impacts on socio-economic and financial conditions of local farmers depending on many uncontrollable factors including various technical risks. However, to minimize the potetntial negative effects the Subproject Owner and the concerned authorities of Tra Vinh province should implement the following comprehensive measures: *Provide technical assistance to promote development and expansion of trade for aquaculture products* by: (i) Developing a market forecasts for such products under the subproject; (ii) Developing brand for such aquaculture products; and (iii) Finding out ways to establish stable market for the products through promotion of product introduction on the domestic and international fairs.
- *Provide in-depth knowledge on technical aspects on production by* applying the Field Farming School (FFS) approach with local farmers on technical knowledge as well as hand-on training on ways to convert to new livelihood models. Key activities will include, but not limited to, (i) undertaking a series of technical workshops to provide basic knowledge on technical issues related to on-farm management as well as clear explanation on ways to convert to the new models; (ii) setting up a group of qualified agricultural/aquacultural extension officers who can provide direct guidance to local famers when they require through a "Training-of-Trainer or TOT" program including preparation of technical guidelines and/or manual that could be used to equip local farmers people enough knowledge and techniques when new models are introduced in the area; and (iii) establishing farmer networks through a series of study visits to appropriate areas so that farmers could have opportunities to exchange knowledge and implementation experience that could help enhancing quality of the model application.
- *Conduct socioeconomic survey*: This should be done to assess the potential impacts on socioeconomic of poor farmers. If needed appropriate actions could be carried out during the implementation of the subproject.

***Specific measures for mangrove tree plan management:***

- Forest area must be at least a certain percentage of the area of the land plot depending on the types of certificate (e.g., Natureland Certificate: 40% as a starting point moving to 50% within 2 years). 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 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.

***Specific measures for addressing aquaculture waste and deseases during operation.***

- **Develop and implement a biosecurity program.** DARD should consult with the local communities and authorities to develop and impplement a biosecurity program. This includes a thorough ***risk assessment*** to determine which areas or factors may cause the spread of pathogens; ***risk management***, whereby a prevention plan is developed and carried out; and ***risk communication*** to make sure all employees, suppliers, visitors, and **others** who may enter the facility are educated about the plan and cooperate with it. Appoint a facility biosecurity manager to help develop and oversee the program, and work closely with a fish health professional and aquaculture Extension specialist. They can help fine-tune the plan by identifying diseases of importance and management options based on facility design. The program should have clear goals. It should address all potential risks and establish the corresponding corrective measures required for managing animals, pathogens and people. A biosecurity plan should be simple and easy to follow. Identify practices that are effective and practical. Complicated and burdensome plans will reduce compliance and increase frustration. A good biosecurity plan will also include a facility map and employee training programs that call for accountability and the acknowledgement of workers' goals and duties. The written program should be given to all employees and posted in an accessible location. It should be evaluated and updated on a routine basis. The following simple biosecurity plan template in the box below is recommended.

***Basic Biosecurity Plan Template***

Use the following as a template for a general biosecurity plan. Additional information for recirculating aquaculture systems and pond systems will be provided by the technical assistance under the subproject.

1. Which species is/are being cultured?
2. Draw a schematic of the farm. Include each building and each system, entry and exit points, and major flow patterns (fish movement, visitor and employee movement). Identify the life stages (eggs, juveniles, adults) found in each system.
3. System (pond, tank) management and husbandry
   - How will the system be managed to ensure good water quality/chemistry for the species?
   - Is the system appropriate for the given species, life stage, and density?
   - Can individual units be effectively isolated in the event of an outbreak?
   - Is cleaning the system easy?
   - Changes should be made where possible to correct any problems.
4. What are the important infectious diseases for the species cultured?

For example, diseases of concern for koi producers include koi herpesvirus (KHV) and spring viremia of carp (SVC); diseases of concern for tilapia producers include *Streptococcus* and *Francisella.*

5. Where can these disease-causing agents be found or how can they enter the farm?
   a) Water source: safe (biosecure) or unsafe (not bio-secure)?
      - If safe (from a deep well, municipal supply, or originally from an unprotected source but disinfected before use), your water should pose little or no risk. Note: Water from a safe source is not always the best quality for the species being raised and may need to be treated.
      - If unsafe (from a shallow well or surface water), how will it be disinfected?
   b) Fish:
      - Identify a limited number of well-known, reputable suppliers.
      - Have suppliers provided information on the health status of new fish?
      - Have their fish been tested for specific diseases?
      - How will you quarantine new fish and have them tested for specific pathogens of concern, if necessary?
      - How will you isolate sick fish from the rest of the population?
   c) Diet/Nutrition:
      - Identify reputable sources for live and frozen foods.
      - Where will you store commercially prepared feeds?
      - Who is responsible for labeling and dating stored feeds?
6. How can diseases be spread? They can be spread by the fish, water, pests, other animals, food, people, and equipment.
   - How will the system be designed to separate different "lots" of fish?
   - A "lot" of fish is a unit of animals of the same species, and usually the same life stage, that is managed as one group during production. Different lots of fish should be physically separated (different holding areas, ponds, systems, buildings), with fish of similar biosecurity status and age closest to each other and those of unknown or differing status (broodstock vs. fingerlings vs. eggs) most separate. Normally this means that the group has originated, been raised, and/or been housed together long enough (usually at least several weeks or months) to be considered of the same health and disease status and susceptibility.
   - Where should signs be posted to identify different security zones on the farm and to restrict the movement of employees and visitors?
   - Are there disinfectant footbaths and hand washing stations at the entrances to different buildings and zones? Should there be protective clothing (coats, boots) that is dedicated for a specific building as an added precaution?
   - Who is responsible for cleaning and disinfecting equipment between uses? (Each system should have clearly labeled and dedicated equipment.)
   - How will pests and predators (rats, insects, birds, otters, snakes, turtles) be controlled?
   - How will pets and livestock be prevented from moving from one system (pond or tank system, area of different biosecurity status) to another?
   - When will feeds be inspected so that out-dated or possibly contaminated feeds can be discarded?
7. Management of disease outbreaks
   - What is the plan for observing fish daily for changes in feeding, behavior or appearance that might indicate a disease outbreak?
   - What steps will be taken if there is a disease outbreak?
     - Signs posted
     - Investigation (water quality, nutrition, disease diagnostics)
   - Are diagnostics and tests used to determine which legal drugs and chemicals to use for treatment?

- Who will notify authorities for reportable diseases?
- How will dead fish be disposed of to meet local, state and federal regulations?
- How will discharge from diseased systems be treated and/or disposed of to meet local, state and federal regulations?
- How will the facilities be cleaned and disinfected to eliminate any pathogen reservoirs in holding areas, on equipment, or on any other surfaces?

8. Records

   Records are important legal documents that can demonstrate facility operation and production as well as system isolation during reportable disease outbreaks (which may prevent unnecessary depopulation).

   - Keep records of water quality parameters, changes of footbath and net dip solutions, feed expiration dates, animal inventory, fish disease outbreaks (including dates and number dead per day), disease investigation findings, and use of drugs and chemicals (including expiration dates and when used).

9. Biosecurity plan evaluation

   The plan should be assessed at least once a year for effectiveness and compliance. Appropriate and up-to-date records will provide information about the increase or decrease in the number of losses, the use of drugs and chemicals, and sales.

   Producers developing biosecurity plans should begin by examining their goals and evaluating the related risks. Biosecurity management should target the most important areas and pathogens/diseases to be protected against and implement strategies that are effective and practical. Compliance and documentation are the big challenges to a successful plan. Everyone working in or with a facility needs to have ownership in the plan and recognize why specific procedures are in place.

- **Mitigation measures for aquaculture waste:** To reduce impact farming intensive shrimp on the environment, the following range of measures must be taken by the farmers in pond systems to (i) reduce the amount of contamination of the effluent; (ii) prevent pond effluent from entering surrounding water bodies; and (iii) treat the effluent before its release into the receiving waters to reduce contaminant levels. The following management measures should be implemented to prevent the contamination of effluent:

*Feed:*

- Ensure that pellet feed has a minimum amount of "fines" or feed dust. Fines are not consumed and add to the nutrient load in the water;
- Match the pellet size to the species' life-cycle stage (e.g. smaller pellets should be fed to fry or juvenile animals to reduce the unconsumed fraction);
- Regularly monitor feed uptake to determine whether it is being consumed and adjust feeding rates accordingly. Feed may be wasted due to overfeeding or not feeding at the right time of day;
- Where feasible, use floating or extruded feed pellets as they allow for observation during feeding time;
- Store feed in cool, dry facilities and ideally for no longer than 30 days to avoid reduction in vitamin contents. Moldy feed should never be used as it may cause disease;
- Spread feed as evenly as possible throughout the culture system, ensuring that as many animals as possible have access to the feed. Some species are highly territorial, and uneaten feed adds to the nutrient load;
- Feed several times a day, especially when animals are young, allowing better access to food, better feed conversion ratios and less waste;

- Halt feeding at a suitable interval before harvest to eliminate the presence of food and / or fecal material in the animal's gut;
- During harvesting, contain and disinfect blood water and effluent to reduce the risk of disease spread and to contain effluent matter.

*Suspended solids:*

- Avoid discharging waters from ponds while they are being harvested with nets, as this will add to the suspended solids in the effluent drainage;
- If feasible, use partial draining techniques to empty ponds that have been harvested. The last 10–15 percent of pond water contains the highest quantities of dissolved nutrients, suspended solids, and organic matter. After harvest, hold the remaining water in the pond for a number of days before discharge, or transfer to a separate treatment facility.

*Fertilizers:*

- Plan the rate and mode of application of fertilizers to maximize utilization and prevent over-application, taking into account predicted consumption rates;
- Increase the efficiency of application and dispersion through such practices as dilution of liquid fertilizers or solution of granulated fertilizers prior to application. Other options include the use of powdered fertilizers or the placement of powdered fertilizer bags in shallow water to allow solution and dispersion;
- Consider the use of time-released fertilizer in which resin coated granules release nutrients into the pond water, with the rate of release corresponding to water temperature and movement;
- Avoid the use of fertilizers containing ammonia or ammonium in water with pH of 8 or above to avoid the formation of toxic unionized ammonia (NH3);
- Depending on the system (e.g., freshwater aquaculture), grow organic fertilizer (e.g. natural grass) in the pond basin after harvest;
- Initiate pond fertilization only in static ponds with no pond water overflow that can impact downstream waters and watersheds;
- Conduct pond fertilization to avoid or minimize consequences of potential runoff due to floods or heavy rain and avoid application to overflowing ponds.

*Chemicals:*

- Design the pond depth to reduce the need for chemical control of aquatic weeds and reduce thermal stratification;
- Do not use antifoulants to treat cages and pens. The chemically active substances used in antifouling agents are very poisonous and highly stable in an aquatic environment. Clean nets manually or in a net washing machine.

The following management measures can be taken in pondbased systems to prevent pond effluent from entering surrounding water bodies:

- Avoid automatic drainage of ponds at the end of the production cycle as the same pond water may be used to cultivate several crop rotations of certain species;
- Reuse water from harvested ponds by pumping it into adjacent ponds to help complement their primary productivity, provided that the level of BOD is controlled;

- Consider the hydrology of the region in the design of the pond system and ensure that the pond embankments are high enough to contain the pond water and prevent loss of effluent during periods of increased rainfall and potential flooding;
- Ensure that the ponds effluent meet the following standards:

| *No.* | *Parameter* | *Unit* | *Allowable limit* |
|---|---|---|---|
| 1 | pH | | 5,5 – 9 |
| 2 | $BOD_5(20^0C)$ | mg/l | ≤ 50 |
| 3 | COD | mg/l | ≤ 150 |
| 4 | Total suspended solids | mg/l | ≤ 100 |
| 5 | Coliform | MPN /100ml | ≤ 5.000 |

The following measures should be implemented by the local authorities:

- Develop and implement spatial planning and management for the pilot and model sale up area which include zoning, site selection, and designation and management of an aquaculture management area;
- Develop and promote implementation of the Vietnam Good Acquaculture God Practice (VietGap) for organic shrimps raising models;
- Monitor and supervise the use of medicals, disinfection chemicals in aquacultural against the use of forbidden ones;
- Transfer good practice technologies in improved traditional and imtensive shrimp farming for local people;
- Local authorities and communities to closely monitor implementation of the implementation of the pilots to ensure strict compliance with environmental regulations and standards;
- Enforce implementation of QCVN 02-19/2014/BNNPTNT on national technical regulation on blackish water shrimp culture farm - conditions for veterinary hygiene, environmental protection and food Safety.

- **Develop and integrate real-time environmental monitoring tools into the livelihood component of the subproject**. The inability of farmers, local governments, local water user groups, and sluice management agencies to predict or respond to changing environmental conditions highlights the need for predictive and real time environmental monitoring tools to inform farmer choices of what crops to invest in. There are some initiatives already underway piloting real-time salinity monitoring. Can Tho University (CTU) has been developing a farmer-based salinity monitoring system in coastal provinces where rice farmers are trained in the use of a simple and cheap hydrometer to measure salinity levels and to send the readings to a computer server at CTU. Critical threshold warnings are sent back to farmers' mobile phones enabling them to react at the farm sluice gate before damage is incurred. The International Fund for Agricultural Development (IFAD) project in Ben Tre and Tra Vinh is working to develop and install a real-time salinity monitoring system with the same objective, but using much more costly automated remote in-river sensors. Here, the servers are to be located within the Provincial Department of Science and Technology (DOST).
- **Share and transfer lessons and experience between subprojects under the MD-ICRSL project.** Sharing lessons and experience between subprojects could also help increase diversification.

- **Use farmer cooperatives or collective groups to implement livelihood adaptation models.** The use of farmer cooperatives or collective groups to implement the livelihood adaptations should form the basis of the livelihood implementation strategy for the subproject. Forming new cooperatives, or implementing through existing cooperatives, will help to instill farmer confidence through collective risk sharing, particularly with risk-averse farmers that are unwilling to adopt the new adaptation models. Cooperatives can play an important role in helping farmers to manage production, post-harvest, and market risks. For example, the cooperative can bulk buy high quality seed at discount prices which an individual farmer may not have the knowledge or financial capacity to do so. Post harvest risks can be reduced by sharing post harvest equipment such as refrigeration for aquaculture products which would not be available to individual farmers. Market risks can be better managed through better access to market prices, collective bargaining, bulk/contract selling, etc.
- **Locate pilot livelihood demonstrations near successful models in order to change farmer's perceptions.** Farmers and local government officials alike have acknowledged that rice farmers are reluctant to adopt risky aquaculture models in particular. Therefore, pilot demonstrations should be located in areas around the successful shrimp farming groups where it is more likely that farmer perceptions are more positive. Farmer to farmer exchanges of knowledge and experience would also be more likely to occur, and easier to facilitate. Neighboring farmers should be provided with financial and economic analysis of the demonstrations once the pilots are demonstrated to be financially beneficial. Scaling-up should branch out from these areas.
- **Reduce the risk of over-supply by working with agribusinesses on a staged incremental approach.** Livelihood implementations should take a staged approach to up-scaling so markets can be tested and agribusinesses have time to expand their markets or find new markets incrementally. The subproject needs to consider a number of market related risks. Brackish water has large fluctuations in market prices that are related to supply and demand. The respective agribusiness interests must be consulted on the proposed scale of investments and production, and on the scale of start-up. Agribusinesses, by their nature, have good knowledge of existing and potential markets. Depending on location, there will be some tension/tradeoff here between the need to demonstrate at compartment scale rather than sub-compartment level to avoid conflicts of interest over water management, and the agribusiness' current demand for production.
- **Start-up capital needs to be provided to fund the livelihood investments.** The subproject, provincial government and/or agribusiness company with an interest in the products should seed the start-up capital for a cooperative (either an existing cooperative or a new one) to invest in the livelihood models. There are high levels of indebtedness at all the subproject sites and without such seed funding, it will be difficult for farmers to capitalize the start-up of the new livelihoods by themselves. They also risk further indebtedness if they were to fail.
- **Hire aquaculture and agriculture specialists to support cooperatives/collective groups.** Technical training (farming techniques) and development support for extension agencies and the cooperatives/collective groups and their agribusiness partners (where they lack the technical capacity) should be provided by aquaculture and agricultural specialists from universities (Can Tho, An Giang) and other organizations like International Union for Conservation of Nature (IUCN)/SNV Netherlands Development Organisation (SNV) (organic shrimp). At the farmer level, technical training should be combined with farmer to farmer exchanges (between pilot areas and successful farmers) as a strategy to facilitate the

transfer of knowledge and experience. This can overcome the limitations of more formal technical training particularly where low levels of literacy exist. Just as important, the approach helps to transfer attitudes and confidence from successful farmers to inexperienced farmers.

- **Establish hatcheries capable of producing high quality aquaculture seed as close as possible to the subproject site.** The availability and affordability of high quality aquaculture seed is a critical factor in almost all subproject area and individual farmers try to economize by buying cheaper low quality seed leading to the result predictably is crop losses from disease. So the local authorities should be establish or call for private investment in good hatcheries as close as possible to the subproject site to maximize efficiency of the sustainable livelihoods models.
- **Mitigation measure for Ethenic minorities:** (i) Training to raise awareness of the community on husbandry and agricultural production. The activity contributes to agricultural growth, economic restructuring, poverty reduction, improvement of EM lives especially for landless and land poor households; (ii) Training to raise awareness of the community on climate change and adaption to changes in water resources, ecological and social; (iii) Livelihood Development Training: this is an important activity for household for economic development. The training courses aim to members (as EM households) to determine/analyze new livelihood ideas to be developed into a viable plan, as an output of the training, which will help them get a loan the subproject for a job that they plan to do; and (iv) Develop livelihood models, with the participation of organizations, social organizations, coordinate the selection of models site, support technical guidance, implementation, monitoring and replicable results.
- **The MD-ICRSL project would support a study contributing to the improvement of current water management practices for shrimp aquaculture**. In particular, the study would cover the following aspects: (a) developing a categorized inventory of the current farms; (b) analyzing the current use of fertilizers and antibiotics; (c) identifying areas with acute environmental issues; and (d) establishing and disseminating best practices. Wastewater treatment systems are required for aquaculture and shrimp farming to reduce surface water pollution.

# CHAPTER 6. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

Based on the assessment of the potential negative impacts discussed in Chapter 4 and the mitigation measures proposed in Chapter 5, this chapter presents the Environmental and Social Management Plan (ESMP) for the subproject. The ESMP identifies actions to be carried out under the subproject including the environmental monitoring program and the implementation arrangements, taking into account the need to comply with the Government's EIA regulations and the WB's safeguard policies, including those of the World Bank Group's Environmental, Health, and Safety Guidelines.

