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DEPARTMENT OF TRANSPORT HO CHI MINH CITY
ENVIRONMENT SANITATION PROJECT INVESTMENT MANAGEMENT AGENCY

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

HOCHI MINHCITY ENVIRONMENTAL SANITATION PROJECT – PHASE 2

HO CHI MINH CITY, SEPTEMBER 2014

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ABBREVIATION

ADB	Asian Development Bank
ADEME	The French Agency for the Environment and Energy Management
AP	Affected Person
AS	Activated Sludge
BME	Benefit Monitoring and Evaluate
BOD	Biochemical Oxygen Demand
BOT	Build Operate Transfer
CAS	Conventional Activated Sludge
CAPEX	Capital Expenditure
CDM	Clean Development Mechanism
CESPIMA	City Environment Sanitation Project Investment Management Agency
CFR	Carbon Financing Revenue
CHP	Combined Heat and Power
COD	Chemical Oxygen Demand
CSO	Combined Sewer Overflow
D.2	District 2
DARD	Department of Agriculture and Rural Development
DB	Design and Build
dBA	Decibel
DOC	Department of Construction
DOF	Department of Finance
DOT	Department of Transport and Public Works
DONRE	Department of National Resources and Environment
DPA	Department of Planning and Architecture
DPI	Department of Planning and Investment
EA	Executive Agency
EBS	East Bank Shaft
EIA	Environmental Impact Assessment
EPC	Engineering Procurement Construction
FIDIC	International Federation of Consulting Engineers
FCC	Flood Control Center
FS	Feasibility study
GDP	Gross Domestic Product
GHG	Green House Gas
GIS	Geographic Information System
GoV	Government of Vietnam
GBT	Gravity Belt Thickener
GRP	Glass Reinforced Panels
GTT	Gravity Thickening Tank
HCMC	Ho Chi Minh City
HCMCES	Ho Chi Minh City Environmental Sanitation Project
HCMCES 2	Ho Chi Minh City Environmental Sanitation Project – Phase 2
ICB	International Competitive Bidding
JBIC	Japan Bank for International Cooperation
IFI	International Financial Institutions
JICA	Japan International Cooperation Agency
KVA	Kilo Volt Ampere
MARD	Ministry of Agriculture and Rural Development
MBR	Membrane Bioreactor
MBBR	Moving Bed Bio film Reactor
MOC	Ministry of Construction
MOET	Ministry of Education and Training
MOF	Ministry of Finance

MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MP	Master Plan
NDN	Nitrification – Denitrification
NLTN	Nhieu Loc-Thi Nghe
ODA	Official Development Assistance
O&M	Operation and Maintenance
OPEX	Operational Expenditure
PC	People's Committee
PCI	Pacific Consultant International
PE	People Equivalent
PM	Prime Minister
PPP	Public Private Partnership
PPTAF	Project Prepare Technical Assistance Facility
PSP	Private Sector Participation
PS	Pumping Station
PST	Primary Settling Tank
QCBS	Quality and Cost- Based Selection
RAP	Resettlement Action Plan
RC	Reinforced concrete
SA	Social Assessment
SAWACO	Saigon Water Company
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control And Data Acquisition
SCFC	Steering Center for Urban Flood Control Program
SOE	State Owned Enterprise
SS	Suspended Solid
TLBC	Tham Luong Ben Cat
TN	Total Nitrogen
TP	Total Phosphorus
UDC	Urban Drainage Company
UFW	Unaccounted For Water
UMRT	Urban Mass Rail Transit
USD	United States Dollar
UV	Ultra Violet
VAT	Value added tax
VND	Vietnam Dong
WB	World Bank
WEIP	Water Environment Improvement Project
WS	Water Supply
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

VOLUME 1:

EXECUTIVE SUMMARY OF ENVIRONMENTAL IMPACT ASSESSMENT

I. INTRODUCTION

1. The City Environmental Sanitation Project Investment Management Agency (CESPIMA) has prepared the environmental impact assessment (EIA) report for the project "Ho Chi Minh City Environmental Sanitation - Phase2" in cooperation with the Meinhardt (Singapore) Ltd.. The EIA report was prepared based on existing statistical data of the meteorology, hydrology, and socioeconomic conditions in the project area. Additional environmental data on air, noise, and water quality were collected from the project area and analyzed by the Institute for Environment and Resources, National University of Ho Chi Minh City. Technical manuals on process engineering, pollution control technologies (including wastewater, air emission, and solid waste) and environmental rapid assessment manuals were used in the analysis. Pollution factors estimated by the World Health Organization (WHO) and other popular methods.

2. The proposed project is classified in line with the World Bank operational policy on Environmental assessment (OP 4.01) as category A project, since it is a project with significant potential impacts given the construction and operation of the WWTP and affiliated infrastructure in HCMC financed by this project. The original EIA reports on which the current document has been based on are available in both Vietnamese and English for public information. Their content has been discussed separately in a public meeting held in HCMC on April 24, 2014.

3. The EIA report was prepared pursuant to Vietnam's Decree No. 29/2011/ND-CP dated April 18, 2011 on strategy Environment Assessment, Environmental Impact Assessment and Environment Protection Commitment. The structure of the report followed Circular No. 26/2011/TT-BTNMT. The EIA report is also prepared taking all applicable World Bank environmental and social safeguard policies and guidelines into consideration.

II. PROJECT DESCRIPTION

4. The proposed Ho Chi Minh City Environmental Sanitation Project – Phase 2 (HCMC ESP2) is a continuation of the Bank's HCMC ESP1, which closed on June 30, 2012. Under the first project, through the construction of an interceptor and rehabilitation of the drainage system, wastewater from the NLTN basin is transferred to a pumping station. The pumping station is now operational and the untreated wastewater is pumped under the Saigon River to a shaft on the East Bank in District 2 from where it is currently discharged into the Saigon River. Under the Phase 2 project, the large volume of untreated wastewater currently discharged into the Saigon river will be treated through the newly planned WWTP and discharged at a new location into the Dong Nai river; this will improve the environmental condition in the city.

5. According to the Law on Environment Protection dated November 29, 2005 of the National Assembly which came into effect from July 1, 2006 and the Decree No. 29/2011/ND-CP dated April 18, 2011 issued by the Government on strategic environment assessment, environmental impact assessment and environment protection commitment the City environment sanitation project investment management agency (CESPIMA) has to prepare and submit an EIA report of the HCM ESP 2 to the Department of Natural Resources and Environment of Ho Chi Minh City for review and appraisal.

6. The national environmental requirements and procedures for the HCMC ESP2 are described in the Circular No. 26/2011/TT-BTNMT issued by MONRE on detailing some articles of Decree No. 29/2011/ND-CP dated April 18, 2011 of the Government on strategic environmental assessment, environmental impact assessment, and environment protection commitment.

7. In line with the World Bank Group operational policies, the HCMC ESP2 investments trigger the following five safeguard policies: (a) OP4.01: Environmental Assessment; (b) OP4.04: Natural Habitats; (c) 4.11: Physical Cultural Resources; (d) OP4.12: Involuntary Resettlement; and (e) OP7.50: International Waterways. OP4.01 and OP7.50 are discussed below and the other three policies triggered are discussed in the relevant sections later in this document.

8. ***Environmental Assessment (OP4.01)***. The project triggers the Bank safeguard policy on Environmental Assessment (OP 4.01). The project will improve the environment of HCMC by collection and treatment of wastewater from the Nhieu Loc-Thi Nghe basin and parts of District 2 and water quality modelling carried out for the project illustrates that the quality of the Saigon River will improve due to project interventions (as the current practice of discharging untreated wastewater to the Saigon river would cease, reducing the pollution discharged to the river). However, there will be minor and temporary site-specific environmental impacts primarily during the construction period (due to dust pollution, noise and vibration due to the operation of heavy equipment, waste generation at the construction site, and traffic interferences). Also, due to the construction activities, local vegetation and landscape will be affected (e.g., vegetation at the site of the WWTP will be removed and also a creek that is located at the site will be diverted to another location within the site). The main impacts would be: permanent loss of agricultural land (about 74% of the land is agricultural), movement of six graves, and removal of 01 thatch restaurant and two temporary shelters. The relocation of the creek (about 150 m within the site) will be done in line with the overall flood control measures that are being considered for the site. The negative impacts will be mitigated through the application of mitigation measures outlined in the Environmental Management Plan (EMP) which will include a monitoring plan and through the application of health and safety requirements of workers that would be involved in the construction. Implementation of the EMP will be a requirement for contractors under the project.

9. ***OP7.50 on International Waterways is triggered.*** The project will finance a WWTP discharging into Dong Nai River, a tributary of Saigon River, which is in turn an international waterway rising from Cambodia. The policy OP 7.50 is triggered since the project will take place on an international river (Saigon River) and since the wastewater will be discharged to the Dong Nai River which is a tributary of an international river (Saigon River) [paras. 1(a) and 1(b) of the policy].

10. The HCMC ESP2 has five components which are summarized below (costs shown exclude VAT):

    Component 1: Construction of Interceptor (Cost: US$65 million): The sewage interceptor total length of 8 km and diameter of 3.2m will be constructed to connect sewage from East Bank Shaft to the wastewater treatment plant at Thanh My Loi ward, District 2. It will convey sewage from NLTN to the Pumping Station at the entrance of the WWTP. The construction of the interceptor will prevent the discharge of untreated wastewater to the Saigon River.

    Component 2: Construction of Wastewater Treatment Plant (Cost: US$261 million): The WWTP will treat the wastewater collected in the NLTN basin and in the D2 area. The WWTP is being designed for a capacity of 480,000 m3/day and will be constructed through a Design Build and Operate contract where the same private company will carry out these three stages. The WWTP will be located near the confluence of the Saigon and Dong Nai rivers, and the treated wastewater will be discharged to the Dong Nai River. The site is prone to flooding and, as a result, flood protection measures are included in the project design.

    Component 3: Construction of Sewerage Network in the District 2 area (Cost: US$52 million): The project will invest in drainage level 2 and level 3 in District 2. Investment objective of the drainage in District 2 is to maximize the wastewater collection to improve the environmental conditions in the project areas where untreated

wastewater is discharged to water bodies. In addition, households in the project area will be connected, if they are not currently connected to the combined or separated system. The wastewater collected from the District 2 area will be transferred to the interceptor that also will convey wastewater to the wastewater treatment plant (being constructed under this project) from the Nhieu Loc-Thi Nghe (NLTN) area.

Component 4: Project Implementation (Cost: US$32 million): This component has two parts: (a) Component 4a: Construction Supervision will support hiring of consultants to supervise construction during project implementation; and (b) Component 4b: Improving Sanitation Management and Project Implementation will provide technical assistance including implementation support and capacity building for key project entities (e.g. CESPIMA). In addition, support will be provided to the CESPIMA to enhance sanitation management in HCMC.

Component 5: Land Acquisition and Operating Cost of Implementation Management Agency (Cost US$40 million): CESPIMA coordinates with the People's Committee of District 2 to setup the general plan for the compensation assistance and resettlement. District 2 People's Committee is responsible for the establishment of a committee for the compensation assistance and resettlement as prescribed. The committee for the compensation assistance and resettlement will setup the land acquisition plan, documents and decisions for households, individuals, and organizations (if any) under the provisions and give land hand-over decision for CESPIMA. Component 5a: Resettlement and Land Acquisition will include costs (borne solely by HCMC) to compensate people that currently own the land where the WWTP would be constructed. Component 5b: Operating Cost of the Implementation Management Agency includes salaries, fees and other costs (all borne by HCMC) for the eight years of the project implementation period.

11. Under HCMC ESP2 the wastewater will be conveyed from the East Bank shaft and District 2 to a proposed new wastewater treatment plant via a 3.2m diameter and 8 km long interceptor (See Figure 1). The proposed routing of the interceptor will also take into account the plans for sewerage and drainage investments necessary for the development of District 2 and the capacity of the interceptor would be sufficient to also eventually transfer the wastewater from District 2 once the area will be developed in the future. The sewerage and drainage investments' locations in District 2 are being identified now and relevant detailed designs would be completed after the proposed approval of the project by the Bank. As most of the sewer and drainage infrastructure in the District 2 area are expected to be installed under existing roads, the environmental and social impacts are not expected to be substantial. A separate Environmental and Social Management Framework (ESMF) has been prepared for these investments. The ESMF outlines the process that will be carried out to address environmental and social considerations that may come up during the construction phase once the location of the investments is known.

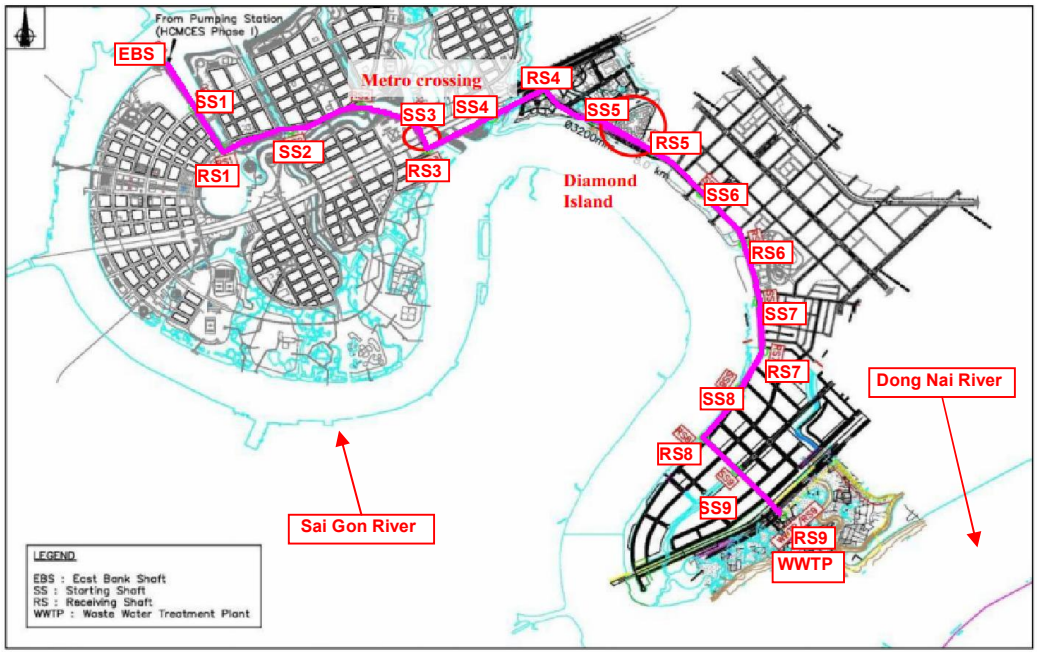

Figure 1. Interceptor route

12. A Wastewater Treatment Plant with a capacity of 480,000 m^3/day by 2020 will be built at Thanh My Loi Ward, District 2 (See Figure 2). The proposed WWTP is located at the confluence of the national Dong Nai River and the international Saigon River. The outlet of WWTP will be located in the Dong Nai River, which is a national river that originates in Vietnam and flows to the East Sea. The area assigned for the WWTP construction requires 38.47 hectares used in the past (more than 5 years ago) primarily for agricultural and residential purposes. Currently, this area is covered by randomly grown vegetation (e.g., shrubs, small bushes, nipa); three creeks and ditches, all of which give the area the characteristics of shrub swamp conditions. The overall area is flat but partially flooded during high tide.

13. The wastewater treatment standard for the future WWTP is regulated in line with QCVN 14:2008/BTNMT[1] for domestic wastewater, column A[2] in 2020 as decided by the People Committee of HCMC. Furthermore, based on the Feasibility Study prepared in May 2014, four treatment technologies were considered and the bidder will have the option to bid on any one of these 4 technologies or other feasible alternatives. The technology with the lowest life-cycle cost taken in consideration socio-economic and environmental aspects would be selected. .

[1] QCVN14 is the national technical regulation on domestic wastewater
[2] Column A regulates the value of parameters for wastewater discharging into water bodies, which is used for water supply purposes

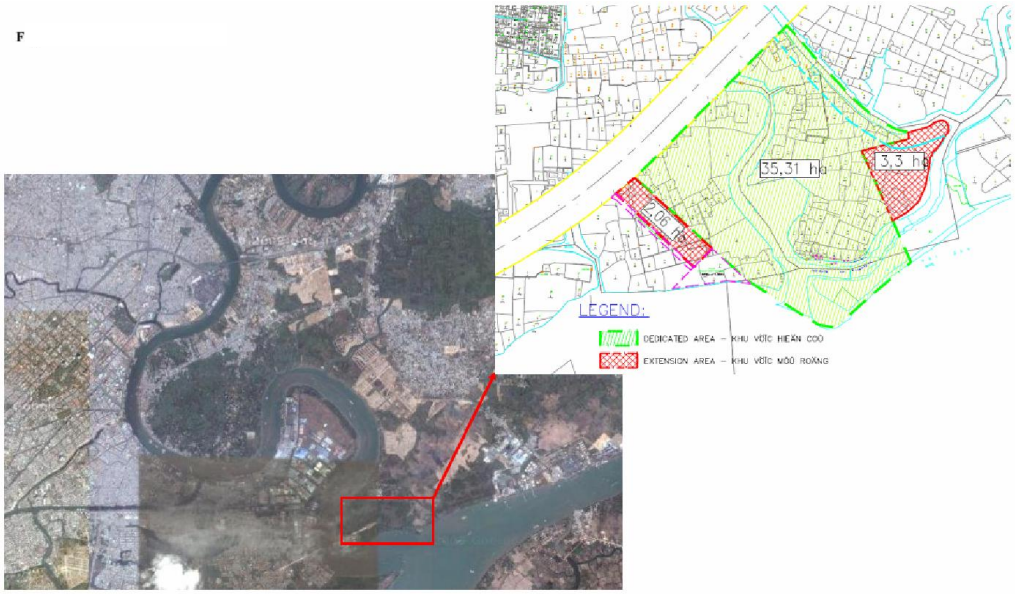

Figure 2. Location of wards along the interceptor and WWTP

14. The same entity that worked with the World Bank on the first phase project (HCMC ES1) would also implement the second phase project, as the staff is familiar with the World Bank procedures. The project will provide financing for institutional strengthening of the key project entities (e.g. CESPIMA), which will consist of implementation support and capacity building including safeguard management. for key project entities. Under the project, consultants would be in place to support the implementing agency. The environmental monitoring program proposed for implementation during the WWTP operation will ensure the treated wastewater meets the effluent standard and any possible impacts downstream are managed and reduced. It would be important for HCMC to have the necessary resources to ensure that the investments are carried out in a proper way and that wastewater and sanitation management in the city is sustainable from environment and financial standpoints. Semi-annual environmental and social audits would be carried out to ensure that proper procedures are being followed.

III. DESCRIPTION OF THE ENVIRONMENT

A. Physical Environment

1). Atmospheric Conditions

15. Data provided by the meteorological stations of Tan Son Hoa Station during 2005-2012 years show the annual average, maximum, and minimum temperatures are 28.16^{o}C, 34.2^{o}C (year of 2000), 20.8^{o}C (year of 2000), respectively. The average maximum temperature occurs in April and the minimum in January. Average annual rainfall of the city varies from 1,742.8 to 2,340.2 mm/year. The West - Southwest wind from the Indian Ocean blows into the rainy season, from June to October, with average speed about 2.4 m/s. By while, the North - Northeast wind from the East Sea blows into the dry season, from November to February, with average speed of about 2,4 m/s.

16. Throughout the project area air samples were taken, with the result that the concentrations of dust, sulfur dioxide, nitrogen dioxide, carbon monoxide and volatile organic constituents in the ambient air are within the limits of the Vietnamese technical environmental regulations for ambient air quality (QCVN 05:2013/BTNMT and QCVN 06:2009/BTNMT). The noise levels in the project area are within the limits of the National Technical Regulations on Noise (QCVN 26:2010/BTNMT).

2). Hydrological Conditions

17. Ho Chi Minh City, located in the downstream of the Dong Nai river basin system, has an interlinked rivers and canals network. The Dong Nai River has many tributaries such as the La Nga River, the Nha Be River with average flow of 980 m^3/s and the highest flow of 10,000m^3/s during floods. The international waterway Saigon River originates from the Hon Quan district (near to the border between Cambodia and Vietnam), Binh Phuoc Province, flows through Thu Dau Mot to the HCMC with a length of about 200 km (80 kilometers in the city). The width of the Saigon River in the city ranges from 225m to 370m and its depth is 20 meters. The hydrological conditions of the rivers in Ho Chi Minh City area are influenced by semi-diurnal variation of tidal of the East Sea. Monitoring results measured at Phu An station in 2010, showed that the highest of average tide level in the Saigon River is 1.385 m. The highest water level is registered in November (1.55 m) and the lowest in July (-2.22 m) The average flow of the Saigon and Dong Nai rivers near the project site are 93 and 980 m^3/s, respectively.

18. The results of surface water samples analysis showed that at the present the water quality in the Sai Gon and Dong Nai rivers in the project's area are within limits of QCVN 08:2008/BTNTM, Column B2. The BOD and ammonia concentrations in some locations are exceeding the QCVN 08:2008/BTNMT, column A2.[3] Groundwater in Ho Chi Minh City is quite abundant. According to geological survey, an average depth of groundwater is equivalent to sea level and directly affected by tides. Groundwater in project area appears in the inner aquifer (layer 2, 5, and 6a) with a small reserve. The result of underground water analysis at the 05 drilled wells of 40 m depth in the project area indicates that the groundwater quality is good.

3). Geological Condition

19. The topography of District 2 is low lying and flat, therefore, District 2 may have problem with flooding, especially when climate change and sea level rise are considered as well. Because of its low terrain, the ground level of District 2 needs to be raised from +2.5m to +3.0m above the sea level to prevent flooding. Based on the original terrain, the survey region is the type of the coastal plain, formed by the sediment originated from rivers and sea. According to geo-technical works and analysis in the laboratory from drilling samples, the geological strata of the region is divided into 6 soil layers from top to bottom, which permit construction of WWTP of the planned size. The WWTP itself will also be protected against flooding through measures taken under the project.

B. Biological Environmental

20. The analysis of the phytoplankton, zooplankton, and macro invertebrates' samples collected at 5 sample sites within the project area in Saigon River shown that there are 72 species of the phytoplankton and 39 species of zooplankton. However, there are no endangered species found in the project area. Further, the area of the future WWTP is characterized by shrubs swamp, which is not a natural habitat for migratory birds or any protected species. Common vegetation seen at the site includes shrubs and nipa without any mangrove species.

C. Socio Environment

21. The construction of the wastewater treatment plant will require 38.47 ha of land, of which the public land (creeks and ditches, traffic road) is 6.82 ha, accounting for 20%, and the privately owned land is 31.64 ha. This land is agricultural in nature (former paddy fields) and is held by private individuals and two companies. One fish pond area, 01 thatch

[3] Column A2 and Column B2 - please see Annex 2, which shows the referenced document (QCVN 08:2008/BTNTM). See column labels to find "A2."

restaurant and two thatch houses are currently observed in this area. These thatch houses were temporary built by two households for the purpose of attending their crops. Also, six graves have been noted in the area. A Resettlement Action Plan has been developed to address any social impacts due to the project.

22. The area where the interceptor will be laid (Thu Thiem, An Loi Dong, Binh Khanh, An Khanh and Binh Trung Tay Wards) will also be impacted by the project during construction period and in areas where land will have to be acquired for the man-holes (which will also be the area where shafts would be used to build the interceptor). However, the interceptor is expected to be constructed through a pipe jacking method that uses only partial length of the pipe under the ground reducing the impact of the project during the construction period. These concerns are addressed through the Resettlement Policy Framework and the ESMF that have been prepared for the project.

IV. PROJECT ALTERNATIVES

23. In the HCMC ESP1, waste water is collected and discharged to the East Bank Shaft of the Saigon River without treatment ("Zero" alternative). In the HCMC ESP2, waste water will be collected and treated at a WWTP before final discharge in Dong Nai River. There were three alternative locations in District 2 proposed for the construction of the NLTN WWTP, including Thu Thiem (location 1), Nha Be (location 3) and Cat Lai (location 2) (See Figure 3). After consideration and discussions with HCMC authorities, the site in Cat Lai was selected for the following reasons: The site is located closer to the existing discharge point of untreated wastewater in the Saigon river than Nha Be site; Thu Thiem site will be designated in the future as business center area and not appropriate for WWTP construction. Also, the Cat Lai site is close to the Dong Nai River which has a higher flow than the Saigon River which will allow greater dispersion of the treated wastewater after it comes out of the treatment plant. Given these considerations, HCMC PC approved the decision to build the WWTP, in Cat Lai site located in Thanh My Loi Ward. The choice of this site is also in line with earlier approval of the People's Committee of Ho Chi Minh City. .

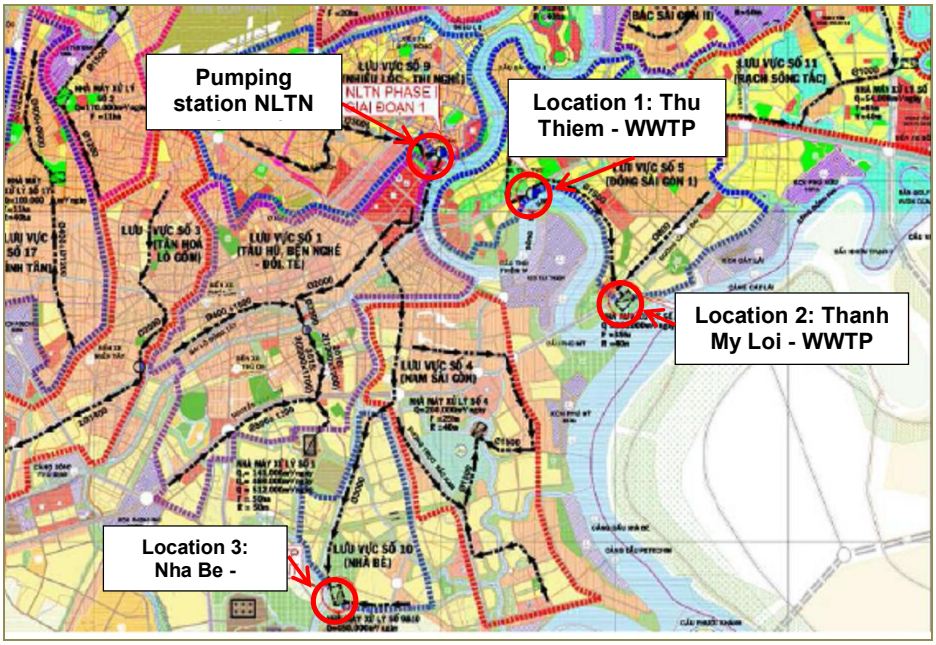

Figure 3. Locations of proposed WWTPs

24. There were three alternative routes proposed for the interceptor sewer construction (See Figure 4). The location P03 is the proposed site of the treatment plant; and the location

EBS is where the wastewater is currently being discharged in the Saigon River. The first alternative of A2 - PO1 -PO3 route was rejected as most of this route passes under a main road beneath which several public services are located (including a 2.2 meter tunnel). Furthermore, this route would cross a high density area which would make the construction more complicated. The second alternative was the A1 - PO1 route but that also was not retained as construction would have to take place through densely populated areas. The third option, which is the route EBS - A3 - A31 - A34 - PO3 has been selected because it is the shortest; there are no major issues of crossing utility lines; and part of the route is under green undeveloped areas.

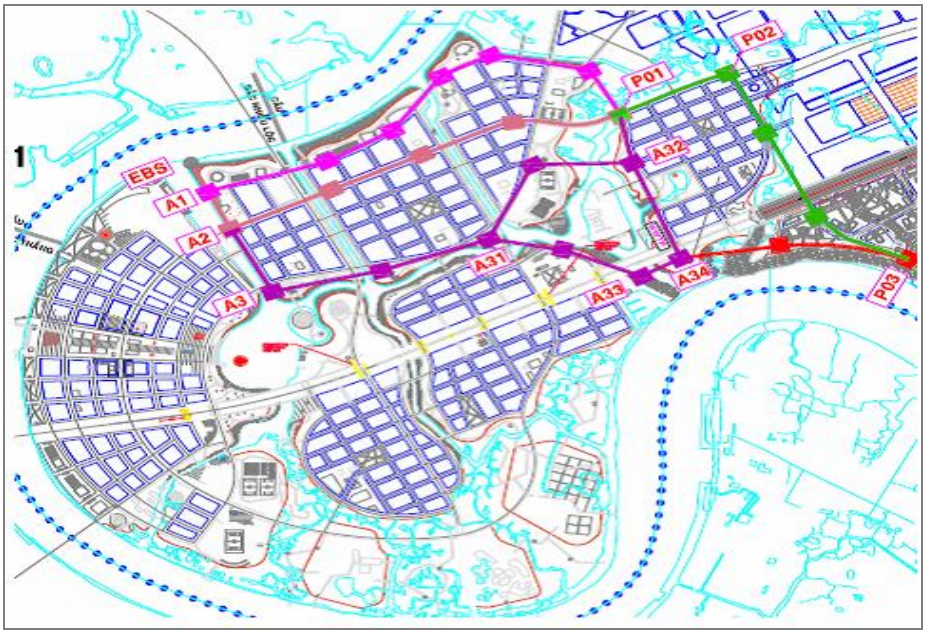

Figure 4. Location of selected interceptor route

25. Furthermore, there were three alternative locations proposed for the WWTP outlet, including Ky Ha Canal, Ngon Ngay Canal and Dong Nai River. Based on screening criteria, the position on the Dong Nai River is the most suitable option because the dilution at this position is higher compared to the other 2 locations, reducing any possible impacts of the project. In addition, according to the survey of social consultation, mainly from Nhon Trach side, on the opposite side of WWTP, there are few aquaculture households of communes Phu Huu, Phuoc Khanh, Dai Phuoc; thus the choice of the location at the lower part away from these areas will reduce any possible impacts on these areas.

26. In the framework of HCMCES 2 Feasibility Study, there are 4 WWT technologies considered for NLTN WWTP, as follows: (1) Conventional Activated Sludge (CAS), (2) Sequencing Batch Reactor (SBR) (3) Bio-filtration (BF) and (4) Trickling filter. All four processes are considered fully suitable to NLTN WWTP constraints and meet the environmental regulation QCVN 14:2008/BTNMT (Column A). Bidders will have the option to bid on one of the 4 alternatives. The technology that has the lowest life cycle cost (CAPEX plus discounted OPEX) and the least environmental and social impact will be chosen.

V. POTENTIAL NEGATIVE ENVIRONMENT AND SOCIAL IMPACTS, AND MITIGATION MEASURES

A. Physical Environment

1). During pre-construction and construction phases

27. The construction equipment and transport vehicles will emit exhausts such as nitrogen oxides, SO_2, CO, carbon dioxide, and hydrocarbons and generate noise. The activities involving heavy vehicles will be particularly intense during site preparation and construction. The level of emissions from these vehicles will be managed through an appropriate maintenance schedule for all vehicles, correct engine tuning, and a reduction in the numbers of diesel driven equipment. Dust pollution can be managed by regularly spraying the site with water (particularly during the dry season), washing down vehicles as they leave the site and sealing surface as soon as practical to minimize the dust exposure.

28. At the wastewater treatment plant area there are 3 creeks namely, (i) Phu My (4.5 m deep and 50 m wide; (ii) Ngon Ngay (1 m deep and 20 m wide), and (iii) Ky Ha (5.5 m deep and 50 m wide) as presented in Figure 5. Based on the latest Feasibility Study information, there is a proposal to divert the Phu My creek (about 150 m in the WWTP area) to the Ngon Ngay creek in order to create space for the WWTP. However, this proposal is subject to change as it would need to be considered in conjunction with the plans to construct the treatment plant and flood protection measures that are planned at the site. A preliminary survey and the basic design of the creek diversion concluded that a final design would need to take in consideration the additional flow, which would call for an increased depth and proper embankment of the Ngon Ngay creek. Potential impacts of the creek diversion include erosion and sedimentation along the Ngon Ngay creek due to higher flows from the Phu My creek; and impacts due to diversion of water away from the Phu My creek within the WWTP.

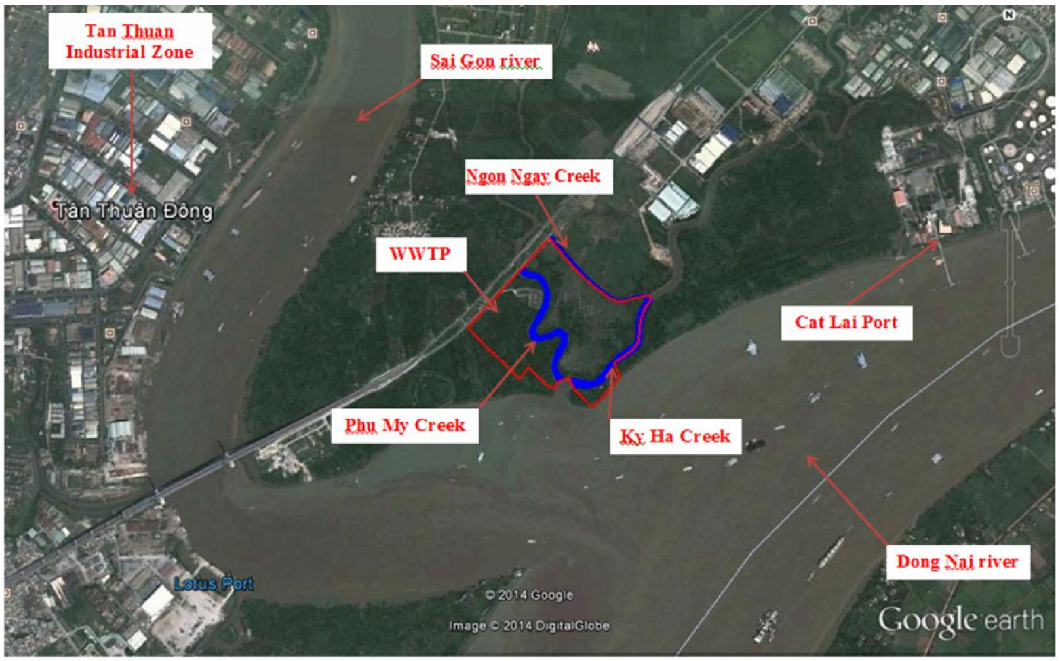

Figure 5. Creeks (including the diversion creek) located at WWTP site

29. Domestic wastewater discharged during the construction phase by workers contains suspended solid, organic matter (BOD, COD), nutrients (N, P) and *E.coli* which is higher than the permissible values set by the relevant technical regulations (QCVN 14:2008/BTNMT, column A).This can be controlled by arranging the mobile toilets to serve workers' personal hygiene needs; and signing a contract with Urban Environment Management Company of Ho Chi Minh City for periodic collection and treatment to avoid further pollution. During the construction period, the Contractor has to install the

necessary mobile toilets close to the project area.

30. Reclamation activities will generate waste such as vegetation, unused materials, sand, soil, gravel and waste oil. These materials could be washed away into the water sources without proper cover. Reducing waste during construction, planning specific items for construction, and quantifying materials are needed for construction work. Garbage and other construction waste will be collected separately in assigned temporary storage, and then transported to Go Cat landfill.

2). During operation phases

31. *Water quality*. "Without project" scenario: The entire effluent from NL-TN canal is discharged into the Sai Gon River through NL-TN pumping station at Nguyen Huu Canh Street in HCMC. Currently, the concentration of pollution parameters in Saigon river water is affected by untreated waste waters discharged directly into the river. Model results simulating current situation show main values (BOD, COD, TSS, NH_4^+) of the Sai Gon River water quality exceeding the QCVN 08:2008/BTNMT column B1 standards, especially at the discharge location. In the Dong Nai and Nha Be river segments (where the new wastewater treatment plant will be located) concentrations of pollutants are reduced because of dilution ability and high flow of the national river. The model simulated water quality parameters that showed achieving the standards of QCVN 08:2008/BTNMT, column B1 at these locations.

32. In the rainy season, the concentrations of pollutants in the river water are slightly decreased comparing to those in the dry season, except for the TSS concentration. The model simulated values that are slightly increased comparing with the current state of the water quality because of the high water flow in both rainy and dry seasons and strong dilution ability of the Sai Gon-Dong Nai Rivers. The calculated results shown that, in this scenario, wastewater from the NL-TN Basin is directly discharged into the Sai Gon River, which cause strong impact on the Sai Gon river water quality. Additionally, other loads of pollutants from urban, residential, sand exploiting, industrial sources etc. in the upstream area may generate cumulative impact on the Sai Gon River water quality as well as on the Nha Be river water quality in the downstream in the future.

33. In "with-project" scenario, the model simulated concentrations of pollutants in the Sai Gon River that notably decreased, especially at the pump station location. In this position, BOD, COD, NH_4^+, TSS concentrations decreased based on model results. The Sai Gon River water quality showed simulated levels that meet QCVN 08:2008/BTNMT, column B1, while value BOD met QCVN 08:2008/BTNMT, column A2. The Dong Nai River water quality at the discharge location of the wastewater treatment plant showed slightly increased values. In particular, concentrations of BOD, COD, NH_4^+, TSS increased by 1.8, 0.6, 0.06, 3mg/l, respectively. The concentrations of the pollutants meet QCVN 08:2008/ BTNMT, column B1. Further, the Nha Be River water quality concentration was found to slightly decrease. Concentrations of BOD, COD, NH4+, TSS are decreased by 1.0, 1.5, 0.005, 1.4 mg/l, respectively. It is believed that with the influence of the tide, the water quality along the Saigon River, Dong Nai and Nha change calculated results showed that in this scenario, the Sai Gon river water quality will be improved overall. In addition, the construction of wastewater treatment systems and wastewater collection line will bring benefits for the protection of the environment as well as reduce the pollution loads to the Sai Gon-Dong Nai Rivers.

34. Sludge quantity generated from WWTP depends on the choice of technological processes. Total amount of sludge estimated for SBR technology as reference option is about 1,100 m^3/day (from the settling tank); 100 m^3/day dewatered and thickened sludge; 37 m^3/day (from screening) in 2045; 37 m^3/day from grit removal tank (2045). The sludge is expected to be transferred by land way to Da Phuoc landfill, located about 25 km from WWTP. The potential environmental issues caused by the sludge transportation and overall management are dust, odors, noise, waste water leakage, traffic incidents etc. The quantity of hazardous wastes, including packaging and chemical containers, oil and grease generated from the maintenance and repair of operation machines in the WWTP are insignificant, which should be separately collected and stored in warehouses, then disposed in the planned area.

35. *Da Phuoc landfill* area. Once the WWTP is operational, sludge from the treatment plant is expected to be transported and disposed at the Da Phuoc landfill area (located in Da Phuoc commune, Binh Chanh District). The details of sludge disposal will be confirmed at project appraisal. This landfill is currently used by HCMC for disposal of sludge generated from other WWTPs and other wastews generated in HCMC. About 47 ha of the landfill will be used to take the sludge from the WWTP and the development of the landfill is considered an ancillary activity under the HCMC ES2 project. As confirmed by the Binh Chanh Resettlement Committee, Da Phuoc commune, and the project implementing agency, the land acquisition and compensation for the 47 ha was completed and the land is ready for HCMC ES2 use. Households consulted (in 2012) indicated their livelihoods were fully restored.

36. A number of the risks and accidents may be caused by the project interventions during the construction and operation phases including traffic incidents during transportation of construction materials by water or land ways, the flooding due to heavy rains and climate change impacts. Also, there may be a number of other incidents occurred such as equipment damage, clogged pipes, temporary improper operation of WWTP; spillage of sludge, the chemical leakage, explosion/fire incidents, working accidents etc.

B. Biological Environment

1). During pre-construction and construction phases

37. In the project area, it is necessary to reclaim and level land to prepare building construction. To build the WWTP requires an area of 38.47m^2. That land area is primarily (74%; 28.47 ha) agricultural and crop land, with 65 land owners. The needed land area is primarily privately owned (80%; 31.64ha [including 0.04 hectares of residential land, accounting for 0.10%], with public land (creeks and ditches) accounting for 20% (6.8 ha). The area includes some trees of nipa (Nypa fruticans) and swamp land, and rice paddy field. The owners of the land will sell their land to HCMC for the construction of the wastewater treatment plant and they shall be compensated as per the procedures used in Vietnam and in line with the World Bank's resettlement policies. In addition, there are six graves and one thatch restaurant and two temporary thatch houses that would be impacted, and compensation would be made. The land acquisition at the proposed site of WWTP would not result in the physical resettlement of the affected households since no households are living in the proposed site for the WWTP. Especially, in the WWTP area, some nipa, coconuts, other trees will be cut down. Since the damaged area is very small, it does not affect the aquatic species. Nevertheless, the contractor must ensure to eliminate trees when necessary, and in line with approved construction plan based on the detailed design.

38. The interceptor line will be installed below the urban space, and a pipe jacking method is being considered for the interceptor construction where the pipe would be pushed under the ground through shafts which would minimize open excavation causing less inconvenience for the citizens. The areas where the vertical shafts would be installed

would need to be acquired permanently. About 17 such locations have been identified.

39. ***Natural Habitats (OP4.04)***. This policy is being triggered as the location of the wastewater treatment plant is in a swamp area and is near a natural reserve area in Can Gio (20 to 30 km downstream). Site survey conducted during the preparation of the EIA did not indicate that there are any endangered species in the location of the treatment plant. However, this policy is being triggered in case during the design and construction period it is seen that natural habitat of a species would be affected. In such a case, appropriate mitigation measures would be considered and reflected in the site specific EMP.

2). During operation phases

40. Since the treated effluent discharged from WWTP will meet the regulation QCVN 14:2008/BTNMT, column A, therefore, the effluent will not affect the ecological environment in the surrounding area. However, some specific environmental protection measures will be monitored including satisfactory treatment of wastewater before discharging into receiving source; regular environmental monitoring and WWTP operation training will be duly implemented.

C. Social Impacts and Mitigation Measures

41. ***Social Assessment (SA)***. An SA exercise was initiated in 2010. It was updated in subsequent years – from 2011 to 2014, to reflect the development of the project activities and environmental assessment results as the project preparation evolves. The purpose of the SA is two-fold: a) examine the potential impacts of the project –positive and negative (on the basis of planned project activities), and b) inform the design of mitigation measures that address identified potential adverse impact and propose other community development activities (i.e. behavior change communication) to enhance project's development effectiveness. The SA confirms that the overall social impact of the project is positive - because the project will improve the environmental sanitation for the two target catchment areas - Nhieu Loc – Thi Nghe area (Phase 1) and District 2 area (Phase 2).

42. ***Involuntary Resettlement (OP 4.12).*** Because land acquisition is required to construct the WWTP, and some temporary land acquisition may be required for the installation of the Interceptor and the sewerage in the District 2 area, the World Bank's OP 4.12 on Involuntary Resettlement is triggered. A Resettlement Policy Framework (RPF) has been prepared in accordance with the World Bank's OP 4.12 to guide the preparation of Resettlement Action Plan (RAP) for any site-specific civil works under the project that requires land acquisition. The RPF specifies steps to be taken for preparation, review, and clearance of a RAP when required during project implementation. It also specifies how compensation would be made to local people who are affected with loss of land, structures, crops, businesses during project implementation, and how livelihood restoration of local people will be supported, and monitored. In addition to RPF, an Environmental Social Management Framework (ESMF) has been prepared in accordance with the World Bank's OP 4.01 (Environmental Assessment), and OP 4.12 (Involuntary Resettlement). The ESMF provides guidance on how environmental and social impact will be addressed in an integrated manner.

43. ***Physical Cultural Resources (OP 4.11).*** The Bank's policy on Physical Cultural Resources (OP 4.11) is triggered as the land acquisition for the construction of the WWTP (in Thanh My Loi ward) will require the relocation of six graves of local people. These graves would be removed in accordance with Bank policy and local procedures which would include consultation with the affected group and compensation for relocating the grave site. No major impacts on other physical cultural resources (PCR) are expected during Project implementation. However, the provisions of the EMP will apply to minimize

the impact of the project on other PCR that may be located near the site (monuments, religious buildings etc.). The works contracts will also have provisions to address chance finds in case such instances come up during the construction phase.

44. ***Social*** **safeguards implementation:** HCMC People's Committee (HCMC PC) is primarily responsible for the implementation of the RAP(s) to be carried out under this project. The costs for compensation payment/livelihood restoration will be financed by HCMC People's Committee. During project implementation, IMA, as assigned by HCMC PC, will do the day-to-day RAP implementation in collaboration with District 2 People's Committee, and other relevant governmental agencies. A social staff will be appointed at IMA to provide technical support to relevant government agencies to ensure the RAP is implemented in accordance with the RPF. An independent price appraisal and a monitoring agency will be engaged by IMA to assist in carrying out necessary tasks to ensure the compensation payment is made at the replacement costs and that the compensation payment and livelihood restoration are monitored appropriately in line with the objectives of the RPF.

45. **Disclosure of social safeguards documents.** Prior to appraisal, the social safeguard documents, including SA, RPF, and the RAP will be disclosed in Vietnamese at the Vietnam Development Information Center in Hanoi, and locally at the office of District 2 People's Committee, and on the website of the IMA. The English version of the above documents will also be disclosed at Bank's Info Shop.

D. Cumulative Impacts

46. Overall, the project will have a positive cumulative impact, as water quality of the Saigon River will improve based on water quality modeling, as noted earlier. Also, the wastewater collected in the D2 area, where they do not have sewers, would now be treated before release, and this would also have a positive impact. Sludge generated by the WWTP would be properly handled. The positive effects are mostly from improving water quality of Sai Gon - Dong Nai River and reducing wastewater treatment costs for companies, thereby raising awareness of environmental protection of the people.However, there would be some negative impacts on the environment mainly from the clearing and reclamation process; construction activities; sludge production from the plant operation.

VI. ECONOMIC ASSESSMENT

47. The investment cost is US$495 million. Apart from the investment cost, HCMC has budgeted US$29 million for operating costs to pay the DBO (Design Build and Operate) contractor during the first five years of the operational phase of the project. The investment cost depends on the choice of technology process. Total cost, including the operation of the wastewater treatment plant for 5 years, is thus estimated to be US$524 million (including the cost for preparation phase, cost for implementation phase, and contingencies and VAT). The project will be financed by a Bank loan of US$250 million (IBRD) and an IDA credit of US$200 million. HCMC will provide the remaining financing of US$74 million (US$45 million for investments plus US$29 million for operations).

VII. ENVIRONMENTAL MANAGEMENT PLAN

48. Environmental Management Plan (EMP) consists of the set of mitigation, monitoring, and institutional measures to be undertaken during project implementation and operation, in order to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels. EMP also includes the actions needed to implement these measures. The full EMP, which is presented in chapter 8 of the EIA report, would be attached to the contract of the DBO operator and revised if necessary before works may commence.

49. The Environmental Management Plan (EMP) consists of a set of mitigation, monitoring, and institutional measures to be taken during the project's implementation and operation to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels. The plan also includes specific actions needed to implement these measures and assigned responsibilities. In summary, the EMP address a range of issues, such as air pollution, dust generation, drainage and sedimentation control, solid waste management, etc. that could be encountered during pre-construction or construction phase; as well as impacts that could occur during the operations phase, such as effluent standards not being met, operational problems, odors, and waste from the operations. In addition, the DBO contractor would also prepare and utilize site-specific EMPs. See Annex 1 for the matrix presenting the EMP issues, actions and responsibilities. The EMP would also be attached to the contract of the DBO operator that will design build and operate the plant. The environmental management entities consist of MONRE, People Committee of HCMC, DONRE of HCMC, and the CESPIMA. The environmental audit is to be carried out by an environmental consultant employed by the CESPIMA. The environmental auditor is responsible for assessment of the environmental performance of the construction contractor, the facility operator construction monitoring consultant and the CESPIMA. The audits will be carried out at agreed period of intervals in line with the recommendation in the Project Environmental Performance Reporting System (PEPRS) Manual.

50. The structure of the environmental management of the project is shown below (Figure 7).

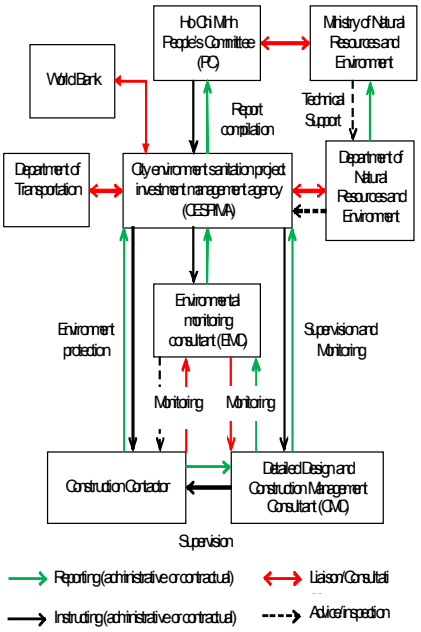

Figure 6. The structure of the project environmental management

51. A training program will be designed for the construction and operation phases since gaps in environmental protection and occupational safety management aspects have been proposed. Specifically, knowledge about labor safety, collection and treatment of waste and environmental protection is essential. The training programs for workers should be conducted by contractors according to construction contracts between the CESPIMA and contractors. Public information program and community relation will be developed during the preconstruction, construction and operation phases. Public, and especially media, reaction has been excessively and increasingly negative towards infrastructure projects meant for public services. This is because public agencies in Vietnam are generally not well acquainted with implementing large-scale urban infrastructure projects, especially on

public consultation mechanisms.

52. Site-specific Environmental Management Plan (SEMP) will be developed by construction contractor prior to the start of any pre-construction and construction activities following to the measures specified in the project EMP and with modifications in line with the detailed design. These included mitigation measures for negative impacts caused by the construction of the interceptor sewer and WWTP, including measures for health, safety, environmental pollution, and traffic management.

53. The project owner will carry out periodic visits to implement the project environmental monitoring program in line with national legislation and requirements. Environmental Audit Quarterly Reports conducted by Auditing Consultant every 3 months will be attached as an annex to the Progress Report prepared by the CESPIMA for the World Bank. Environmental Quality Monitoring Reports conducted by construction monitoring consultant during construction phase and the first year of operation (2 times/year) will be submitted to CESPIMA, then to DONRE of Ho Chi Minh City and the World Bank. A Final Report at the end of the construction phase will summarizes the environmental auditing completed and provides recommendations for continued auditing in operation phase.

VIII. PUBLIC CONSULTATION

54. The public consultation held during the preparation process of the EIA report for the HCMC ESP2 is regulated in Article 14 of the Circular and the WB's safeguard policy OP 4.01. For category A project, proposed for IBRD or IDA financing, during the EA process, the borrower consults project-affected groups and local non-governmental organizations (NGOs) about the project's environmental aspects and takes their views into account as early as possible in the EA process. For Category A projects, the borrower consults these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EA are finalized; and (b) once a draft EA report is prepared. In addition, the borrower consults with such groups throughout project implementation as necessary to address EA-related issues that affect them.

55. The EIA Consultant carried out the survey of affected area at upstream, middle stream and downstream of WWTP discharged point.

- The 1st public consultation was held during first phase of EIA preparation. The information was disseminated in two rounds in the proposed project area as follows: (i) Round 1 was run from December 24th, 2010 to December 26th, 2010. The implementation contents during this phase included project information dissemination, questionnaire-based interviews with a sample of approx. 10% households living in the proposed project area – Thanh My Loi ward. (ii) Round 2 took place from December 20th, 2011 to December 23th, 2011. Consultants organized additional meetings to seek opinions of local authorities and residents in wards/communes where are affected by WWTP discharged point. The 2nd public consultation was performed after the draft EIA report preparation.

- The 2nd public consultation was implemented from February 9th, 2012 to February 24th, 2012 with the objective to present the main findings of EIA reports and to get feedback from affected household (PAHs). In addition, to comply with Circular 26/2011/BTNMT and Decree 29/2011/ND-CP, consultation was undertaken to collect opinion from leaders (People's Committee, Fatherland Front's Committee) of Wards and Communes, of representative of affected people.

- The final public consultation was held on 24 April 2014 by CESPIMA and Meinhardt Vietnam before completion of the EIA report and ESMF for the sewer investment project in D2. The consultation results show that the participants support the Project investments. They acknowledge that their living

conditions will improve due to the project. They requested that appropriate measures should be taken by the local authorities to keep the environment clean; and they also wanted to be informed about the developments regarding the project and the area. Minutes are attached in the main report.

IX. CONCLUSION

56. The discharge of untreated waste waters to the Saigon River will be eliminated due to the project, since the interceptor will take the waste waters from the East bank shaft and sewerage lines will be laid in the D2 area, where also untreated wastewater is currently being discharged to the Saigon River. This project combined with other similar projects will improve the environment in HCMC.

57. During pre-construction, construction, and operation, the CESPIMA commits to apply the measures for mitigation of negative impacts in order to address environmental or social impacts in accordance with Vietnamese and World Bank regulations. Workers shall be trained to enhance managerial capabilities, ensure operational safety and effectively, and control environmental pollution.

58. The CESPIMA will coordinate with authorities during the pre-construction, construction and operation stages of the project to fully implement pollution control and harmful environmental impacts mitigation measures, and to prevent environmental incidents.

Annex 1: Environmental Management Plan

Issues	Mitigation measures	Vietnamese code/regulation	Execution	Supervision
Pre-construction and construction phase				
Air pollution	- Construction vehicles must undergo a regular emissions check and get certified named: "Certificate of conformity from inspection of quality, technical safety and environmental protection" following Decision No. 35/2005/QD-BGTVT; - Maintain vehicles and equipment daily and every 6 months (or 8.000 km on the road); - Do not burn waste on site; - All vehicles must comply with Vietnamese regulations controlling allowable emission limits of exhaust gases.	- TCVN 6438-2005: Road vehicles. Maximum permitted emission limits of exhaust gas; - Decision No. 35/2005/QD-BGTVT on inspection of quality, technical safety and environmental protection; - QCVN 05:2013/BTNMT: National technical regulation on ambient air quality.	Contractors	CESPIMA+ HCM DONRE
Dust generation	- Removing waste out of construction site as soon as possible; - Cover the transport means to avoid dust, soil and building materials scattering during transportation; - The Contractor shall implement dust suppression measures (e.g. use water spraying vehicles to water roads, covering of material stockpiles, etc.) as required.	QCVN 05: 2013/BTNMT: National technical regulation on ambient air quality	Contractors	CESPIMA + HCM DONRE
Disruption of vegetative cover and ecological resources	- When needed, erect temporary protective fencing to protect trees before commencement of any works within the site or planting trees in buffer zone of the construction site; - The Clearance Plan shall be approved by CESPIMA and followed strictly by contractor. Areas to be cleared should be minimized as much as possible; - The application of chemicals for vegetation clearing is not permitted; - Prohibit cutting of any tree unless explicitly authorized in the vegetation clearing plan; - No area of potential importance as an ecological resource should be disturbed unless there is prior authorization from local government. This could include areas of breeding or feeding of	Law on Environment protection No. 52/2005/QH11	Contractors	CESPIMA + HCM DONRE

Issues	Mitigation measures	Vietnamese code/regulation	Execution	Supervision
	birds or animals, fish spawning areas, or any area that is protected as a green space.			
Domestic wastewater of workers	- Build portable or use temporary toilets in construction site; - Clean toilet every day; - Construct septic tank and withdraw the wastewater and sewage when the construction finishes; - Wastewater over permissible values set by relevant Vietnamese technical standards/regulations must be collected in a conservancy tank and removed from site by licensed waste collectors. - Workers working in pumping station to be equipped with earplugs, head phone to reduce noise.	QCVN 14:2008/BTNMT: National technical regulation on domestic wastewater	Contractors	CESPIMA + HCM DONRE
Drainage and sedimentation control	- Periodic dredging of sewers; - Ensure drainage system is always maintained and cleared of mud and other obstructions; and periodically check the status of the drainage system; - Prevent discharge of garbage into drains; - Site de-watering and water diversions: In the case that construction activities require that work be carried out within the watercourse (e.g. retaining wall construction, erosion protection works), the work area must be dewatered to provide for construction in dry conditions. The sediment laden water pumped from the work area must be discharged to an appropriate sediment control measure for treatment before re-release to the stream; - Stream diversions or construction of cofferdams would require site-specific mitigation measures in the EMP; - The Investor 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.	TCVN 4447:1987: Earth works-Codes for construction; Decree No. 22/2010/TT-BXD on regulation of construction safety; QCVN 08:2008/BTNMT – National technical regulation on quality of surface water.	Contractors	CESPIMA + HCM DONRE

Issues	Mitigation measures	Vietnamese code/regulation	Execution	Supervision
Solid Waste Management	- Before construction, a solid waste control procedure must be prepared by the Contractors and it must be carefully followed during construction activities. - Use excavated materials for land leveling; - Remove waste on construction site within 24h; - Collect sand stone and materials from digging and clean construction sites every day. 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; - Before construction, all necessary waste disposal permits or licenses must be obtained; - Measures shall be taken to reduce the potential for litter and negligent behavior with regard to the disposal of all refuse. At all places of work, the Investor shall provide litter bins, containers and refuse collection facilities; - Solid waste may be temporarily stored on site in a designated area approved by the local Government to collection and disposal through a licensed waste collector. In case, if not removed off site, solid waste or construction debris shall be disposed of only at sites identified and approved by the Government 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 habitants or in watercourses; - Waste storage containers shall be securely covered at all times; - No burning, on-site burying or dumping of solid waste shall occur; - Residual sludge from WWTP : proposed contract in place with the Da Phuoc complex solid waste treatment area to send biological sludge from WWTP to this area following current	Decree No. 59/2007/ND-CP on solid waste management	Contractors	CESPIMA + HCM DONRE

Issues	Mitigation measures	Vietnamese code/regulation	Execution	Supervision
	regulations; - Residual sludge from interceptor: periodically dredged every 3 months, and dredged mud proposed to be transported to Da Phuoc solid waste treatment complex area.			
Chemical or hazardous wastes	- Chemical waste shall be disposed at an approved appropriate landfill site and in accordance with local legislative requirements; - 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; - Relevant agencies (DONRE, environmental police office) shall be promptly informed of any accidental spill or incident. Initiate a remedial action plan following any spill or incident. In such as case, the contractor shall provide a report covering the reasons for the spill remedial actions taken, consequences/damage from the spill, and proposed corrective actions; - Training programs to prepare workers to recognize and respond to workplace chemical hazards.	Circular No. 12/2011/TT-BTNMT on management of hazardous substance	Contractors	CESPIMA + HCM DONRE
Operation phase				
Outlet discharge	- Regular monitoring of the effluent and river quality at the outlet discharge; - Installing warning signs “DISCHARGE LOCATION OF WWTP” at suitable locations; - Eliminating the discharge of untreated wastewater.	QCVN 14:2008/BTNMT: National technical regulation on domestic wastewater	WWTP Operation Unit	HCM DONRE
Groundwater contamination	- Monitoring and controlling the groundwater quality in the area; - Preventing leakage at connections in the wastewater pipe.	QCVN 09:2008/BTNMT – National technical regulation on quality of ground water	WWTP Operation Unit	HCM DONRE
Operational problems	- Monitoring of water quality to evaluate the efficiency of the WWTP operation; - Installing signs to warn people about on the risks of contacting untreated wastewater; -	QCVN 08:2008/BTNMT – National technical regulation on quality of surface water.	WWTP Operation Unit	HCM DONRE

Issues	Mitigation measures	Vietnamese code/regulation	Execution	Supervision
	- Maintain and submit daily working records and effluent discharge reports to the environmental supervising agency; - Have back-up systems if possible in case of accidents or operation failure.			
Odors	- Ensuring a suitable radius of buffer zone based on local regulations; - Planting trees in the buffer zone to block the view of the treatment plant; - Regular maintenance of treatment units; - Odor control equipment installed in the plant. ;	QCVN 06:2009/BTNMT: National technical regulation on organic pollutant in the ambient air .	WWTP Operation Unit	HCM DONRE
Waste from the operation	- A good plan of collection and treatment; - WWTP to be equipped with waste storage tanks; - Regular collection of sludge; - Hazardous waste properly handled; - - Keeping a good personal hygiene.	Circular No. 12/2011/TT-BTNMT on management of hazardous substance	WWTP Operation Unit	HCM DONRE

Annex 2: National Technical Regulation on Surface Water Quality

Surface water

The national technical regulation on surface water quality **QCVN 08:2008/BTNMT** is applied for evaluation of monitored results, including:

- Column A1 – Suitable for domestic water supply purposes and for other purposes such as A2, B1 and B2;
- Column A2 - Suitable for domestic water supply purposes after applying the appropriate treatment technologies, as well as suitable for purposes of conservation of aquatic plants or other purposes such as B1 and B2;
- Column B1 – Suitable for the irrigation purpose or other purposes with requirement of the similar water quality or other purposes such as B2;
- Column B2 – Suitable for waterway transportation and other purposes with the requirement of low quality water.