## 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 ICMB10 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.

DARDs of Tra Vinh and Vinh Long will be responsible for 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

### *Positive impacts*

#### *6.2.1.1. Positive impacts from construction 3 sluice gates*

Building 3 sluice gates will bring positive impacts for the subproject areas as follows:

***Improving regulation of freshwater supply and salinity intrusion.*** When the subproject is completed and put into operation, the effects on saltwater intrusion and inundation due to flood tide controls are positive. Under the regulatory activities of the sluice gates, the intrusion of salinity into inland canals and rivers will be limited. In addition, when the sluice gates supply adequate freshwater for usage, they will reduce the salinity in the rivers and canals in the subproject area.

***Enhancing biological resources and biodiversity.*** When the in-field canal system is supplied with adequate freshwater and suitable farming methods are applied, there will a contribution to the growth of freshwater species (eg. Snakehead fish, Channa micropeltes fish, Anabas, Snakeskin gourami, Philippine catfish, Pangasius catfish, etc.) and agricultural biological diversity (e.g. diversity of crops and livestocks). There also will be reduced use of fertilizers and pesticides as well as chemicals used in aquaculture. As such, the quality of the environment is expected to improve. Improved biological resources and biodiversity also enhance the livelihood solutions for people shifting to sustainable farming methods.

***Contributing to economic development.*** Salinity control and irrigation will be provided for 225,682 ha of land (including 49,020 ha in Vinh Long and 176,662ha in Tra Vinh). This scenario will help to provide water, drainage, alluvium, deacidification, and alkaline wash to serve agricultural and aquaculture production for 171,662 ha of arable land of Vinh Long and Tra Vinh provinces. Furthermore, diversification of crops and livestock would lead to creation of more jobs and an increase in income for the people in the subproject area.

***Ensuring social development.*** Subproject implementation will include development plans to help the population in the subproject area, including: (i) Building bridges over the sluice gates to improve the road network of the suproject communes and districts. Particularly, in the Tan Dinh and Bong Bot area, people often travel across the river by ferry, which is time-consuming. When the bridges over the Tan Dinh and Bong Bot sluicegates are completed, travel from Vung Liem district to Cau Ke district and vice-versa as well as to other districts of Tra Vinh and Vinh Long provinces will be more convenient. Freight transportation also will be faster which will result in cost reductions. For example, in the Mekong Delta, fruit growing and trading are important agricultural activities and reduced transport time will result in fresher fruits arriving at the market and these will command a better price for the farmer; (ii) improving people's access to services such as health care and schools due to improved transport conditions. Hence, people can take advantage of healthcare services, schools, and markets easier, particularly children and women; (iii) Contributing to the connection of the geographical regions, facilitating the exchange of cultural activities, participation in the great festivals of the people in the region and (iv) More than 60% of the subproject communes still use river water for cooking and other domestic purposes, so the freshwater reserves will supply water and improve drinking water for the people.

#### *6.2.1.2. Positive impacts from supporting to organically certified mangrove-shrimp, raising aquaculture toward bio-safety and other non-strutural measures*

***Increasing capacity of climate change adaptation***. The subproject objective of up-scaling organically certified mangrove-shrimp in Tra Vinh is to simultaneously raise capacity of climate change adaptation outcome through a market driven sustainable livelihood. It does this by increasing farmer incentives to invest in increasing mangrove cover to a minimum of 50 % of tree cover on their farms. In addition, establisment of Climate Change Response Teams and conducting campain to raising awareness of local people on impact of climate change will contribute to increasing capacity of climate change adaptation.

***Increasing income of local people***. In Tra Vinh province, profits from non-certified mangrove-shrimp systems are approximately 21 million VND/ha and by obtaining organic certification, similar farms are able to increase profits by between 7 and 10 million VND/ha, representing a 20% increase. In addition, forming new cooperatives, or implementing through existing cooperatives, will help to instill farmer confidence through collective risk sharing, particularly with risk-averse farmers that are unwilling to adopt the new adaptation models. Cooperatives can play an important role in helping farmers to manage production, post-harvest, and market risks. For example, the cooperative can bulk buy high quality seed at discount prices which an individual farmer may not have the knowledge or financial capacity to do so. Post harvest risks can be reduced by sharing post harvest equipment such as refrigeration for aquaculture products which would not be available to individual farmers. Market risks can be better managed through better access to market prices, collective bargaining, bulk/contract selling, etc.

### *Negative impact*

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 *Table 6.1*. The negative impacts of project could be summarized as follows:

- Potential increase in traffic accident especially in 3 bridges over the sluice gates.
- Interruption of waterway navigation during contruction.
- Increase in other negative impacts on environment during construction and operation stages.
- Impacts on aquatic life, water quality and waterway navigation if closing the sluice gate in the long time.

*Table 6.1: Potential Negative Impacts of the Subproject*

| No. | Impacts/ Issues | Impact Description | Location / Affected Object | Significance of impacts | Impact duration |
|---|---|---|---|---|---|
| ***A*** | ***Construction of 3 sluice gates*** | | | | |
| **I** | **Pre-construction phase** | | | | |
| 1 | Permanently and temporarily acquired land | Subproject requires acquisition of 33,997m$^2$ (permanently acquire 17,734m$^2$ of production land and 3,190m$^2$ of residential land; and temporarily acquire 16,243 m$^2$ of production land). There are 13 HHs will be affected, including 12 HHs and 5 graves of 1HH in Trung Thanh Tay commune to be physically displaced and cutting down 1934 trees. | 4 HHs in An Phu Tan commune, 4 HHs in Tich Thien commune, 2 HHs in Trung Thanh Dong commune, 3HHs in Trung Thanh Tay | Moderate | Long-term |
| 2 | 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 | - 4 HHs in An Phu Tan commune, 4 HHs in Tich Thien commune, 2 HHs in Trung Thanh Dong commune, 3HHs in Trung Thanh Tay<br>- Workers at the construction site. | Low | Short-term |
| 3 | Worker and public safety | Workers and local people may have injury due to explosion and accident from searching and removing/destroying unexplored ordinances (UXO). | - Residents surround the construction area of Bong Bot, Tan Dinh and Vung Liem sluice gates<br>- Workers at the construction site. | Moderate | Short-term |
| **II** | **Construction stage** | | | | |
| 1 | Impact on operation of 2 ferries in Bong Bot and Tan Dinh sluice gates | - During construction of Bong Bot and Tan Dinh sluice gates, no need to remove Bong Bot and Tan Dinh feries but need to set up a new ferry terminal about 200 - 300m (at the right hand side of the sluice gate) compare to the old terminal toward infield for Tan Dinh and Bong Bot ferry perspectively | Ferry Owners and passengers (400 - 500 passengers and 200 motorbikes/day for each ferry) | Moderate | Short-term |

| | | | | | |
|---|---|---|---|---|---|
| 2 | Dust generation/ Air pollution | - Earthworks and excavation activities of the 3 sluice gates will generate dust.<br>- The amount of dust generated from these activities depends on volume of digging and backfilling, and also depends on the number of machines and trucks working on site.<br>- The total volume of soil excavation is expected to be 57,729$m^3$ in 90 days. The construction will be on the river, canal, in sequences, which will help to minimize dust generation issues so air pollution caused by soil excavation is *moderate* | - Residential clusters surrounds the construction area of Bong Bot, Tan Dinh and Vung Liem sluice gates<br>- Workers at the construction sites. | Moderate | Short-term |
| | | 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 | - Resident surrounds the construction area of Bong Bot, Tan Dinh and Vung Liem sluice gates<br>- Resident along the transportation route<br>- Workers at the construction sites. | Moderate | Short-term |
| | | Activities of concrete mixing stations with capacity of about 30$m^3$/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. | - Resident surrounds the construction area of Bong Bot, Tan Dinh and Vung Liem sluice gates<br>- 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. No sensitive receptors but some houses within 100m from the construction sites of 3 sluice gates | - Resident surrounds the construction area of Bong Bot, Tan Dinh and Vung Liem sluice gates<br>- An Tinh and Hung Giao temples (280m far from Bong Bot sluice gate construction)<br>- Workers at the construction sites. | Low | Short-term |

| | | | | | |
|---|---|---|---|---|---|
| | | For a mixing station with capacity of about 30m3/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). | - Resident surrounds the construction area of Bong Bot, Tan Dinh and Vung Liem sluice gates<br>- Workers at the construction sites. | Low | Short-term |
| 4 | Surface water pollution from excavation and filling activities, worker's camp and construction equipment. | - Wastewater from construction machines and equipment maintenance containing organic 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 $2m^3$ of water per day; i) machine cleaning needing $4m^3$ and iii) cooling needing $2m^3$. 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 not significant.<br>- Soil excavation in the bed of Vung Liem, Tan Dinh Rivers and Bong Bot canal will increase suspended solids and disturb rivers and canal bed causing pollution water quality and aquatic life of Vung Liem, Tan Dinh rivers and Bong Bot canal. However, all construction activities will be in a stell sheet pile coffer dam so these impacts will be low<br>- Runoff water on the construction site contains high concentration of suspend solid and leakage oil from machine hat lead to increasing the concentration of pollution matters such as: SS, COD, oil in the surrounding water sources.<br>- Wastewater from worker's camps ($8.82m^3$/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. | - Water quality and aquatic life Bong Bot canal, Tan Dinh and Vung Liem rivers and natural habitat in the intersection between Hau river and Tan Dinh river and Bong Bot canal and Co Chien river and Vung Liem river<br>- Catfish pond (350m far from the construction site of Tan Dinh sluice)<br>- Surrounding 3 workers' camps<br>- Aquatic life in the intersections between Hau river and Bong Bot canal and Tan Dinh river and Co Chien river and Vung Liem river | Low | Short-term |
| 5 | Drainage and sedimentation | - Lacking of control of the temporary material yards in the subproject area may be lead to erosion and sedimentation problems. | - Bong Bot canal, Tan Dinh and Vung Liem rivers | Low | Short-term |

| | | | | | |
|---|---|---|---|---|---|
| | | | - Tree gardens and residents surround the temporary material yards. | | |
| 6 | Solid waste | - Solid waste includes construction solid waste and domestic solid waste.<br>- 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 need to be handled to avoid impacts on air, water qualities, and big dirty masses in the subproject area.<br>- Domestic waste and rubbish (domestic solid waste) generated from workers' camp 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 0.3 kg/person/day.<br>- 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 | - At the construction sites and worker's camps. | Moderate | Short-term |
| 7 | Hazardous wastes | - Other wastes as waste batteries, accumulators, plastic cores contain printing ink, etc. generated with small volume (estimate about 5 kg/month), but not directly at the construction sites, almost at the construction management offices and repair workshops. These wastes will be collected, transported and treated by a licensed agency according the provisions of the Hazardous Waste Management.<br>- The waste oil and oil-containing wipers from periodical oil change also identified as hazardous wastes. The amount of waste oil is estimated that: i) the amount of oil discharged each time is 07 litters; and ii) frequency of maintenance is 600 shifts. The amount of hazardous wastes is not much, 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 | Short-term |
| 8 | Interruption of waterway navigation, fishing, and | Sluice gates construction will happen mainly in the Bong Bot canal, Tan Dinh and Vung Liem rivers can cause interruption of waterway navigation, fishing, and irrigation activities on these rivers and canal. However, construction activities is in a coffer, only partly narrow theirs cross sections | - In the construction sections of Bong Bot canal, Tan Dinh and Vung Liem rivers | Moderate | Short-term |

| | | | | | |
|---|---|---|---|---|---|
| | irrigation activities | of and these rivers and canal are Grade-V inland waterways and fishing is forbidden in these rivers (1-2 boats/day each sluice gate) so impact on waterway navigation, fishing, and irrigation activities is moderate | - Land for fruit trees surrounding in the construction sites of Vung Liem, Tan Dinh and Bong Bot sluice gates | | |
| 9 | Worker and public safety | Workers and local people could be at risk if they travel around or closed 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<br>- Narrow partly cross-section of Bong Bot canal, Vung Liem and Tan Dinh rivers will lead waterway incidents | - Along transportation route<br>- At the construction section of Vung Liem, Tan Dinh and Bong Bot sluice gates | Moderate | Short-term |
| 11 | Communication with local communities | Lack of communication and consultation with local communities can lead to an opposition to the subproject delays in the construction process, increased costs and unsatisfactory solutions. | Communities and local authorities in the construction area of 3 sluice gates | Low | Short-term |
| 12 | Workforce management | Worker concentration will cause the following impacts:<br>- Increased demand for infrastructure and utilities.<br>- Pollution caused by waste and domestic wastewater.<br>- Increase risk of communicable diseases, such as malaria, HIV/AIDS, etc threaten health of workers and local people.<br>- Affect local social secure, increase crime rate, drug use, prostitution, social conflict, etc. | Communities and local authorities in the construction area of 3 sluice gates | Moderate | Short-term |
| 13 | Cultural impacts | - There are also no important historical and cultural sites identified in the subproject construction sites. There are two sites, Hung Giao and An Tinh temples located about 280m to Bong Bot sluice gate but impacts on the temples is likely small and to mitigate potential noise impacts, equipment with low noise signatures will be used, work activities will avoid days of worship, and if necessary, noise barriers will be installed. | At any location in the subproject area if cultural work findings. | Low | Short-term |

| | | | | | |
|---|---|---|---|---|---|
| | | - No adverse impacts on other historical and cultural heritage features are expected during the construction phase of the subproject | | | |
| 14 | Fire and explosive incident during 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 of fire and explosion are as following:<br>- 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;<br>- Using the temporary power supply systems for machinery, construction equipment can cause electric shock, electrical leakage, fire, explosion, causing economic damage or accident at work;<br>- Using of heating equipment could cause fire, burns or accidents if no preventive measures. | In the whole of construction area | Moderate | Short-term |
| **III** | **Operation stage** | | | | |
| 1 | Removal of 2 ferries | When 2 brigdes over the Tan Dinh and Bong Bot sluice gates will be built, all passengers of Tan Dinh and Bong Bot ferries will travel on the 2 brigde leading to 2 ferries will not be used. | Ferry owners of Bong Bot and Tan Dinh ferries | Low | Long-term |
| 2 | Dust and exhaust gases generation | The operation of the 3 bridges over the sluice gates could increase air pollutant concentration, however, still be under thresholds of technical regulations. | Along the 3 bridges over the sluice gates | Low | Long-term |
| 3 | Traffic safety | Increase in traffic-related accidents in the locality. Road safety facilities have been incorporated in the subproject design at both preparatory and detailed design phase | Along the 3 bridges over the sluice gates | Moderate | Long-term |
| 4 | Waterway limitation | This impact is small because the closing time of 3 sluice gates is very short | At Vung Liem, Tan Dinh and Bong Bot sluice gates | Low | Long-term |
| 5 | Water pollution | Closing of the sluice gates will reduce water exchange in the subproject area and the risk of water pollution may be increase. But this impact is small due to short time of sluice gates closing | At Vung Liem, Tan Dinh and Bong Bot sluice gates | Low | Long-term |

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| 5 | Temporary blockage of fish pass | When closing the sluice gates, fish can not pass from Hau river to Bong Bot canal and Tan Dinh river, Vung Liem river to Mang Thit river and vice versa but sluice gates will be closed in short time so impact on fish pass is low | At Vung Liem, Tan Dinh and Bong Bot sluice gates | Low | Short-term |
| 6 | Risks and incidents | - Traffic accidents can cause losses of properties and lives. The reasons for traffic accidents can be many, including transport vehicles do not meet technical standards; driver fatigue or distraction; and non-compliance with traffic safety regulations. When the bridges over the 3 sluicegates are completed, the traffic volume is projected to increase.<br>- Damage of sluice gates: the salinity from the main rivers will quickly enter into the water environment of the fields. Salt water will immediately interact with every aspect of the environment, leading to severe consequences, including damage of rice, fruit trees, and other crops; depletion of freshwater aquatic sources in the area, directly affecting aquaculture in the area; salinity intrusion into surface water, contaminating the soil environment. | At Vung Liem, Tan Dinh and Bong Bot sluice gates | Moderate | Long-term |
| **B** | **Planting mangrove trees** | | | | |
| I | In preconstruction phase | In the locations of mangrove - shrimp ponds for additional mangrove planting to achieve requirements of ecofarming certification are mainly water surface land and agricultural land, there have very few houses and reforestation will take place in the existing ponds and no land acquisition and land clearance. So impacts in this phase are negligible. | Mangrove - shrimp ponds | Negligible | Short- term |
| II | In 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 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 |

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| **C** | **Raising aquaculture toward bio-safety** | | | | |
| **I** | **In preconstruction phase** | These activities require no land acquisition and resettlement, as well as public infrastructure encroachment because they are developed on the existing ponds. | Aquaculture ponds using for demonstrations | Negligible | Short- term |
| **II** | **In construction phase** | The demonstration sites are located in the existing ponds, so no need to dig new ponds or building infrastructure for the demonstrations, only cleaning out the mud layer on the bottom of the ponds and very few people live surrounding so impacts on local environment and people in this phase is low. | Aquaculture ponds using for demonstrations | Low | Short- term |
| **III** | **In operation phase** | Currently, ponds for demonstration are now raising intensive shrimp, the impacts of this method on the environment mainly from organic wasteswater and solid waste. However, in case of "with out subproject", these impacts still occur, and when implementation of the subproject, objectives will be diversified not only shrimp - rice but also shrimp - Oreochromis niloticus, shirmp - garb and farming will be done in form of cleaner production, the impact on the environment will reduced however the problem of concern is the spread of disease. When outbreaks occur, the government offers free treatment of ponds when disease appears. If the shrimp are older than one month when they become infected, shrimp farmers will not notify authorities but try to salvage their investment by releasing water to harvest the shrimp to sell. However, these modes use for demonstration purposes only and its impacts will be localized and minimized through increasing farmer awareness on the impacts of the diseases and develop good quality seeds. | Aquaculture ponds using for demonstrations | Moderate | Long - term |
| | | Impacts due to upscaling livelihood: (i) increase environmental pollution due to waste from aquaculture; (ii) descrease income of local farmers due to market failure | In the area of applying livelihood models | Moderate | Long - term |

## 6.3. MITIGATION MEASURES

This section presents the measures to be carried out by the subproject owner (Tra Vinh DARD) during the implementation of the subproject to mitigate the potential negative impacts of the subproject activities considered to be general impacts and the site-specific impacts. Section 6.3.1 (***Error! Reference source not found.****6.2*) presents the potential negative impacts of the subproject activities (Component 3) considered as general impacts and they could be mitigated through ECOP while Section 6.3.2 (***Error! Reference source not found.***) presents site-specific impacts that require special attention. Nonetheless, it is noted that if the contract for Component 1 is implemented through different contractor, the simplified ECOP shown in Annex 1 will be applied.

For works of Components 3, during the preparation of bidding documents, the Tra Vinh PPMU will incorporate both the mitigation measures identified under the preconstruction and construction phases under the ECOP and site-specific requirements into the bidding and contract documents and ensure that the contractor are well aware of these obligations. During construction, the PPMU will assign the Construction Supervision Consultant (CSC) to also be responsible for the day-to-day supervision and monitoring of contractor performance in compliance with these measures. During contruction, the contractor will be required to prepare and implement a Contractor Environmental and Social Management Plan (CESMP) in line with these requirements. The Tra Vinh PPMU will also include results of contractor performance in the subproject monthly progress report to be submitted to the Cetral Project Management Unit (CPMU) of the Central Project Management Office (CPO) to be established in CanTho.