Table 1. The limit value of surface water quality parameters according to QCVN 08:2008/BTNMT

No.	Parameter	Unit	Limit Value			
			A		B	
			A1	A2	B1	B2
1	pH		6-8.5	6-8.5	5.5-9	5.5-9
2	DO	mg/l	≥ 6	≥ 5	≥ 4	≥ 2
3	TSS	mg/l	20	30	50	100
4	COD	mg/l	10	15	30	50
5	BOD_5 (20^oC)	mg/l	4	6	15	25
6	Amoni (NH^+_4) (N)	mg/l	0.1	0.2	0.5	1
7	Clorua (Cl^-)	mg/l	250	400	600	-
8	Florua (F^-)	mg/l	1	1.5	1.5	2
9	Nitrite (NO^-_2) (N)	mg/l	0.01	0.02	0.04	0.05
10	Nitrate (NO^-_3) (N)	mg/l	2	5	10	15
11	Phosphate (PO_4^{3-})(P)	mg/l	0.1	0.2	0.3	0.5
12	Xianua (CN^-)	mg/l	0.005	0.01	0.02	0.02
13	Asen (As)	mg/l	0.01	0.02	0.05	0.1
14	Cadimi (Cd)	mg/l	0.005	0.005	0.01	0.01
15	Chì (Pb)	mg/l	0.02	0.02	0.05	0.05
16	Crom III (Cr^{3+})	mg/l	0.05	0.1	0.5	1
17	Crom VI (Cr^{6+})	mg/l	0.01	0.02	0.04	0.05
18	Cu	mg/l	0.1	0.2	0.5	1
19	Zn	mg/l	0.5	1.0	1.5	2
20	Niken (Ni)	mg/l	0.1	0.1	0.1	0.1
21	Fe	mg/l	0.5	1	1.5	2
22	Hg	mg/l	0.001	0.001	0.001	0.002
24	Oils & grease	mg/l	0.01	0.02	0.1	0.3
31	E. Coli	MPN/100ml	20	50	100	200
32	Coliform	MPN/100ml	2,500	5,000	7,500	10,000

VOLUME 2:

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

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CHAPTER 1.
INTRODUCTION

1.1. BACKGROUND OF PROJECT

According to the survey results implemented in 1999, the water quality in Nhieu Loc-Thi Nghe (NL-TN) canal was poor. The average concentration of BOD_5 was 121 mgO_2/l (while the allowable limit is 25 mgO_2/l) and total Coliform was 800,000 MPN/100ml (while the allowable limit is 10,000 MPN/100ml). The pollution situation is a result of direct discharge of the untreated domestic wastewater and solid waste disposal into the canals. Due to the domestic discharge the drainage capacity of the canals will be reduced, the chance of flooding will be increased in HCMC.

Based on the above, the HCMC Environmental Sanitation Project aims to improve the environmental quality of the Nhieu Loc- Thi Nghe Canal waters, which consists of two main phases:

- Phase 1 (HCMC ESP 1, during 1999 to 2012): this improves, through installation of sewerage systems and rehabilitation of the sewerage network, the pollution discharge into the Saigon River to reduce flooding and overflows in the basin;
- Phase 2 (HCMC ESP 2, under preparation): planning to construct the Nhieu Loc-Thi Nghe waste water treatment plant (WWTP) to treat domestic sewage from selected HCMC districts and to improve the overall water quality of the Sai Gon River.

The Feasibility Study for the construction of Nhieu Loc-Thi Nghe WWTP was approved by the HCMC People's Committee according to the Decision No. 1147/QĐ-UBND dated March 12th, 2010; the analysis considered that the capacity of the WWTP will be 480,000 m^3/day until 2020 and 830,000 m^3/day until 2045. Additionally, the project will include the installation of 8 km interceptor sewers from the East Bank Shaft to the planed WWTP, which will treat the sewages collected from district 1, 2, 3, 10, Phu Nhuan, Tan Binh, Binh Thanh and Go Vap. The treated sewage will be discharged into the Dong Nai River (a national waterway) with acceptable improved quality.

Furthermore, specific investments in sewerage network expansion will be carried out in the D2 area, for which locations will be known during project implementation once the technical studies area available. For these investments an Environmental Management Framework (EMF) document has been prepared separately to outline the environmental processes that will be followed to meet World Bank's safeguard policies and Vietnamese requirements.

In order to comply with Vietnamese environmental legislation, the Project owner has prepared this Environmental Impact Assessment Report (EIAR) for the Ho Chi Minh City Environmental Sanitation Project - Phase 2 in Thanh My Loi Ward, District 2, HCM City. This will be approved by the People Committee of Ho Chi Minh City.

1.2. OBJECTIVES OF THE EIA STUDY

This EIA report has the following objectives:

- Description of the proposed HCMC Environmental Sanitation Project- Phase 2 investments;
- Description of the existing environment aspects in the Nhieu Loc-Thi Nghe Canal and surrounding area, based on the investigation data carried out by FS Consultant Services in August 2012 and supplementary field surveys carried out by Meinhardt (Singapore) Ltd in May 2013;

- Assessment and prediction of the main potential impacts caused by the project's activities on the environmental, socio-economic and biological conditions in the project's area and surroundings in the project's pre-construction, construction and operation phases.
- Proposal of feasible measures to mitigate the possible negative impact in the project's pre-construction, construction and operation phases.
- Proposal of Environmental Management Plan (EMP) and Environmental Monitoring Plan during the project's pre-construction, construction and operation phases.
- Implementation of public consultation for the project affected people.

1.3. ENVIRONMENTAL LEGISLATION AND GUIDELINES

1.3.1. World Bank Policy on Environmental Assessment

The environmental impact assessment study for the sanitation project is designed to evaluate its status with respect to all applicable World Bank Safeguard Policies as well as national legislation. According to Operational Policy (OP)/Bank Procedure (BP) 4.01: Environmental Assessment (http://go.worldbank.org/OSARUT0MP0), the overall project is classified as Category A project and therefore requires the completion of full-scale EIA.

Environmental Assessment (OP4.01). The project triggers the Bank safeguard policy on Environmental Assessment (OP 4.01). The project will improve the environment of HCMC by collection and treatment of wastewater from the Nhieu Loc-Thi Nghe basin and parts of District 2 and water quality modeling carried out for the project illustrates that the quality of the Saigon River will improve due to project interventions (as the current practice of discharging untreated wastewater to the Saigon river would cease, reducing the pollution discharged to the river). However, there will be minor and temporary site-specific environmental impacts primarily during the construction period (due to dust pollution, noise and vibration due to the operation of heavy equipment, waste generation at the construction site, and traffic interferences). Also, due to the construction activities, local vegetation and landscape will be affected (e.g., vegetation at the site of the WWTP will be removed and also a creek that is located at the site will be diverted to another location within the site). The main impacts would be: permanent loss of agricultural land (about 74% of the land is agricultural), movement of six graves, and removal of one thatch restaurant and two temporary shelters.The relocation of the creek (about 150 m within the site) will be done in line with the overall flood control measures that are being considered for the site. The negative impacts will be mitigated through the application of mitigation measures outlined in the Environmental Management Plan (EMP) which will include a monitoring plan and through the application of health and safety requirements of workers that would be involved in the construction. Implementation of the EMP will be a requirement for contractors under the project.

In line with the World Bank Group operational policies, the HCMC ESP2 investments trigger the following five safeguard policies: (a) OP4.01: Environmental Assessment; (b) OP4.04: Natural Habitats; (c) 4.11: Physical Cultural Resources; (d) OP4.12: Involuntary Resettlement; and (e) OP7.50: International Waterways.

Detailed requirements on assessment methodologies and common impact associated with urban drainage and water development work were provided by World Bank's Environment assessment Sourcebook (WB Paper Number 140, Volume II- Sectorial Guidelines, Washington D.C, 1991). Additionally, the EIA study follows the applicable International Conventions for which Vietnam is a member (e.g. International Waters, Climate Change, etc.).

Furthermore, the World Bank Group's General Environmental, Health and Safety (EHS) Guidelines contain information on cross-cutting environmental, health, and safety issues

relevant to investments. The environmental guidelines, which are relevant to EIA report are including Air Emissions and Ambient Air Quality; Sewage and ambient water quality; Hazardous Material Management, Waste Management, and Noise management.

1.3.2. Vietnamese Policy and Administrative Framework on Environmental Assessment

(1). Administrative framework on Environmental Assessment

In Vietnam, the Ministry of Science, Technology and Environment (MOSTE), formed in October 1992, was the top decision-making body with overall responsibility for the environmental sector until 2002 when the Ministry of Natural Resources and Environment (MONRE) was established. Government Decree No 91/2002/ND.CP on the functions, tasks, powers and organizational structure of the MONRE was promulgated on November 11, 2002, and amended in Government Decree No 21/2013/ND-CP on March 4, 2013.

At the national level, the Vietnam Environmental Administration (VEA) within MONRE has its function and targets to advise MONRE to develop the environmental legislation and regulations, to issue the environmental protection programs, to carry out environmental monitoring program in Vietnam. In the provincial level, the Environmental Protection Administration (EPA) within Department of National Resources and Environment (DONRE) has its responsibilities to advise the Provincial People's Committee in management and enforcement of the environmental legislation and regulations in provinces. For the Project, the framework's relevant institutes are as follows:

- Ministry of Natural Resources and Environment (MONRE). This ministry will include vice-ministers, 21 departments, one newspaper, and one magazine. The MONRE will merge with numerous departments from several national agencies. These are outlined in Decree 91/2002/ND-CP and Decree No 21/2013/ND-CP: Providing for the functions, duties, powers and organizational structure of the Ministry of Natural Resources and Environment;
- Environmental Impact Assessment and appraisal Department. This Department is under the Vietnam Environmental Administration (VEA) within MONRE. According to Decree 91/2002/ND.CP, Decree No 21/2013/ND-CP the Department's function includes: To advise VEA to review environmental impact assessment reports of proposed projects then submit to MONRE for approval. The Environmental Impact Assessment and Appraisal Department is guided by Vietnam's regulatory framework: i.e. Law on Environmental Protection (LEP) 2005, Decree 29/2011/ND-CP, Circular 26/2011/TT-BTNMT;
- The city's Department of Environment and Natural Resources (DONRE) was formed in late 2003. DONRE houses an Environmental Protection Agency (EPA). The EPA is responsible for ensuring environmental protection and management of provincial matter's in accordance with LEP, Decree 29/2011/ND-CP, Circular 26/2011/TT-BTNMT. Hence, it is DONRE - and in particular, the EPA - that plays the key regulatory role during project preparation, construction and operation.

According to the Law on Environment Protection dated November 29, 2005 of the National Assembly and came into effect from July 1, 2006 and the Decree No. 29/2011/ND-CP dated April 18, 2011 issued by the Government on strategic environment assessment, environmental impact assessment and environment protection commitment the City environment sanitation project investment management agency (CESPIMA) has to prepare and submit an EIA report of the HCM ESP 2 to the Department of Natural Resources and Environment of Ho Chi Minh City for review and appraisal.

The national environmental requirements and procedures for the HCM ESP 2 are guided in the Circular No. 26/2011/TT-BTNMT issued by MONRE on detailing some articles of Decree

No. 29/2011/ND-CP dated April 18, 2011 of the Government on strategic environmental assessment, environmental impact assessment and environment protection commitment.

The public consultation during the process of formulating EIA report for the HCM ESP 2 is regulated in Article 14 of the Circular and the WB's safeguard policy OP 4.01 for category A project, proposed for IBRD or IDA financing, during the EA process, the borrower consults project-affected groups and local non-governmental organizations (NGOs) about the project's environmental aspects and takes their views into account. The borrower initiates such consultations as early as possible.

For Category A projects, the borrower consults these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EA are finalized; and (b) once a draft EA report is prepared. In addition, the borrower consults with such groups throughout project implementation as necessary to address EA-related issues that affect them.

The document with the summary of main investment items, key environmental issues, and environmental protection solutions associated with the project should be sent to organizations and individuals participating in the public consultation in a timely manner, in an understandable language and at an accessible place prior to the public consultation. Organizations and agencies contacted as part of the consultation process shall have 15 working days from the receipt of the documents to submit their comments.

According to Article No 13 of the Circular 26/2011/TT-BTNMT, the dossiers should be submitted for EIA review and appraisal include one official letter from the project owner, seven copies (or more if necessary) of the EIA report, one investment report (or Feasibility Study report). The time limit for appraisal shall not exceed 30 working days from the date of receipt of sufficient application. In cases where the project has complicated impacts to the environment, the time limit for appraisal will be extended, not to exceed 45 working days from the date of receipt of a sufficient application (Article 20, Decree 29/2011/ND-CP).

Before the project is put into official operation, CESPIMA is responsible for construction and application of environmental protection measures and works; including; undertaking the trial operation of waste treatment facilities and compiling dossiers to request examination and certification of the implementation of environmental protection measures and works for the operation phases of projects which has to be submitted to DONRE Ho Chi Minh City for getting the necessary certificates (Article 35, Circular 26/2011/TT-BTNMT).

During pre-construction, construction of the project, CESPIMA is responsible for implementing environmental monitoring program with frequency of 4 times/year for the waste sources and 2 times/year for the surrounding environment. In addition, this responsibility will be handed over to CESPIMA in the first year of operation (See Appendix 2.5, Circular 26/2011/TT-BTNMT). The annual monitoring reports should be submitted to DONRE of Ho Chi Minh City.

(2). Legal background

- Law on Cultural Heritage No. 28/2001/QH10 which was ratified by Vietnam National Assembly in June 29, 2001 and came into effect from January 1, 2002;
- Construction Law 16/2003 QH11 dated November 26, 2003 of Vietnam National Assembly;
- Law on Land No. 13/2003 QH11 dated November 26, 2003 of Vietnam National Assembly;
- Law No.29/2004/QH11 of December 3rd, 2004 on Forest Protection and Development;

- Law on Environment Protection dated November 29, 2005 of the National Assembly and came into effect from July 1, 2006;
- Law No.20/2008/QH12 of November 13th, 2008: stipulates biodiversity conservation and sustainable development;
- Law No. 32/2009/QH12 dated June 18, 2009 on amending and supplementing some articles of Law on Cultural Heritage No. 28/2001/QH10;
- Law No. 38/2009/QH12 dated June 19, 2009 on amending and supplementing some articles of regulations related to infrastructure construction investment.
- Law No. 34/2009/QH12 dated June 18, 2009 on amending and supplementing Article 126 of Law on Housing and Article 121 of Law on Land;
- Law on water resources was issued by the National Assembly of Socialist Republic of Vietnam dated June 21, 2012 and period of validity from January 1, 2013.
- Decree No.149/2004/NĐ-CP dated July 27, 2004 on the issuance of permits for exploration, exploitation and using on water resources, discharge of sewage into water sources;
- Decree No. 197/2004/ND-CP dated December 3, 2004 of the Government on compensation, support and resettlement when the state recovers land; Decree No. 69/2009/ND-CP dated August 13, 2009 on supplementing land-use plan, land price, compensation, support and resettlement;
- Decree No. 131/2006/ND-CP dated November 9, 2006 of the Government on regulations on ODA management and use;
- Decree No.88/2007/NĐ-CP dated May 28, 2007 on water drainage in urban and industrial park;
- Decree No. 12/2009/ND-CP dated February 12, 2009 of the Government on management of construction investment project and Circular No. 03/2009/TT-BXD dated March 26, 2009 of MOC on guiding Decree No. 12/2009/ND-CP implementation;
- Decree No. 59/2007/ND-CP dated April 9, 2009 of the Government on solid waste management;
- Decree No. 83/2009/ND-CP dated October 15, 2009 on amending and supplementing some articles of Decree No. 12/2009/ND-CP dated February 12, 2009 of the Government on construction work investment management;
- Decree No.117/2009/NĐ-CP dated December 31, 2009 relating violation of the law in the field of environmental protection;
- Decree No 26/2010/NĐ-CP dated March 22, 2010, amending and supplementing clause 2 article 8 of Decree No. 67/2003/NĐ-CP on environmental protection charges for sewage;
- Decree No. 29/2011/ND-CP dated April 18, 2011 on strategy environment assessment, environmental impact assessment and environment protection commitment;
- Decision No. 35/1999/QĐ-TTg dated March 05, 1999, on National orientation on drainage development in urban areas by 2020;
- Decision No.752/QĐ-TTg dated June 19, 2000 of Prime Minister on approving master plan drainage systems in Ho Chi Minh city up to the year 2020;
- Decision No 2377/QD-TTg dated December 6, 2013 of Prime Minister on approving the list of project's "Ho Chi Minh City's Environmental Sanitation-Phase 2", World Bank (WB) Loan

- Decision No. 3733/2002/QD-BYT dated October 10, 2002 of Ministry of Health on promulgating 21 standards of working sanitation, 5 principles and 7 parameters of working sanitation;
- Decision 48/2008/QĐ-TTg dated April 3, 2008 regulating the Common General Guidelines on Feasibility Study Preparation for ODA Projects funded by the Five Banks (Asian Development Bank, French Development Agency, Japan Bank for International Cooperation, German Reconstruction Bank, World Bank);
- Decision No. 04/2008/QD-BXD dated April 3, 2008 on promulgating national technical regulation on construction planning;
- Decision No. 04/2008/QD-BTNMT dated July 18, 2008 of MONRE on promulgating National Technical Regulation on Environment;
- Decision No.16/2008/QĐ-BTNMT dated December 31, 2008 of Ministry of Natural Resources and Environment issued national technical regulations on surface water quality, underground water quality, coastal water, sewage and pesticide residues in soil;
- Decision No. 1849/QD-TTg dated October 8, 2009 of the Prime Minister on approving list of projects calling ODA fund in 6 urban areas in Mekong River Delta;
- Decision No. 2149/QD-TTg dated December 17, 2009 of the Prime Minister on approving national strategy on integrated management of solid waste to 2025 with vision to 2050;
- Decision 1930/QĐ-TTg dated November 20, 2009 of Prime Minister approving orientations for development of water drainage in Vietnamese urban center and industrial parks up to 2025 and a vision towards 2050;
- Circular No. 13/2007/TT-BXD dated December 31, 2007 of MOC on guiding implementation of some articles of Decree No. 59/2007/ND-CP dated April 9, 2007 on solid waste management;
- Circular No. 02/2009/TT-BTNMT dated March 19, 2009 of MONRE on assessment of sewage receiving capacity of the water source;
- Circular No.09/2009/TT-BXD in May 21, 2009 detailing some provisions of the Government's Decree No. 88/2007/NĐ-CP dated May 28, 2007 on Urban drainage and Industrial area;
- Circular No. 14/2009/TT-BTNMT dated October 1, 2009 detailing compensation, support and resettlement, and procedure for land recovery, allocation and lease;
- Circular No. 16/2009/TT-BTNMT dated October 7, 2009 of the Ministry of Natural Resources and Environment issued 02 national technical regulations on the environment: ambient air quality, toxic substances in some surrounding air;
- Circular No. 25/2009/TT-BTNMT dated November 16, 2009 of the Minister of Natural Resources and Environment issued 09 national technical standards on the environment;
- Circular No. 41/2010/TT-BTNMT dated December 28, 2010 of MONRE's Minister on National Technical Regulation on environment;
- Circular 02/2010/TT-BXD dated February 5, 2010 issued QCVN 07:2010/BXD - Vietnam Building Code Urban Engineering Infrastructures;
- Circular 39/2010/TT-BTNMT dated December 16, 2010 of Minister of Natural Resources and Environment issued provisions of national technical regulations on the environment;
- Circular No. 26/2011/TT-BTNMT on detailing some articles of Decree No. 29/2011/ND-CP dated April 18, 2011 of the Government on strategic environmental

assessment, environmental impact assessment and environment protection commitment;

- Circular No. 12/2011/TT-BTNMT dated April 18, 2011 of MONRE's Minister on hazardous solid waste management.

(3). Applicable Environmental Standards and regulations

1). Water Quality

- QCVN 08:2008/BTNMT - National Technical Regulations on surface water quality;
- QCVN 09:2008/BTNMT- National Technical Regulations on ground water quality;
- QCVN 14:2008/BTNMT- National Technical Regulations on domestic sewage quality;
- QCVN40:2011/BTNMT- National Technical Regulations on industrial sewage.

2). Air Quality

- QCVN 05:2013/BTNMT-Air Quality-National Technical Regulation on ambient air quality;
- QCVN 06:2009/BTNMT-Air Quality-Maximum allowable limit of hazardous substances in ambient air.
- QCVN 19:2009/BTNMT-National Technical Regulation on Industrial Emission of Inorganic Substances.
- QCVN 20:2009/BTNMT-National Technical Regulation on industrial emission of organic Substances

3). Soil Quality

- QCVN 03:2008/BTNMT – National technical regulation on allowable limit of heavy metals in soil.

4). Solid Waste Management

- Decision No. 27/2004/QD - BXD dated November 9, 2004 of MOC on promulgating TCXDVN 320: 2004 "Hazardous waste disposal site – Design standard";
- TCVN 6696:2009- Solid waste – Sanitary landfill. General requirement on environment protection;
- QCVN07:2009/BTNMT- National Technical Regulation on hazardous waste threshold.
- QCVN 25:2009/BTNMT-National Technical Regulations on wastewater from solid waste landfill;

5). Noise and Vibration

- QCVN 26:2010/BTNMT – National Technical Regulation on noise.
- QCVN 27:2010/BTNMT – National Technical Regulation on vibration.

6).Working Safety and Health

- Decision No. 3733/2002/QD-BYT dated October 10, 2002 on application of 21 standards on safety and health.

1.3.3. Legal base of the Ho Chi Minh City Environmental Sanitation Project (Phase 2)

- Master Plan on drainage sewage and runoff in Ho Chi Minh City approved by the Government in 2001;

- Decision 185/2006/QD-UBND dated December 29, 2006 on promulgating regulations on the management and protection of the public drainage systems in HCM City;
- Notice No. 885/TB-VP dated November 15th 2008 of HCM City People's Committee, the conclusion of the Chairman of HCM City People's Committee Le Hoang Quan on resolving some issues related to Feasibility Study report on Nhieu Loc - Thi Nghe basin wastewater treatment plant, Wijaya Global Berhad Group (Malaysia);
- Notice No. 874/TB-VP dated November 28, 2009 of HCM City People's Committee, the conclusion of the City People's Committee Chairman - Le Hoang Quan, The Vice Chairman of City People's Committee - Nguyen Trung Tin on the progress of pollution treatment Ba Bo Canal and the solutions to prevent flooding in Ho Chi Minh City following the request of the Steering Center For Urban Flood Control;
- Notice No. 179/TB-VP dated March 30, 2010 of HCM City People's Committee, the conclusion of the Chairman of HCM City People's Committee Le Hoang Quan on inspection of implementation progress of ODA project in Ho Chi Minh City;
- Document No. 3719/UBND-DTMT dated August 2, 2010 by Ho Chi Minh City People's Committee to approving construction site of Nhieu Loc -Thi Nghe Canal waste water treatment plant in Thanh My Loi Ward, District 2;
- Minutes of the agreement the boundary of adjacent projects No.1297/BB-TTCN dated September 23, 2010 between the Nhieu Loc-Thi Nghe Basin and District 2 Wastewater Treatment Plant, the construction project of Fire Police Headquarters and the Thanh My Loi B residential project, in Thanh My Loi Ward, District 2;
- Decision No.141/QD-UBND dated January 13rd 2010 of the HCM City People's Committee on the delivery of construction plans for 2010 (phase 1) from the lottery capital, the focus budget capital and Official development assistance capital (ODA);
- Decision No.1147/QD-UBND dated March 12nd 2010 of the HCM City People's Committee on approving the Sanitation Technical Support project of HCM City - Phase 2.
- Decision 421/QD-TNMT-KH dated July 02nd 2010 of the Department of Natural Resources and Environment on approving the cost estimate for environmental impact assessment reports of the Sanitation Technical Support project of HCM City- Phase 2.
- Decision 1258/QD-SGTVT dated May 16 2011 of Department of Transportation on regulations promulgated organization and operation of the Project Management Unit of Ho Chi Minh City Environmental Sanitation.

1.4. APPLIED EIA METHODOLOGY

During the preparation of this EIA Report, different assessment methods were used to assess the project's potential impacts, including:

- Statistics: to collect and analyze the existing available data, including physical, socio-economic, and biological conditions in the project area and surroundings.
- Sampling in the field and analyses in the laboratory: To determine the parameters of current environmental quality of air, water, soil, noise in the project area.
- Checklist: to identify the potential impacts caused by the project's activities in the pre-construction, construction and operation phases of the project.
- Matrix assessment: to assess the different impacts caused by project's activities on the physical, socio-economic, and biological conditions based on the expert's opinion.
- Environmental rapid assessment: to estimate the pollution loads generated from project's activities based on the pollution factors, those established by the World Health Organization.

- Environmental Modeling: to predict the environmental impacts caused by the project's activities in different scenarios.
- Public consultation: to assess the socio-economic impacts caused by the project's activities by consulting with different impacted stakeholders, including the opinions of the representative of the Ward's People's Committee, the Vietnamese Fatherland Front Union of Thanh My Loi Ward and the impacted households in the project's area and surrounding.

1.5. EIA IMPLEMENTATION ORGANIZATION

The EIA Report of the project "Ho Chi Minh City Environmental Sanitation - phase 2: Nhieu Loc - Thi Nghe Wastewater Treatment Plant" was carried out by the Steering Center for Urban Flood Control in Ho Chi Minh City, with the consultation of the Center for Environmental Technology CEFINEA within Institute for Environment and Resources, National University of Ho Chi Minh City.

This EIA Report was revised and completed by Meinhardt (Singapore) Ltd. in cooperation with experts from PPTAF Subproject CESPIMA.

CHAPTER 2.
PROJECT DESCRIPTION

2.1. INTRODUCTION

2.1.1. Project Owner

- Line agency/Governing Body: The People's Committee of Ho Chi Minh City.
- Project owner: City Environment Sanitation Project Investment Management Agency (CESPIMA) for Ho Chi Minh City's Environmental Sanitation Project - Phase 2 (Government Decision No 2377/QD-TTg dated 6 December 2013 on approving the list of project's "Ho Chi Minh City's Environmental Sanitation-Phase 2", World Bank (WB) Loan), .
- HCMC People's Committee has decided to establish the Investment Management Sanitation Project under the City Transportation Department.
- Address: 12 Vo Van Kiet Street, Nguyen Thai Binh Ward, District 1, Ho Chi Minh City.
- Tel: (08) 39142903 Fax: (08) 39142983
- E-mail: hcmes@gmail.com

2.1.2. Project area and maps

Ho Chi Minh City Environmental Sanitation Project includes 2 phases:

2.1.2.1. Ho Chi Minh City Environmental Sanitation Project -Phase 1 (1999-2012)

HCMC ESP 1 was developed since 1999. The purpose was to sustainably collect the drainage and sewerage in the NTLT basin and to construct main interceptor to collect and transfer sewage and discharge to the East Bank Shaft of the Saigon River. This project was implemented until June 2012 and about 250,000 m^3 of waste water per day is collected, screened and discharged to the Saigon River without treatment, but no significant improvement is made to the overall quality of the Saigon River.

NLTN basin includes parts or all of districts 1, 3, 10, Binh Thanh, Phu Nhuan, Go Vap, and Tan Binh with total area of 3,320 ha (Figure 2.1).

2.1.2.2. Ho Chi Minh City Environmental Sanitation Project -Phase 2

HCMC ESP 2 will construct a WWTP to treat the sewage from NLTN basin, including the sewage from 7 districts (partly or wholly from 1, 3, 10, Binh Thanh, Phu Nhuan, Tan Binh and Go Vap Districts) with total area of 3,320 ha (Figure 2.2) and District 2 (the sewage in the Northeast of Ho Chi Minh City with total area of 4,974 ha) (Figure 2.2). Initially, several decentralized WWTPs were planned for District 2[18]. However, lately the underlying project also considered to integrate domestic sewage from District 2 into the NLTN WWTP to reduce the overall cost of investment and operation.

The sewage from NLTN basin will be collected in point A which is the pump station with a construction area of 8.110 m², located at No 10 Nguyen Huu Canh Street, Binh Thanh District, and operated by Nhieu Loc Thi Nghe Enterprise under the Urban Drainage Company Limited. Point B (East Bank Shaft), located in An Khanh ward, District 2, is the starting point of the interceptor and connected to the pumping station.

The project site for HCMC ESP 2 is presented in Figure 2.2.

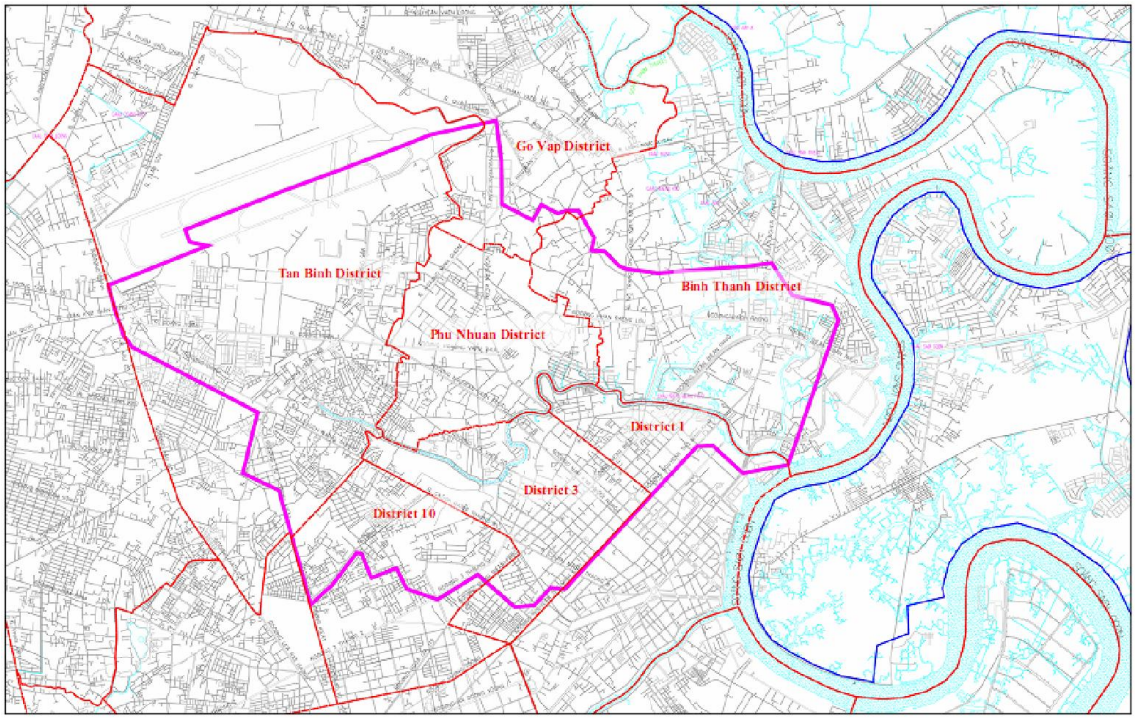

Figure 2.1. NLTN catchment area (HCMC ESP1, Phase 1)

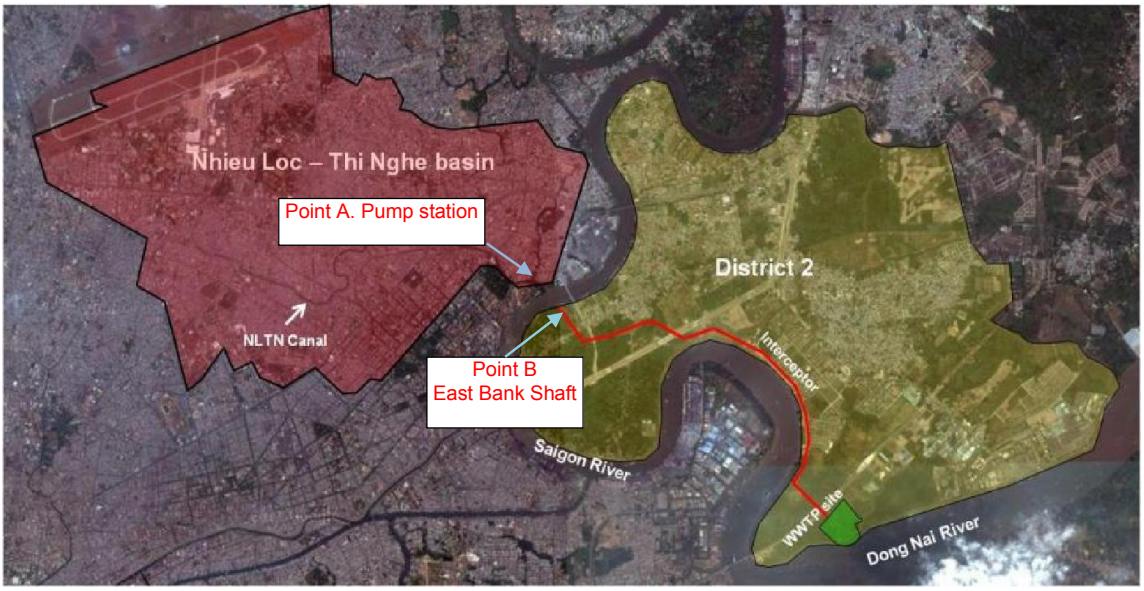

Figure 2.2. Project site (HCMC ESP2, Phase 2)

2.1.3. General description of the project components

HCMC ESP1 included the following components:

- Rehabilitation of the sewerage network in the NLTN catchment area;
- Construction of an interceptor beneath the NLTN canal to convey sewage from NLTN basin to a pumping station Construction of a pumping station and Saigon River crossing to discharge untreated sewage on the East Bank of the Saigon River;
- Rehabilitation of the NLTN canal and embankments.

HCMC ESP2 includes the following main activities:

- Building an interceptor to convey sewage from the NLTN catchment area (end point of Phase 1, Point A, Figure 2.2) to the new Wastewater Treatment Plant and to collect sewage from District 2 (Point B, Figure 2.2),
- Building a WWTP in Thanh My Loi Ward to treat sewage from NLTN and D.2. This WWTP will also incorporate odor and sludge lines in order to reduce odor pollution and the volume of sludge produced,
- Improving the technical, operational, and managerial skills of the CESPIMA.

2.2. DETAIL DESCRIPTION OF THE HCMC ESP2 PROJECT COMPONENTS

HCMC ESP2 has five specific components which are summarized below (costs shown exclude VAT):

- *Component 1: Construction of Interceptor (Cost: US$65 million):* The sewage interceptor total length of 8 km and diameter of 3.2m will be constructed to connect sewage from East Bank Shaft to the wastewater treatment plant at Thanh My Loi ward, District 2. It will convey sewage from NLTN to the Pumping Station at the entrance of the WWTP. The construction of the interceptor will prevent the discharge of untreated wastewater to the Saigon River.
- *Component 2: Construction of Wastewater Treatment Plant (Cost: US$261 million):*The WWTP will treatthe wastewater collected in the NLTN basin and in the D2 area. The WWTP is being designed for a capacity of 480,000 m^3/day and will be constructed through a Design Build and Operate contract where the same private company will carry out these three stages. The WWTP will be located near the confluence of the Saigon and Dong Nai rivers, and the treated wastewater will be discharged to the Dong Nai River. The site is prone to flooding and, as a result, flood protection measures are included in the project design.
- Component 3: Construction of Sewerage Network in the District 2 area (Cost: US$52 million): The project will invest in drainage level 2 and level 3 in District 2. Investment objective of the drainage in District 2 is to maximize the wastewater collection to improve the environmental conditions in the project areas where untreated wastewater is discharged to water bodies. In addition, households in the project area will be connected, if they are not currently connected to the combined or separated system. The wastewater collected from the District 2 area will be transferred to the interceptor that also will convey wastewater to the wastewater treatment plant (being constructed under this project) from the Nhieu Loc-Thi Nghe (NLTN) area.
- Component 4: Project Implementation (Cost: US$32 million): This component has two parts: (a) Component 4a: Construction Supervision will support hiring of consultants to supervise construction during project implementation; and (b) Component 4b: Improving Sanitation Management and Project Implementation will provide technical assistance including implementation support and capacity building for key project entities (e.g. CESPIMA). In addition, support will be provided to the CESPIMA to enhance sanitation management in HCMC.
- Component 5: Land Acquisition and Operating Cost of Implementation Management Agency (Cost US$40 million): CESPIMA coordinates with the People's Committee of District 2 to setup the general plan for the compensation assistance and resettlement. District 2 People's Committee is responsible for the establishment of a committee for the compensation assistance and resettlement as prescribed. The committee for the compensation assistance and resettlement will setup the land acquisition plan, documents and decisions for households, individuals, and organizations (if any) under the provisions and give land hand-over decision for CESPIMA. Component 5a: Resettlement and Land Acquisition will include costs (borne solely by HCMC) to

compensate people that currently own the land where the WWTP would be constructed. Component 5b: Operating Cost of the Implementation Management Agency includes salaries, fees and other costs (all borne by HCMC) for the eight years of the project implementation period.

2.2.1. Sewage Interceptor

Under HCMC ESP2 the wastewater will be conveyed from the East Bank shaft and District 2 to a proposed new wastewater treatment plant via a 3.2m diameter and 8 km long interceptor (Figure 2.3). It will convey sewage from NLTN to the Pumping Station at the entrance of the WWTP.

The proposed routing of the interceptor will also take into account the plans for sewerage and drainage investments necessary for the development of District 2 and the capacity of the interceptor would be sufficient to also eventually transfer the wastewater from District 2 once the area will be developed in the future. The sewerage and drainage investments' locations in District 2 are being identified now and relevant detailed designs would be completed after the proposed approval of the project by the Bank.

As most of the sewer and drainage infrastructure in the District 2 area are expected to be installed under existing roads, the environmental and social impacts are not expected to be substantial. A separate Environmental and Social Management Framework (ESMF) has been prepared for these investments. The ESMF outlines the process that will be carried out to address environmental and social considerations that may come up during the construction phase once the location of the investments is known.

After discussions with the consulting agencies and project owners, the following interceptor route was established to prevent conflicts with other existing or planned infrastructure projects (see Figure 2.3):

- Urban Railway Network: the interceptor route will be located above the metro line No 2, which is between SS3 and RS3 pits. The average depth of the metro tunnel is 16m below the ground. The sewer interceptor route locates above the metro line at 12.9 meter height below the ground (that is 3.1 meter higher than metro line). This depth is considered being safe distance in line with vibration and seismic impact assessment for construction and operation of the metro line.
- Existing canals: The interceptor will pass under existing canals in HCMC. The crossing point is located between SS5 and RS5 pits ata depth of about 6.5m below ground (comparison with the future situation). At this location, the top of the interceptor will have the depth of 12 m under the ground that is 5.5 m below the bottom of the channel. Therefore, the channel should be filled in the construction process to ensure the safety of the pipe size.
- Piles: piles were built around Diamond Island (See point SS5, Figure 2.3) to reinforce the banks of the river. These piles have a depth of 25m. On the west, drainage lines will cross these piles. It is necessary to build new replacement poles to adjust the status. Some piles were built along the interceptor in Diamond Island with a depth of up to 12 m under the ground. Depth of interceptor sewer was adjusted to be lower than the depth of piles.
- Bridge: interceptor sewer will pass near a bridge between SS5 and RS5 pits (See Figure 2.3). At Ca Tree and Ca Tree 1 bridges, the interceptor can hit the piles in the river near the bridge. In this case, there may be need to remove the piles in the construction phase. There was not any alternative studied for construction of the interceptor between the pits.
- Main street/highway: the interceptor will cross the East-West Highway;this location is near the Large Ca Tree Bridge, in Thu Them area. In this regard, the drainage lines

direction must be adjusted to ensure no collisions with the bridge piles.

- Thu Thiem new urban area, Thanh My Loi A and B residential areas are locations where the longest drainage line will be crossing. The drainage lines will be constructed near the bank of the Saigon River, therefore the residential areas will not be impacted by the project. Besides, Thanh My Loi B residential area has a part of the drainage lines crossing the main road in residential area located on opposite of the plant. Therefore, this residential area will be affected directly by dust and noise from the construction activities and possible odor from the plant operation. The mitigation measures for the negative impact are detailed in Chapter 6.
- The remaining locations are favorable for the construction activities because those mainly are roads and parks. Drainage lines are deeply located under the ground and above the groundwater level (about 40 m) and will not impact on the residential areas in during operation phase.
- Pipe installation technology: The pipe jacking technology is suitable for this project because it minimizes the negative impacts on the environment. This technology was also used successfully in the case of HCMC ESP 1 project.

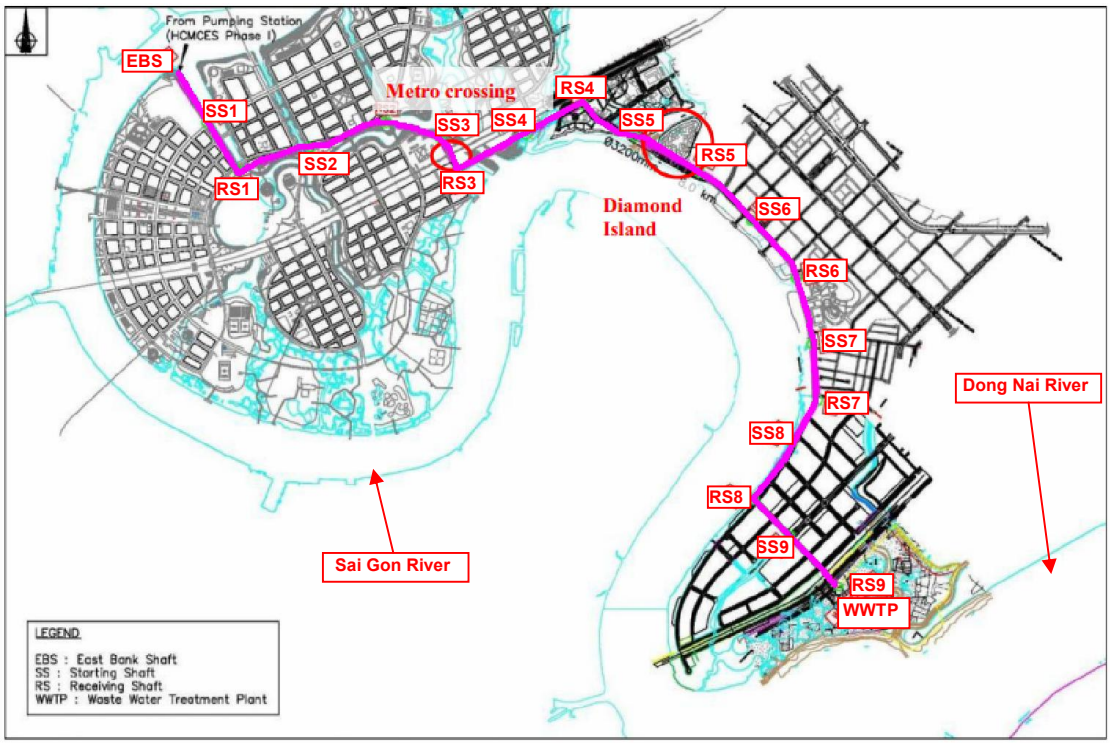

Figure 2.3.Selected Interceptor route

Three different pipe materials, including Reinforced concrete (RC), Glass Reinforced Plastic (GRP), Polymer Concrete (PC) could be considered for the interceptor's construction. In the cost estimate, reinforced concrete pipes have been proposed as they represent the cheapest option. However, this aspect may be left up to bidding to allow contractors to propose what they consider to be the most suitable material. GRP may be especially advantageous as it would facilitate pipe transportation to the construction site, reduce pipe roughness (and eventually inner pipe diameter), and limit corrosion and possibly infiltration. PC presents good physical and chemical characteristics but would be expensive (estimated as twice the material price of reinforced concrete pipes) and hence does not seem feasible as a material choice for the interceptor.

The maximum sewage flow for NL-TN catchment and District 2 will be 210,000m^3/day (or

8,750 m^3/h) in 2020 and 445,000 m^3/day (or 18,542 m^3/h) in 2045. By 2045, 100% sewage from the District 2 area will be connected to the beginning of sewer network in Thu Thiem area.

The total estimated infiltration flow will be around 210,000m^3/day in 2020 and 280,000 m^3/day in 2045,while it was estimated to be about 190,000 m^3/day in 2008. This infiltration flow will represent about 40% of the total flow (60% of the sanitary sewage flow in 2045)and is mainly due to soil and network conditions combined with a presence of groundwater at low depth which infiltrates into the sewers (groundwater thought to be found at a depth of -1 to -2 meters according to CDM FS).

2.2.2. Wastewater Treatment Plant

Wastewater Treatment Plant with a capacity of 480,000 m^3/day by 2020 will be built at Thanh My Loi Ward, District 2 (See Figure 2.4). The proposed WWTP is located at the confluence of the national Dong Nai River and the international Saigon River. The outlet of WWTP will be located in the Dong Nai River, which is a national river that originates in Vietnam and flows to the East Sea. The area assigned for the WWTP construction requires 38.47 hectares used in the past (more than 5 years ago) primarily for agricultural and residential purposes. Currently, this area is covered by randomly grown vegetation (e.g., shrubs, small bushes, nipa); three creeks and ditches, all of which give the area the characteristics of shrub swamp conditions. The overall area is flat but partially flooded during high tide.

The wastewater treatment standard for the future WWTP is regulated in line with QCVN 14:2008/BTNMT[4] for domestic wastewater, column A[5] in 2020 as decided by the People Committee of HCMC. Furthermore, based on the Feasibility Study prepared in May 2014, four treatment technologies were considered and the bidder will have the option to bid on any one of these 4 technologies or other feasible alternatives. The technology with the lowest life-cycle cost taken in consideration socio-economic and environmental aspects would be selected. .

2.2.2.1. Capacity of WWTP

WWTP will be constructed in 2 phases. First phase will be completed by the year of 2020 and second phase will be completed by the year of 2045. The WWTP capacity is presented in Table 2.1.

Table 2.1. WWTP capacity

		2020	2025	2035	2045
Population	NLTN	1,060,000	1,080,000	1,110,000	1,110,000
	D2	390,000	650,000	700,000	760,000
	Total	**1,450,000**	**1,730,000**	**1,810,000**	**1,870,000**
Water consumption (m^3/day)	NLTN	205,000	226,000	257,000	275,000
	D2	88,000	173,000	205,000	234,000
	Total	**300,000**	**400,000**	**470,000**	**510,000**
Sewage flow (m^3/day)	NLTN	160,000	187,000	224,000	248,000
	D2	48,000	108,000	155,000	198,000
	Total	**210,000**	**300,000**	**380,000**	**450,000**
Infiltration water (m^3/day)	NLTN	179,000	181,000	203,000	204,000
	D2	33,000	49,000	74,000	78,000
	Total	**220,000**	**230,000**	**280,000**	**290,000**

[4] QCVN14 is the national technical regulation on domestic wastewater
[5] Column A regulates the value of parameters for wastewater discharging into water bodies, which is used for water supply purposes

Daily average flow (m^3/day)	NLTN	339,000	368,000	427,000	452,000
	D2	81,000	157,000	229,000	276,000
	Total	**430,000**	**530,000**	**660,000**	**740,000**
Daily peak flow (m^3/day)	NLTN	394,000	428,000	498,000	527,000
	D2	86,000	168,000	244,000	294,000
	Total	**480,000**	**600,000**	**750,000**	**830,000**
Hourly average flow (m^3/h)	NLTN	15,000	16,000	18,000	19,000
	D2	4,000	7,000	10,000	12,000
	Total	**19,000**	**23,000**	**28,000**	**31,000**
Hourly peak flow (m^3/h)	NLTN	29,000	31,000	36,000	38,000
	D2	5,000	10,000	14,000	17,000
	Total	**34,000**	**41,000**	**50,000**	**55,000**
Load(PE)	NLTN	471,000	540,000	704,000	792,000
	D2	142,000	322,000	542,000	735,000
	Total	**620,000**	**870,000**	**1,250,000**	**1,530,000**
Resulting sewage concentration (mg/lofBOD$_5$)	NLTN	84	88	99	105
	D2	106	123	143	160
	Total	**88**	**99**	**114**	**126**

Note: 1PE = 60g BOD_5/m^3/day

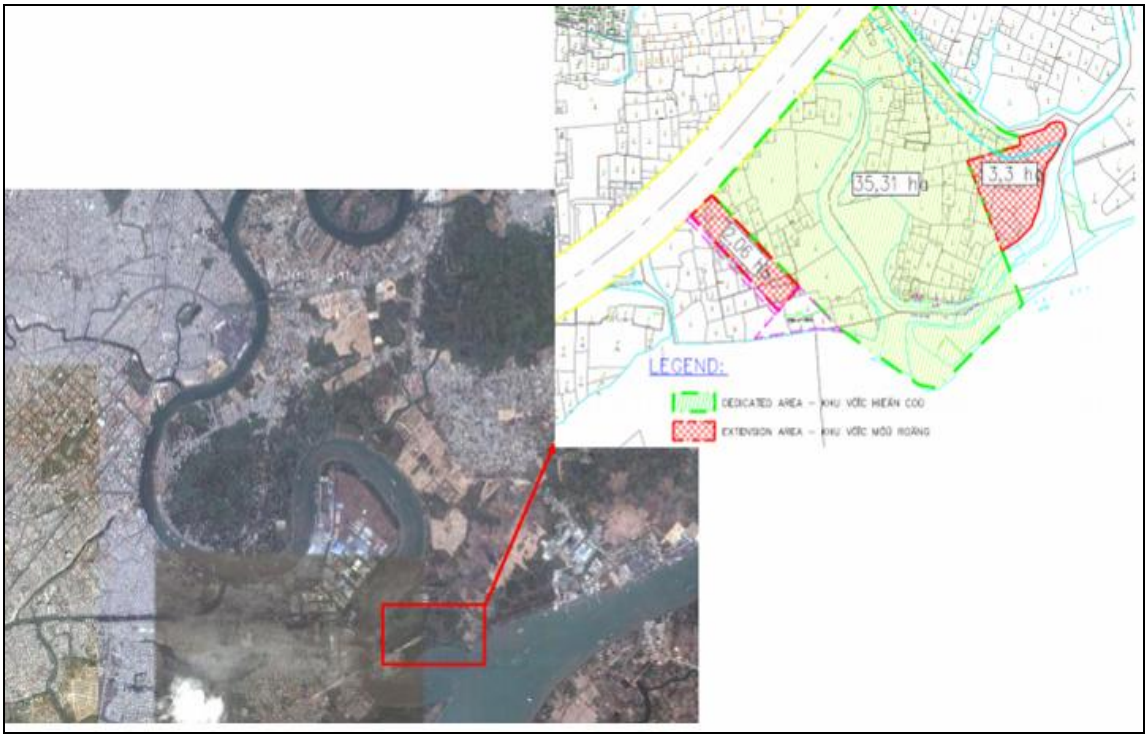

Figure 2.4.Location of wards along the interceptor and WWTP

At the wastewater treatment plant area there are 3 creeks (Figure 2.5) namely, (i) Phu My (4.5 m deep and 50 m wide; (ii) Ngon Ngay (1 m deep and 20 m wide), and (iii) Ky Ha (5.5 m deep and 50 m wide) as presented in Figure 5. Based on the latest Feasibility Study information, there is a proposal to divert the Phu My creek (about 150 m in the WWTP area) to the Ngon Ngay creek in order to create space for the WWTP. However, this proposal is subject to change as it would need to be considered in conjunction with the plans to construct the treatment plant and flood protection measures that are planned at the site. A preliminary survey and the basic design of the creek diversion concluded that a final design would need to take in consideration the additional flow, which would call for an increased

depth and proper embankment of the Ngon Ngay creek. Potential impacts of the creek diversion include erosion and sedimentation along the Ngon Ngay creek due to higher flows from the Phu My creek; and impacts due to diversion of water away from the Phu My creek within the WWTP.

Figure 2.5.Creeks (including the diversion creek) located at WWTP site

2.2.2.2. Inlet and Outlet Sewage Characteristics

(1). WWTP's Inlet sewage quality

The WWTP's inlet sewage is referenced to the Binh Hung existing WWTP with capacity of 141,000 m^3/day and the NL-TN pumping station with capacity of 250,000 m^3/day (See Tables 2.2 and 2.3).

Table 2.2. Inlet/outlet wastewater quality of Binh Hung WWTP and inlet wastewater quality of NLTN pumping station

No.	Parameter	Unit	Binh Hung WWTP		NLTN pumping station
			Inlet	Outlet	Inlet (*)
1	TSS	mg/l	150	22	172
2	BOD	mgO_2/l	42.4	25	92
3	COD	mgO_2/l	200	55	133
4	NH_4^+	mg/l	-	-	19

Source: SCFC, May, 2010

(*): Data from pumping station, implemented by CDM Consultant, May-June, 2012,

Table 2.3. Projected Wastewater parameters (Average concentrations) of NLTN WWTP inlet

No.	Parameter	Unit	2020	2025	2035	2045
01	Equivalent population	Person	620,000	870,000	1,250,000	1,530,000
02	Daily average flow	m^3/day	430,000	530,000	660,000	740,000
03	BOD	mgO_2/l	82	94	105	119
04	COD	mgO_2/l	165	187	210	239
05	SS	mg/l	96	109	123	139

No.	Parameter	Unit	2020	2025	2035	2045
06	Total N	mg/l	21	23	26	30
07	Total P	mg/l	3	3	4	4

The sewage samples taken in May, June (year) are in the dry season. The BOD, COD concentrations at the inlet of Binh Hung WWTP are increasing comparing with ones at the inlet of the NLTN pumping station. That may explain the dilution of the sewage in the NLTN pumping station by infiltration water. In the raining season, the concentrations of the pollutants may be reduced comparing with ones in dry season.

The semi-annual monitoring data analyzed by HCMC Environmental Protection Administration, CESPIMA and CDM Consultant shown that the concentrations of heavy metals (i.e. Hg, As, Cd, Pb, total Cr), other typical physical, chemical and biological parameters meet the regulation QCVN 14:2008/BTNMT, column A, K=1.0.

(2). WWTP's outlet wastewater quality

The discussion on various proposed WWTP sites and the justification of the selected one will be presented in paragraph 4.2.1.

The WWTP's outlet wastewater quality has to meet the relevant technical environmental regulations (QCVN) issued by the Ministry of Natural Resources and Environment (MONRE) (See Table 2.4).

Table 2.4. Effluent characteristics in line with the National Technical Regulations on domestic sewage quality for NLTN WWTP

No	Parameters	Units	QCVN 14:2008/BTNMT Column A (K=1.0)
01	PH		5 -9
02	BOD_5(20°C)	mg/l	30
03	TSS	mg/l	50
04	Total of dissolved solids	mg/l	500
05	Sulfide(calculate accordingto H_2S)	mg/l	1.0
06	Ammonia (accordingto N)	mg/l	5
07	Nitrate(NO_3^-) (accordingto N)	mg/l	30
08	Oil (vegetable oil and animal fat)	mg/l	10
09	Total of surface active agent	mg/l	5
10	Phosphate(PO_4^{3-})(accordingto P)	mg/l	6
11	Total Coliform	MPN/100ml	3,000

After discussion with HCMC DONRE, the Vietnamese technical environmental regulation of QCVN 14:2008/BTNMT column A will` be applied for the NLTN WWTP for the following reasons:

- Based on City Decision 16/2014 dated May 2014, the wastewater received in HCMC area requires application of A standard at discharge point of relevant WWTP;
- Based on the Decision 24/QD-TTg dated January 06th, 2010 regarding to approval of amended master plan of construction in HCMC until 2025, all wastewater from industrial zones should be treated to meet standard A before discharging to surrounding water bodies. Although it is not stated clearly about the cases of municipal waste water treatment plants, all WWTP should meet class A standard;
- The Vietnamese government and HCMC authorities would like to improve water quality in the Saigon and Dong Nai Rivers and increase its self-cleaning capacity in near future, therefore, they ask the WWTPs to achieve the technical regulation (column A) to be able to receive waste waters from other existing decentralized

WWTP which can only treat the wastewaters to meet the column B of the regulation;

- The outlet wastewater from NLTN WWTP will discharge into the Dong Nai River where there is border of the water supply sources and other purposes (water intake located 40 km upstream HCMC and impacted by tide). Hence the chosen water quality of NL-TN WWTP should meet QCVN 14:2008/BTNMT, column A;
- Based on the Decision No. 187/2007/QD-TTg issued by the Prime Minister on December 03, 2007 on approval of scheme for environmental protection of Dong Nai River system basin by 2020 (hereinafter referred to as the Dong Nai River project), the Saigon and Dong Nai River water quality and its self-purification capacity have to be improved in near future, therefore, the NLTN WWTP should meet QCVN 14:2008/BTNMT column A;
- Riparian residential downstream of Dong Nai River still used river water for domestic purposes;
- There is an private water supply plant in Can Gio District, approximately 20 km downstream of NLTN WWTP planned outlet, operating with capacity of 5,000 m^3/day. Even its capacity is small and locates far away of the outlet, the impacts on water quality may not be significant but the discharge following the regulation QCVN 14:2008/BTNMT can help to protect Dong Nai river quality and healthy of water ecosystem;
- Furthermore, Can Gio mangrove forest area, biosphere reserves downstream is another good reason for which the level of treated wastewater should meet QCVN 14:2008/BTNMT, column A.