During operation of the Components 1 and 3 activities, the subproject owner (Tra Vinh DARD) will be responsible for ensuring that the responsible agencies of the province will take actions to implement the activities identified in ECOP (***Error! Reference source not found.***) as well as those identified under the site-specific requirements (***Error! Reference source not found.***). One technical assitance will be provide for safeguard training as well as ensuring that the sluice operation procesure will be developed in close consultation with water users and key stakeholders. For the Component 1, in additional to the technical assistance to be provided during the planning and implementation of the sustainable livelihood models, one additional technical assistance will be needed to mitigate the potential negative socio-economic impacts on poor farmers and the potential negative impacts that may occur due to possible expansion of the models in the future.

### *Mitigation measures of general impacts*

The mitigation measures of general impacts during pre-construction, construction, and operation phases, the environmental codes of practices (ECOP), related to the general construction activities of the three sluice gates are presented in *Table 6.2.*

*Table 6.2: 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. In pre-construction** | | | | |
| **1. Complaints due to subproject implementation** | - Prior to 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.<br>- 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.<br>- 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<br>- Law on Environmental Protection No. 55/2014/QH13 | - Contractor<br>- PPMU | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **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<br>- Law on Environmental Protection No. 55/2014/QH13 | - Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **II. In construction phase** | | | | |
| **1. Dust generation and air pollution** | - The Contractor is responsible for compliance with relevant Vietnamese legislation with respect to ambient air quality.<br>- 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.<br>- The Contractor shall implement dust suppression measures (e.g. covering of material stockpiles, etc.) as required.<br>- Material loads shall be suitably covered and secured during transportation to prevent the scattering of soil, sand, materials, or dust. | - TCVN 6438-2005: Road vehicles. Maximum permitted emission limits of exhaust gas.<br>- Decision No. 35/2005/QD-BGTVT on inspection of quality, technical safety and environmental protection; | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| | - 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.<br>- Dust masks should be used by workers where dust levels are excessive<br>- All vehicles must comply with Vietnamese regulations controlling allowable emission limits of exhaust gases.<br>- 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.<br>- There should be no burning of waste or construction materials on site.<br>- Cement processing plants should be far from residential areas. | - QCVN 05:2013/BTNMT: National technical regulation on ambient air quality. | | |
| **2. Impacts from noise and vibration** | - The contractor is responsible for compliance with the relevant Vietnamese legislation with respect to noise and vibration.<br>- 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.<br>- 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.<br>- 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.<br>- QCVN 27:2010/BTNMT: National technical regulation on vibration | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| **3. Water pollution** | - The Contractor must be responsible for compliance with Vietnamese legislation relevant to wastewater discharges into watercourses.<br>- 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.<br>- Wastewater containing pollutants over standards set by relevant Vietnamese technical standards/regulations must be collected in a conservancy tank and removed from site by licensed waste collectors.<br>- Make appropriate arrangements for collecting, diverting or intercepting wastewater from households to ensure minimal discharge or local clogging and flooding.<br>- Before construction, all necessary wastewater disposal permits/licenses and/or wastewater disposal contracts have been obtained.<br>- At completion of construction works, wastewater collection tanks and septic tanks shall be safely disposed or effectively sealed off. | - QCVN 08-MT:2015/BTNMT: National Technical Standard on surface water quality;<br>- QCVN14:2008/BTNMT: National technical regulation on domestic wastewater;<br>- QCVN 40: 2011/BTNMT: National technical regulation on industrial wastewater; | Contractor | - Supervision reports of CSC<br>Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **4. Drainage and sedimentation control** | - The Contractor shall follow the detailed drainage design included in the construction plans, intended to prevent storm water from causing local flooding or scouring slopes and areas of unprotected soil, resulting in heavy sediment loads affecting local watercourses.<br>- Ensure the drainage system is always maintained cleared of mud and other obstructions.<br>- Areas of the site not disturbed by construction activities shall be maintained in their existing conditions.<br>- Earthworks, and fill slopes shall be properly maintained, in accordance with the construction specifications, including measures such as installation of drains, use of plant cover.<br>- 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 of logging slash, rock berms, sediment catchment basins, straw bales, storm drain inlet protection systems, or brush fences. | - TCVN 4447:2012: Earth works-Codes for construction;<br>- Circular No. 22/2010/TT-BXD on regulation of construction safety;<br>- QCVN 08-MT:2015/BTNMT-National technical regulation on quality of surface water | - Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| | - 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 plansor 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.<br>- Stockpile topsoil when first opening a borrow pit and use it later to restore the area to near natural conditions.<br>- If needed, disposal sites shall include a retaining wall.<br>- If the need for new sites arises during construction, they must be pre-approved by the Construction Engineer.<br>- If landowners are affected by use of their areas for stockpiles or borrow pits, they must be included in the subproject resettlement plan.<br>- If access roads are needed, they must have been considered in the environmental assessment.<br>- PPMU's Environment Officer should conduct due diligence to make sure that borrow pits and quarries are legally operating, with licensed and that sound environment and social standards are being practiced.<br>- 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.<br>- 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.<br>- Include monitoring of borrow pits and quarries. | - Decree No. 59/2015/ND-CP<br>- Decree No. 38/2015/NĐ-CP | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **6. Solid waste** | - 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. | - Decree No. 38/2015/NĐ-CP on | - Contractor | - Supervision reports of CSC |

| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| | - Before construction, all necessary waste disposal permits or licenses must be obtained.<br>- 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.<br>- 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.<br>- Waste storage containers shall be covered, tip-proof, weatherproof and scavenger proof.<br>- No burning, on-site burying or dumping of solid waste shall occur.<br>- 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.<br>- 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. | solid waste management<br>- Circular No. 36/2015/TT-BTNMT on management of hazardous substance | | - Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **7. Chemical or hazardous wastes** | - 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.<br>- The removal of asbestos-containing materials or other toxic substances shall be performed and disposed of by specially trained and certified workers.<br>- Used oil and grease shall be removed from site and sold to an approved used oil recycling company.<br>- Used oil, lubricants, cleaning materials, etc. from the maintenance of vehicles and machinery shall be collected in holding tanks and removed from site by a specialized oil recycling company for disposal at an approved hazardous waste site. | Circular No.36/2015/TT-BTNMT on management of hazardous substance | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| | - Used oil or oil-contaminated materials that could potentially contain PCBs shall be securely stored to avoid any leakage or affecting workers. The Vinh Long and Tra Vinh DONREs must be contacted for further guidance.<br>- Unused or rejected tar or bituminous products shall be returned to the supplier's production plant.<br>- Relevant agencies shall be promptly informed of any accidental spill or incident.<br>- Store chemicals appropriately and with appropriate labeling<br>- Appropriate communication and training programs should be put in place to prepare workers to recognize and respond to workplace chemical hazards<br>- 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.<br>- 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<br>- Circular No. 36/2015/TT-BTNMT on management of hazardous substance | - Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **9. Disruption of vegetative cover and ecological resources** | - The Contractor shall prepare a Clearance, Revegetation and Restoration Management Plan for prior approval by the Construction Engineer, following relevant regulations. The Clearance Plan shall be approved by the Construction Supervision Consultant and followed strictly by the contractor. Areas to be cleared should be minimized as much as possible.<br>- Site clearance in a forested area is subject to permission from Tra Vinh DARD.<br>- The contractor shall remove topsoil from all areas where topsoil will be impacted by construction activities, including temporary activities such as storage and stockpiling, etc; the stripped topsoil shall be stockpiled in areas agreed to by the | Law on Environment protection<br>No. 55/2014/QH13 | Contractor | - Supervision reports of CSC<br>Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| | Construction Supervision Consultant for later use in re-vegetation and shall be adequately protected.<br>- The application of chemicals for vegetation clearing is not permitted.<br>- Trees cannot be cut down unless explicitly authorized in the vegetation clearing plan.<br>- When needed, temporary protective fencing will be erected to efficiently protect the preserved trees before commencement of any works within the site.<br>- 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 that is protected as a green space.<br>- 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.<br>- Significant increases in 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.<br>- Installation of lighting at night must be done, if necessary, to ensure safe traffic circulation.<br>- Place signs around the construction areas to facilitate traffic movement, provide directions to various components of the works, and provide safety advice and warnings.<br>- Employ safe traffic control measures, including road/rivers/canal signs and flag persons to warn of dangerous conditions.<br>- Avoid material transportation for construction during rush hours.<br>- 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<br>- Law on construction No. 50/2014/QH13<br>- Circular No.22/2010/TT-BDX dated 03 Dec., 2010 on labor safety duringthe construction of civil works | - Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| **11. Interruption of utility services** | – Provide information to affected households on working schedules as well as planned disruptions (at least 5 days in advance).<br>– Interruptions of water supply to agricultural areas must be avoided.<br>– The contractor should ensure alternative water supply to affected residents in the event of disruptions lasting more than one day.<br>– Any damages to existing cable utility systems shall be reported to the authorities and repaired as soon as possible. | Decree No. 73/2010/NDCP on administrative penalization security and society issues | Contractor | – Supervision reports of CSC<br>Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **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 construction of the subproject works shall be restored using landscaping, adequate drainage and revegetation.<br>– Start revegetation at the earliest opportunity. Appropriate local native species of vegetation shall be selected for the planting and restoration of the natural landforms.<br>– Spoil heaps and excavated slopes shall be re-profiled to stable conditions, and grassed to prevent erosion.<br>– 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.<br>– Trees shall be planted at exposed land and on slopes to prevent or reduce land collapse and keep stability of slopes.<br>– Restore all damaged roads and bridges caused by subproject activities. | Law on Environment protection No. 55/2014/QH13 | | |
| **13. Worker and public Safety** | – Contractor shall comply with all Vietnamese regulations regarding worker safety.<br>– Prepare and implement an action plan to cope with risk and emergency.<br>– Preparation of emergency aid service at the construction site.<br>– Training workers on occupational safety regulations.<br>– If blasting is to be used, additional mitigation measures and safety precautions must be outlined in the ESMP.<br>– 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. | – Circular No. 22/2010/TT-BXD dated 03 December 2010 on regulation of construction safety<br>– Directive No. 02 /2008/CT-BXD on safety and sanitation | – Contractor | – Supervision reports of CSC<br>– Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| | - During 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.<br>- The contractor shall provide safety measures such as installation of fences, barriers warning signs, lighting system against traffic accidents as well as other risk to people.<br>- Contractors' 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 use of child labor; and comply with the government's labor laws and related international treaty obligations.<br>- Maximize employment of women and poor HH during construction. | issues in construction agencies<br>- TCVN 5308-91: Technical regulation on safety in construction<br>- Decision No. 96/2006/QD-TTg dated 04 May 2006 on management and implementation of bomb mine explosive material disposal. | | |
| **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).<br>- 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.<br>- 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. | - Decree No. 73/2010/ND-CP on administrative penalization security and society issues<br>- 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<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| | - 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.<br>- Provide a community relations contact from who interested parties can receive information on site activities, subproject status and subproject implementation results.<br>- 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 of fact sheets and news releases, when major findings become available during the subproject phase.<br>- Monitor community concerns and information requirements as the subproject progresses.<br>- Respond to telephone inquiries and written correspondence in a timely and accurate manner.<br>- Inform local residents about construction and work schedules, interruption of services, traffic detour routes and provisional waterway routes, blasting and demolition, as appropriate.<br>- Provide technical documents and drawings to PC's community, especially a sketch of the construction area and the ESMP of the construction site.<br>- 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. Workers'camp management** | - The Contractor will consult with 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<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| 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:<br>- Stop the construction activities in the area of the chance find.<br>- Delineate the discovered site or area.<br>- 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 takes over.<br>- 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).<br>- 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.<br>- 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 an irremovable remains of cultural or archeological importance) conservation, preservation, restoration and salvage.<br>- 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.<br>- Decisions concerning the management of the finding shall be communicated in writing by relevant authorities.<br>- Construction works could resume only after permission is granted from the responsible local authorities concerning safeguard of the heritage. | - Law on Cultural Heritage 32/2009/QH12<br>- Decree No. 98/2010/ND-CP | - Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **III. In operation phase** | | | | |

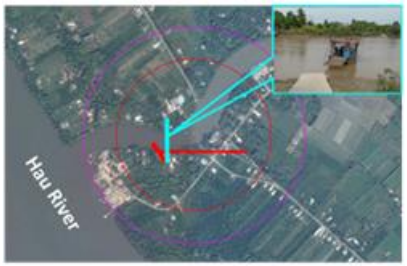
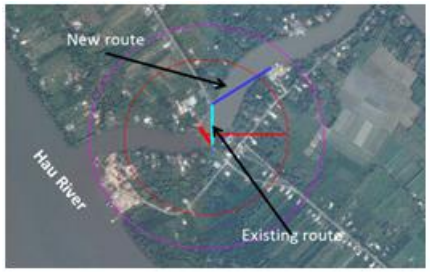
| Environmental – social issues | Mitigation measure | Vietnam code/regulation | Responsibility | Verification to determine effectiveness of measures |
|---|---|---|---|---|
| Dust and exhaust gases generation | - There is a measurable link between traffic noise and speed. Speed control is the most direct and economic way to reduce traffic noise.<br>- Encourage the use of less noisy vehicles and periodic maintenance of vehicles | - QCVN 06:2009/BTNMT<br>- TCVN 6438-2005<br>- Decision No. 249/2005/QĐ-TTg | Local government and traffic authorities | - Supervision reports of CSC<br>- Supervision and monitoring reports of Tra Vinh DARD |
| Traffic safety | - Road safety facilities have been incorporated in the subproject design at both preparatory and detailed design phases. These include traffic separation medians, pedestrian and light vehicle underpasses, lighting at intersections and bridges longer than 100 m and signs and pavement markings complying with Vietnamese standards. These will be put in place by the Contractors during construction and will be maintained by the subproject owner during the subproject's service life.<br>- Using environmentally friendly vehicles<br>- Old vehicles will be checked 6-monthly and maintained in good order | - Law on traffic and transportation No. 23/2008/QH12<br>- Circular No. 22/2010/TT-BXD on labor safety in work construction | Local government and traffic authorities | - Supervision reports of CSC<br>- Supervision and monitoring reports of Tra Vinh DARD |

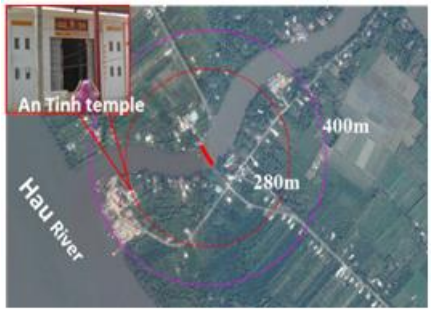
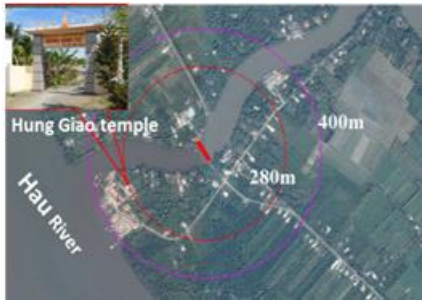
### *Site-specific Impacts and Mitigation Measures*

*Table 6.3* presents site-specific impacts and mitigation measures that could not 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.

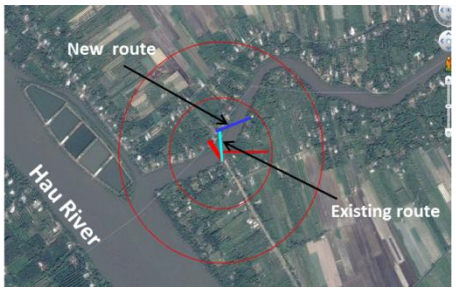
*Table 6.3: Site -specific Mitigation Measures*

| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| ***A*** | ***For 3 sluice gates*** | | | | |
| ***I*** | ***During construction 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:<br>- Compensate for all losses at replacement costs and provide replacement land within their village or commune satisfactory to them so that their cultural and social cohesion could be maintained.<br>- Support to relocating HHs to restore their livelihood and living conditions.<br>- The affected people are given priority to be recruited for the activities under the subproject. | - Law on Land No. 45/2013/QH13;<br>- Decree No. 43/2014/ND-CP;<br>- Decree No. 44/2014/ND-CP;<br>- Decree No. 47/2014/NĐ-CP;<br>- Circular No. 36/2014/TT-BTNMT;<br>- Circular No. 37/2014/TT-BTNMT;<br>- Decision No.52/2012/QD-TT; | - Compensation, support and resettlement councils of Tra Vinh and Vinh Long<br>- PPMU Tra Vinh and Vinh Long | Supervision reports of PPMU Tra Vinh and Vinh Long and Independent resettlement monitoring consultant |
| **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 Tra Vinh province to carry out the UXO clearance at the construction sites. This activity will be implemented right after completing land acquisition and compensation and before any dismantling, demolition or ground levelling takes place.<br>- Ensure that the contractors shall only commence site works after the subproject areas are already been cleared | - Decision No. 96/2006/QD-TTg dated 04 May 2006 on management and implementation of bomb mine explosive material disposal.<br>- | - Contractor implementing the package of searching and removing/destroying UXO<br>- PPMU Tra Vinh and Vinh Long | - Implementation report<br>- Supervision reports of the PPMU Tra Vinh and Vinh Long |
| **3** | **Relocation of graves** | - Compensation for the removal of the 5 graves is included in the RAP of the subproject and will include the cost for buying of land for re-burial, excavation, relocation, reburial and other related costs which are necessary to satisfy customary religious requirements. Compensation in cash will be paid to each affected | - Policy for grave relocation will be compliance with approval Resettlement Policy Framework (RPF) | | |