(3). Wastewater Treatment Technology

Wastewater treatment technology was selected based on the technical environmental regulations QCVN 14:2008/BTNMT for domestic wastewater. In the framework of HCMCES II Feasibility Study, there were 4 WWT technology options considered for the NLTN WWTP, which are as follows: (1) Conventional Activated Sludge (CAS), (2) Sequencing Batch Reactor (SBR); (3) Bio-filtration (BF) and (4) Trickling filter (TF). All four processes are considered fully suitable to NLTN WWTP constraints and meet the environmental regulation QCVN 14:2008/BTNMT (Column A) from technology/technical point of view.

The Consultant recommends allowing bidders to bid on any of these four solutions in order to leave the choice of process open at bidding stage and to benefit from contractor's own specific knowledge, patented (hence not available in the public domain) processes and methodologies and optimized prices.

For disinfection, it is proposed that UV shall be selected, although costly, as this method does not generate by products and does not require chemical reactants. With regards to the financial comparison, investment cost for chlorination is about 15% less than UV but operation of chlorination (taking into account chlorine cost and without considering UV lamp renewal) is about 3 times more than UV. There are also concerns related to workers' health safety during chlorine maintenance and operation.

With regard to variation between dry weather and wet weather, it is worth to note that the hydraulic load will be changed. However, for all the four proposed processes, the WWTP operation will not be changed as the organic load will be almost the same. In this respect, the main difference (for forced aerated processes) will be related to aeration times that may be regulated depending on wastewater concentration. For all processes, it will not be possible to close some treatment lines during wet weather as these processes are biological processes which require continuous operation. All the four processes will be fine under possible impacts from flooding due to effective implementation of the flooding control project in Ho Chi Minh City and surrounding area.

The standard information on the technologies is presented in the paragraph 4.4. The additional information is referenced to the Feasibility Study – Volume 2: Main Report, June 2013.

2.2.2.3. Discharge outlets

Wastewater collected and treated from the project area is expected to discharge in the Dong Nai River. In addition, according to the survey conducted by the EIA preparation consultant, mainly from Nhon Trach side, on the opposite side of WWTP, there are aquaculture households of Phu Huu, Phuoc Khanh, Dai Phuoc communes. However, these areas are relatively far from the discharge location and there are no impacts envisaged from the WWTP operation. The water quality in the area will be monitored during the WWTP operation in line with the plant environmental monitoring program to ensure that the project will not impact on the surroundings.

Since Can Gio Mangrove Forest is located downstreamatabout 20 to 30 km from the WWTP site, the discharge is expected to be strongly diluted by the river water, therefore, water quality in Can Gio Mangrove Forest should not be affected by the WWTP operation' consequently, the project activities will not impact on the Can Gio biosphere reserve. However, the World Bank policy OP 4.04 on Natural Habitats is being triggered as the location of the wastewater treatment plant is in a swamp area and near the natural reserve area in Can Gio.Site survey conducted during the preparation of the EIA did not indicate that there are any endangered species in the location of the treatment plant.In case the design and construction stage reveal any natural habitat affected during works, appropriate mitigation measures would be considered and reflected in the site specific EMP.

2.2.2.4. Sludge treatment technology

Sludge treatment process depends on the composition and properties of sludge generated.

The standard information on the sludge treatment technologies is presented in the Paragraph 4.5. The additional information is referenced to the Feasibility Study – Volume 2: Main Report, June 2013.

Sludge treatment process depends on the composition and properties of sludge generated.

Based on the advantages of each sludge treatment technologies and in order to limit the final volume of sludge, the Consultant proposes that the following sludge treatment be implemented at the NLTN WWTP:

- Thickening: Gravity thickening or Gravity Belt Thickener,
- Stabilization: Anaerobic digestion,
- Post thickening and homogenization: Gravity thickening,
- Dewatering: Filter Press.

This stabilization process should allow (based on sampling analysis) for disposal in agriculture but also for composting, landfill or incineration. Reduction of the sludge quantity can save the cost for sludge transportation. Furthermore, the digestion of sludge produces heat and power and avoids releasing methane. In this respect, it is possible to apply forcedit'sfrom the Carbon Finance Fund.

This process is envisaged at the current stage although alternative sludge technology may be proposed during bidding by contractors. The contractor may therefore also propose a mechanical or solar drying of sludge in order to reduce sludge volume.

The sludge generated from WWTP depends on the choice of technological processes. Total amount of sludge estimated for SBR technology as reference option is about 1,100 m^3/day (from the settling tank); 100 m^3/day dewatered and thickened sludge; 37 m^3/day (from screening) in 2045; 37 m^3/day from grit removal tank (2045). The sludge is expected to be transferred by land way to Da Phuoc landfill, located about 25 km from WWTP. The potential environmental issues caused by the sludge transportation and overall management are dust, odors, noise, waste water leakage, traffic incidents etc. The quantity of hazardous wastes, including packaging and chemical containers, oil and grease generated from the maintenance and repair of operation machines in the WWTP are insignificant, which should be separately collected and stored in warehouses, then disposed in the planned area.

Once the WWTP is operational, sludge from the treatment plant is expected to be transported, treated and disposed of at the Da Phuoc landfill area (located in Da Phuoc commune, Binh Chanh District), at which construction of the Da Phuoc Sludge Treatment Plant started in April 2014 (and is planned in 2 phases during 2014-2016, respectively 2017-2020)[6].Based on City People Committee's decision, GREEN SAIGON will develop the Da Phuoc Sludge Treatment Plant over an area of 47ha, located at the Da Phuoc Waste Treatment Complex and Cemetery. This company will treat only non-hazardous sludge; therefore, sludge will be tested before being considered for treatment by this company at this location. The sludge that is contaminated but no-hazardous will be treated through composting technology. A Memorandum of Agreement(Document 32/BB-VSMTTP) was signed by IMA and GREEN SAIGON company on July 24, 2014 based on which sludge generated by the HCMC ESP2 WWTP will be received and treated at Da Phuc landfill.

The Da Phuc landfill is currently used by HCMC for disposal of sludge generated by other WWTPs and for other solid waste generated in HCMC. Specifically, the city currently stores and treats sludge at this site from 3 sources:

- Dredging sludge from Tan Hoa – Lo Gom canal (WB project). The estimated total volume of sludge from Tan Hoa – Lo Gom is about 415,000 m^3 of which 85,000 m^3 is contaminated requiring treatment. Starting with April 2014, the company has received 30,000 $m^3$of non-contaminated sludge and 10,000 $m^3$of contaminated sludge. The contaminated sludge has been stored in appropriate built cells protected and coveredby HDPE and equipped with ventilation;
- Sludge from sewerage system(starting from July 2014) with a capacity of 800m^3/d.
- The company currently constructed 6 storage cells for dredging and sewerage sludge with the total volume of about 20,000 m^3. The sludge treatment unit including the warehouse for composting and the waste water treatment plant (500m3/d) are under construction and estimated to start operation in October 2014.
- Sludge from Binh Hung wastewater treatment plant (starting from April 2014), witha total capacity of about 38m3/d. This sludge is dry/dehydrated and being treated right after receiving at the composting warehouse area (4,300 m^2).
- In the near future, the Da Phuoc landfill also receive sludge generated by the activities of the Urban Metro Project(the exact amount is yet to be determined).

The sludge generated by the HCMC ESP2WWTP will be transported by land ways to Da Phuoc landfill, which is located about 25 km from the WWTP site. Landfill alternatives have been analyzed including consideration for HCMC ESP2 WWTP sludge disposal to be transferred to other sites such as the Phuoc Hiep, Go Cat or Dong Thanh landfill (see Figure 2.6 and details of selection discussed in later chapters).

The average amount of sludge to be transferred is about 100 m^3/day (equivalent to 5 trucks

[6]Although the investment report and EIA are under appraisal process, due to the urgent need for sludge treatment as requested by HCMC People Committee, the Department of Construction issued a temporary construction certificate for some investments of Da Phuoc Sludge Treatment Plant.

per day), which is equivalent to 4.5% % of future landfill capacity per day.

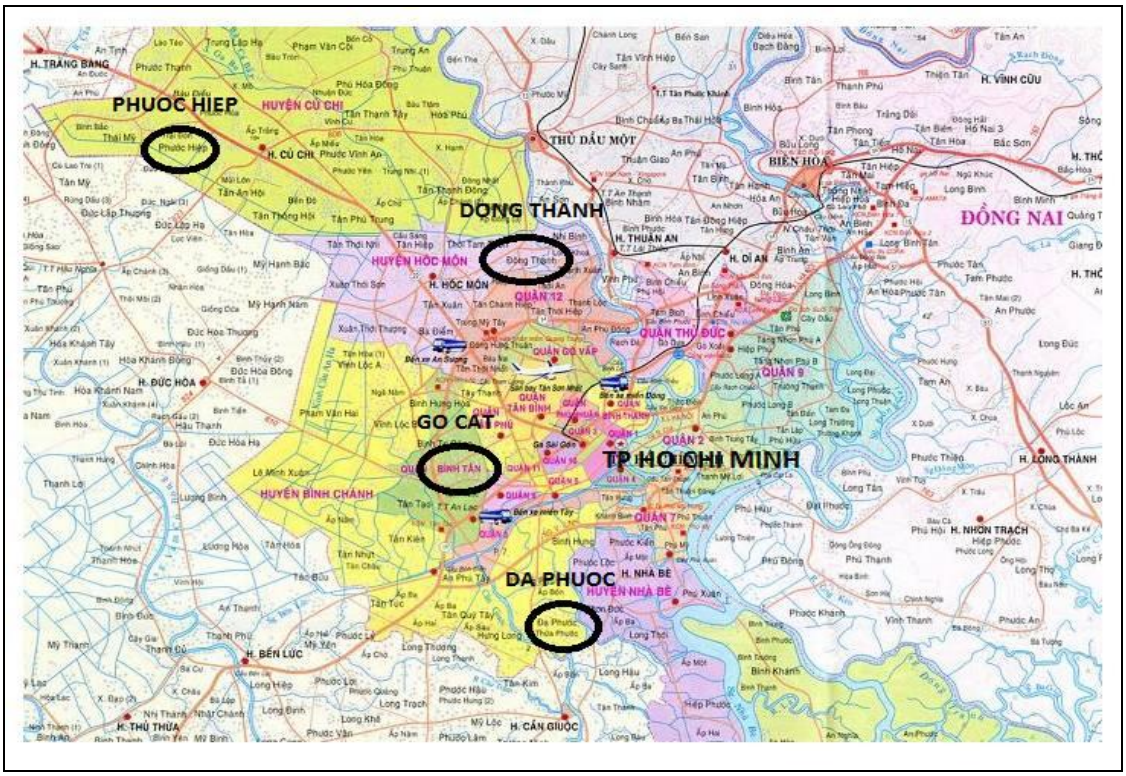

Figure 2.6.Location of DaPhuoc Landfill and alternatives analyzed for receiving sludge from HCMC ESP2 WWTP

2.2.3. Construction of Sewerage Network in District 2 area

Construction of Sewerage Network in the District 2 area: The project will invest drainage level 2 and level 3 in District 2, including drainage and sewage. Investment objective of the drainage district 2 is: Maximum wastewater collection to improve environmental conditions in district 2 where untreated wastewater is discharged to water bodies. In addition, all houses in the project area will be connected, if they are not currently connected to the combined or separated system. The wastewater collected from the District 2 area will be transferred to the interceptor that also will convey wastewater to the wastewater treatment plant (being constructed under this project) from the Nhieu Loc-Thi Nghe (NLTN) area. As this District will be urbanized by 2035, sewage will be collected and treated which will protect the quality of the Saigon and Dong Nai Rivers. In the previous Master Plan, several WWTPs were planned for construction in District 2. Currently, as it is proposed that the sewage shall be collected and treated at a centralized WWTP, depending on the construction schedule of the NLTN WWTP (Phase 2 project), the construction of these small-scale WWTPs in D.2 area may not be necessary.

The priority area(s) covered by the ESP2 WWTP will be those of existing development currently discharging to septic tanks/small WWTPs and new areas under construction or to be completed within the lifetime of the project (i.e. before 2019).

The main rainwater drainage components for District 2 area including renovation of canal drainage, road construction along the canal, construction and renovation of the bridges passing through the canals, construction of tide preventing and water regulating, construction of storm drainage culverts of level 2, elevation of the foundation of the construction land, renovation and upgrading, and construction of relevant small scale dikes.

2.2.4. Institutional Strengthening

The same entity that worked with the World Bank on the first phase project (HCMC ES1) would also implement the second phase project, as the staff is familiar with the World Bank procedures. The managing agency is the City People's Committee, through the City environment sanitation project investment management agency (CESPIMA). CESPIMA coordinates with the People's Committee of District 2 to setup the general plan for the compensation assistance and resettlement. District 2 People's Committee is responsible for the establishment of a committee for the compensation assistance and resettlement as prescribed. The committee for the compensation assistance and resettlement will setup the land acquisition plan, documents and decisions for households, individuals, and organizations (if any) under the provisions and give land hand-over decision for CESPIMA.

The project will provide financing for institutional strengthening of the key project entities (e.g. CESPIMA), which will consist of implementation support and capacity building including safeguard management. Under the project, consultants would be in place to support the implementing agency. The environmental monitoring program proposed for implementation during the WWTP operation will ensure the treated wastewater meets the effluent standard and any possible impacts downstream are managed and reduced. It would be important for HCMC to have the necessary resources to ensure that the investments are carried out in a proper way and that wastewater and sanitation management in the city is sustainable from environment and financial standpoints. Semi-annual environmental and social audits would be carried out to ensure that proper procedures are being followed.

2.3. RESETTLEMENT PLAN

At the project area (WWTP) it is necessary to reclaim and level land to prepare building construction. To build the WWTP requires an area of 38.47ha.This is primarily 31.64ha agricultural land (owned by 59 households; two companies; and 4 households with affected structures). The needed land area is primarily privately owned 31.64ha, 82%, while the remaining land is public (creeks and ditches) accounting for 12% (6.8ha).

The Resettlement Policy Framework is prepared by IMA, in accordance with the relevant laws of the Government of Vietnam, and the World Bank safeguards policies (OP 4.12 on Involuntary Resettlement) (Please see the project’s Resettlement Policy Framework for details).

The resettlement plan and implementation schedule are referenced to the Feasibility Study – Volume 6: Resettlement Action Plan, June 2013.

2.4. INVESTMENT CAPITAL

The investment cost depends on the choice of technology process. Total grand cost estimated is US$524,000,000, including cost for preparation phase cost for implementation phase and contingencies and VAT. The cost for implementation includes ones for interceptor, WWTP, support and TA activities, MIS software, for compensation and site clearance.

Bank loan is 450 million from two sources: Loan from International Development Association (IDA): $ 200 million and Loan from International Bank for Reconstruction and Development (IBRD): $ 250 million. Counterpart funding from Vietnam Side is 74 million, the budget allocated from Ho Chi Minh City.

2.5. THE PROJECT'S SCHEDULE

The project preparation stage should be achieved using PPTAF funding from the WB and managed by MPI. In this respect, USD 4.9 million should be made available to recruit the consultants that will prepare the interceptor detailed design, the bidding documents for both

interceptor and WWTP, and assist for the corresponding bide valuations. The PPTAF should be initiated as early as possible so as to allow project preparation to proceed further without unnecessary delay.

Project implementation period: from year of 2014 to year of 2019. Construction will be undertaken from 2015 to 2019. The interceptor will take 2 years to build while the WWTP will require 3.5 years for construction and equipment installation.

The detailed implementation schedule is referenced to the Feasibility Study – Volume 2: Main Report, June 2013

CHAPTER 3.
BASELINE DATA

3.1. PHYSICAL CONDITIONS

3.1.1. Meteorological conditions

According to meteorological data collected from the Southern Meteorological and Hydrographic Center from 2005 to 2012, the climate in the project area has the general characteristics of a tropical monsoon. The climate is mild and homogeneous with two seasons in a year, including a rainy season from May to November and a dry season from December to April. It is warm and sunny in the whole year, and less affected by storms.

When the project will be implemented, the climate factors will have influence by the dispersing and transforming of the pollutants to the surrounding environment. Therefore, it is essential to monitor the climate's characteristics in the project area. Based on the observed meteorological data at Tan Son Hoa Station, the climate data can be described as follows:

3.1.1.1. Temperature

The monthly average air temperature is approximately 28.16^{o}C. The highest temperature is 34.2^{o}C (2000), the lowest temperature is about 20.8^{o}C (2000). The monthly average temperature from 2005 to 2012 is presented in Table III.1, Appendix III.

The climate change has a strong impact on Vietnam with an increase of the average temperature of approximately 3^{0}C during 100 years. By 2060, HCM City will not have temperature below 21^{0}C and an extreme temperature to 44 - 45^{0}C can occur. Temperature increase within different scenarios of climate change in HCM City is presented in Figure 3.1.

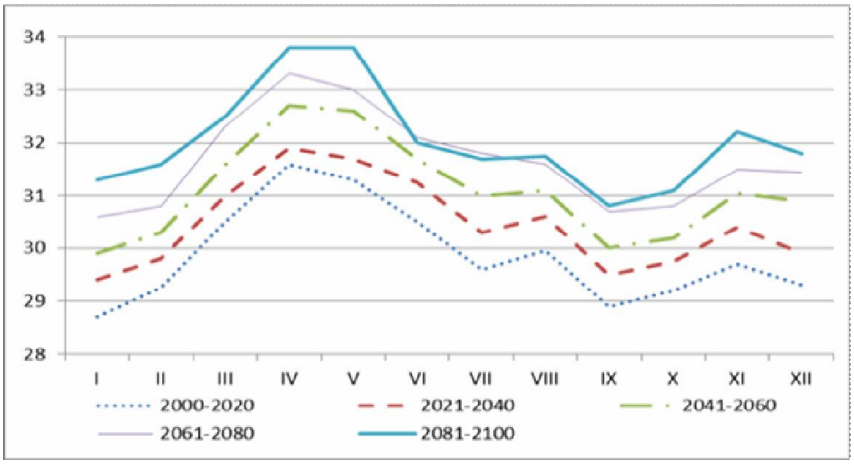

Figure 3.1.Temperature increase within different scenarios of climate change in HCM City (dT= 3^{0}C/year)

3.1.1.2. Sunshine hours

Total annual sunshine hours are 2,073.7 hours. April is the month, which has the highest number of monthly average sunshine hours (i.e. 240.8 hours) (See Table III.2, Appendix III). The total of daily average radiation is about 110-160 Kcal/cm^{2}.

3.1.1.3. Humidity and evaporation

The monthly average humidity measured in Tan Son Hoa Meteorological Station is 74%, The

difference between the highest wet and dry places is about 10 to 12%. The highest humidity in the rainy months is around 83% (September) and the lowest one in the dry months is 68% (February) (See Table III.3, Appendix III).Recorded data from Tan Son Hoa meteorological station for many years show that during the dry months (February- March) the monthly average evaporation may reach to 170-180 mm; the lowest evaporation one is from 54 to 58 mm in September, October.

3.1.1.4. Rainfall

In the city area, the rainfall is uneven, which tends to increase along the Southwest – North East. The rainfall in the suburban and northern districts is higher than that in the rest regions. Annual rainfall of the city is high, that varies from 1,742.8 to 2,340.2 mm/year (See Table III.4, Appendix III). The rainfall concentrates on the rainy months, accounting for 90% of annual rainfall. Thereby, heavy rains usually occur from August to October. In January to March there is a very low rainfall or no rainfall. Monitoring data indicates that the highest rainfall is 2,340.2 mm in 2007.

Unevenly distributed rainfall, rainy season often causes local flooding, whereas the dry season is water scarcity in some regions.

Rainfall in the future will not be changed significantly. The rainfall in the dry season will decrease while that in rainy season increases. The highest rainfall in the future may be increased by 20% compared to that in the present. Thus, the calculation of drainage and filling of the Ngon Ngay Canal must take in consideration the drainage ability of the basin. However, it will insignificantly effect on interceptor and the WWTP because the sewer and storm drainage have been separately constructed.

3.1.1.5. Wind regime

HCMC is influenced by two main wind directions, including West - Southwest and North - Northeast. The West - Southwest wind with average speed of about 2.4 m/s blows from the Indian Ocean in the rainy season (from June to October) and the strongest one with average speed of about 4.5 m/s in August. By while, the North - Northeast wind with average speed of about 2.4 m/s blows from the East Sea in the dry season (from November to February). Besides, Trade wind with average speed of about 3.7 m/s blows from South - Southeast during March to May (See Table III.5, Appendix III and Figure 3.2).

In the project area, the prevailing wind direction is southwest from May to October, bringing moisture air from Thailand Bay. From November to March, the main wind direction is northeast; it is cool and less disturbed.

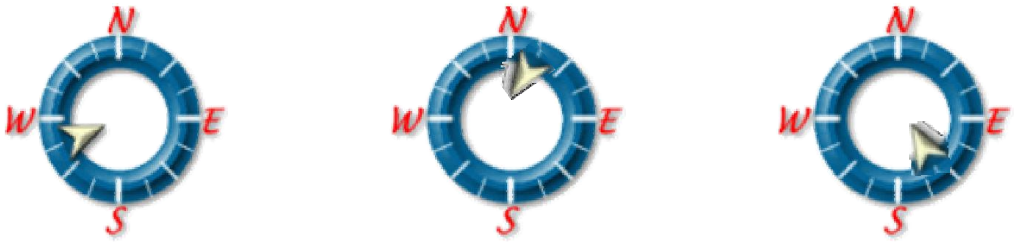

Figure 3.2. Main wind directions in HCM city

3.1.2. Hydrological conditions

Ho Chi Minh City is located in the downstream of the Dong Nai River system and has an interlacing network of rivers and canals.

The Dong Nai River originates from Lang Biang Plateau (Da Lat) and has many tributaries

such as the La Nga River, the Be River with a large basin of 45,000km^2. Its average flow is 20-500 m^3/s and the highest flow during floods is up to 10,000m^3/s. It annually supplies about 15 billion m^3 of water for Ho Chi Minh City**.**

The Sai Gon River originates from Cambodia (specifically, in Hon Quan District, Binh Phuoc Province at the border between Vietnam and Cambodia) and flows through Thu Dau Mot city to HCM city with a length of about 200 km. Its length in the territory of the city is 80 kilometers.

The system of tributaries of the Sai Gon River is too interlaced with its average flow of about 54m3/s. The width of the Sai Gon River in the city ranges from 225m to 370m and its depth is 20 meters. The Dong Nai River connects with the Sai Gon River through the expansion area of the inner city by the system of Rach Chiec Canal. The Nha Be River had formed from the confluence of the Dong Nai and Sai Gon River, located in distance of about 5km from the center in the South-East direction. It flows into the East Sea by two streams: the Soai Rap River with 59km length and average width of 2km is a shallow one with slow flow rate.

Another stream is the Tau Bay River with 56 km length and 0.5 km width, which is flowing into Ganh Rai Bay. Nha Be is a deep river and is also the major waterway for the ships coming and leaving from Sai Gon Port. Since the Sai Gon River within the Dong Nai River basin system is bordered within the territory of Cambodia, it is considered international waterway and subjected to the Bank procedures for the Operational Policy7.50 on international waterways (http://go.worldbank.org/NEYC01UF60), including the OP (Operational Procedure) and the BP (Bank Practice).

The river network in the project is presented in Figure 3.3.

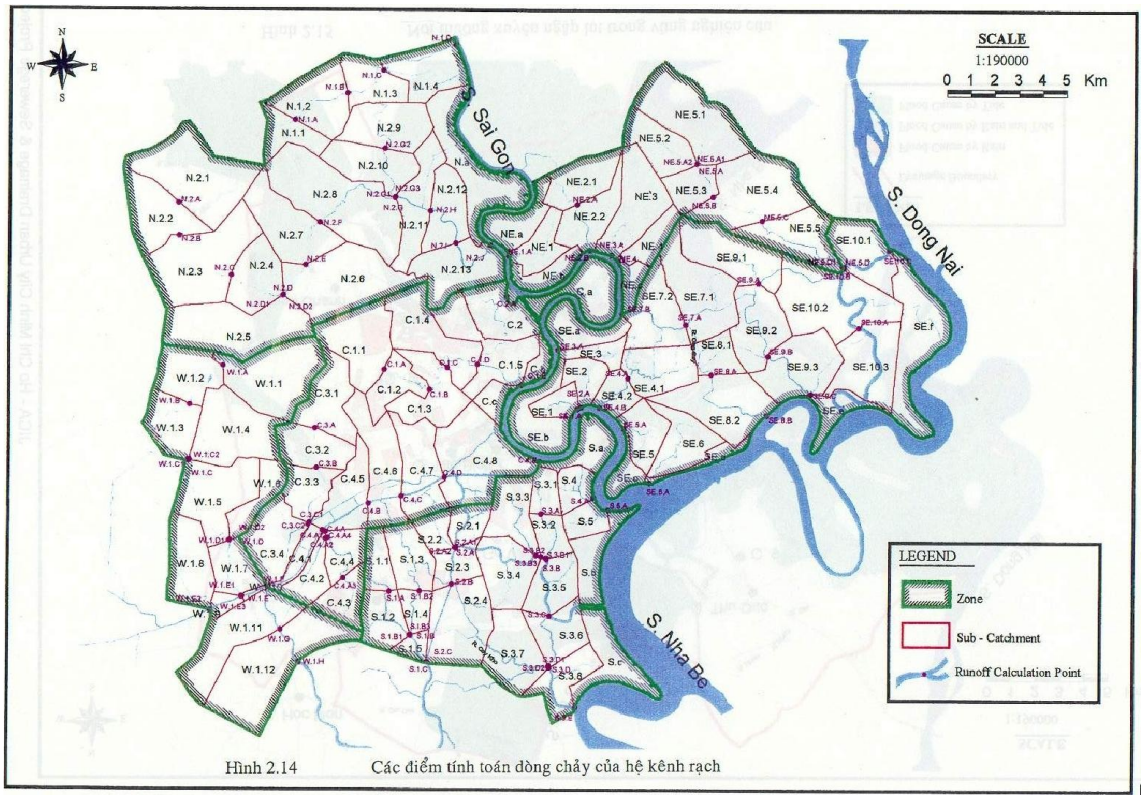

Figure 3.3. Map of rivers network in the project

Most of the rivers in Ho Chi Minh City are influenced by semi-diurnal variation of the East Sea tide. Each day, tides rise up and down twice a day, so they penetrate into the canals in

the city, causing impact on agricultural production and limiting the water drainage in the urban areas. Hydrological results measured in Phu An station (located in the Sai Gon river) in the year of 2010 shown that the highest tide level in the Saigon River is 1.385 m. The highest water level is 1.55 m in November and the lowest is -2.22 m in July. In dry season, the river flow is small, salinity of 0.4 ‰ isoline can intrude on the Saigon River to Lai Thieu, in some years that can intrude on the Dong Nai River to Thu Dau Mot and Long Dai. In rainy season, the river flow is huge, so the salinity will be strongly diluted.

The lowest and highest monthly average water levels of the Saigon River are presented in Tables III.6, III.7, Appendix III.

With increasing of climate change impacts, the Dong Nai River basin will be flooded over 12% in 2050, in which construction area of NLTN wastewater treatment plant can increased 2m compared to the present (See Figure 3.4). Therefore, the process of building of wastewater treatment plant must be considered to ensure that the flooding will not affect on the WWTP.

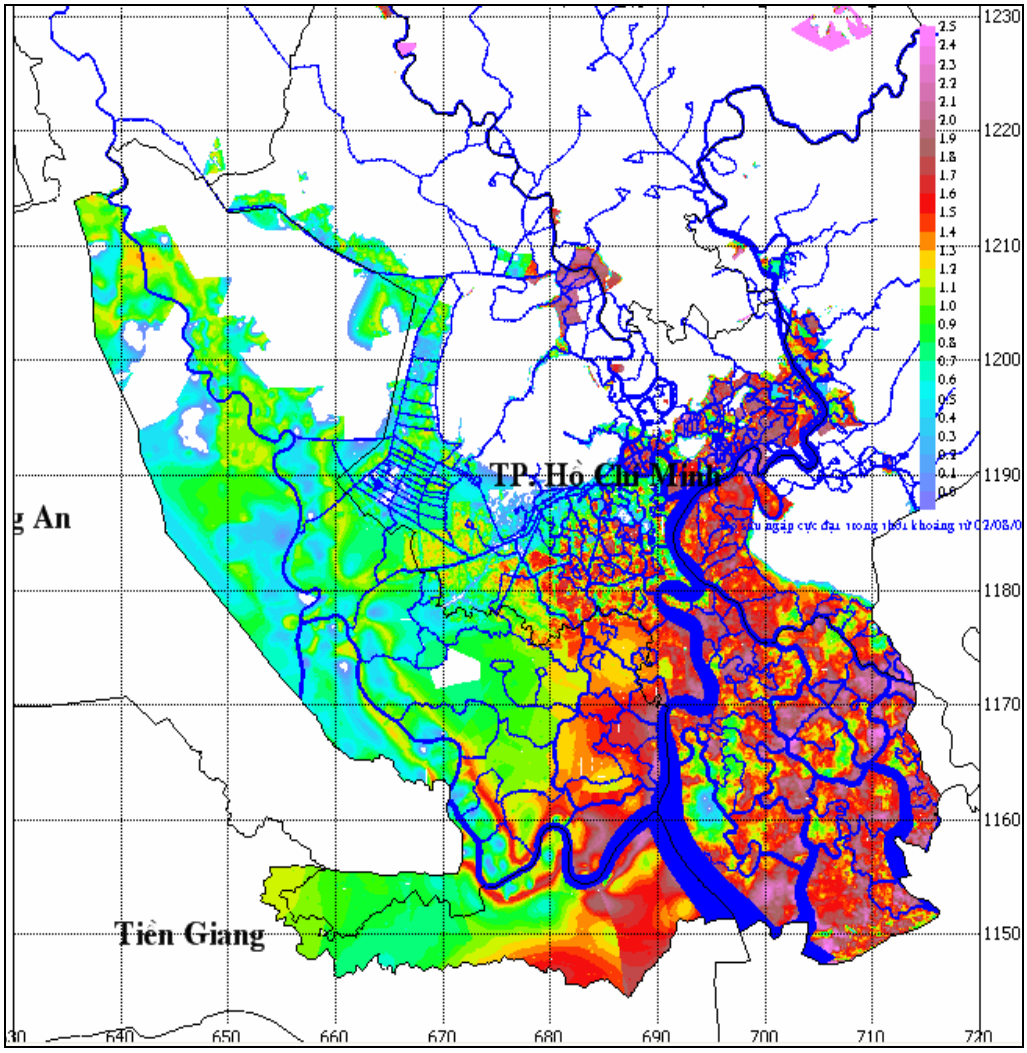

Figure 3.4. Water level rise scenarios in the Dong Nai River Basin by climate change (Sources: Impact of Climate Change on Water Resources and Adaptation Measures, Academy of Sciences Hydrometeology and Environment – Embassy of Denmark)

In District 2 area, Giong Ong Canal is about 7.5 km length and about 70m width. This is a relatively large canal from the Saigon River and through to Ba Cua Canal (the boundaries of

District 2 and District 9). Canal is wide in source region and is narrow in the region through Ba Cua Canal, strong flow, swirl in the region near the Giong Ong To, where are many bends.

The Giong Ong To Canal has received whole domestic wastewater from people living in the Mekong Region, and is also the place to collect water from small canals in the river basin.

Groundwater in Ho Chi Minh City is quite abundant, concentrating on a half of the Northern region in the Pleistocene sediment; as going down to the Southern area (Nam Binh Chanh, District 7, Nha Be, Can Gio) in the Holocene sediment. Groundwater quality is characterized as high acidity and salinity. According to geological survey, an average depth of groundwater table is equivalent to sea level and directly affected by tides. Groundwater in project area appears in the inner aquifer (layer 2, 5, and 6a) with a small reserve. Particularly in the boreholes BH7, at 14.1 m depth, it appears in layer 5 with large reserve.

3.1.3. Geographical and geological conditions

The topography of District 2 is quite flat. However, District 2 may encounter problems with flooding, especially in the situation of climate change and sea level rise impacts (Source: Adaptation to Climate Change in Ho Chi Minh City – ADB). Because of its low terrain, the ground level of District 2 needs to be raised from +2.5m to +3.0m above the sea level to prevent flooding.

Based on the original terrain, the survey region is the type of the coastal plain, formed by the sediment, which had originated from the rivers and sea. According to geo-technical works and analysis results of drilling samples in the laboratory, the geological strata of the region is divided into different soil layers from top to bottom as described below.

3.1.3.1. Nhieu Loc - Thi Nghe Wastewater Treatment Plant Area

Figure 3.5Map of borehole locations:

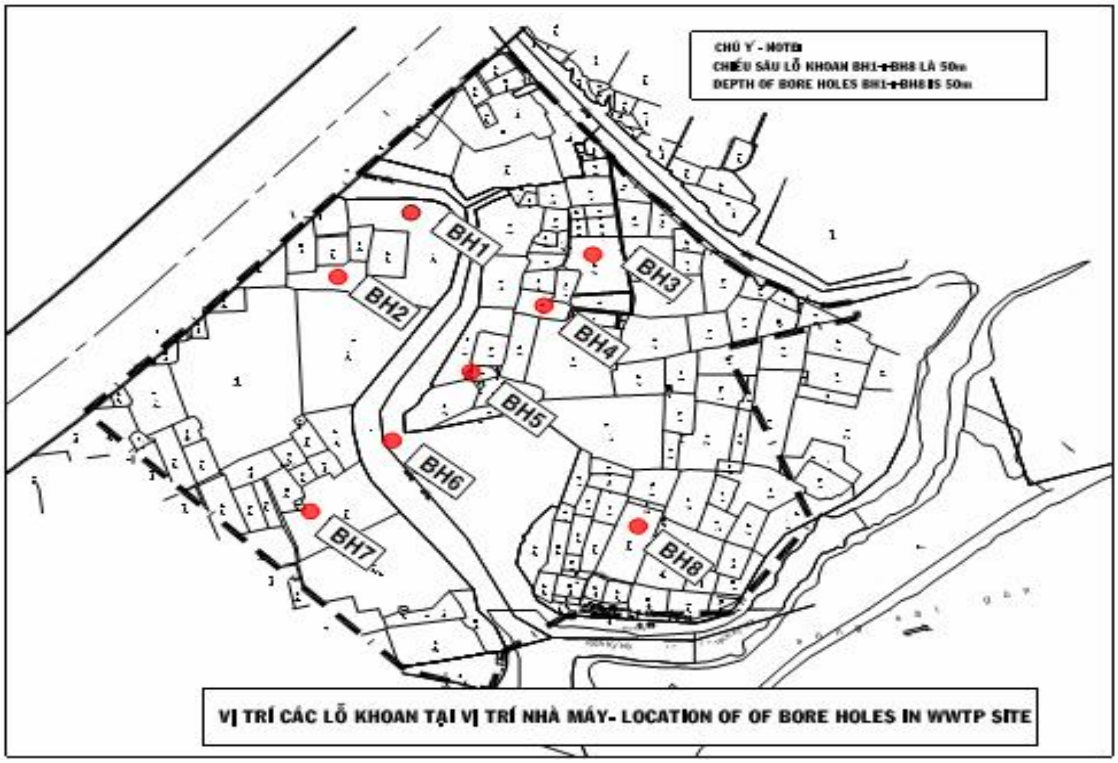

Figure 3.5. Map of Boring Holes in Wastewater Treatment Plant Area

Based on geological survey dossiers in project's area, implemented by Truong Sinh Design

and Construction JSC, some mechanical-physical properties of several layers can be described as follows:

(a). Layer 1 - with mostly bluish grey and blackish grey mud clay

This layer has a wide distribution area, is in the hole, just above the surface. The thickness of layer 1 at the point of drilling ranges from 10.5 m (in BH2 drill hole) to 13.7 m (in BH1 drill hole). Height of surface layer ranges from 0.5 m (in BH4 hole) to 1.2 m (in BH8 hole)

(b). Layer 2 – This layer is divided into two classes

Layer 2a – The main ingredient is clay, with yellowish grey, bluish, patchy whitish grey, sepia and hard plastic state

This layer has a local distribution area, only found in BH3, BH4, and BH8 holes only presented just under the layer 1. The thickness of the layer ranges from 2.3 m (in BH3 hole) to 4.3 m (in BH4 hole). Height of surface layer is from -11.9 m (in BH3 drill hole) to -10.2 m (in BH4 drill hole).

Layer 2b – Fine to medium sand, yellowish brown, pale yellow, bluish grey, blackish grey, medium dense in state, medium textured tight.

This layer has a local distribution area, only found in BH3, BH5, BH6 holes, found just beneath layer 2b. The thickness of the layer ranges from 4.0 m (in BH3 hole) to 6.5m (in BH5 hole). Height of surface layer is from -9.9 m (in BH5 hole) to -14.2m (in BH3 drill hole).

(c). Layer 3 – Main components are sand with light gray, yellowish grey and plastic state. This layer is only found in BH8 hole. The thickness of the layer is 3.7 m. Height of surface layer at the hole is -14.6 m

Layer 3b - The main ingredient is clay with bluish gray, light gray, sepia, yellow color and hard to semi-hard plastic in state.

This layer has a wide distribution area, in all holes. The thickness of the layer varies from 12.5 m (in BH8 drill hole) to 24.8 m (in BH1 drill hole). Height of surface layer ranges from -19.2 m (in BH4 drill hole) to -9.8 m (in BH2 hole).

Layer TK – Main components are sand with light gray, yellowish gray and plastic state. This layer has a local distribution area, only found between BH2 hole and layer 3. This layer's thickness is 11.3 m and ones' height is -17.8 m

(d). Layer 4 – The main component at this composition is sand with light purple, brownish pink, yellowish grey, plastic state, and somewhere with sandy clay.

This layer has a wide distribution area, encountered in almost every hole (except for BH5, BH7 holes). The thickness of the layer varies from 8.0 m (in BH2 hole) to 11.5 m (drill hole in BH8) and this layer's height ranges from -38.3 m (in BH6 drill hole) to -35.2 m (in BH4hole).

(e). Layer 5: The main ingredients are small and medium sand with yellowish gray, light purple and medium textured.

This layer is has an area with wide distribution, all of the holes (except for BH3, BH6, BH8 holes). The thickness of the layer varies from 3.0 m (hole in BH1) to 14.1 m (in BH7 drill hole). Surface layer's height changes from -30.9 m (in BH5 hole) to - 46.5 m (in BH4 hole). Turning to fine-medium sand, thickness of this kind is from 3.0m to 14.1m with light violet, yellowish grey, medium density.

(f). Layer 6a – The main compositions are coarse sand and quartz grains, with yellowish gray and medium textured. This layer has a local distribution area, only found in BH5 hole. The thickness of the layer 6.0 m and height of surface layer is -40.4 m.

Layer 6b: major components are the sandy with yellowish gray and brownish pink and plastic state. This layer has a local distribution area, only found in BH5, BH7 holes. The thickness layers of both two holes are 3.0m and height of surface layer at the position of both two drill holes are -46.4m.

3.1.3.2. Sewerage Area

Land reclamation is brownish grey, blackish grey clay, loam and gravel, and debris. This class has a wide distribution area, found in all of drilling holes, appears on the nature's face. The thickness of the layers at drilling holes ranges from 0.7 m (in BH3 hole) to 3.5 m (in BH6 hole) and height of surface layer varies from -0.4 m (in BH2 hole) to 2.8 m (in BH4 hole).

(1). Layer 1: bluish, dark gray mud clay. This layer has a wide distribution area, encountered in all drill holes and located just under KQ layer. Due to have not drilled all the depth in some holes, only determine the thickness of the layer in depth surveyed. The thickness of the layer varies from 7.0 m (in BH8 holes) to 14.3 m (in BH3 hole) and height of layer surface change from -1.4m (in BH6 holes) to -0.3 m (in BH3 holes).

(2). Layer 2: This layer has contained gray, white gray color and soft plastic clay. This layer has a local distribution area, only found in BH5, BH6, BH8 holes, located just under layer 1. The thickness of the layer varies from 3.0m (in holes BH6) to 5.7 m (in BH8 hole). Height of surface layer changes from -9.6 m (in BH5 hole) to -7.5 m (in BH8 hole).

(3). Layer 3: This layer is yellow gray, yellow brown, hard plastic clay. This is main composition of yellowish gray, yellowish brown, hard plastic state clay. This layer is located beneath the layer 2, only found in BH6, BH7, BH8 holes. The thickness of the layer varies from 5.2 m (in BH6 hole) to 8.5 m (in BH7 hole). Height of surface layer changes from -13.2 m (in BH8 drill hole) to -8.0 m (in BH7 hole).

(4). Layer 4: This layer is sandy with light gray, yellowish gray, plastic state. This layer has a local distribution area, only found in BH4 hole. The thickness of the layer is 4.5m and height of surface layer is-13.6m.

(5). Layer 5: This layer is medium grain sand, yellowish gray, white gray. The composition is mainly medium grain sand, yellowish gray, white gray. This layer has a local distribution area, only found in BH6, BH7 holes. The thickness of the layer varies from 1.3 m (in BH6 hole) to 1.5 m (in BH7 hole). Height of surface layer changes from -16.6 m (in BH6 drill hole) to -16.5 m (in BH7 drill hole).

Conclusion: Geology of this region is quite complex, layers change local, alternating distributes and changes in this area. The first soil layer is weak, large thickness; the forcing ability of remaining soil layers is from medium to good with the small deformation. The geological condition is suitable for construction of a large WWTP with the planned capacity in HCMC. There are no earthquakes in the project area, which may cause any possible indirect impacts on the WWTP operation.

Map of borehole locations is presented in Figure 3.6).

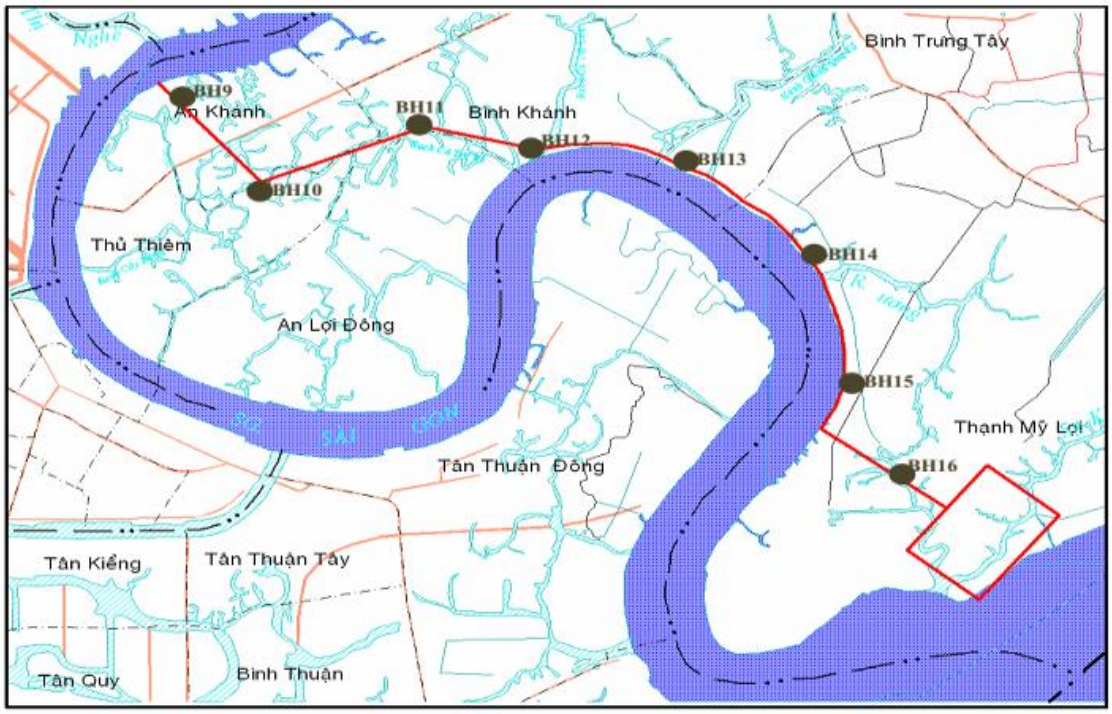

Figure 3.6. Map of Boreholes Locations

3.1.4. Air quality

The air quality in the sewer interceptor and WWTP areas has been measured on 09 June 2010 by the Center for Environmental Technology within the Institute for Environment and Resources. The air sampling points are presented inFigure 3.7.

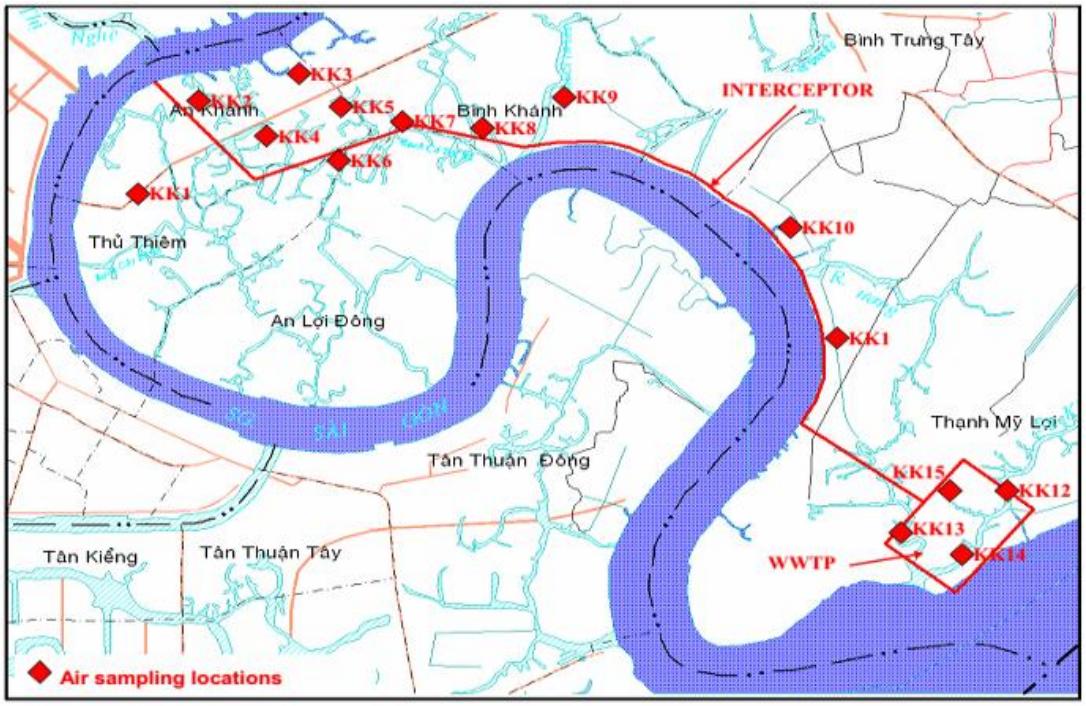

Figure 3.7. Map of ambient air sampling locations

The analyzed results in Table IV.1, Appendix IV shown that the air quality in most sampling

locations is good; concentrations of all measured parameters are lower than QCVN 05:2009/BTNMT. Dust content at the WWTP location is very low, as this area is mainly agricultural land. In addition, this area is covered by green trees that make the air environment better.

Comparing with QCVN 26:2010/BTNMT- National Technical Regulations on Noise, the noise limit at residential areas from 6h - 21h is 70 dBA, most points are lower than or approximate to the allowable limits (seeFigure 3.8).

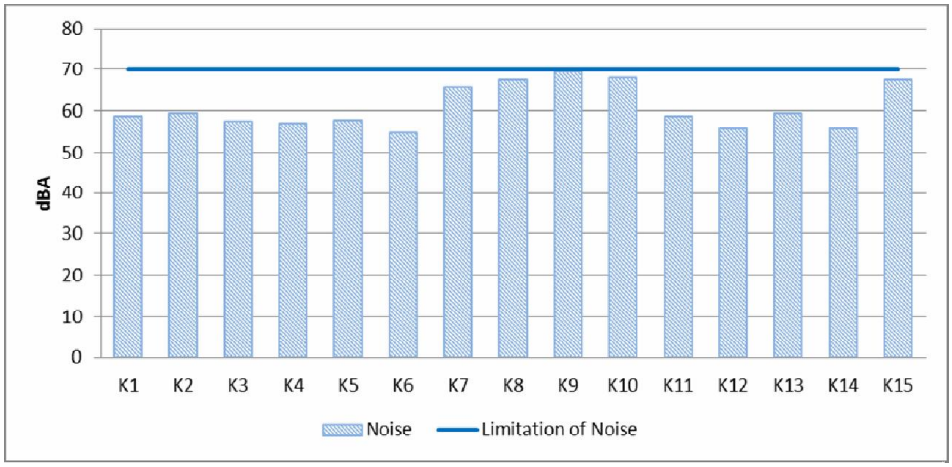

Figure 3.8. Noise level at the survey points

The positions K7, K8, K9, K15 are located closely to the route through the Thu Thiem Bridge, Phu My Bridge, East-West Highway, connecting District 2 to District 1 and District 7 with crowded vehicles, especially, there are more heavy trucks. Therefore, the noise level is approximately equal to the national regulation level.

3.1.5. Water quality

Water quality in the project area is evaluated based on two different sets of data sources, including:

- The data on the water quality collected by the EIA report's consultant, which is used to assess the current status of water quality in the project area;
- The data on the water quality collected by CDM consultant, who used to evaluate the effectiveness of Ho Chi Minh City's Sanitation Projects - Phase 1.

3.1.5.1. Surface water

The national technical regulation on surface water quality QCVN 08:2008/BTNMT is applied for evaluation of monitored results, including:

- Column A1 – Suitable for domestic water supply purposes and for other purposes such as A2, B1 and B2;
- Column A2 - Suitable for domestic water supply purposes after applying the appropriate treatment technologies, as well as suitable for purposes of conservation of aquatic plants or other purposes such as B1 and B2;
- Column B1 – Suitable for the irrigation purpose or other purposes with requirement of the similar water quality or other purposes such as B2;
- Column B2 – Suitable for waterway transportation and other purposes with the requirement of low quality water.

Table 3.1. The limit value of surface water quality parameters according to QCVN 08:2008/BTNMT

No.	Parameter	Unit	Limit Value			
			A		B	
			A1	A2	B1	B2
1	pH		6-8.5	6-8.5	5.5-9	5.5-9
2	DO	mg/l	≥ 6	≥ 5	≥ 4	≥ 2
3	TSS	mg/l	20	30	50	100
4	COD	mg/l	10	15	30	50
5	BOD_5 (20^oC)	mg/l	4	6	15	25
6	Amoni (NH^+_4) (N)	mg/l	0.1	0.2	0.5	1
7	Clorua (Cl^-)	mg/l	250	400	600	-
8	Florua (F^-)	mg/l	1	1.5	1.5	2
9	Nitrit (NO^-_2) (N)	mg/l	0.01	0.02	0.04	0.05
10	Nitrat (NO^-_3) (N)	mg/l	2	5	10	15
11	Phosphat (PO_4^{3-})(P)	mg/l	0.1	0.2	0.3	0.5
12	Xianua (CN^-)	mg/l	0.005	0.01	0.02	0.02
13	Asen (As)	mg/l	0.01	0.02	0.05	0.1
14	Cadimi (Cd)	mg/l	0.005	0.005	0.01	0.01
15	Chì (Pb)	mg/l	0.02	0.02	0.05	0.05
16	Crom III (Cr^{3+})	mg/l	0.05	0.1	0.5	1
17	Crom VI (Cr^{6+})	mg/l	0.01	0.02	0.04	0.05
18	Cu	mg/l	0.1	0.2	0.5	1
19	Zn	mg/l	0.5	1.0	1.5	2
20	Niken (Ni)	mg/l	0.1	0.1	0.1	0.1
21	Fe	mg/l	0.5	1	1.5	2
22	Hg	mg/l	0.001	0.001	0.001	0.002
24	Oils & grease	mg/l	0.01	0.02	0.1	0.3
31	E. Coli	MPN/100ml	20	50	100	200
32	Coliform	MPN/100ml	2,500	5,000	7,500	10,000

(1). In the project area (interceptor and wastewater treatment plant location)

In order to assess the current status of surface water quality at the vicinity of sewer interceptor and wastewater treatment plant, surveys were conducted on September 06, 2010 on the canals at positions from NM21 to NM30 (See Table IV.6, Appendix IV). The map of the surface water sampling locations is presented in Figure 3.9.

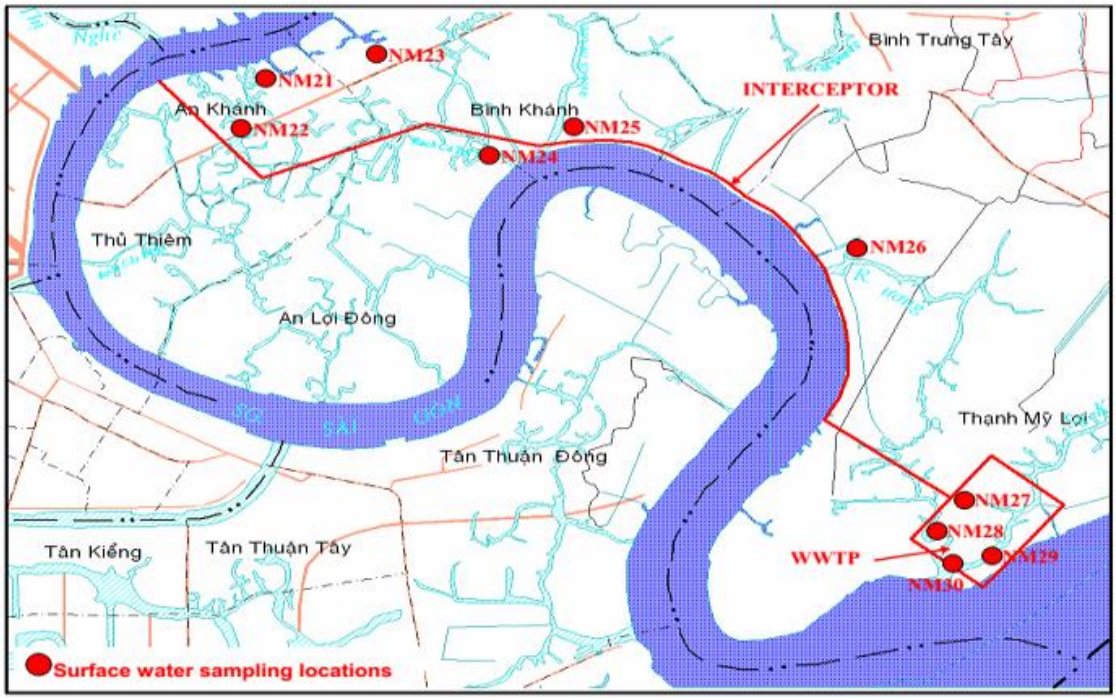

Figure 3.9. Map of surface water sampling locations

The analyzed results in Table IV.5, Appendix IV shown that all samples have high levels of COD and BOD exceeding of allowable limits. At the positions NM24 and NM28, COD concentration exceeds 2 times, BOD concentration exceeds 2.33 times comparing with QCVN 08:2008/BTNMT, column A2 (See Figure 3.10). However, these values are still within the regulation QCVN 08:2008/BTNMT, column B1.

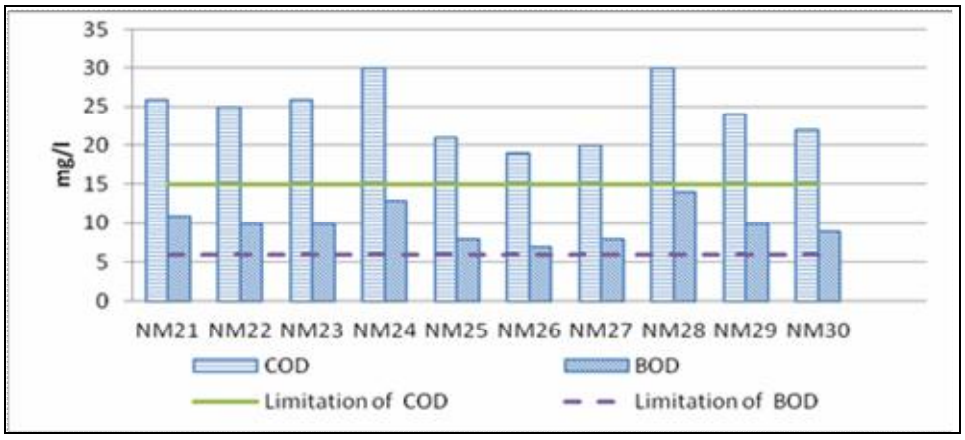

Figure 3.10. The COD, BOD5 concentrations in the survey points, compared with QCVN 08:2008/BTNMT, columnA2

Furthermore, surface water in some locations is still contaminated by $N\text{-}NO_2$, such as from NM21 to NM25; position NM22 ($N\text{-}NO_2$: 0.19 mg/l) and position NM25 ($N\text{-}NO_2$: 0.21 mg/l) have higher concentration compared with other positions.

The survey samples at the positions NM21, NM22, NM23 have $P\text{-}PO_4^{3-}$ concentrations higher than the allowable limits, showed in Figure 3.11. Especially at position NM23, concentration reached 0.36 mg/l being higher than the regulation QCVN 08:2008/BTNMT, column A2 by 1.8 times but still lower than these of column B1. It is highest pollution place in the project area.

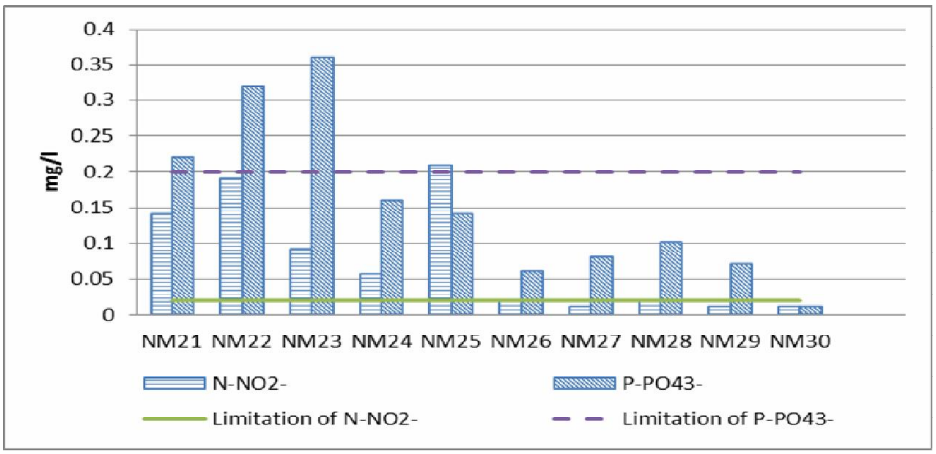

Figure 3.11. The concentration of N-NO_2, P - PO_4^{3-} at the sample locations compared to QCVN 08:2008/BTNMT, column A2

Eight of 10 sample positions have N-NH_4^+ concentration exceeding allowable limits, those positions are NM21 (4.72 mg/l higher than 23.6 times); NM23 (3.51 mg/l higher than 17.55 times) and NM26 (1.75 mg/l higher than 8.75 times), which shows that eutrophication is taking place in surface water (See Figure 3.12). Concentrations of the most samples were higher than QCVN 08:2008/BTNMT, column A2 (except sample NM24, NM25). It is shown that the water in this area is contaminated by ammonium.