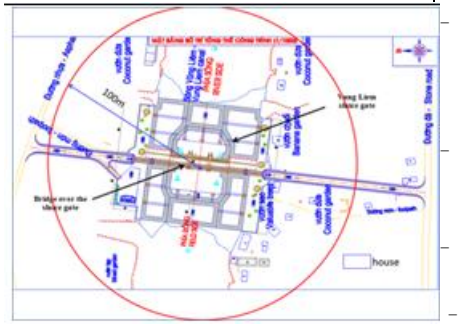
| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| | | family or to the affected group as a whole as is determined through a process of consultation with the affected community. The level of compensation will be decided in consultation with the affected families/communities. All costs of excavation, relocation and reburial (3,000,000 VND/grave) will be reimbursed in cash. Graves to be exhumed and relocated in culturally sensitive and appropriate ways.<br>- During implementation the Subproject Owner will make early announce to the households whose graves are affected so that they can arrange their embodiment in consistence with the spiritual practices of the people and compensate to the affected household as required in the subproject RAP and ESMP. | and Resettlement Action Plan (RAP) | | |
| ***II*** | ***During Construction phase*** | | | | |
| ***1*** | ***At Bong Bot sluice gate*** | | | | |
| **1.1** | **Bong Bot ferry**<br>  | - Sett up a new ferry terminal for Bong Bot ferry (at the right hand side) about 300m compare to the old terminal toward infield<br>  <br>- Support for ferry owner to move to new location at the beginning of Bong Bot sluice gate operation<br>- Arrange a speedboat to regulate, control, and guide waterway traffic for the ferry operation | Law on inland waterways 48/2014/QH13 | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| 1.2 | **An Tinh temple**<br>  | - Inform the temple management of the construction activities and their potential impacts of construction activities such as dust and noise one month before start of the construction.<br>- Use axial compressive load pile driving method instead of using pile driving hammer.<br>- Sprey sufficient water to suppress dust during dry and windy days.<br>- Pay special attention to the above mitigation measures during religious events every first and 15th days of the lunar month and during festival days.<br>- Immediately addess any issue/problem caused by the construction activities and raised by the temple. | - QCVN 05:2013/BTNMT:<br>- QCVN 06:2008/BTNMT<br>- QCVN 19: 2009/BTNMT<br>- QCVN 26:2010/BTNMT<br>QCVN 27:2010/BTNMT | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| 1.3 | **Hung Giao temple**<br>  | - Inform the temple management of the construction activities and their potential impacts of construction activities such as dust and noise one month before start of the construction.<br>- Use axial compressive load pile driving method instead of using pile driving hammer.<br>- Sprey sufficient water to suppress dust during dry and windy days.<br>- Pay special attention to the above mitigation measures during religious events every first and 15th days of the lunar month and during festival days.<br>- Immediately addess any issue/problem caused by the construction activities and raised by the temple. | - QCVN 05:2013/BTNMT<br>- QCVN 06:2008/BTNMT<br>- QCVN 19: 2009/BTNMT<br>- QCVN 26:2010/BTNMT<br>- QCVN 27:2010/BTNMT | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| 1.4 | **Natural river habitat in the intersection between Hau River and Bong Bot canal** | - Collect wastewater, solid wastes, spoils as required in the contractor's SEMP to avoid pollution of surface water sources.<br>- Apply appropriate construction methods to minimize the loss and disturbance of benthic habitats and organisms, and reduce suspended solids in the water column, including using sheet pile coffer dam. | - Law on inland waterways 48/2014/QH13<br>- QCVN 08-MT:2015/BTNMT<br>- Circular 36/2015/BTNMT | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| |  |  <br>- Arrange a speedboat to regulate, control, and guide waterway traffic to avoid oil and hazardous spill.<br>- Put the floating pontoon surrounded rigs to facilitate the collection of solid waste, floating objects accidentally falling flow.<br>- Arrange 2 different trash containers on each floating rigs for containing oil rags and other solid wastes. | | | |
| 1.5 | **Residential cluster in Bong Bot construction site**<br>  | - Sprey sufficient water during dry days to avoid dust around the residential area.<br>- Do not allow construction activities before 6:30 am and after 8:00 pm. If night shift is unavoidable, prohibit use of construction methods that cause noise at night.<br>- Ensure traffic safety by installing safety fence and warning signs, traffic instruction around construction area that adjacent to the residential area.<br>- Provide good drainage to avoid water run-off to residential area.<br>- Immediately collect any domestic wastes and construction spoils caused by the construction activities around the residential area and dispose in a designated site.<br>- Hold monthly meeting with the community on construction progress and issues and immediately address any issue/complaint raised by the community. | - QCVN 05:2013/BTNMT<br>- QCVN 06:2008/BTNMT<br>- QCVN 08-MT:2015/BTNMT<br>- QCVN 19: 2009/BTNMT<br>- QCVN 26:2010/BTNMT<br>- QCVN 27:2010/BTNMT<br>- Circular 36/2015/BTNMT | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| *2* | ***At Tan Dinh sluice gate*** | | | | |
| 2.1 | **Tan Dinh ferry**<br>  | - Setting up a new ferry terminal for Tan Dinh ferry (at the right hand side) about 200m compare to the old terminal toward infield<br>  <br>- Support for ferry owner to move to new location at the beginning of Tan Dinh sluice gate operation<br>- Arranging a speedboat to regulate, control, and guide waterway traffic for the ferry operation | - Law on inland waterways 48/2014/QH13 | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| 2.2 | **Natural habitat in the intersection between Hau River and Tan Dinh river**<br>  | - Collect wastewater, solid wastes, spoils as required in the contractor's SEMP to avoid pollution of surface water sources.<br>- Apply appropriate construction methods to minimize the loss and disturbance of benthic habitats and organisms, and reduce suspended solids in the water column, including using sheet pile coffer dam.<br>  | - Law on inland waterways 48/2014/QH13<br>- QCVN 08-MT:2015/BTNMT QCVN 19: 2009/BTNMT<br>- Circular 36/2015/BTNMT | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| | | - Arrange a speedboat to regulate, control, and guide waterway traffic to avoid oil and hazardous spill.<br>- Put the floating pontoon surrounded rigs to facilitate the collection of solid waste, floating objects accidentally falling flow.<br>- Arrange 2 different trash containers on each floating rigs for containing oil rags and other solid wastes. | | | |
| 2.3 | **Catfish pond 350m far from the construction site of Tan Dinh**<br>  | - Inform the catfish pond onwers of the construction activities and their potential impacts of construction activities such as increased suspended solids in the water, wastewater, domestic wates and construction spoils one month before start of the construction.<br>- Arrange a speedboat to regulate, control, and guide waterway traffic to avoid oil and hazardous spill.<br>- Put the floating pontoon surrounded rigs to facilitate the collection of solid waste, floating objects accidentally falling flow.<br>Arrange 2 different trash containers on each floating rigs for containing oil rags and other solid wastes. | - QCVN 08-MT:2015/BTNMT<br>- Circular 36/2015/BTNMT | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **3** | **At Vung Liem sluice gate** | | | | |
| **3.1** | **Natural habitat in the intersection between Vung Liem and Co Chien rivers**<br>  | - Collect wastewater, solid wastes, spoils as required in the contractor's SEMP to avoid pollution of surface water sources.<br>- Apply appropriate construction methods to minimize the loss and disturbance of benthic habitats and organisms, and reduce suspended solids in the water column, including using sheet pile coffer dam.<br>- Arrange a speedboat to regulate, control, and guide waterway traffic to avoid oil and hazardous spill.<br>- Put the floating pontoon surrounded rigs to facilitate the collection of solid waste, floating objects accidentally falling flow. | - Law on inland waterways 48/2014/QH13<br>- QCVN 08-MT:2015/BTNMT<br>- Circular 36/2015/BTNMT | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |

| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| | | - Arrange 2 different trash containers on each floating rigs for containing oil rags and other solid wastes. | | | |
| **3.2** | **Residential cluster in Vung Liem construction site**<br>  | - Sprey sufficient water during dry days to avoid dust around the residential area.<br>- Do not allow construction activities before 6:30 am and after 8:00 pm. If night shift is unavoidable, prohibit use of construction methods that cause noise at night.<br>- Ensure traffic safety by installing safety fence and warning signs, traffic instruction around construction area that adjacent to the residential area.<br>- Provide good drainage to avoid water run-off to residential area.<br>- Immediately collect any domestic wastes and construction spoils caused by the construction activities around the residential area and dispose in a designated site. | - QCVN 05:2013/BTNMT<br>- QCVN 06:2008/BTNMT<br>- QCVN 08-MT:2015/BTNMT<br>- QCVN 19: 2009/BTNMT<br>- QCVN 26:2010/BTNMT<br>- QCVN 27:2010/BTNMT<br>- Circular 36/2015/BTNMT | Contractor | - Supervision reports of CSC<br>- Supervision and monitoring reports of PPMU Tra Vinh and Vinh Long |
| **III** | ***During operation*** | | | | |
| 1 | Temporary obstruction of waterway transport through the three sluice gates | - The sluice will be opened most of time<br>- Develop a plan to optimize time of sluice gate closures and consult with local authorities and people.<br>- Notify local people and authorities regarding sluice gate operation (opening and closing times). | - Law on inland waterways No. 48/2014/QH13 | - Local government and traffic authorities<br>- Provincial Division of Water Resources of Tra Vinh and Vinh Long | - Supervision reports of CSC<br>- Supervision and monitoring reports of Tra Vinh and Vinh Long DARDs |
| 2 | Temporary blockage of fish passes | - The sluice will be opened most of time<br>- Monitoring aquatic life during the first two year of sluice gates operation | - Law on biodiversity No. 20/2008/QH12 | - Provincial Division of Water Resources of Tra Vinh and Vinh Long | |

| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| 3 | Air pollution and road safety on the bridges | - Road safety facilities have been incorporated in the suboroject design at both preparatory and detailed design phases. These include traffic separation medians, pedestrian and light vehicle underpasses, lighting at intersections and bridges longer than 100 m and signs and pavement markings complying with Vietnamese standards. These will be put in place by the Contractors during construction and will be maintained by the subproject owner during the subproject's service life.<br>- Using environmentally friendly vehicles<br>- Old vehicles will be checked 6-monthly and maintained in good order | - Law on traffic and transportation No. 23/2008/QH12<br>- Circular No. 22/2010/TT-BXD on labor safety in work construction | Local government and traffic authorities | - Supervision reports of CSC<br>- Supervision and monitoring reports of Tra Vinh and Vinh Long DARDs |
| 4. | Present of Ethnic Minorities in the subproject area | - Training to raise awareness of the community on husbandry and agricultural production. The activity contributes to agricultural growth, economic restructuring, poverty reduction, improvement of EM lives especially for landless and land poor households.<br>- Training to raise awareness of the community on climate change and adaption to changes in water resources, ecological and social.<br>- Livelihood Development Training: this is an important activity for household for economic development. The training courses aim to members (as EM households) to determine / analyze new livelihood ideas to be developed into a viable plan, as an output of the training, which will help them get a loan the subproject for a job that they plan to do.<br>- Develop livelihood models, with the participation of organizations, social organizations, coordinate the selection of models site, support technical guidance, implementation, monitoring and replicable results; | - Decree No. 84/2012/ND-CP<br>- Decision No. 29 / QD-TTg dated 20 May 2013 | Local government | - Supervision reports of CSC<br>- Supervision and monitoring reports of Tra Vinh and Vinh Long DARDs |

| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| B. | **Mangrove forest management** | - Forest area must be at least a certain percentage of the area of the land plot depending on the types of certificate (e.g., Natureland Certificate: 40% as a starting point moving to 50% within 2 years). So, farmers always keep the forest area as requirements of certification authorities.<br>- 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.<br>- 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.<br>- Do not pump soil from pond construction or cleaning into waterways.<br>- 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.<br>- Regularly circulate water in the ponds to prevent low oxygen conditions and reduce local accumulations of mangrove leaves. | - Law on Forest Protection and Development No. 29/2004/QH11 | - Division of Foresty of Tra Vinh province<br>- Tra Vinh PPMU<br>- Division of Aquaculture of Tra Vinh province<br>- Agriculture and Fishery Extension Center of Tra Vinh province | - Supervision reports of CSC<br>- Supervision and monitoring reports of Tra Vinh DARD |
| C. | **Raising aquaculture toward biosecurity** | - Treatment waster water from aquaculture farming before discharging into water course.<br>- Develop and integrate real-time environmental monitoring tools into the livelihood component of the subproject.<br>- Share and transfer lessons and experience between subprojects under the MD-ICRSL project.<br>- Use farmer cooperatives or collective groups to implement livelihood adaptation models. | - Decision No. 3824/QĐ-BNN-TCTS<br>- Decision No. 4835/QĐ-BNN-TCTS<br>- QCVN 08-MT:2015/BTNMT: National Technical Standard on surface water quality; | - Division of Aquaculture of Tra Vinh province<br>- Agriculture and Fishery Extension Center of Tra Vinh province<br>- Tra Vinh PPMU | - Supervision reports of CSC<br>- Supervision and monitoring reports of Tra Vinh DARD |

| No | Sensitive Area or Activity | Mitigation Measures | Vietnam code/regulation | Responsibility | Verification of effectiveness of measures |
|---|---|---|---|---|---|
| | | - Locate pilot livelihood demonstrations near successful models in order to change farmer's perceptions.<br>- Reduce the risk of over-supply by working with agribusinesses on a staged incremental approach.<br>- Start-up capital needs to be provided to fund the livelihood investments.<br>- Hire aquaculture and agriculture specialists to support cooperatives/collective groups.<br>- Establish hatcheries capable of producing high quality aquaculture seed as close as possible to the subproject site.<br>- Reduce potential negative impacts due to possible expansion of aquculture farming and/or the models via Provide technical assistance to establish a registration system for aquaculture farming | - QCVN 02 - 19 : 2014/BNNPTNT: National technical regulation on brackish water shrimp culture farm -Conditions for veterinary hygiene, environmental protection and food safety | | |

*Addressing Regional Environmental Impacts*

The REA report systematically and qualitatively assesses the regional impacts of the proposed subprojects. The regional impacts, both positive and negative, are generally mild and moderate for two reasons: i) the scale of the investments, from a regional perspective, are small; and ii) the investments are designed to be low-regret and conform with the 2013 Mekong Delta Plan strategies for sustainable development. In addition to addressing the regional environmental impacts at the subproject level through satisfactory implementation of the subproject ESMP, a Technical Assistance (TA) will be provided to help address regional issues. A well-designed Component 1 ($48 million) of the MDICRSL supports the following initiatives through technical assistance activities in the Project:

- **Formulation of a Mekong Delta Climate Sustainability Assessment**: This will be comprehensive assessment of Delta sustainability issues, including status, trends, and recommendations on how to adaptively manage the Delta in context of rapidly changing environmental conditions. It will be a document that informs the government's next five year regional, local, and sectoral planning in the Delta. The Assessment should be completed by 2019 and will help to inform planning exercises in the Vietnam government, including the Ministry of Planning and Investment's (MPI) "Socio-Economic Development Plan for the Mekong Delta", provincial socio-economic development and land use plans, and sector master plans for the next planning cycle (2021-2025). The Assessment will develop a set of key environmental and socio-economic indicators related to MD sustainability taking into account the regional environmental impacts of the MD development, and then assess the status, trends, and driving factors related to those indicators. The Assessment will also identify any data or knowledge gaps which need to be addressed for the next Assessment process, which ideally should take place every five years. Finally, the Assessment will provide a set of recommendations related to the next planning cycle in order promote adaptive management of the Delta.
- **Upgrading Monitoring Programs:** Including remote sensing, land use, water quantity and quality, groundwater, coastal and river morphology, coastal zone protection, etc. to provide better information. These programs will help produce better tools and information for both planning and management purposes, including informing design of phase II subprojects to address the regional environmental impacts. The results of the programs will be shared with the project provinces and broader MD stakeholders, and other relevant capacity building activities will be developed and carried out during project implementation.
- **Establishment of the Mekong Delta Center:** Several research institutes and departments are involved in gathering and analyzing data and information on the Delta; however, there are no current mandates for data sharing which would contribute to the integrated and multi-sectoral solutions that are often needed. The Center is envisioned to serve as a hub for Delta-wide information, including water, land use, environmental and climate change information, education and outreach, and provide support to specialized studies and research projects that inform decisions and investments in the Mekong Delta. For addressing regional environmental impacts the provinces will benefit from data provided by the center.
- **MARD Real Time Operations System for Hydraulic Infrastructure:** This will be a decision support center to provide real-time information on salinity, floods, and droughts to

allow for better operation of infrastructure, especially the sluice gates, to meet real-time conditions and demands. Under the system a database on MD sea dykes and mangrove forests will be established for a systematic assessment and monitoring of sea dykes and mangrove belts, which will allow for better monitoring, maintenance, and investments for these critical coastal assets.

## 6.4. ENVIRONMENTAL MONITORING PROGRAM

The main objective of the environment 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.

### *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 ICMB10. The CSC will include the monitoring results in the subproject progress reports.
- 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 ICMB10 and the WB.
- Community monitoring: Monitoring by local communities will be conducted following the Government practices with the technical and management support from the ICMB10.

### *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:

- General Construction Impacts: To include local flooding; traffic management especially in residential clusters; air, noise, and dust levels in residential clusters; and water quality upstream and downstream of construction sites, with specific attention on impacts to local residents;
- Others: As agreed with local agencies and communities during the preparation of the monitoring program.

*Table 6.4* 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 *Figure 6.1*. 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.