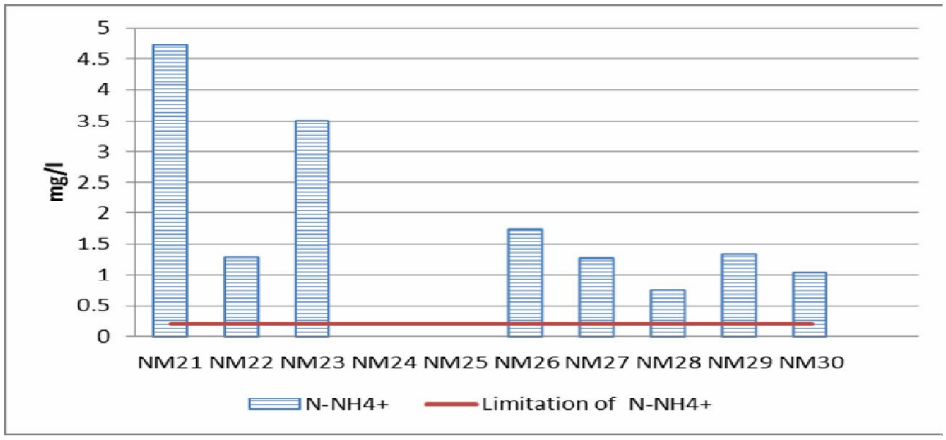

Figure 3.12. The concentration of N-NH4+ at the sample locations compared to QCVN 08:2008/BTNMT, column A2

Simultaneously, microorganisms exceeded the allowable limits in some sample points; for example, position NM23, in canal of Binh Khanh Ward, District 2, has number of bacteria exceeded 7.8 times more than the regulation. Besides, there is heavy metal contamination such as Fe, Pb, Cd, Ni, especially As in the surface water of the project area. Arsenic concentration is higher than limit in QCVN 08:2008/BTNMT – Column A2, found at positions NM21, NM22, NM26 and NM27. The highest concentration of As is at position NM22 about 0.196 mg/L. Arsenic may enter water source from industrial wastewater.

The pollution is caused by the operation of the Ben Nghe port, Cat Lai Port, Tan Thuan and Cat Lai Industrial Zone, etc. around the sampled areas. In addition, sewage, garbage from residential areas directly flows into the canals and makes increase of the content of organic matters in water. Moreover, at positions NM26, NM27, NM28, Cl^- concentration is high due to the saline or alum intrusion.

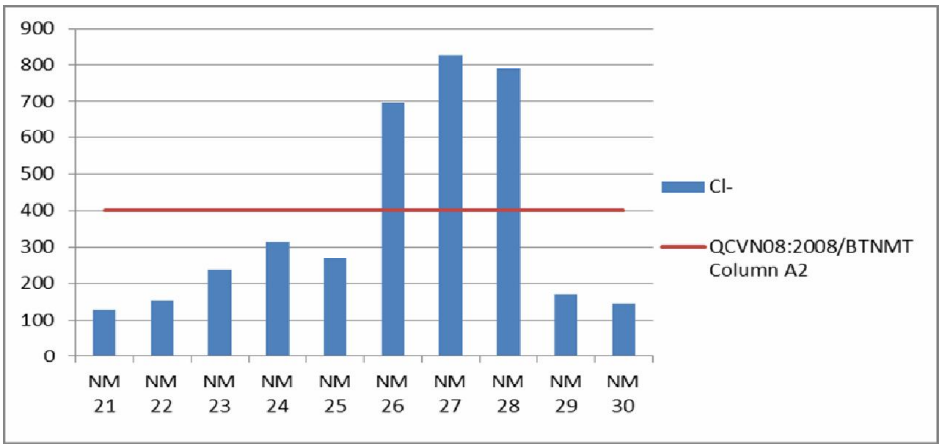

Figure 3.13. Cl- concentrations in the survey locations

(2). Basic condition of water quality of the Sai Gon-Dong Nai River

To assess the water quality of the Sai Gon River at high tide and low tide, Center for Environmental Technology within Institute for Environment and Resources have carried out sampling and analyzing on 23-24 October 2010. Sampling locations on the Sai Gon - Dong Nai River are shown in Table IV.4, Appendix IV and Figure 3.14 as follow:

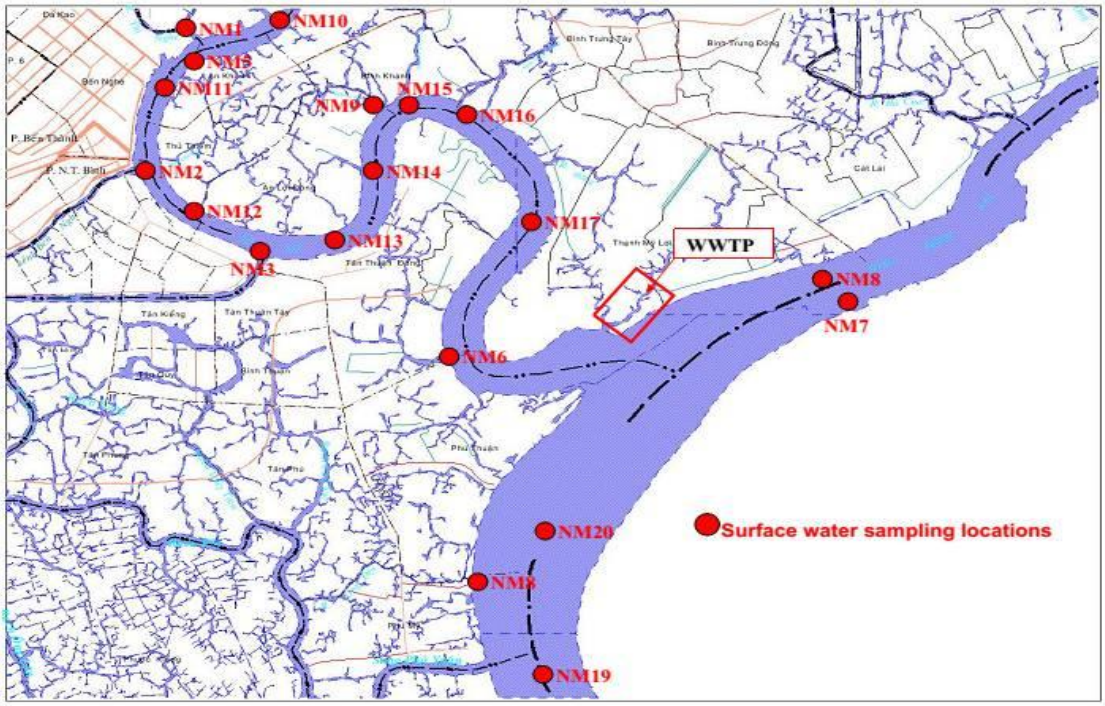

Figure 3.14. Map of the Sai Gon-Dong Nai River water sampling locations

Analysis results in Table IV.3, Appendix IV shown that the river waters at sampled points are contaminated by pollutants such as DO, BOD, COD, TSS, N-NH_4^+, N-NO_2^-, P-PO_4^{3-}, Cl^-, As, Fe, total oil, Coliform. In particular, BOD and COD concentrations in most samples exceeded QCVN 08:2008/BTNMT-Column A2 in the high tide and low tide (See Figures 3.15 and 3.16).

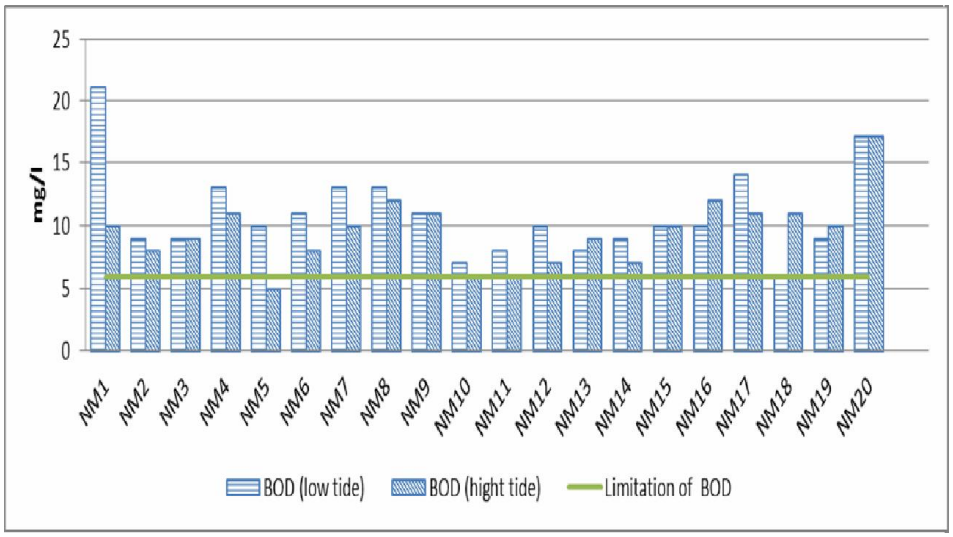

Figure 3.15. BOD concentrations at the sampling sites in the Sai Gon – Dong Nai River (compared with QCVN 08:2008/BTNMT – Column A2)

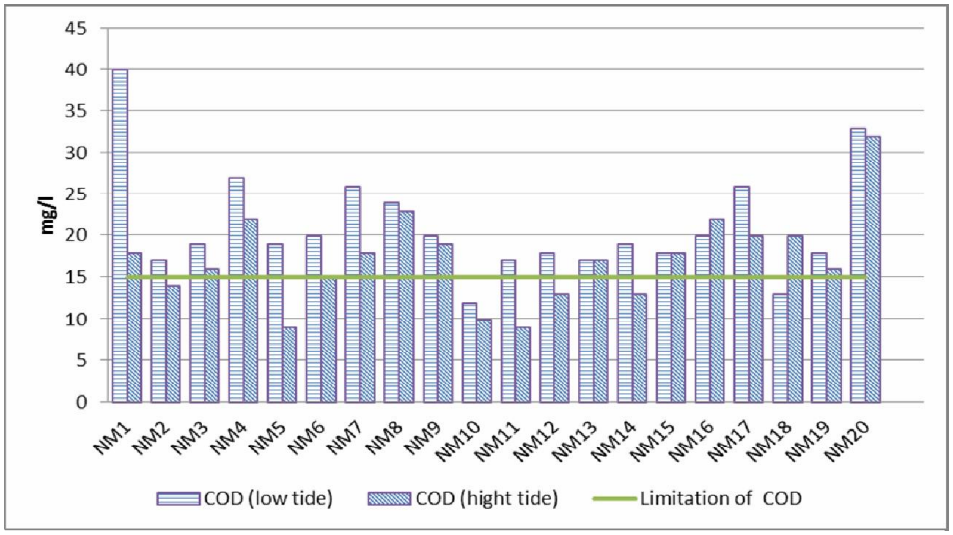

Figure 3.16. COD concentrations at the sampling sites in the Sai Gon – Dong Nai River (compared with QCVN 08:2008/BTNMT – Column A2)

The highest concentration of sampled point near Thi Nghe canal (NM1) exceeds 2.0 times to QCVN 08:2008/BTNMT – Column A2. Thi Nghe canal has polluted because it daily receives wastewater from the inner sewer in HCM city.

In addition, Arsenic was found in 15 samples of 20 samples in the Sai Gon - Dong Nai River. At the time of low tide at sampling positions NM4, NM6, NM9 and NM13, Arsenic concentration is higher from 1.05 to 1.35 times than permitted regulation. Besides, at the high tide, Arsenic pollution at sampling points NM12, NM13, and NM18 is exceeding the regulation and equivalent to that at the low tide (See Figure 3.17).

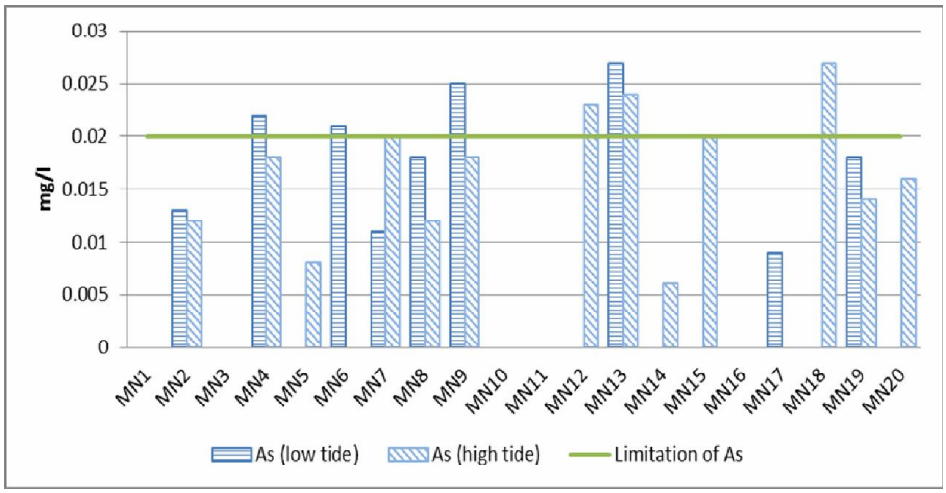

Figure 3.17. Arsenic concentrations in the Sai Gon – Dong Nai River (compared with QCVN 08:2008/BTNMT – Column A2)

Arsenic may be naturally occurring and that is why it is showing up in the water but it is not generated from domestic wastewater.

Moreover, $N\text{-}NO_2^-$ contaminates the river water (See Figure 3.18). At the time of high tide, the $N\text{-}NO_2^-$ concentration reaches the highest value near to the Nha Rong port (NM12) and Te canals (NM3), about 5.5 times higher than the QCVN 08:2008/BTNMT - Column A2. In the low tide, in the region of Phu My Bridge and the Tan Thuan Port, water is contaminated with concentrations higher than the regulation and is equivalent to that at high tide.

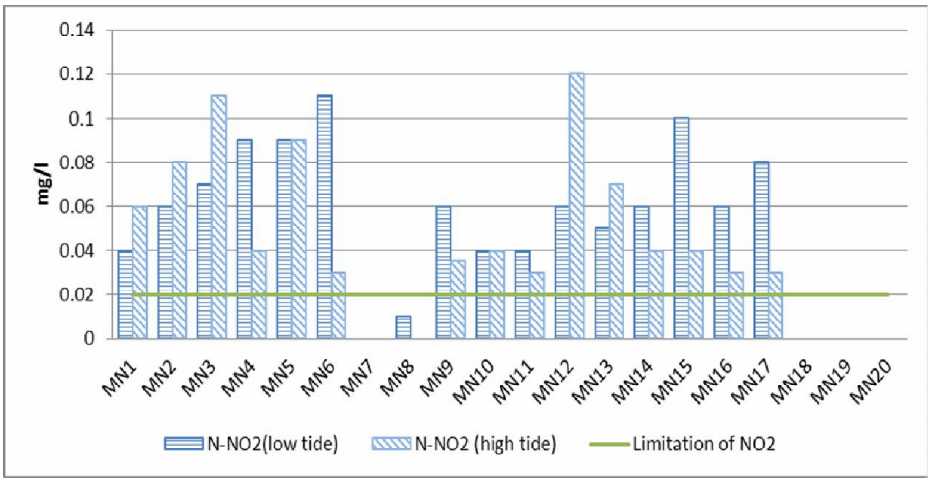

Figure 3.18. N-NO2- concentrations in Sai Gon – Dong Nai River (compared with QCVN 08:2008/BTNMT – Column A2)

There is a large difference in Fe concentrations at high tide and low tide. Analysis data shown that 18/20 samples have Fe concentrations higher than QCVN 08:2008/BTNMT – Column A2 (See Figure 3.19).

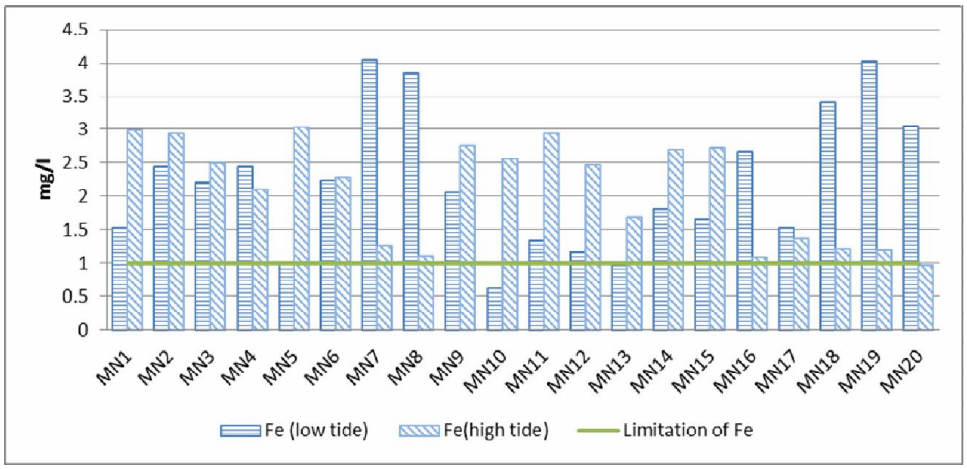

Figure 3.19. Fe concentrations in the Sai Gon – Dong Nai River (compared with QCVN 08:2008/BTNMT – Column A2)

Besides, the concentration of $N\text{-}NH_4^+$ is exceeded the allowable limits, especially at low tide, heavily contaminated areas are near to the Thi Nghe canal (NM1), Giong Ong To canal (NM4), near to Ba Son port (NM11), etc, which caused the water eutrophication (See Figure 3.20).

Conclusion: In the general, the Sai Gon river is contaminated by organic matter (BOD, COD), nutrients (nitrogen, phosphorus) and coliform at almost sampling locations.

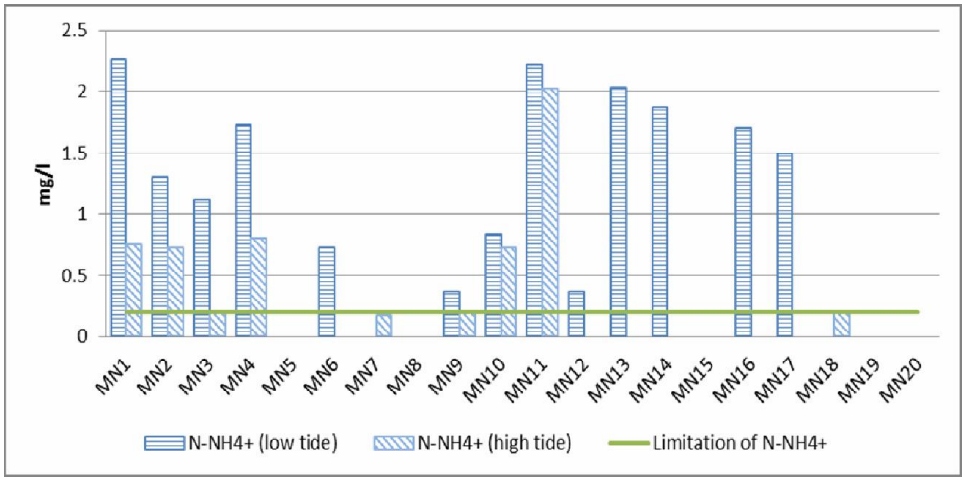

Figure 3.20. N-NH4+ concentrations in the Sai Gon – Dong Nai River (compared with QCVN 08:2008/BTNMT – Column A2)

(3). Surface water quality monitored by CDM consultant in the framework of HCM ESP1

CDM Consultants had carried out the surface water quality monitoring survey in the Sai Gon River at 4 sampling points (NM1-SG, NM2-SG, NM3-SG, NM4-SG) and Nhieu Loc-Thi Nghe canal at 6 points, including Thi Nghe 1 Bridge, (NL-TN1), Dien Bien Phu Bridge, (NL-TN2), Kieu Bridge, (NL-TN3), Le Van Sy Bridge, (NL-TN4), Xe Lua Bridge, (NL-TN5); Pham Van Hai Bridge, (NL-TN6) in June, 2012 and March, 2013 (See Figure V.4, Appendix V). The surface water quality at 4 sampling points in the Sai Gon river will be compared with the QCVN 08:2008/BTNMT, column A2, while that at 6 sampling points in the Nhieu Loc-Thi Nghe canal will be compared with QCVN 08:2008/BTNMT, Colum B2.

(a). Surface water quality of the Sai Gon River

Monitoring results of the Sai Gon River water quality are presented in Table V.7, Appendix 5 and Figures 3.21-3.24.

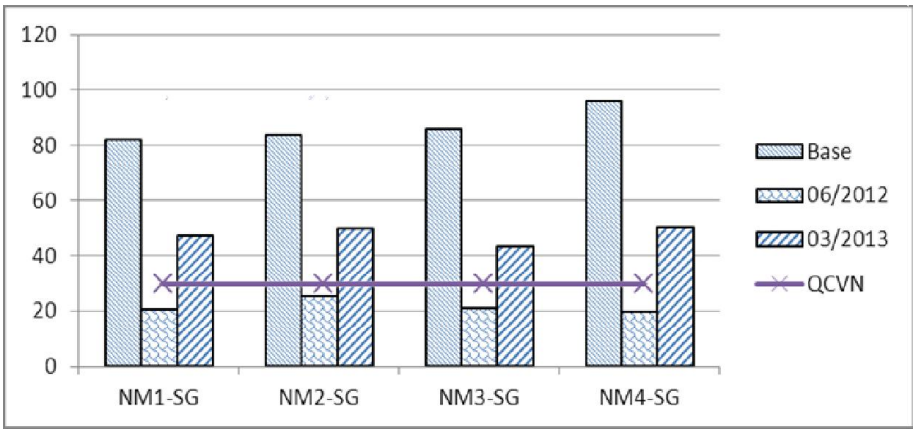

Figure 3.21. TSS concentrations in the Sai Gon River water in June 2012 and March, 2013 (compared with the background concentration and QCVN 08:2008/BTNMT – Column A2)

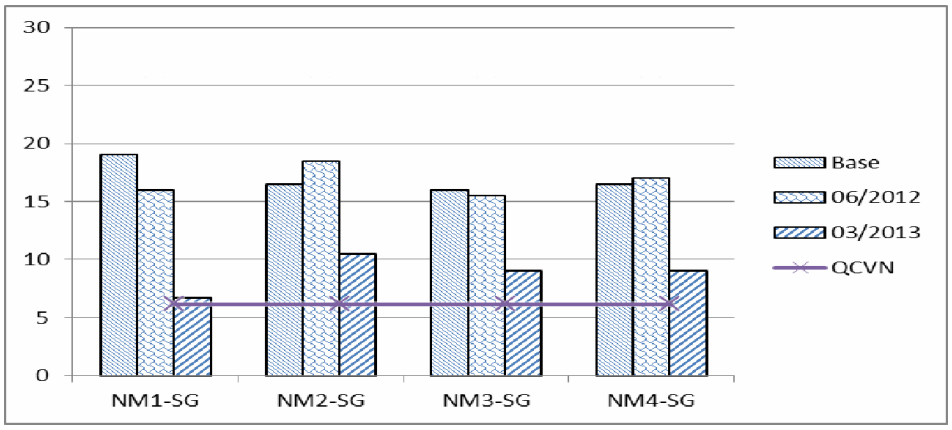

Figure 3.22. BOD concentrations in the Sai Gon River water in June 2012 and March, 2013 (compared with the background concentration and QCVN 08:2008/BTNMT – Column A2)

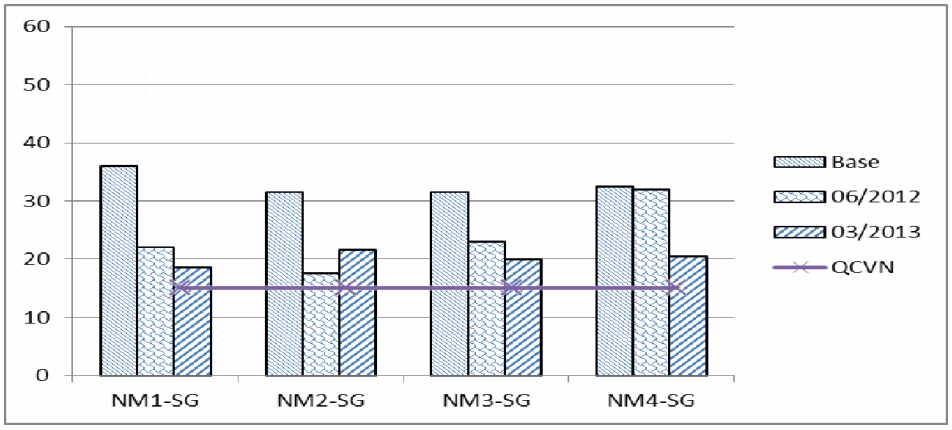

Figure 3.23. COD concentrations in the Sai Gon River water in June 2012 and March, 2013 (compared with the background concentration and QCVN 08:2008/BTNMT – Column A2)

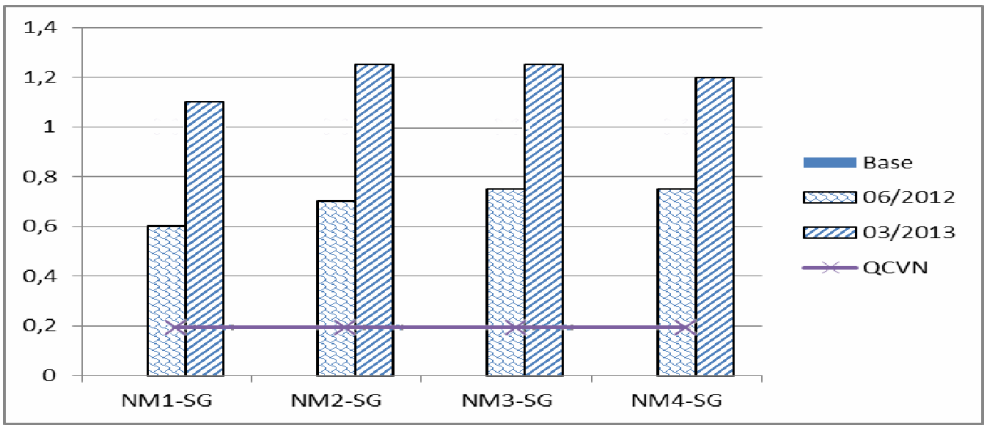

Figure 3.24. Ammonia concentrations in the Sai Gon River water in June 2012 and March, 2013 (compared with the background concentration and QCVN 08:2008/BTNMT- Column A2)

Comparing the monitoring results of the Sai Gon River water with QCVN 08:2008/BTNMT column A2 shows that concentrations of TSS, BOD, COD, Ammonia parameters are higher than the national technical regulation QCVN 08:2008/BTNMT- Column A2.

(b). Surface water quality of the Nhieu Loc – Thi Nghe Canal

The 48-hour monitoring results of Nhieu Loc-Thi Nghe canal water quality is presented in Table V.8, Appendix V. The location of sampling on Nhieu Loc - Thi Nghe canal as figure 3.25.

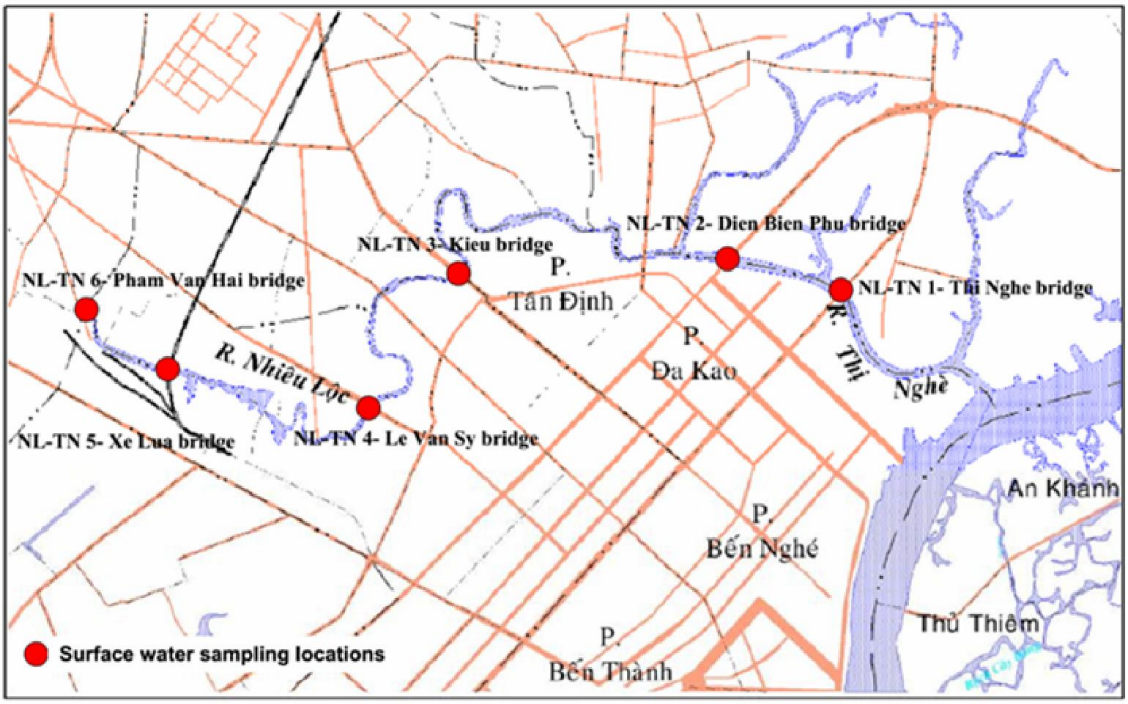

Figure 3.25. The location of sampling on Nhieu Loc - Thi Nghe canal

Comparing the monitoring results of pH, TSS, DO, COD, BOD, Ammonia, Total coliform in the Nhieu Loc-Thi Nghe canal water with QCVN 08:2008/BTNMT column B2 shown that:

- Surface water quality at Thi Nghe 1 Bridge: Concentrations of the most parameters at

the most monitoring times are lower than the regulations, except DO, which did not meet the regulation.