*Table 6.4: Scope of environmental monitoring during construction and operation phase*

| No | Contents | Specific requirements | Applied standard |
|---|---|---|---|
| **I** | **Construction phase** | | |
| *1* | *Air/noise, vibration* | | QCVN 05:2013/BTNMT, QCVN 26:2010/BTNMT; QCVN 27:2010/BTNMT |
| a | Parameters | TSP, $NO_2$, $SO_2$, CO, noise, vibration | |
| b | Locations | 3 stations | |
| c | Frequency | 03 months/time x 18 months | |
| *2* | *Water + micro organism + aquatic life* | | QCVN 08-MT:2015/BTNMT |
| a | Parameters | pH, turbidity, Salinity, DO, TSS, $BOD_5$, TN, TP, oil & grease, coliform, phytoplankton, zooplankton, zoobenthos | |
| b | Locations | 6 stations | |
| c | Frequency | 03 months/time x 18 months | |
| *3* | *Sediment* | | QCVN 43:2012/BTNMT; |
| a | Parameters | pHKCl, salinity, Cu, Pb, Zn, Cd, As, TP, TN, TC | |
| b | Locations | 6 stations | |
| c | Frequency | 03 months/time x 18 months | |
| *4* | *Groudwater* | | QCVN 09:2008/BTNMT; |
| a | Parameters | pH, Total hardness, $Cl^-$, $N\text{-}NH_4$, $N\text{-}NO_2$, $N\text{-}NO_3$, $SO_4^{2-}$, Cu, Pb, Zn, Cd, As, Coliform | |
| b | Locations | 3 stations | |
| c | Frequency | 03 months/time x 18 months | |
| **II** | **Operation phase** | | |
| *1* | *Water + micro organism + aquatic life* | | QCVN 08-MT:2015/BTNMT |
| a | Parameters | pH, Turbidity, Salinity, DO, TSS, $BOD_5$, TN, TP, oil & grease, coliform, phytoplankton, zooplankton, zoobenthos | |
| b | Locations | 6 stations | |
| c | Frequency | 03 months/time during the first 2 years of operation | |
| *2* | *Sediment* | | QCVN 43:2012/BTNMT; |
| a | Parameters | $pH_{KCl}$, salinity, Cu, Pb, Zn, Cd, As, TP, TN, TC | |
| b | Locations | 6 stations | |

| | | | |
|---|---|---|---|
| c | Frequency | 03 months/time during the first 2 years of operation | |

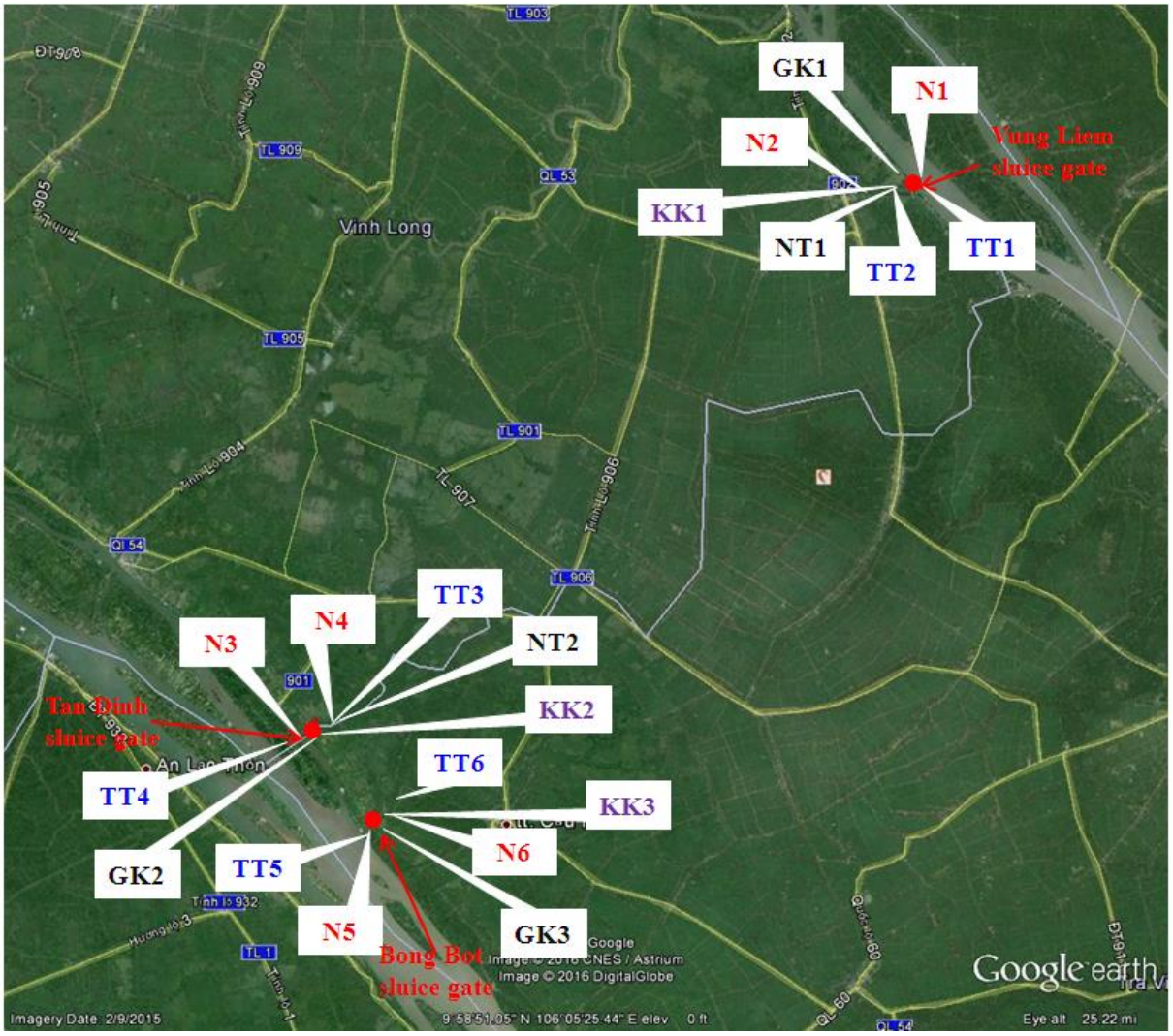



*Figure 6.1: Environmental monitoring site during construction and operation phase*

### *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 others 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

### *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 ICMB10 and the WB. Cost for the monitoring will be part of the ICMB10 cost.

## 6.5. ROLE AND RESPONSIBILITIES FOR ESMP IMPLEMENTATION

### *Implementation arrangement*

Role and responsibilities for ESMP implementation are described in *Figure 6.2* and

Table 6.5.

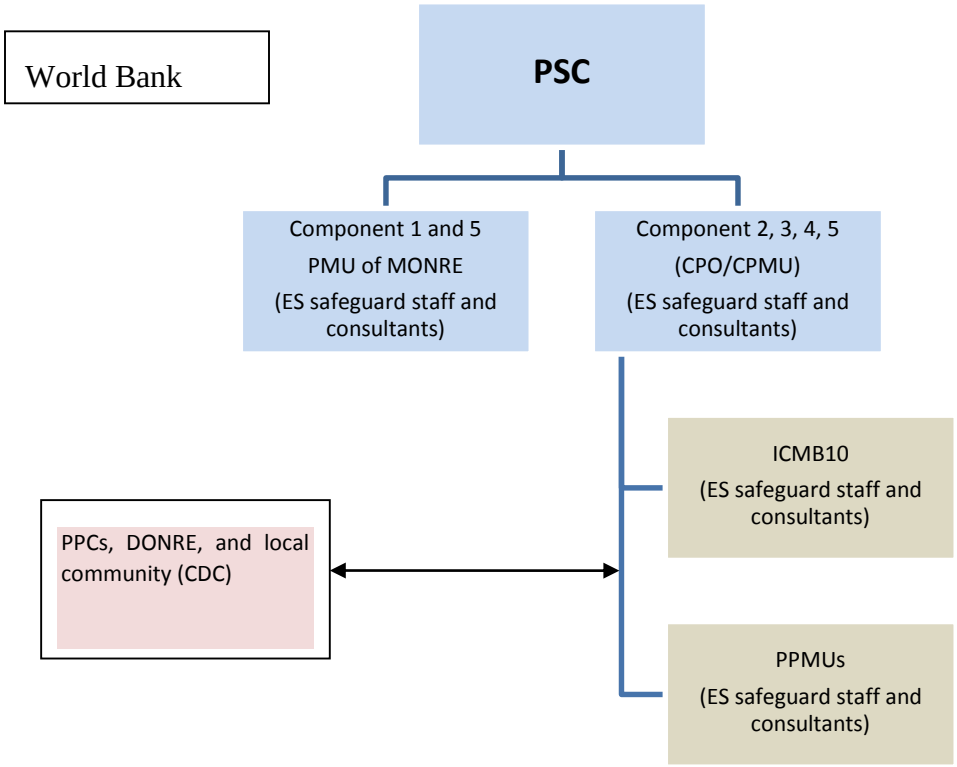


*Figure 6.2: Organization structure for safeguard monitoring*

*Table 6.5: Institutional Responsibilities for the Project and Subproject Safeguard Implementation*

| Community/ Agencies | Responsibilities |
|---|---|
| Project Implementing Agency (IA) and PMU<br>(The IA means MARD and MONRE while PMU here means the PMU of MONRE and CPMU and ICMB10 of MARD and PPMUs of the provinces) | - The IA will be responsible for overseeing the Project implementation including ESMF implementation and environmental performance of contractors.<br>- PMU, representative of the IA, will be responsible for monitoring the overall Project implementation, including environmental compliance of the Project. PMU will have the final responsibility for ESMF implementation and environmental performance of the Project during the construction and operational phases.<br>- 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.<br>- 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. |
| PPMUs, DARDs, ICMB10, PMU of MONRE | - As the subproject/activity owner, PPMU/ICMB10/PMU of MONRE is responsible for implementation of all the ESMP activities to be carried out under the Project, including fostering effective coordination and cooperation between contractor, local authorities, and local communities during construction phase. PPMU/ICMB10/PMU of MONRE will be assisted by the environmental staff, safeguard consultants, and CSC/or field engineer.<br>- Division of Aquaculture of Tra Vinh province DARD and Agriculture and Fishery Extension Center of Tra Vinh province are responsible for livelihoods models.<br>- During operation, the responsibility to operate the sluice gate will be transferred to the Provincial Department of Water Resources (PDWRs) of Tra Vinh and Vinh Long DARDs and they will be responsible for monitoring of water quality and ecosystem before and after the operation of the sluice gates and submit water quality report to the Vinh Long and Tra Vinh DONREs one time per three months. |
| 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 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.<br>- The CSC will also assist the PMU/PPMU/ICMB10/PMU of MONRE 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/ICMB10/PMU of MONRE 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.<br>- 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).<br>- Take actions to mitigate all potential negative impacts in line with the objective described in the CESMP.<br>- Actively communicate with local residents and take actions to prevent disturbance during construction.<br>- Ensure that all staff and workers understand the procedure and their tasks in the environmental management program.<br>- Report to the PPMU/ICMB10/PMU of MONRE on any difficulties and their solutions.<br>- Report to local authority and PPMU/ICMB10/PMU of MONRE if environmental accidents occur and coordinate with agencies and keys stakeholders to resolve these issues. |
| Independent Envionmental Monitoring Consultants (IEMC) | - IEMC will, under the contract scope, provide support to PPMU/ICMB10/PMU of MONRE 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/ICMB10/PMU of MONRE to prepare monitoring reports on ESMP implementation.<br>- 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 CPMU/PPMU/ICMB10/PMU of MONRE. If unexpected problems occur, they will report to the CSC and/or CPMU/PPMU/ICMB10/PMU of MONRE. |
| Social organizations, NGOs and civil society groups | - These organizations could be a bridge between the PPC/DPC, communities, Contractors, and the CPMU/PPMU/ICMB10/PMU of MONRE by assisting in community monitoring.<br>- 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/ICMB10/PMU of MONRE to ensure compliance of Government policy and regulations. DONRE is responsible for monitoring the compliance with the Government environmental requirements. |

## *Environmental Compliance Framework*

### *6.5.1.1. Environmental Duties of the Contractor*

The contractor firstly shall adhere to minimize the impact that may be result of the subproject construction activities and secondly, apply the mitigation measures under ESMP to prevent harm and nuisances on local communities and 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 limiting 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 case of non-compliances/discrepancies, carry out 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.

### *6.5.1.2. 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 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.

#### *6.5.1.3. Independent Environmental Monitoring Consultant (IEMC)*

In order to minimize the environmental impacts during 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 report periodically to PPMU (every 06 months in construction stage and in operation stage).
- IEMC will also supply specialized assistance to CPMU and ECO in environmental matters.

#### *6.5.1.4. Environmental Supervision during Construction*

During construction stage, 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 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.

#### *6.5.1.5. 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.

#### *6.5.1.6. Environmental Claims and 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 money).

In 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.

### *Reporting Arrangements*

ESMP monitoring and reporting requirements are summarized in *Table 6.6*.

*Table 6.6: Regular Reporting Requirements*

| No. | Report Prepared by | Submitted to | Frequency of Reporting |
|---|---|---|---|
| 1 | Contractor to the Employer | PPMU/ICMB10 | Once before construction commences and monthly thereafter |
| 2 | Construction Supervision consultant (CSC) | PPMU/ICMB10 | Weekly and monthly |

| | | | |
|---|---|---|---|
| 4 | Community Monitoring | PPMU/ICMB10 | When the community has any complaint about the subproject safeguards implementation |
| 5 | PPMU/ICMB10 | CPMU | Monthly |
| 6 | CPMU | WB | Every six-month |

## 6.6. CAPACITY BUILDING PROGRAM

### *Technical assistance support for the implementation of safeguards*

An assessment of safeguards implementation capacity of existing PPMUs staff indicates the staffs have limited knowledge on WB safeguard requirements as well as limited knowledge of environmental and social issues. Such lack of capacity represents a risk to subproject implementation of safeguards requirements contained in the ESMP and, as required by the WB policy, is to be addressed through capacity building. Therefore it is proposed to provide capacity building through technical assistance that will support the PPMUs during the implementation of the safeguards requirements. The technical assistance will provide the necessary technical support for the PPMU in its work with contractors as well as other entities involved in the implementation of the ESMP.

The scope of the technical assistance would cover support from experts and training that would include knowledge on safeguards requirements and procedures for the subproject as well as training that covers both specific knowledge on safeguard procedures and requirements for the subproject staff, consultants, and national contractor. More specifically, the support would include, for example, assistance in the preparation of documents and implementation of training programs on environmental management and environmental monitoring for contractors, CSC and relevant staff of PPMU (environmental staff and coordinators of packages) to do their tasks. It would also include assisting the PPMUs' environmental staff with the review of contract documents on the bidding packages for construction items of the subproject to ensure compliance with environmental protection policies and impact mitigation and monitoring requirements; as well as provide general environmental guidance as requested by the PPMU to enhance overall project implementation and performance.

Given the nature, locations, and scale of construction, it is anticipated that the safeguard technical assistance support and training will be provided at least during the first 3 years of the project implementation. The WB safeguard specialists will participate in the capacity building, in particular in the training activities as appropriate.

***Special technical assistance:*** Additional technical assistance will be necessary for ensuring that (a) the potential negative impacts during sluice operations will be minimized and accepted by key stakeholders, (b) the mitigation measures for potential impacts on socio-economic conditions of poor farmers is adequate and farmers have improved knowledge to minimize technical and marketing risks, and (c) regulatory measures to control and manage possible induced impacts due to possible expansion of the livelihood models is inplace before the subproject closing. It is expected that 2 national firms will be mobilized to provide these technical services: for (1) for safeguard training and the development and consultation of the operation plan for the sluice gates

including meetings and workshops for 2 years during 2017-2019 and (2) (i) the planning and undertaking socio-economic survey for the farmers in the pilot sites and nearby areas for 3 years during (2017-2020), (ii) development of a registration program on aquacutlure farming in the subproject and nearby areas, and (iii) development of FFS application and implementation of a series of technical workshops, TOT, and development of guidelines and awareness materials, and study visits and building farmer network etc. to be implemented during 2017-2020. TORs for these technical assistances will be prepared by the subproject owner in close consultation with CPMU.

### *Training programs proposed*

*Table 6.7* provides the basic training programs for safeguards during subproject implementation. The training programs will be developed and delivered by the Technical Assistance team for the implementation of safeguards for the PMU training. The PMU/IEMC with the support of the the Technical Assistance team for the implementation of safeguards will provide the training to contractors, CSC and other groups. In addition, given limited safeguard capacity of the main stakeholders of the project, The Bank will provide a training on Preparation of ESIA and Integration of Cumulative Impact Assessment (CIA) into ESIA which is part of the safeguards capacity program to develop during implementation while identifying and agreeing on one of the specific training or capacity building activities. The Bank consultant will provide a five-day training on integration of CIA into ESIA and on how to address the quality and the implementation of the EIAs in conjunction with other safeguards instruments.

Other more specific and tailored training will be developed and agreed upon between PPMUs, IEMC and the Technical Assistance team for the implementation of safeguards during project implementation based upon a reassessment of needs and the status of safeguards implementation with the following contents (*Table 6.7*):

- Target groups for the training include PPMU staff, ESU staff, field engineers, CSC, construction contractors.
- Training schedule: At least 1 month before the implementation of the first contract. The training can be adjusted in line with the implementation schedule of the subproject/contracts.
- Training frequency: The basic training programs proposed in will take place every six months on a yearly basis and its content updated and adapted to implementation issues. Training frequency and content will be reassessed during implementation depending on needs.

*Table 6.7: Training Programs for Capacity Building on Environmental Supervision and Management*

| **1. Objects** | **CPO, CPMU, PPMUs, ESIA Consultants** |
|---|---|
| Training course | Preparation of Environmental and Social Impacts Assessment and integration of cumulative impact assessment (CIA) into ESIA. |
| Participants | **CPO, CPMU, PPMUs technical staff and ESIA Consultants**.<br>The week long or so training referred to integrates CIA but goes beyond to address the quality and the implementation of the EIAs in conjunction with other safeguards instruments. |
| Course duration and time | A five-day training to be conducted in June 2016, before implementation of the MDICRSL project |

| | |
|---|---|
| Content | –World Bank requirements for ESIAs<br>–Preparation of ESIA<br>–Intergation of CIA into ESIA<br>–Quality requirements and quality control of ESIA<br>–Implementation of the EIAs in conjunction with other safeguards instruments. |
| Responsibilities | The World Bank |
| **2. Objects** | **PROVINCE PROJECT MANAGEMENT UNIT** |
| Training course | Environmental supervision, monitoring and reporting. |
| Participators | Environmental staff and technical staff. |
| Training Frequency | At least 1 month before implementation of the first contract. The follow-up training will be scheduled as needed. |
| Time | Four days of training twice a year to be repeated on a yearly basis. |
| Content | –General environmental management relating to the subproject including requirements of WB, DONRE, and cooperating with relevant enterprises.<br>–Requirements on environmental supervision.<br>–Supervision and implementation of mitigation measures; community participation in environmental supervision.<br>–Guide and supervise contractor, CSC and community representatives in implementation of environmental supervision.<br>–Forms used in environmental supervision.<br>–Risk response and control.<br>–Reporting and submit forms. |
| Responsibilities | PPMU, IEMC with support of the Technical Assistance team for the implementation of safeguards. |
| **3. Objects** | **CSC, CONTRACTOR** |
| Training course | Implementation of mitigation measures. |
| Participators | CSC; on-site construction management staff; environmental staff of contractor. |
| Training frequency | After bidding, update based on requirements. |
| Time | three days of training twice a year to be repeated on a yearly basis |
| Content | –Overview of environmental monitoring.<br>–Requirements of environmental monitoring.<br>–Role and responsibilities of contractors and CSC.<br>–Content and methods of environmental monitoring.<br>–Response and risk control. |

| | |
|---|---|
| | –Propagate monitoring forms and guide how to fill in the forms and risk reports.<br>–Preparation and submission of reports. |
| Responsibilities | PPMU, IEMC with support of the Technical Assistance team for the implementation of safeguard policies. |

## 6.7. ESTIMATED ESMP COST

The EMP cost will 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 *Table 6.8*.

- 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 (
  -
  -
  - *Table 6.9*).
- 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 sluice gates including the development of operational plan for sluices in consultation with water users and key stakeholders.

Cost for technical assistance for mitigation of potential negative impacts due to the implementation of the 5 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 **10,994,878,000VND** ($545,000**) + US$300,000** over a 6 years period. Estimation cost for ESMP is shown in *Table 6.8*.

*Table 6.8: Cost for ESMP in the entire subproject (VND)*

| Activity | Source of fund | Total cost (VND) |
|---|---|---|
| (a) Resettlement and land acquisition | Part of subproject cost | 15,331,488,410 |
| (b) Mitigation measures during the construction phase | Part of contract cost | |

| | | |
|---|---|---|
| (c) Safety monitoring during the construction phase (18months x 10 millions VND/months) | Part of subproject cost | 180,000,000 |
| (d) PPMU environmental staff | Part of subproject cost | 90,000,000 |
| (e) Environmental monitoring in the entire subproject (see in *Table 6.9*) | Part of subproject cost | 544,878,000 |
| (f) Environmental monitoring consultant (EMC) | Part of subproject cost | 180,000,000 |
| (g) Technical assistance (national consultant) for safeguard training and development and consultation of the operation plan for the sluice gates including meetings and workshops for 2 years during 2017-2020 | Part of subproject cost | 4,000,000,000 |
| (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 (2017-2020) to evaluate effectiveness of the pilot models, (ii) development of a registration program on aquacutlure farming in the subproject and nearby areas, and (iii) development of FFS application and implementation of a series of technical workshops, TOT, and development of guidelines and awareness materials, and study visits and building farmer network etc. (to be implemented during 2017-2020) | Part of subproject cost | 6,000,000,000 |

*Table 6.9: Cost for environmental monitoring in the entire subproject*

| TT | Activities | Unit | Quantity | Unit price (VND) | Total (VND) |
|---|---|---|---|---|---|
| **I** | **Construction phase** | | | | **263,358,000** |
| 1 | Total of sampling (18 months x 3 months/time = 6 times) | Time | 6 | | |
| 2 | Air/noise (3 stations x 6 times) | Sample | 18 | 654,000 | 11,772,000 |

| | | | | | |
|---|---|---|---|---|---|
| 3 | Water + micro organism + aquatic life<br>(6 stations x 2 samples/station - (high tide and low tide) x 6 times) | Sample | 72 | 2,247,000 | 161,784,000 |
| 4 | Sediment (6 stations /time x 6 times) | Sample | 36 | 1,371,000 | 49,356,000 |
| 5 | Wastewater (3 stations x 1samples/station x 6 times) | Sample | 18 | 2,247,000 | 40,446,000 |
| 6 | Groundwater (3 stations x 1samples/station x 6 times) | Sample | 18 | 1,482,000 | 26,676,000 |
| **II** | **Operation phase (during the first 2 years of operation)** | | | | **281,520,000** |
| 1 | Total of sampling (24 months x 3 months/time = 8 times) | Time | 8 | | |
| 2 | Water + micro organism + aquatic life (6 stations x 2 samples/station-(high tide and low tide) ) x 8 times | Sample | 96 | 2,247,000 | 215,712,000 |
| 3 | Sediment (6 stations /time x 8 times) | Sample | 48 | 1,371,000 | 65,808,000 |
| | **Total= I+II** | | | | **544,878,000** |

## 6.8. GRIEVANCE REDRESS MECHANISM (GRM)

Within the Vietnamese legal framework citizen rights to complain are protected. As part of 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 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 ICBM10/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 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 adddress 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 Inspecition Panel, please visit www.inspectionpanel.org.

# CHAPTER 7. PUBLIC CONSULTATION AND DISCLOSURE

In the ESIA process, information disclosure and public consultation on environment ensures the acceptance of local authorities, local NGOs and local affected people in the subproject area. Public participation is one of basic conditions that ensure the local authority and community's support for subproject and take their view into account. Through public consultation, unidentified environmental adverse impacts and mitigation measures can be recognized and included in ESIA report. In fact, if community takes part early in the subproject preparation, the relationship between community and project officials becomes closer. Thereafter, the community can continue to contribute their feedback and any concerns they may have during subproject implementation.

## 7.1. OBJECTIVES OF PUBLIC CONSULTATION

The World Bank's policy (OP/BP 4.01) on environmental impact assessment requires that the Project Affected People (PAPs) and local authorities to be provided and consulted during the preparation of the ESIA report.

Public consultation (in the preparation of ESIA report for the subproject) must comply with the requirements in the Government's Decree No. 18/2015/ND-CP dated 14 February 2015 on environmental protection planning, strategic environmental ssessment, environmental impact assessment and environmental protection plan, and Circular No. 27/2015/TT-BTNMT dated 29 May 2015 of the Ministry of Natural Resources and Environment on strategic environmental assessment, environmental impact assessment and environmental protection plan, and the World Bank requirements.

Objectives of public consultation:

- The consultation with the participation of local authorities and local people in the subproject site during the preparation and implementation of ESMP and ESIA is to provide essential information for further understanding about the project, impacts of the subproject implementation and potential mitigation measures for the subproject;
- Clarify issues discussed in the beginning period of the subproject;
- Inform benefits achieved when the subproject is implemented;
- State responsibilities and awareness of stakeholders, beneficiary people in the subproject site during the subproject implementation;
- Encourage the community participation in determining the environmental impacts of the subproject.
- Collect information about demands as well as correspondences of local people and authorities in the construction and recommendation in order to mitigate environmental impacts or considering adjustment in the technical design stage.

## 7.2. IMPLEMENTATION METHODS

Technical consultants and environmental consultants collaborated closely with PPMU and conducted two public consutaltation with the local authorities and communities in the affected

areas. The first round of consultation was conducted after the project environmental and social screening and before TOR for the ESIA report is finalized. The second public consultation was carried out after the draft ESIA was completed.

For the first consultation, the CPO organized consultation meetings with the People's Committees and Vietnam Fatherland Front of 4 communes in 3 districts of Cau Ke, Vung Liem and Tra On. Before consulting at communes, CPO held general meetings at Tra Vinh province to introduce the project, the subproject and collect opinions for the subproject. The meeting was held at the office of Tra Vinh DARD on at 8h00 on 18 September 2015. The participants at these meetings consist of representatives of DPC, provincial departments as DONRE, DOST, DOIT, etc. After holding the general meetings at the province, CPO coordinate with the local authorites for consultations affected communes in the subproject area at 14h00 on 18 September 2015 at the meeting hall of An Phu Tan commune to introduce the subproject, collect information about the status of environmental sanitation at the locality, discuss potential environmental impacts and mitigation measures.

For the second consultation, the CPO organized consultation meetings with the subproject districts and communes and affected people on 8h00 on 26 January 2016 at the meeting hall of Cau Ke district.

All the feedbacks and inputs from the consultation were taken into account and incorporated into the subproject design and the safeguard instruments of the subproject. Some pictures of the public consultation are presented in Annex 2.

## 7.3. PUBLIC CONSULTATION RESULTS

Generally, through the public consultations at the subproject area, the authorities and local people supported the subproject and desired the subproject to be implemented early. Some consultation opinions are summarized as follows:

### *The first consultation*

- Most people in the subproject area are poor, so when taking their land for the subproject implementation, there need to have compensation policies, supports for their movement out of subproject area.
- Mobilization of construction workers at the work site leading to disease spreading and increasing in social evils as gambling, prostitution, HIV/AID, drugs…).
- Loccal experiences show that in the construction phase of some, project, contractors are regardless of the environment and health of people around, so for this subproject, the subproject owner should focus on this issues.
- Consider landslides, land subsidence due to pile driving.
- There are still people in the subproject living by fishing on the river (but they catch fish on the big rivers), and the local authorities has set up fishing team to develop fishing model for the subproject area and when building sluice gates will affect water navigation and fishing activities of local people. During conduting the environmental assessment needs to pay attention to this issue.
- Evaluation of inundation after sluice gates operation so as not to affect fruit trees.

- Livelihood models: current effective economic trees in the area are rambutan (main tree), orange, and lemon. Therefore, after the subproject operation, the local people will wants to plant citrus (orange, grapefruit...) and longan, rambutan and tourism development.

***The second consultation***

- For the construction of 03 sluice gates: all participants agree that this is the essential need of the people which came up in many meetings. In 1/2016, the salt 1% entered into the construction site of Tan Dinh culvert for several hours during the day, so the need for building 3culverts become more necessary.
- Sensitive receptors:
  - In the construction sites of 2 sluice gates: Tan Dinh and Bong Bot, there are 2 ferries that serve people's movement. During the construction of 2 sluice gates, the ferries still work; hence the navigation safety for the ferries must be secured.
  - About 300m to the construction site of Bong Bot sluice gate is Hieu Tu pagoda and the cultural house.
- For the farming and fishery impacts: currently, the local authorities ban fishing in Tan Dinh, Vung Liem rivers and Bong Bot canals by local practices but some households still go fishing on the canals but they are not many and this is extra job, which mainly provide food for their households only.
- For the livelihood model:
  - In the region where there is the plan of brackish economic transition, it needs to conduct the demonstration first for people to learn, not to expand the mass. When seeing it possible and suitable, the local government will organize conversion plan.
  - In the region where there is the VietGap production support and ecological certification of the shrimp – forest model, the delegates agree the implementation plan and needs for expansion area of support.
- Ethnic minorities:
  - The communes where the livelihood model is proposed have the high very proportion of minorities, e.g. Kim Son: 90%, Luu Nghiep Anh: 68%, so that if the subproject has support measure for these households, it is very good.
  - The ethnic minority policy is the cross-cutting issue of the District and it has taken many programs and policies to support ethnic minority people, so when the subproject deploys, it will have more advantages.
- Resettlement:
  - in the construction area of Bong Bot culvert, there is another project that build ferry and road which carried out the compensation for people who lived here, so now there are a few households living in this region and he also said that the resettlement policy that the subproject proposes is in conformity with the local condition and the District also has extensive experiences in the compensation and resettlement, so the implementation of compensation for this subproject will be more favorable.

- Affected households would like to receive compensation in cash and people will find new land to buy and conduct close monitoring of the compensation in order that people are not affected.

- Cau Ke district, the subproject beneficiaries, affected people and organizations have planned to disseminate information to the people to know to gain their consensus and we propose the subproject to be implemented soon to promote the subproject efficiency.

## 7.4. ENVIRONMENTAL INFORMATION DISCLOSURE

Following requirements for disclosure of information of the Bank and the government, the PPMU has locally disclosed the draft Vietnamese version of the ESIA at the CPO office, the office of Vinh Long and Tra Vinh PPC and CPC of the subproject communes. The draft ESIA report (English version) has been disclosed at the World Bank InfoShop. The final ESIA will also be disclosed locally and at the InfoShop.

# CONCLUSIONS, RECOMMENDATIONS AND COMMITMENTS

## 1. CONCLUSIONS AND RECOMMENDATIONS

Overall, the subproject is feasible and consistent with the socio-economic development plans of Tra Vinh and Vinh Long province as well as with the irrigation and rural development sector in the Mekong Delta both in current situation and in context of climate change. The subproject meets the needs for socio-economic development in Tra Vinh, Vinh Long provinces, and facilitates salinity instrusion prevention the provinces. Based on the assessment and preparation of this ESIA, it is considered that the proposed mitigation measures designed on the monitoring program during construction and operation are adequate for mitigating the potential negative impacts of the subproject. The positive impacts of the subproject include improving living conditions of the residents in the provinces; prevent salinity instrusion, promotion of socioeconomic development, and addressing climate change and sea level rise impacts in the medium and long term.

During subproject implementation, some negative impacts will affect the local environment and local populations in the project areas. Land acquisition and resettlement of subproject affected households will be required.

During the construction phase, there will be negative impacts including vehicle and equipment exhaust emissions, dust and noise from construction equipment during the construction of roads and sluices, wastewater from construction workers and construction activities, construction solid waste, dredged sludge and some contaminated waste, among others. These have been identified in the ESMP and included in ECOP.

These impacts can be mitigated by ensuring that the subproject contractors comply with the provisions of their contracts, including those which relate to environmental impacts. The PPMU and their CSC and EMC will be responsible for ensuring that this compliance occurs. In accordance with their contracts, contractors will be required to prepare the Contract Specific Environmental Plan (CSEP) describing detailed environmental safeguard actions. The CSEP will be approved by PPMUs and supervised by CSCs prior to the work commencing. Periodic monitoring reports will be prepared by the EMC and the results will be submitted to CPMU and the World Bank (as needed).

Environmental monitoring will be carried out to ensure that the project activities do not create adverse impacts. The monitoring results will be periodically reported to CPMU and the World Bank (as needed).

## 2. COMMITMENTS

- General Commitments:
  - The Client and PPMU commit to complying with Vietnam Laws on Environmental protection: Law on Environmental protection 2014, Laws and legal documents (Decree No. 18/2015/ND-CP dated 14 February 2015 of the Government on environmental protection assessment, strategic environmental assessment, environmental impact assessment and environmental protection plan; Decree No. 38/2015/ND-CP dated 24 April 2015 on management of waste and scrabs; Decree No. 88/2007/ND-CP dated 28 May 2007 of the

Government on urban drainage and urban areas, etc.) and WB's safeguard policies during the subproject implementation.

- The Client commits to complying with the mitigation measures of adverse impacts of the subproject on environment during the construction preparation, construction and operation according to contents as mentioned in Chapter 6 of this Report.
- Project's activities shall be under the inspection of the competent authorities in charge of environmental management of DONRE of Tra Vinh and Vinh Long and relevant functional agencies to ensure the subproject development and environmental protection
- The Client commits to disclose contents of approved ESIA report approved at the subproject locality to monitor the compliance with environmental protection commitments in the approved ESIA report.

- Commitment To Complying With Environmental Standards And Regulations: the Client commits to complying strictly with environmental standards and regulations:
  - Air quality: In accordance with Vietnam standard QCVN 05:2013/BTNMT – National technical regulation on ambient air quality and and exhaust gas: in accordance with Vietnam standard QCVN 19: 2009/BTNMT National Technical Regulation on Industrial Emission of Inorganic Substances and Dusts.
  - Waste water: Commit to implementing mitigation measures and operation of waste water treatment system to ensure waste water treatment according to QCVN 14:2008/BTNMT (column B): National technical regulations on domestic waste water quality;
  - Noise: Control noise in accordance with QCVN 26:2010/BTNMT – National technical regulation on noise.
  - Solid waste: Solid waste will be collected and treated properly to ensure not drop down and exposure to ambient environment to ensure requirements for environmental sanitation and regulations in Decree No. 38/2015/NĐ-CP of the Government dated 24 April 2015 on solid waste management.
  - Hazardous waste: Commit to complying with 36/2015/TT-BTNMT of MONRE dated 30 June 2015 on hazardous waste management.
- Commitment To Management And Control Of Environmental Pollution
  - The environmental management and control of environmental pollution will be given top priority during the construction and operation;
  - During the operation, the Client commits to implementing the environmental pollution management and control program in the subproject area as mentioned in this report and periodically reporting to the DONRE of Tra Vinh and Vinh Long province.
  - The Client commits for compensation and remedy of environmental pollution in case of environmental incidents and risks due to the project implementation;
  - The Client commits to completing planned works; especially completion of the environmental treatment works after the ESIA report is approved.

## REFERENCES


1. Can Tho University (2013). *Baseline study and assess the status of biodiversity in Vinh Long province and identify the priority issues of biodiversity conservation*.
2. Assess the impact of the South Mang Thit irrigation system project on socio-economic development and environment of Tra Vinh province
3. Pham Ngoc Dang, 2003. Air environment. Science and Technology Publishing House, 2003.

## ANNEX 1. SIMPLEFIED ENVIRONMENTAL CODE OF PRACTICE FOR SMALL WORKS

1. This annex presents the Environmental Codes of Practice (ECOP) to be applied in the proposed subproject when small works are involved. The content and requirements following the WB guideline described in (the ESMF tool kit -annex 5).

### A4.1 Objectives

2. The Environmental Codes of Practice (ECOP) is prepared to manage small environmental impacts during construction. The ECOPs will apply to manage small scale infrastructure investments subproject. ECOP will be a mandatory part of construction contract or bidding documents so that contractor complies with environmental covenants. The subproject owner (Tra Vinh PPMU) and construction supervisors will be responsible for monitoring of compliance with ECOP and preparing the required reports.

3. There are a number of national technical regulations related to environmental, health and safety that apply to construction activities. Some of them are listed below:

- *Water Quality*: (QCVN 01:2009/BYT, QCVN 02:2009/BYT, QCVN 08:2008/BTNMT, QCVN 09:2008/BTNMT, QCVN 10:2008/BTNMT, QCVN 14:2008/BTNMT, TCVN 5502:2003; TCVN 6773:2000, TCVN 6774:2000, TCVN 7222:2002)
- *Air and Soil Quality* (QCVN 05:2008/BTNMT, QCVN 06:2008/BTNMT, QCVN 07:2008/BTNMT
- *Solid Waste Management* (QCVN 03:2008/BTNMT, TCVN 6438:2001, TCVN 6696:2009, QCVN 07:2009)
- *Vibration and Noise* (QCVN 27:2010/BTNMT, QCVN 26:2010/BTNMT, TCVN 5949: 1998)
- *Labor Health and Safety*: Decision No.3733/2002/QĐ-BYT issued by Ministry of Healthcare dated on 10/10/2002 about the application of 21 Labor health and safety standards that concerned about microclimate, noise, vibration, Chemicals – Permitted level in the working environment
- The World Bank Group Environmental Health and Safety Guidelines which available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/ehsguidelines

### A4.2 Responsibilities

4. The subproject owner (Tra Vinh PPMU) and Contractors are the key entities responsible for implementation of this ECOP. Key responsibilities of the PPMU and the contractors are as follows:

***(a) Tra Vinh PPMU***

- PPMU is responsible for ensuring that the ECOP is effectively implemented. The PPMU will assign a qualified staff to be responsible for checking implementation compliance of Contractors, include the following: (a) monitoring the contractors' compliance with the environmental plan, (b) taking remedial actions in the event of non-compliance and/or adverse impacts, (c) investigating complaints, evaluating and identifying corrective measures; (d) advising the Contractor on environment improvement, awareness, proactive pollution prevention measures; (e) monitoring the activities of Contractors on replying to complaints; (f) providing guidance and on-the-job training to field engineers on various aspects to avoid/mitigate potential negative impacts to local environment and communities during construction.

***(b) Contractor***

- Contractor is responsible for carrying out civil works and informs PPMU/ICBM10, local authority and community about construction plan and risks associated with civil works. As such, contractor is responsible for implementing agreed measures to mitigate environmental risks associated with its civil works.
- Contractor is required to obey other national relevant legal regulations and laws.

**Part 1 – Contractor's Responsibilities**

7. This is an example and is not necessarily a full treatment of all requirements for a specific project. For example, there might be reason to have contractor deal with sexually transmitted diseases, medical and hazardous waste s (e.g., oil from vehicle or furnace repair and similar, oily rags).

| Issues/Risks | Mitigation Measure |
|---|---|
| **1) Dust generation/ Air pollution** | • The Contractor implement dust control measures to ensure that the generation of dust is minimized and is not perceived as a nuisance by local residents, maintain a safe working environment, such as:<br>. water dusty roads and construction sites;<br>a. covering of material stockpiles;<br>b. Material loads covered and secured during transportation to prevent the scattering of soil, sand, materials, or dust;<br>c. Exposed soil and material stockpiles shall be protected against wind erosion. |
| **2) 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/QD-BGTVT; to avoid exceeding noise emission from poorly maintained machines. |
| **3) Water pollution** | • 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 water body.<br>• Wastewater over permissible values set by relevant Vietnam technical standards/regulations must be collected in a conservancy tank and removed from site by licensed waste collectors.<br>• At completion of construction works, water collection tanks and septic tanks shall be covered and effectively sealed off. |
| **4) Drainage and sedimentation** | • The Contractor shall follow the detailed drainage design included in the construction plans, to ensure drainage system is always maintained cleared of mud and other obstructions.<br>• Areas of the site not disturbed by construction activities shall be maintained in their existing conditions. |
| **5) Solid waste** | • At all places of work, the Contractor shall provide litter bins, containers and refuse collection facilities.<br>• 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.<br>• Waste storage containers shall be covered, tip-proof, weatherproof and scavenger proof.<br>• No burning, on-site burying or dumping of solid waste shall occur.<br>• 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. |

| Issues/Risks | Mitigation Measure |
|---|---|
| | • 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. |
| **6) Chemical or hazardous wastes** | • Used oil and grease shall be removed from site and sold to an approved used oil recycling company.<br>• Used oil, lubricants, cleaning materials, etc. from the maintenance of vehicles and machinery shall be collected in holding tanks and removed from site by a specialized oil recycling company for disposal at an approved hazardous waste site.<br>• Unused or rejected tar or bituminous products shall be returned to the supplier's production plant.<br>• Store chemicals in safe manner, such as roofing, fenced and appropriate labeling. |
| **7) Disruption of vegetative cover and ecological resources** | • Areas to be cleared should be minimized as much as possible.<br>• The Contractor shall remove topsoil from all areas where topsoil will be impacted on by rehabilitation activities, including temporary activities such as storage and stockpiling, etc; the stripped topsoil shall be stockpiled in areas agreed with the Construction Supervision Consultant for later use in re-vegetation and shall be adequately protected.<br>• The application of chemicals for vegetation clearing is not permitted.<br>• Prohibit cutting of any tree unless explicitly authorized in the vegetation clearing plan.<br>• When needed, erect temporary protective fencing to efficiently protect the preserved trees before commencement of any works within the site.<br>• The Contractor shall ensure that no hunting, trapping shooting, poisoning of fauna takes place. |
| **8) Traffic management** | • Before construction, carry out consultations with local government and community and with traffic police.<br>• Significant increases in 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.<br>• Installation of lighting at night must be done if this is necessary to ensure safe traffic circulation.<br>• Place signs around the construction areas to facilitate traffic movement, provide directions to various components of the works, and provide safety advice and warning.<br>• Employing safe traffic control measures, including road/rivers/canal signs and flag persons to warn of dangerous conditions.<br>• Avoid material transportation for construction during rush hour.<br>• Signpost shall be installed appropriately in both water-ways and roads where necessary. |
| **9) Interruption of utility services** | • Provide information to affected households on working schedules as well as planned disruptions of water/power at least 2 days in advance.<br>• Any damages to existing utility systems of cable shall be reported to authorities and repaired as soon as possible. |
| **10) Restoration of affected areas** | • Cleared areas such as disposal areas, site facilities, workers' camps, stockpiles areas, working platforms and any areas temporarily occupied during construction of the project works shall be restored using landscaping, adequate drainage and revegetation.<br>• Trees shall be planted at exposed land and on slopes to prevent or reduce land collapse and keep stability of slopes. |

| Issues/Risks | Mitigation Measure |
|---|---|
| | • Soil contaminated with chemicals or hazardous substances shall be removed and transported and buried in waste disposal areas. |
| **11) Worker and public Safety** | • Training workers on occupational safety regulations and provide sufficient protective clothing for workers in accordance with applicable Vietnamese laws.<br>• Install fences, barriers, dangerous warning/prohibition site around the construction area which showing potential danger to public people.<br>• The contractor shall provide safety measures as installation of fences, barriers warning signs, lighting system against traffic accidents as well as other risk to people and sensitive areas.<br>• If previous assessments indicate there could be unexploded ordnance (UXO), clearance must be done by qualified personnel and as per detailed plans approved by the Construction Engineer. |
| **12) Communication with local communities** | • The contractor shall coordinate with local authorities (leaders of local communes, leader of villages) for agreed schedules of construction activities at areas nearby sensitive places or at sensitive times (e.g., religious festival days).<br>• 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.<br>• Disseminate project information to affected parties (for example local authority, enterprises and affected households, etc) through community meetings before construction commencement.<br>• Provide a community relations contact from whom interested parties can receive information on site activities, project status and project implementation results.<br>• Inform local residents about construction and work schedules, interruption of services, traffic detour routes and provisional bus routes, blasting and demolition, as appropriate.<br>• Notification boards shall be erected at all construction sites providing information about the project, 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 channel to voice their concerns and suggestions. |
| **13) 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:<br>• Stop the construction activities in the area of the chance find;<br>• Delineate the discovered site or area;<br>• 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 and Information takes over;<br>• 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);<br>• Relevant local or national authorities would be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. This would 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; those include the aesthetic, historic, scientific or research, social and economic values;<br>• 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 an irremovable remain of cultural or archeological importance) conservation, preservation, restoration and salvage; |

| Issues/Risks | Mitigation Measure |
|---|---|
| | • If the cultural sites and/or relics are of high value and site preservation is recommended by the professionals and required by the cultural relics authority, the Project's Owner will need to make necessary design changes to accommodate the request and preserve the site;<br>• Decisions concerning the management of the finding shall be communicated in writing by relevant authorities;<br>• Construction works could resume only after permission is granted from the responsible local authorities concerning safeguard of the heritage. |

**Part 2 – Contractor's Workers Environmental Code of Conducts**

8. This is an example for typical project.

| Do: | Do not |
|---|---|
| ◆ Use the toilet facilities provided – report dirty or full facilities<br>◆ Clear your work areas of litter and building rubbish at the end of each day – use the waste bins provided and ensure that litter will not blow away.<br>◆ Report all fuel or oil spills immediately & stop the spill from continuing.<br>◆ Smoke in designated areas only and dispose of cigarettes and matches carefully. (littering is an offence.)<br>◆ Confine work and storage of equipment to within the immediate work area.<br>◆ Use all safety equipment and comply with all safety procedures.<br>◆ Prevent contamination or pollution of streams and water channels.<br>◆ Ensure a working fire extinguisher is immediately at hand if any "hot work" is undertaken e.g. Welding, grinding, gas cutting etc.<br>◆ Report any injury of workers or animals.<br>◆ Drive on designated routes only.<br>◆ Prevent excessive dust and noise | ◆ Remove or damage vegetation without direct instruction.<br>◆ Make any fires.<br>◆ Poach, injure, trap, feed or harm any animals – this includes birds, frogs, snakes, etc.<br>◆ Enter any fenced off or marked area.<br>◆ Drive recklessly or above speed limit<br>◆ Allow waste, litter, oils or foreign materials into the stream<br>◆ Litter or leave food lying around.<br>◆ Cut trees for any reason outside the approved construction area<br>◆ Buy any wild animals for food;<br>◆ Use unapproved toxic materials, including lead-based paints, asbestos, etc.;<br>◆ Disturb anything with architectural or historical value<br>◆ Use of firearms (except authorized security guards)<br>◆ Use of alcohol by workers during work hours<br>◆ Wash cars or machinery in streams or creek<br>◆ Do any maintenance (change of oils and filters) of cars and equipment outside authorized areas<br>◆ Dispose trash in unauthorized places<br>◆ Have caged wild animals (especially birds) in camps<br>◆ Work without safety equipment (including boots and helmets)<br>◆ Create nuisances and disturbances in or near communities<br>◆ Use rivers and streams for washing clothes<br>◆ Dispose indiscriminately rubbish or construction wastes or rubble<br>◆ Spill potential pollutants, such as petroleum products<br>◆ Collect firewood<br>◆ Do explosive and chemical fishing<br>◆ Use latrines outside the designated facilities; and<br>◆ Burn wastes and/or cleared vegetation. |

## ANNEX 2. ANALYSIS RESULTS OF EXISTING ENVIRONMENTAL QUALITY

***ANALYSIS RESULT OF SOIL QUALITY***

| No | Lable | Layer | $pH_{H2O}$ (1:5) | $pH_{KCl}$ (1:5) | EC (1:5) | Salinity (1:5) | Organic matter | TN | TP | $Ca^{2+}$ | $Mg^{2+}$ | $SO_4^{2-}$ | $P\text{-}PO_4^{3-}$ | $Fe_{TS}$ | $Cl^-$ | Acid | $Al^{3+}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | mS/cm | ‰ | % | | | mg/100g | | | | | | | |
| 1 | Đ1 | 1st | 5.88 | 5.36 | 353 | 0.1 | 2.93 | 0.168 | 0.040 | 48.17 | 103.96 | 42.84 | 13.77 | 140.92 | 42.60 | 0.21 | 0.21 |
| 2 | Đ1 | 2nd | 4.38 | 4.02 | 615 | 0.4 | 2.30 | 0.118 | 0.048 | 90.12 | 126.94 | 92.10 | 7.66 | 30.64 | 78.20 | 5.10 | 3.16 |
| 3 | Đ1 | 3rd | 4.72 | 4.28 | 536 | 0.3 | 2.05 | 0.075 | 0.033 | 96.07 | 121.25 | 72.40 | 6.21 | 34.68 | 67.10 | 3.64 | 2.85 |
| 4 | Đ2 | 1st | 5.57 | 4.89 | 351 | 0.1 | 2.89 | 0.162 | 0.027 | 44.09 | 115.83 | 32.80 | 14.58 | 144.76 | 38.99 | 0.52 | 0.32 |
| 5 | Đ2 | 2nd | 5.56 | 4.10 | 686 | 0.4 | 2.16 | 0.087 | 0.039 | 84.15 | 139.75 | 87.40 | 5.86 | 105.60 | 84.40 | 2.48 | 2.14 |
| 6 | Đ2 | 3rd | 6.08 | 4.60 | 584 | 0.4 | 1.73 | 0.076 | 0.023 | 80.08 | 136.21 | 69.50 | 6.83 | 59.28 | 76.40 | 3.00 | 1.35 |
| 7 | Đ3 | 1st | 5.45 | 4.93 | 393 | 0.1 | 2.59 | 0.176 | 0.025 | 44.09 | 118.82 | 46.70 | 11.88 | 128.18 | 45.99 | 0.57 | 0.21 |
| 8 | Đ3 | 2nd | 5.45 | 4.61 | 462 | 0.2 | 2.50 | 0.116 | 0.033 | 76.07 | 121.53 | 64.70 | 10.94 | 72.34 | 52.80 | 1.87 | 1.29 |
| 9 | Đ3 | 3rd | 4.74 | 4.19 | 698 | 0.4 | 1.64 | 0.061 | 0.023 | 94.09 | 160.76 | 82.40 | 6.90 | 66.56 | 91.30 | 2.17 | 1.39 |
| 10 | Đ4 | 1st | 5.99 | 4.84 | 324 | 0.1 | 2.63 | 0.146 | 0.030 | 40.12 | 81.25 | 35.10 | 15.53 | 106.86 | 36.70 | 0.36 | 0.27 |
| 11 | Đ4 | 2nd | 4.70 | 4.28 | 722 | 0.4 | 2.33 | 0.117 | 0.044 | 84.16 | 162.84 | 98.88 | 13.57 | 81.32 | 94.10 | 1.57 | 1.08 |
| 12 | Đ4 | 3rd | 4.47 | 4.03 | 440 | 0.2 | 1.75 | 0.077 | 0.021 | 50.12 | 117.88 | 94.90 | 6.76 | 46.48 | 50.40 | 3.26 | 2.97 |
| 13 | Đ5 | 1st | 5.38 | 4.72 | 336 | 0.1 | 2.88 | 0.167 | 0.036 | 58.33 | 102.59 | 36.83 | 16.20 | 74.78 | 32.48 | 1.05 | 0.64 |
| 14 | Đ5 | 2nd | 4.67 | 4.33 | 440 | 0.2 | 2.19 | 0.094 | 0.034 | 78.25 | 122.11 | 62.10 | 9.82 | 115.44 | 49.10 | 8.13 | 2.46 |
| 15 | Đ5 | 3rd | 4.73 | 4.28 | 544 | 0.3 | 1.93 | 0.054 | 0.030 | 80.16 | 134.23 | 77.70 | 6.83 | 58.34 | 73.52 | 6.22 | 2.17 |
| 16 | Đ6 | 1st | 6.14 | 5.23 | 392 | 0.1 | 2.54 | 0.151 | 0.027 | 72.14 | 120.41 | 51.40 | 13.31 | 58.80 | 41.50 | 0.21 | 0.10 |
| 17 | Đ6 | 2nd | 5.02 | 4.64 | 529 | 0.3 | 2.36 | 0.106 | 0.031 | 94.16 | 100.41 | 56.20 | 9.03 | 97.28 | 58.70 | 2.36 | 1.68 |
| 18 | Đ6 | 3rd | 4.82 | 4.64 | 446 | 0.2 | 1.87 | 0.059 | 0.030 | 62.10 | 119.09 | 54.50 | 9.52 | 66.62 | 52.30 | 1.27 | 1.74 |
| 19 | Đ7 | 1st | 5.37 | 4.76 | 446 | 0.2 | 2.89 | 0.151 | 0.029 | 80.16 | 110.97 | 62.35 | 12.41 | 134.94 | 56.90 | 1.87 | 0.56 |
| 20 | Đ7 | 2nd | 5.04 | 4.30 | 743 | 0.4 | 2.38 | 0.117 | 0.035 | 88.11 | 167.22 | 95.10 | 11.24 | 20.38 | 98.60 | 0.68 | 1.12 |
| 21 | Đ7 | 3rd | 5.28 | 4.40 | 529 | 0.3 | 2.04 | 0.084 | 0.032 | 90.10 | 102.07 | 81.70 | 6.76 | 17.26 | 61.40 | 1.09 | 1.34 |

***ANALYSIS RESULT OF AIR QUALITY***

| No | Label | Parameter | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Noise | | | | | | | |
| | | **Temperature** | **Humidity** | **Min** | **Max** | **TB** | **PM** | **$SO_2$** | **$NO_2$** | **CO** | **NH3** |
| | | **ºC** | **(%)** | **dBA** | | | **$mg/m^3$** | **$mg/m^3$** | **$mg/m^3$** | **$mg/m^3$** | **$mg/m^3$** |
| 1 | **KK1** | 28,7 | 83 | 44,8 | 72,8 | 56,8 | 26,4 | 5,71 | 6,84 | 480 | KPH |
| 2 | **KK2** | 29,1 | 86 | 47,2 | 82,9 | 67,3 | 31 | 12,97 | 8,14 | 560 | KPH |
| 3 | **KK3** | 28,2 | 84 | 45,7 | 74,9 | 57,1 | 25,7 | 6,05 | 6,12 | 510 | KPH |
| 4 | **KK4** | 27,9 | 86 | 46,4 | 81,1 | 57,2 | 24,1 | 7,12 | 7,05 | 480 | KPH |
| 5 | **KK5** | 26,8 | 86 | 45,7 | 82,7 | 65,2 | 41 | 13,84 | 8,16 | 580 | KPH |

***ANALYSIS RESULT OF WATER QUALITY***

| NO | Label | | Tide | pH | Turbidity | EC | Salinity | DO | BOD5 | COD | Total hardness | Ca2+ | Mg2+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | NTU | mS/cm | ‰ | | | | mgCaCO3/l | mg/l | |
| 1 | N1 | 1 | Low | 7.18 | 45.4 | 1735 | 0.9 | 7.45 | 3.5 | 5.4 | 665.3 | 32.9 | 139.9 |
| 2 | | 2 | High | 6.95 | 84.4 | 225 | 0.0 | 6.62 | 5.7 | 8.0 | 118.6 | 25.2 | 13.3 |
| 3 | N2 | 1 | Low | 7.27 | 22.8 | 1760 | 0.9 | 7.40 | 3.9 | 5.5 | 706.2 | 31.8 | 150.4 |
| 4 | | 2 | High | 6.81 | 61.2 | 212 | 0.0 | 6.49 | 4.3 | 6.1 | 81.4 | 15.4 | 10.3 |
| 5 | N3 | 1 | Low | 7.21 | 29.6 | 1800 | 1.0 | 7.02 | 4.3 | 5.9 | 669.6 | 33.5 | 140.6 |
| 6 | | 2 | High | 6.79 | 134.1 | 225 | 0.0 | 6.56 | 4.9 | 7.0 | 105.1 | 23.9 | 10.9 |
| 7 | N4 | 1 | Low | 7.25 | 17.2 | 1850 | 1.0 | 7.30 | 3.5 | 4.9 | 728.6 | 32.3 | 155.5 |
| 8 | | 2 | High | 7.03 | 28.8 | 235 | 0.0 | 6.72 | 5.0 | 6.9 | 115.5 | 23.0 | 13.9 |
| 11 | N5 | 1 | Low | 7.17 | 52.7 | 1903 | 1.1 | 6.99 | 4.1 | 6.2 | 742.3 | 34.8 | 157.2 |
| 12 | | 2 | High | 6.8 | 54.2 | 232 | 0.0 | 6.63 | 5.1 | 7.4 | 108.6 | 23.1 | 12.2 |
| 13 | N6 | 1 | Low | 7.04 | 18.5 | 1995 | 1.1 | 7.00 | 3.5 | 5.2 | 790.3 | 34.3 | 169.1 |
| 14 | | 2 | High | 6.7 | 40.6 | 225 | 0.0 | 6.44 | 4.5 | 6.9 | 122.6 | 24.4 | 14.8 |
| 15 | N7 | 1 | Low | 6.86 | 27.8 | 1995 | 1.2 | 7.37 | 3.6 | 5.4 | 804.2 | 35.1 | 172.0 |
| 16 | | 2 | High | 6.75 | 134.9 | 210 | 0.0 | 6.30 | 5.8 | 8.3 | 108.5 | 23.8 | 11.8 |
| 17 | N8 | 1 | Low | 7.14 | 36.3 | 2140 | 1.2 | 7.20 | 3.7 | 5.3 | 811.0 | 36.8 | 172.6 |
| 18 | | 2 | Low | 6.82 | 88.2 | 225 | 0.0 | 6.44 | 5.7 | 8.1 | 117.0 | 24.1 | 13.6 |
| 19 | N9 | 1 | High | 7.09 | 66.1 | 2130 | 1.2 | 7.54 | 3.6 | 5.1 | 896.2 | 38.6 | 191.9 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | | 2 | Low | 6.76 | 125.8 | 225 | 0.0 | 6.43 | 4.9 | 7.2 | 120.4 | 24.4 | 14.3 |
| 21 | N10 | 1 | High | 7.15 | 36.2 | 2290 | 1.3 | 7.37 | 4.3 | 6.0 | 811.2 | 36.7 | 172.7 |
| 22 | | 2 | Low | 6.94 | 62.8 | 255 | 0.0 | 6.20 | 5.5 | 7.7 | 101.9 | 4.7 | 21.6 |

***ANALYSIS RESULT OF WATER QUALITY (cont.)***

| NO | Label | | Tide | Mg2+ | SO42- | TSS | N-NH4+ | N-NO2- | N-NO3- | TN | P-PO43- | FeTS | Cl- | K+ | Na+ | Total Coliform | Fecal Coliform |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mg/l | | | | | | | | | | | | MPN/100ml | |
| 1 | N1 | 1 | High | 139.9 | 135.5 | 44.1 | 0.09 | 0.019 | 0.96 | 1.46 | <0.01 | 1.35 | 481.9 | 31.5 | 77.1 | 490 | 45 |
| 2 | | 2 | Low | 13.3 | 53.1 | 114.8 | 0.17 | 0.009 | 0.97 | 1.34 | <0.01 | 0.97 | 20.8 | 3.1 | 14.3 | 2400 | 420 |
| 3 | N2 | 1 | High | 150.4 | 128.5 | 45.5 | 0.07 | 0.012 | 1.11 | 1.35 | <0.01 | 0.98 | 517.6 | 31.2 | 77.2 | 520 | 92 |
| 4 | | 2 | Low | 10.3 | 32.8 | 86.1 | 0.12 | 0.014 | 1.16 | 1.41 | <0.01 | 0.73 | 17.0 | 3.3 | 14.3 | 1700 | 250 |
| 5 | N3 | 1 | High | 140.6 | 145.2 | 36.4 | 0.08 | 0.008 | 1.01 | 1.31 | <0.01 | 1.30 | 486.5 | 32.9 | 72.9 | 840 | 84 |
| 6 | | 2 | Low | 10.9 | 31.8 | 158.2 | 0.12 | 0.009 | 1.13 | 1.41 | <0.01 | 0.96 | 18.8 | 3.4 | 13.7 | 2500 | 340 |
| 7 | N4 | 1 | High | 155.5 | 144.5 | 29.1 | 0.08 | 0.007 | 0.97 | 1.21 | <0.01 | 0.33 | 528.6 | 35.0 | 70.1 | 520 | 71 |
| 8 | | 2 | Low | 13.9 | 51.1 | 45.5 | 0.09 | 0.010 | 1.08 | 1.39 | <0.01 | 0.56 | 22.3 | 3.8 | 14.1 | 1100 | 180 |
| 11 | N5 | 1 | High | 157.2 | 145.2 | 45.5 | 0.08 | 0.019 | 1.19 | 1.54 | <0.01 | 0.86 | 594.6 | 35.5 | 78.3 | 1300 | 78 |
| 12 | | 2 | Low | 12.2 | 39.2 | 51.8 | 0.11 | 0.017 | 0.94 | 1.30 | <0.01 | 0.95 | 29.0 | 3.4 | 9.0 | 1300 | 120 |
| 13 | N6 | 1 | High | 169.1 | 162.2 | 44.1 | 0.07 | 0.016 | 0.93 | 1.36 | <0.01 | 2.64 | 554.2 | 36.9 | 77.0 | 740 | 65 |
| 14 | | 2 | Low | 14.8 | 35.4 | 83.3 | 0.09 | 0.019 | 0.92 | 1.34 | <0.01 | 2.01 | 22.7 | 4.0 | 9.0 | 3900 | 84 |
| 15 | N7 | 1 | High | 172.0 | 152.3 | 40.6 | 0.08 | 0.009 | 1.05 | 1.30 | <0.01 | 1.51 | 570.0 | 38.1 | 82.8 | 380 | 72 |
| 16 | | 2 | Low | 11.8 | 37.2 | 146.3 | 0.19 | 0.010 | 0.94 | 1.21 | <0.01 | 1.17 | 24.1 | 3.9 | 11.8 | 3300 | 280 |
| 17 | N8 | 1 | High | 172.6 | 155.1 | 53.2 | 0.07 | 0.002 | 1.09 | 1.37 | <0.01 | 1.85 | 578.4 | 39.1 | 87.3 | 1300 | 86 |
| 18 | | 2 | Low | 13.6 | 42.2 | 168.0 | 0.17 | 0.008 | 0.96 | 1.26 | <0.01 | 1.37 | 17.7 | 4.1 | 10.2 | 4200 | 350 |
| 19 | N9 | 1 | High | 191.9 | 177.3 | 81.9 | 0.07 | 0.011 | 1.25 | 1.86 | <0.01 | 3.19 | 626.5 | 39.4 | 80.7 | 920 | 95 |
| 20 | | 2 | Low | 14.3 | 39.7 | 133.7 | 0.09 | 0.013 | 1.02 | 1.62 | <0.01 | 2.21 | 22.9 | 4.0 | 9.3 | 3400 | 170 |
| 21 | N10 | 1 | High | 172.7 | 162.9 | 61.6 | 0.11 | 0.030 | 1.00 | 1.67 | <0.01 | 1.24 | 694.7 | 37.1 | 99.9 | 450 | 84 |
| 22 | | 2 | Low | 21.6 | 18.9 | 119.4 | 0.19 | 0.013 | 1.14 | 1.91 | <0.01 | 0.79 | 67.1 | 4.4 | 10.9 | 1600 | 540 |

***ANALYSIS RESULT OF ZOOPLANKTON AT HIGH TIDE***

| No. | Species | Label | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **TS1** | **TS2** | **TS3** | **TS4** | **TS5** | **TS6** | **TS7** | **TS8** | **TS9** | **TS10** |
| | **CLADOCERA** | | | | | | | | | | |
| 1 | *Alona davidi* | | | * | | | | | | | |
| 2 | *Alona rectangula* | * | | * | | * | | | | * | * |
| 3 | *Biaperturakarua* | | | * | | | | | | | |
| 4 | *Bosmina longirostris* | | | | | * | | * | | | * |
| 5 | *Bosminopsis deitersi* | | * | | | | | | | | |
| 6 | *Ceriodaphnia laticaudata* | | | | | | | | * | | |
| 7 | *Ceriodaphnia megalops* | | | | * | | | | * | * | |
| 8 | *Ceriodaphnia reticulate* | | | | * | | | * | | | |
| 9 | *Ceriodaphnia rigaudii* | * | | | | * | | | | | |
| 10 | *Diaphanosoma brachyurum* | | | | * | * | | | | | * |
| 11 | *Kurzia latissima* | * | | | | | | | | | |
| 12 | *Moina brachiata* | | | | | | | | | | |
| 13 | *Moina dubia* | | | | | | | * | | | |
| 14 | *Moina macrocopa* | | | * | | | * | | | | |
| 15 | *Moina rectirostris* | * | * | | | | * | | | | * |
| 16 | *Moinodaphnia macleayii* | | | * | | | | * | | | |
| 17 | *Oxyurella longicaudis* | | * | | | | | | | | |
| | ***COPEPODA*** | | | | | | | | | | |
| 18 | *Allodiaptomus gladiolus* | | * | | | * | * | | * | | |
| 19 | *Dentodiaptomus javanus* | * | * | | | | | | | | |
| 20 | *Eodiaptomus dracosinignvomi* | * | | | | * | | | * | * | |
| 21 | *Eodiaptomus lumboltzi* | | * | * | | | | | | * | |
| 22 | *Eucyclops serruatus* | | | | | | * | | | | |
| 23 | *Heliodiaptomus serratu* | | | | | | | | * | | |
| 24 | *Limnoithona sinensis* | * | | | * | | * | | | | |
| 25 | *Limoncaea genuine* | * | | | * | | | | * | | |
| 26 | *Mesocyclops leuckarti* | | | | | | | | | | |
| 27 | *Mongolodiaptomus formosanus* | | | * | | * | * | | | | |
| 28 | *Neodiaptomus botulifer* | | | | | | | | | * | |
| 29 | *Neodiaptomus handeli* | | | | | | | * | * | | * |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | *Neodiaptomus visnu* | * | * | | | | | | | | |
| 31 | *Paracyclops serrulatus* | | | * | | | * | | | * | |
| 32 | *Phyllodiaptomus tunguidus* | | | | | | * | | | | |
| 33 | *Thermocyclops hyalinus* | | * | | * | | | * | | | |
| | **Total (species/site)** | 9 | 8 | 8 | 6 | 7 | 8 | 6 | 7 | 6 | 5 |
| | **Biomass (invidual/m$^3$)** | 1,734 | 2,016 | 1,371 | 1,653 | 792 | 1,741 | 1,520 | 1,684 | 1,205 | 1,947 |
| Note: "*": site finds zooplankton | | | | | | | | | | | |

***ANALYSIS RESULT OF ZOOPLANKTON AT LOW TIDE***

| **NO** | **Species** | **Label** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **TS1** | **TS2** | **TS3** | **TS4** | **TS5** | **TS6** | **TS7** | **TS8** | **TS9** | **TS10** |
| | **OLIGOCHAETA** | | | | | | | | | | |
| 1 | *Aulodrilus prothecatus* | | | * | | | | | * | | |
| 2 | *Branchiodrilus semperi* | | | | | | | | | * | |
| 3 | *Branchiura sowerbyi* | * | * | | * | * | * | | | | |
| 4 | *Branchiura sowerbyi* | | | | * | | | | * | | |
| 5 | *Limnodrilus hoffmeisteri* | | | | | | | | | | |
| | **GASTROPODA** | | | | | | | | | | |
| 6 | *Antimelania swinhoei* | | | | | | | | | | |
| 7 | *Bellamya filosa* | | | * | | | * | | * | | |
| 8 | *Filopaludina filosa* | | | | * | | * | | | | |
| 9 | *Melanoides tuberculatus* | * | | | | | * | | | | * |
| 10 | *Sinotaria reevei* | | | | | | | | | * | |
| 11 | *Stenothyra messageri* | | | | | | | | | | |
| 12 | *Thiana scabra* | * | | * | | * | * | | | | |
| | **BIVALVIA** | | | | | | | | | | |
| 13 | *Corbicula leviuscula* | | * | | | | * | | | | |
| 14 | *Corbicula baudoni* | | | * | | | | | * | | |
| 15 | *Corbicula cyreniformis* | | | | * | | | | | | |
| 16 | *Corbicula bocourti* | * | | | | | | | | | |
| | **CRUSTACEA** | | | | | | | | | | |
| 17 | *Macrobrachium mammilodactylus* | * | | | | * | * | | | | |
| 18 | *Macrobrachium pilimanus* | | * | | | | * | | * | | |
| 10 | *Macrobrachium rosenbergii* | | | | | | | | | | |
| | **INSERTA** | | | | | | | | | | |
| 20 | *Deiellia phaon* | * | | | | | * | | | | |
| 21 | *Chironomus sp* | * | | * | | | * | | * | * | |
| 22 | *Ablabesmya sp* | * | | * | | | * | | | * | |
| 23 | *Nannophya pygmea* | | | * | | | * | | | | |
| 24 | *Graptocorixa sp* | | | | * | | * | | | | * |
| | **Total (species/site)** | 8 | 3 | 7 | 5 | 3 | 11 | 0 | 6 | 4 | 2 |
| | **Biomass (invidual/m2)** | 76 | 108 | 131 | 105 | 94 | 137 | 48 | 71 | 36 | 84 |

***ANALYSIS RESULT OF ZOOBENTHOS AT HIGH TIDE***

| NO | Species | Label | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **TS1** | **TS2** | **TS3** | **TS4** | **TS5** | **TS6** | **TS7** | **TS8** | **TS9** | **TS10** |
| | **OLIGOCHAETA** | | | | | | | | | | |
| 1 | *Aulodrilus prothecatus* | | | * | | | | | * | | |
| 2 | *Branchiodrilus semperi* | | | | | | | | | * | |
| 3 | *Branchiura sowerbyi* | * | * | | * | * | * | | | | |
| 4 | *Branchiura sowerbyi* | | | | * | | | | * | | |
| 5 | *Limnodrilus hoffmeisteri* | | | | | | | | | | |
| | **GASTROPODA** | | | | | | | | | | |
| 6 | *Antimelania swinhoei* | | | | | | | | | | |
| 7 | *Bellamya filosa* | | | * | | | * | | * | | |
| 8 | *Filopaludina filosa* | | | | * | | * | | | | |
| 9 | *Melanoides tuberculatus* | * | | | | | * | | | | * |
| 10 | *Sinotaria reevei* | | | | | | | | | * | |
| 11 | *Stenothyra messageri* | | | | | | | | | | |
| 12 | *Thiana scabra* | * | | * | | * | * | | | | |
| | **BIVALVIA** | | | | | | | | | | |
| 13 | *Corbicula leviuscula* | | * | | | | * | | | | |
| 14 | *Corbicula baudoni* | | | * | | | | | * | | |
| 15 | *Corbicula cyreniformis* | | | | * | | | | | | |
| 16 | *Corbicula bocourti* | * | | | | | | | | | |
| | **CRUSTACEA** | | | | | | | | | | |
| 17 | *Macrobrachium mammilodactylus* | * | | | | * | * | | | | |
| 18 | *Macrobrachium pilimanus* | | * | | | | * | | * | | |
| 10 | *Macrobrachium rosenbergii* | | | | | | | | | | |
| | **INSERTA** | | | | | | | | | | |
| 20 | *Deiellia phaon* | * | | | | | * | | | | |
| 21 | *Chironomus sp* | * | | * | | | * | | * | * | |
| 22 | *Ablabesmya sp* | * | | * | | | * | | | * | |
| 23 | *Nannophya pygmea* | | | * | | | * | | | | |
| 24 | *Graptocorixa sp* | | | | * | | * | | | | * |
| | **Total (species/site)** | 8 | 3 | 7 | 5 | 3 | 11 | 0 | 6 | 4 | 2 |
| | **Biomass (invidual/m2)** | 76 | 108 | 131 | 105 | 94 | 137 | 48 | 71 | 36 | 84 |

***ANALYSIS RESULT OF ZOOBENTHOS AT LOW TIDE***

| No. | Species | Label | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **TS1** | **TS2** | **TS3** | **TS4** | **TS5** | **TS6** | **TS7** | **TS8** | **TS9** | **TS10** |
| | **OLIGOCHAETA** | | | | | | | | | | |
| 1 | *Aulodrilus prothecatus* | | * | | * | | | | * | | * |
| 2 | *Branchiodrilus semperi* | | * | | | | | | | | |
| 3 | *Branchiura sowerbyi* | | | | | | * | * | | * | |
| 4 | *Branchiura sowerbyi* | | * | | | | | | * | | * |
| 5 | *Limnodrilus hoffmeisteri* | | | | | * | | | | | |
| | **GASTROPODA** | | | | | | | | | | |
| 6 | *Antimelania swinhoei* | | | | | | | | | | |
| 7 | *Bellamya filosa* | | | * | | | | | | | |
| 8 | *Filopaludina filosa* | | | | | | | | | * | |
| 9 | *Melanoides tuberculatus* | | | | * | | * | | | | |
| 10 | *Sinotaria reevei* | | | * | | | | | | | |
| 11 | *Stenothyra messageri* | | | | * | | | | * | | |
| 12 | *Thiana scabra* | | | | | | | | * | | * |
| | **BIVALVIA** | | | | | | | | | | |
| 13 | *Corbicula leviuscula* | | | | | | * | | | | |
| 14 | *Corbicula baudoni* | * | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | *Corbicula cyreniformis* | | | * | | | | * | * | | * |
| 16 | *Corbicula bocourti* | | | | | | | | | | |
| | **CRUSTACEA** | | | | | | | | | | |
| 17 | *Macrobrachium mammilodactylus* | | | | | | * | | | * | |
| 18 | *Macrobrachium pilimanus* | | * | * | | | | | | | |
| 10 | *Macrobrachium rosenbergii* | | | | | * | | | | * | |
| | **INSERTA** | | | | | | | | | | |
| 20 | *Deiellia phaon* | | | | | | | | | * | |
| 21 | *Chironomus sp* | * | | | * | | * | * | | * | * |
| 22 | *Ablabesmya sp* | | | | | | | | | | |
| 23 | *Nannophya pygmea* | | * | | * | * | | | * | | * |
| 24 | *Graptocorixa sp* | | | | | | | | | | |
| | **Total (species/site)** | 2 | 5 | 4 | 5 | 3 | 5 | 3 | 6 | 6 | 6 |
| | **Biomass (invidual/m2)** | 172 | 137 | 105 | 62 | 71 | 84 | 192 | 117 | 82 | 76 |

## ANNEX 3. SOME PICTURES OF CONSULTATION MEETINGS









## ANNEX 4. LOCATIONS OF ENVIRONMENTAL MONITORING SITES

Table 1: Coordinates of surface water sampling location

| No. | Label | Coordinates | | Description of sampling location |
|---|---|---|---|---|
| | | Longtitude | Latitude | |
| 1 | N1 | 10° 5'55.40"N | 106°12'44.50"E | at Vung Liem estuary |
| 2 | N2 | 10° 6'7.98"N | 106°11'24.65"E | Inside of Vung Liem river |
| 3 | N3 | 10° 7'9.18"N | 106°11'47.89"E | at Tan Dinh estuary |
| 4 | N4 | 10° 5'2.91"N | 106°13'48.32"E | Inside of Tan Dinh river |
| 5 | N5 | 9°54'11.69"N | 105°59'20.72"E | At Bong Bot estuary |
| 6 | N6 | 9°54'32.63"N | 106° 0'6.39"E | Inside of Bong Bot river |

Table 2: Coordinates of groundwater sampling location

| No. | Label | Coordinates | | Description of sampling location |
|---|---|---|---|---|
| | | Longtitude | Latitude | |
| 1 | GK1 | 10° 5'51.56"N | 106°12'36.56"E | Near Vung Liem sluice gate |
| 2 | GK2 | 9°54'11.18"N | 105°59'25.01"E | At Tan Dinh ferry |
| 3 | GK3 | 9°52'13.91"N | 106° 0'35.24"E | At residential area near Bong Bot estuary |

Table 3: Coordinates of wastewater sampling location

| No. | Label | Coordinates | | Description of sampling location |
|---|---|---|---|---|
| | | Longtitude | Latitude | |
| 1 | NT1 | 10° 5'59.85"N | 106°12'37.12"E | At residential area near Vung Liem estuary |
| 2 | NT2 | 9°54'18.29"N | 105°59'24.14"E | At residential area near Tan Dinh estuary |
| 3 | NT3 | 9°52'9.20"N | 106° 0'40.83"E | At residential area near Bong Bot estuary |

Table 4: Coordinates of sediment sampling location

| No. | Label | Coordinates | | Description of sampling location |
|---|---|---|---|---|
| | | Longtitude | Latitude | |
| 1 | TT1 | 10° 5'55.48"N | 106°12'49.43"E | At Vung Liem estuary |
| 2 | TT2 | 10° 5'55.54"N | 106°12'3.92"E | Inside of Vung Liem river |
| 3 | TT3 | 9°54'11.51"N | 105°59'20.26"E | At Tan Dinh estuary |
| 4 | TT4 | 9°54'23.27"N | 105°59'32.63"E | Inside of Tan Dinh river |
| 5 | TT5 | 9°52'8.97"N | 106° 0'32.81"E | At Bong Bot estuary |
| 6 | TT6 | 9°52'22.70"N | 106° 0'52.64"E | Inside of Bong Bot river |

Table 5: Coordinates of air sampling location

| No. | Label | Coordinates | | Description of sampling location |
|---|---|---|---|---|
| | | Longtitude | Latitude | |
| 1 | KK1 | 10° 6'1.38"N | 106°12'33.71"E | At residential cluster near Vung Liem estuary |
| 2 | KK2 | 9°54'11.15"N | 105°59'26.83"E | At residential cluste near Tan Dinh estuary |
| 3 | KK3 | 9°52'16.60"N | 106° 0'36.37"E | At residential cluste near Bong Bot estuary |