- Surface water quality at Dien Bien Phu Bridge: Concentrations of the most parameters at the most monitoring times are lower than the regulations, except DO, which did not meet the regulation.
- Surface water quality at Kieu Bridge: Concentrations of the most parameters at the most monitoring times are lower than the regulations, except DO, which did not meet the regulation.
- Surface water quality at Le Van Sy Bridge: Concentrations of COD, BOD_5 are exceeded the technical regulation from 1.1 to 2.3 times and 1.24 to 2.72 times. Ammonia concentration is higher than the permissible limit from 1.96 to 44.24 times. The remaining parameters met the allowable limits, but those are exceeded at some instance.
- Surface water quality at Xe Lua Bridge: Concentrations of COD, BOD_5 are exceeded the technical regulation from 1.2 to 3.0 times and 1.6 to 2.5 times. Ammonia concentration is higher than the permissible limit from 11.0 to 40.5 times. The remaining parameters met the allowable limits, but these are exceeded at some instance.
- Surface water quality at Pham Van Hai Bridge: Concentrations of COD, BOD_5 are exceeded the technical regulation from 1.1 to 2.4 times and 1.2 to 2.6 times. Ammonia concentration is higher than the permissible limit from 1.96 to 29.68 times. The remaining parameters met the allowable limits.

Since the monitoring data were collected by CEFINEA and CDM at different locations and different times, therefore those cannot be compared.

3.1.5.2. Ground water quality

The ground water quality of project area has been assessed through sample and analysis of the survey team with a combination of investors and the Institute for Environment and Resources on 06 September 2010. Sample positions are described in Table IV.10, Appendix IV and sampling locations as shown below (Figure 3.26).

The analysis results of underground water (Table IV.9, Appendix IV) indicate that in several survey locations the underground water contains As, Mn, Fe, Cl^-. Underground water sample NN4 at 702/11 Nguyen Thi Dinh, Thanh My Loi ward, District 2, As concentration was 0,0061mg/l, it was more 1,22 times than QCVN 09:2008/BTNMT. At Cat Lai Port, NN3 sample, Arsenic concentration was approximate at the level required by regulation; Fe and Mn concentration were higher than allowable limit. The presence of coliform in the groundwater indicates that the leaking septic tanks or sewer may cause groundwater pollution.

Currently, there is no official report on why Arsenic infected the underground water in this area. Besides that, Cl^- concentration which was in underground water was higher than limit value at NN1, NN3, NN5 locations. Especially, at NN5 location, Cl- concentration was 965 mg/l, was higher 3.86 times than limit. The water resources having high chloride concentration can corrode metal and damage crops; reducing the lifespan of concrete works. Chloride makes salty taste for water, and it more or less affecting food chain and living purpose.

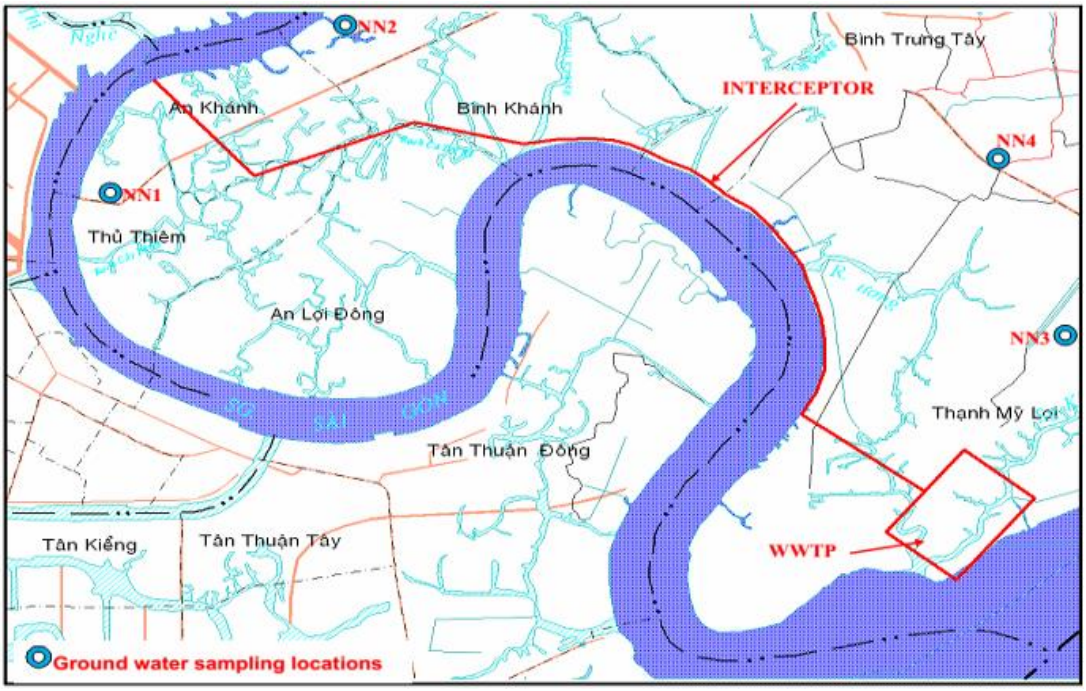

Figure 3.26. Map of the ground water sampling locations

3.1.6. Soil quality

In the process of construction, it will dispose of excavated materials for construction of interceptor sewers and the treatment plant. The Centre for Environmental Technology within Institute of Natural Resources and Environment have taken some soil samples at the area where WWTP is proposed to assess the pollution levels of soil, which can be reused for agricultural or leveling purposes. The sample sites are presented in Table IV.12, Appendix IV and sampling locations as shown below (Figure 3.27).

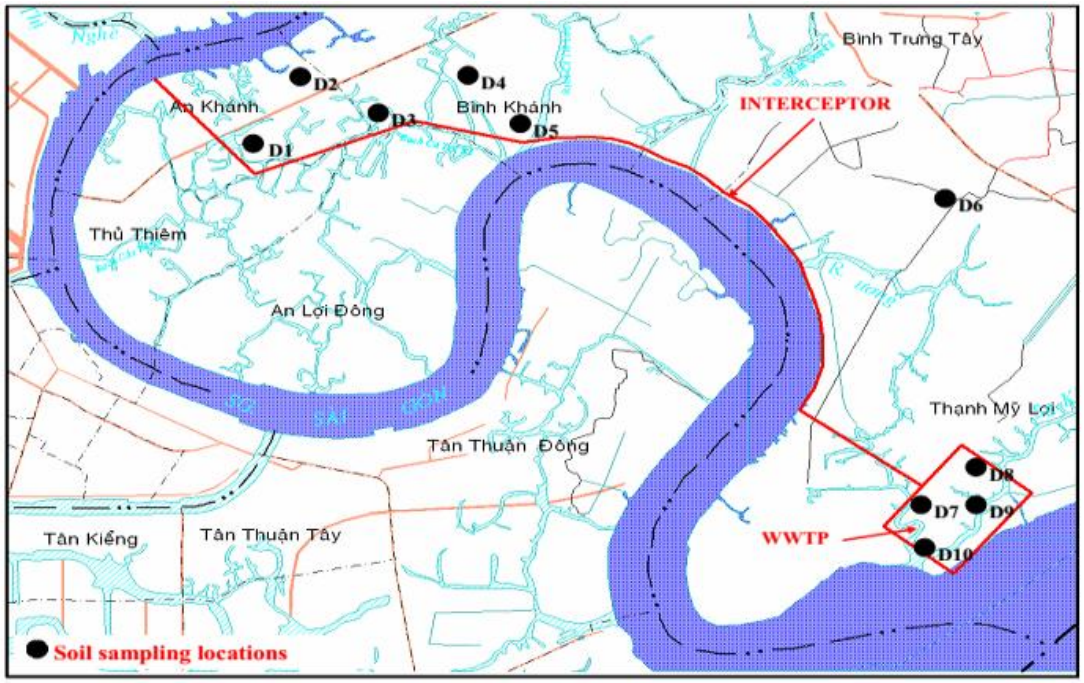

Figure 3.27. Map of the soil sampling locations

Soil samples were taken on the surface, at every position with 5 points, distributed evenly over an area of 1 km^2.

The analysis results of major components and heavy metals in soils (See Table IV.11, Appendix IV) shown that pH_{KCl} range from 3.74 to 8.04, in the form of acidic soils and alkaline soils. Especially, soil sample D3 has a high acidity. Thus, this land loses the capacity of absorption and preservation of soil nutrients.

Most collected soil samples has a humidity > 30% so they have a good moisture-holding capacity. Soil moisture is quite high because of water penetration from the surrounding rivers and canals as well as the flood at high tide time.

The concentrations of minerals in the soil showed that: at the project area, soil is potassium-rich and protein concentration is quite high, but the total amount of phosphorus (P_2O_5) in the surface soil is moderate. The heavy metal concentrations in soil are lower than the regulation for land which is used for agriculture and other purposes (See Appendix IV, Table IV.11). So the amount of soil excavated from the sewer installation or the construction of the WWTP location can be utilized for agriculture and other purposes, such as leveling, filling in hollows.

3.2. BIOLOGICAL CONDITIONS

During operation of HCMC ES2 project, wastewater treatment plant will affect most of aquatic systems, plant and animal plankton, zooplankton; they are the indicators assessing pollution level of river water in the long time. Therefore, the researchers has conducted sample at the upstream as well as the downstream of discharge points in NLTN Project - Phase 1, the downstream of wastewater receiving points was expected in Thu Thiem new urban area.Additional site survey was conducted at the WWTP areato evaluate biological conditions at the 38 ha where the plant will be constructed. The survey did not indicateanyendangered species in the location of the treatment plant.

The sample sites will be identified to assess current pollution levels of Sai Gon - Dong Nai - Nha Be water river. The map of the biological sampling locations on the Sai Gon - Dong Nai River is presented in Figure 3.28.

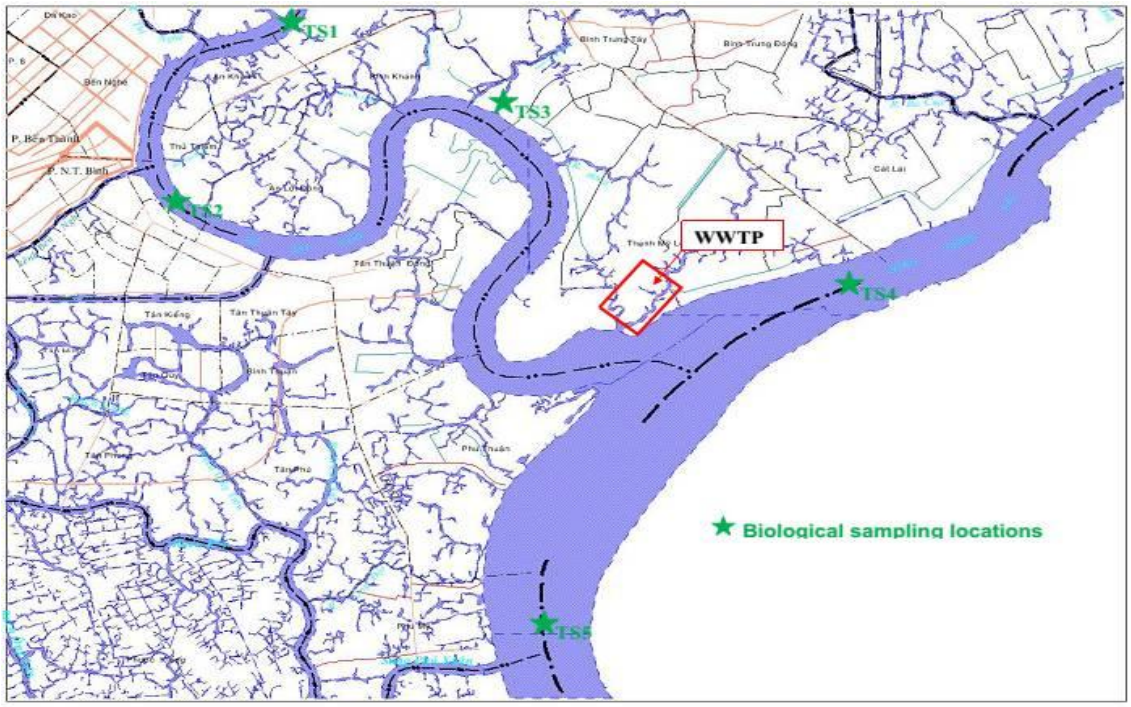

Figure 3.28. Map of the biological sampling locations

3.2.1. Flora

The results of the quantitative analysis of the flora samples collected at 5 sample sites within the project area in the Saigon River (See Figure V.7, Appendix V) shown that there are 72 species belonging to 4 different divisions of phytoplankton were recorded. Among the algal assemblage, diatoms (Bacillariophyta) were dominant with 43 species (gaining 59.72% of total species number), followed by green algae (Chlorophyta) with 15 species (20.83%), cyanobacteria (Cyanophyta or blue-green algae) with 11 species (15.28%) and euglenoids (Euglenophyta) with 3 species (4.17%) (Table 3.2).

Table 3.2. Species composition structure of phytoplankton in the project area

Divisions	Species number	Percentage (%, compared to total)
Cyanobacteria	11	15.28
Bacillariophyta	43	59.72
Chlorophyta	15	20.83
Euglenophyta	3	4.17
Total	72	100

Among the recorded diatoms, many of them are characterized for brackish or saline water, including Actinoptychus annulatus, Cosciconidcus spp., Leptocylindrus danicus, Rhizosolenia styliformis, Triceratium favus, Pleurosigma angulatum, Gyrosigma sinensis etc. Besides those, several species of green algae, euglenoids and cyanobacteria, which are typical for freshwater are also occurred at the sample sites like Scenedesmus spp., Tetraedron, Actinastrum, Micractinium, Phacus, Euglena, Microcystis. The analysis data indicated that the water environment at the sampling sites is mixed between freshwater from inland and marine water from the Indochina Sea. Additionally, it could be seen that the effect of brackish or marine water from the sea was stronger than that of freshwater based on the species composition of phytoplankton recorded at most sample sites except the site 3.

Species number of phytoplankton at each site ranged from 19-31 species, highest at site S1 and lowest at site S2. In general, the recorded number of species at the sites was not high even in running water condition. Therefore, water quality at the sampling sites should be negatively affected. Phytoplankton density at the sampling sites ranges from 5075-419155 individuals per liter, which is highest at the site S3 and lowest at the site S4. The density was quite high at the sites S5 and S3 but in range of normal or a little low at the remaining sites in river conditions. Dominant species at the sites were *Melosira granulata* (a diatoms species dominant at 4/5 sites) and *Microcystis botrys* (a cyanobacterial species, dominant at site S2). Both dominant species are typical for and favorable with seasonal conditions like reservoir and lake. However, they were dominant at sample sites in Saigon River. Hence, the water is from in land water and Dau Tieng Reservoir in rainy season.

The presence and dominance of *M. botrys* at site S2 had better been considered due to their potential of toxin production, which strongly and negatively effects on aquatic organisms and human health.

3.2.2. Fauna

The analysis of the phytoplankton, zooplankton, protozoa and macro invertebrates' samples collected at 5 sample sites within the project area in Saigon River shown that there are 72 species of the phytoplankton and 39 species of zooplankton (See Figure V.7, Appendix V). Recorded species belonged to four main groups *Arthropoda, Aschelminthes*, *Ciliophora* and *Sarcomastighor*a. Species of Aschelminthes were dominant at the sample sites in terms of numbers (21species, gaining 48.84% of total). The division Ciliophora contributed 7 species, Sarcomastighora did 6 species and Arthropoda did 5 ones into the total 39 species of the found macro invertebrates (Table 3.3). additionally, four larvae of *Nauplius Copepoda,*

Gastropoda, Bivalvia and *Polychaeta* were also recorded at the 5 sites.

The fresh water's Rotatoria had widely distribution. Many of them have recorded in all sites such *as Anuraeopsis fissa Brachionus angularis, Brachionus plicatilis, Polyarthra vulgaris, Polyarthra sp., Filinia longiseta*. One crustaceanspecies of brackish water, *Pseudodiaptomus incisus (Copepoda)*, has also been found. In addition, Protozoa species were also recorded at the 5 sample sites, such as *genus Difflugia, Tintinnopsis, Cyttarocylie*. Occurrence of species *Philodina sp. and Rotaria spp. (Rotatoria)* at sites TS2, TS3, and TS4, indicate for organic pollution.

Table 3.3. Species (protozoa, invertebrates) in the project area

Groups/Divisions	Species number	Percentage (%, compared to total)
Arthropoda	5	11.63
Aschelminthes	21	48.84
Ciliophora	7	16.28
Sarcomastighora	6	13,95
Lavar	4	9,30
Total	43	100

.

Within the sample collection at the 5 sample sites in Saigon River, 11 species belonging to 4 classes, Polychaeta (5 species), Oligochaeta (2 species), Bivalvia (1 species) and Crustacea (3 species), of benthic macroinveterbrates were identified. Among the recorded macro invertebrates the Polychaeta group was dominant in species numbers (5 species, gaining 45.4% of total (Table 3.4).

Table 3.4. Species composition structure of macro invertebrates in the project area

Classes	Species number	Percentage (%, compared to total)
Polychaeta	5	45.4
Oligochaeta	2	18.2
Bivalvia	1	9.1
Crustacea	3	27.3
Total	11	100

Within the sample area, the recorded macro invertebrates included brackish and/or marine species such as Nephthys polybranchia, Maldane sarsi, Owenia fusiformis, Neanthes caudate, Bispira polymorpha, Melita sp., Grandidierella lignorum and Alpheus bisincius are immigrating into inland. Besides, some freshwater species were also found in this area like: Limnodrilus hoffmeisteri, Branchiura sowerbyi. Most of species presenting at sites 4 and 5 are typical for brackish water reflecting that these two sites have strongly influenced by the tide from the sea.

The species *Bispira polymorpha (Polychaeta)* and *Limnodrilus hoffmeisteri, Branchiura sowerbyi (Oligochaeta)* occurring at the sites 1, 2, 3 and 5 characterized for organic polluted conditions so that the sample sites were negatively affected and polluted by human activities (e.g. industrial and domestic ones). Species numbers of macro invertebrates recorded at each sample site ranged 3 – 5 species, highest at site 5 and lowest at sites 1 and 2. Generally, the recorded species numbers at each site were not highly compared to the normal and natural conditions of running water. It means the bottom river conditions at the sample sites of the project area negatively affected and pollution could be the reason for the low species numbers of macro invertebrates found.

The density of macro invertebrates ranged from 210 – 3610 individuals per m2, highest at the site 1 and lowest at the site 4 (see analysis results). Dominant species were *Limnodrilus*

hoffmeisteri (dominant at sites 1, 2 and 3), *Maldane sarsi* (dominant at site 4) and *Owenia fusiformis* (dominant at site 5). In general, the dominant species are characteristic for rich organic and low brackish conditions. However, there are no endangered species at the project area that could be impacted by the WWTP construction and operation.

The area of the future WWTP (38 ha) is characterized by shrubs swamp, which is not a natural habitat for migratory birds or any protected species. Common vegetation seen at the site includes shrubs and nipa without any mangrove species. The area has general characteristics of a swamp land.

3.2.3. Biological Ecosystem in Can Gio District, Ho Chi Minh City

Covering an area of over 70,000 ha, of which 35,000 ha is salt-watered forest; Can Gio has been recognized as a biosphere reserve of the world by the United Nations Educational, Scientific and Cultural Organization (UNESCO). It is situated 50km away from southeast of downtown Ho Chi Minh City.

There are 52 true and associate mangrove species, 200 animal species, hundred fish, crab, shrimp species and benthos. Over 40 bird species including shore birds and migratory species have been found in this biosphere reserve.

The mangrove forest gives a lot of ecological services including protecting the shore lines, extension of mud flats and as a “green wall’ to protect the city from storm surges, typhoons and sea level rise.

Since Can Gio Mangrove Forest is located in distance of about 20-30 km from the WWTP site, the treated sewage discharged from the WW will be strongly diluted by the river water, therefore, surface water quality in Can Gio Mangrove Forest cannot be affected by the WWTP, consequently, the project activities are not expected to impact on the Can Gio biosphere reserve.

3.3. SOCIO-ECONOMIC CONDITIONS

The project area is located in District 2 including 6 wards: Thu Thiem and Binh Khanh, An Khanh, An Loi Dong, Binh Trung Tay and Thanh My Loi.

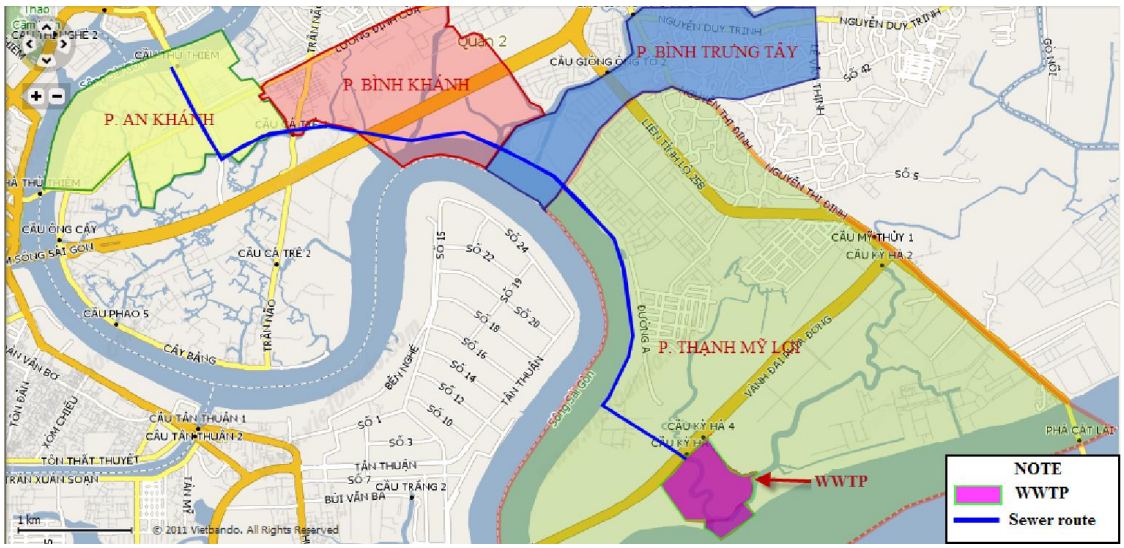

Figure 3.29. Location of wards along the interceptor

3.3.1. Social conditions

3.3.1.1. Population

According to the population census in 1/4/2009 at 6 Ward that the project area passes through, the population of 6 wards is presented in Table 3.5.

Table 3.5. Population in the Project area

Ward	Household	Population		
		Total	Male	Female
Thu Thiem	1,155	5,267	2,379	2,888
Binh Khanh	2,103	8,767	4,224	4,543
An Khanh	3,637	15,659	7,598	8,061
An Loi Dong	1,437	5,710	2,873	2,837
Binh Trung Tay	4,625	18,082	8,804	9,278
Thanh My Loi	3,210	12,468	6,227	6,241
Total	16,167	65,953	32,105	33,848

Source: The population census in 1/4/2009

3.3.1.2. Impacted households

The types of land at the interceptor alignment and at the WWTP are described in Sections 2.3 and 3.1.

Based on the Feasibility Study report and the technical design of the project, the social assessment is conducted covering the entire project, including four main areas:

(i). The area planned for the construction of the interceptor (approximately 12 km long across: Thu Thiem, An Khanh, Binh Khanh, An Loi Dong, Binh Trung Tay and Thanh My Loi, District 2, Ho Chi Minh City): According to the draft FS (which has not yet approved), the laying of the Interceptor (underground) will not require any land acquisition, nor physical resettlement of households who currently live within the right of way of the Interceptor (14m cross section). However, at 6 shaft locations (to the downstream of the Interceptor), land from existing households may be potentially permanently acquired for the installation of the shaft. Land acquisition is expected to be very minor at each shaft location (which is about 10.5m in diameter). Consultation with these households indicated their support for the shaft installation, in particular, and the Project implementation, in general. During the construction, some temporary land acquisition may be required at some shafts to allow the construction. When construction is finished, the temporarily required land will be returned to the land owners. For the other shaft locations, temporary land acquisition is not required because the shaft site is accessible from existing road and/or Saigon river. All land acquisition (both permanent and temporary will be compensated as per project's Resettlement Policy Framework (RPF).

(ii). At the planned location for the construction of Nhieu Loc- Thi Nghe wastewater treatment plant (located in Thanh My Loi ward, District 2), **in terms of land**, the construction of the this plant wouldrequire the acquisition of 38.47 ha of land, affecting 59 households, and two companies whose project land became part of the WWTP area following the WWTP boundary adjustment. Compensation will be paid to these households and the part of land owned by these two companies (Thanh My Loi JC Company, and Saigon Industrial Zone Development Company). Of the total 38.47ha needed for the WWTP, 31.64ha is from private households and the two companies. The remaining 6.82ha is public land (canal, river, traffic road) for which compensation to government is not required. **With regard to the structures** found on the existing WWTP site, there are a) one restaurant(thatch house) located within an 0.3 highlandplot rent by the restaurant owner from three land owners, b) two temporary thatch houses owned by one households (for occasional crop attendance), and c) 6 graves owned by two households. So, all together, four households having structures (as mentioned above) on land will be affected and will be compensated as per the RAP prepared for the

WWTP. **In terms of trees**(primarily water coconut), an estimated area of 9ha (scattered across the entire WWTP site) would be potentially affected. Water coconut (along with other trees as identified during census survey/detailed measurement survey) will be compensated for, and to those who own the land.

(iii). Impacts on the waters which receive the plant treated wastewater at the upstream and downstream of Dong Nai River (Long Truong ward-District 9, Ho Chi Minh City; Phu Huu and Dai Phuoc communes, Nhon Trach district, Dong Nai province): According to the calculation results of the Model (presented in Chapter5, section 5.4.2.2), the impact on the upstream and downstream of the project is not significant. Wastewater is treated to meet QCVN 08:2008/BTNMT, column A before discharging into the environment.

(iv). Potential impacts on District 2 (where the system of culverts for residential areas in District 2 is planned building to connect the interceptor system of the project (HCMCES2).

In addition, according to the survey conducted by the EIA preparation consultant, mainly from Nhon Trach side, on the opposite side of WWTP, there are few aquaculture households of Phu Huu, Phuoc Khanh, Dai Phuoc communes. However, these areas are relativelyfar from the discharge location (from 8- 12km). The water quality in the area will be monitored during the WWTP operation in line with the EMP and for the purpose to ensure timely mitigation on any potential risks for the city and local residents.

By a variety of methods for collecting information and types of data, this SA report provides an overview of the socio-economic conditions in the project area and potential impacts in where the project will affect (both positive and negative affects). On that basis measures to mitigate project negative impacts to people living in the project area will be proposed. Based on the SA results, thereport provides recommendations to address the potential adverse impact while exploring ways to further enhance the effectiveness of the project.

The social impacts caused by the project activities are referenced to the Feasibility Study – Volume 6: Resettlement Action Plan, June 2013.

3.3.2. Economic conditions

As a result of the city urbanization program, the site clearance has been completed in Thu Thiem Ward, in An Loi Dong Ward. Binh Khanh, An Khanh, and Binh Trung Tay Ward - as reported by such wards - have implemented site clearance from 95% to 100% area and population.

Projects are conducting to build infrastructure in resettlement areas, new residential areas. In which Diamond Island project is in completion stage. Projects have interceptor sewers passing through and specially presented in part No. 1.6. In some areas, there are sensitive subjects such as temples, shrines, but far away the sewer location more than 1 km.

Residents in the area are mainly low-income groups, earning their living by providing services like leasing house, doing small businesses, working for factories, of which 52/97 households (53.6%) have average incomes below 50 USD person/month, 22/97 households (22.7%) have average incomes from 50-70 USD/person/month and 23/97 households have average incomes over 70 USD/person/month.

With geographical location, the situation of urban development planning and economic development plan for 5 years (2006 -2010) of the County, the economic structure in wards are the same: economic structure will change from agricultural to commercial and service.

The economic conditions in the project area are referenced to the Feasibility Study – Volume 6: Resettlement Action Plan, June 2013.

3.3.3. Infrastructure development

3.3.3.1. Drainage system

Ho Chi Minh City's core urban area is divided into five main catchment areas corresponding to the basins of the following drainage canals:

- Nhieu Loc-Thi Nghe;
- Tau Hu - Doi - Te - Ben Nghe Canal;
- Tan Hoa - Ong Buong - Lo Gom Canal;
- Tham Luong - Ben Cat;
- Vam Thuat.

Figure 3.30 shows all of the catchment areas in HCMC, including catchment areas in rural zones. These 9 catchment areas are as follows: Tham Luong – Ben Cat (TLBC); Nhieu Loc – Thi Nghe (NLTN); Tan Hoa – Lo Gom (THLG); Tau Hu – Ben Nghe – Doi – Te (THBNDT); Saigon West (SW); Saigon South (SS); Saigon North I (SN-I); Saigon North II (SN-II); Saigon East (SE).

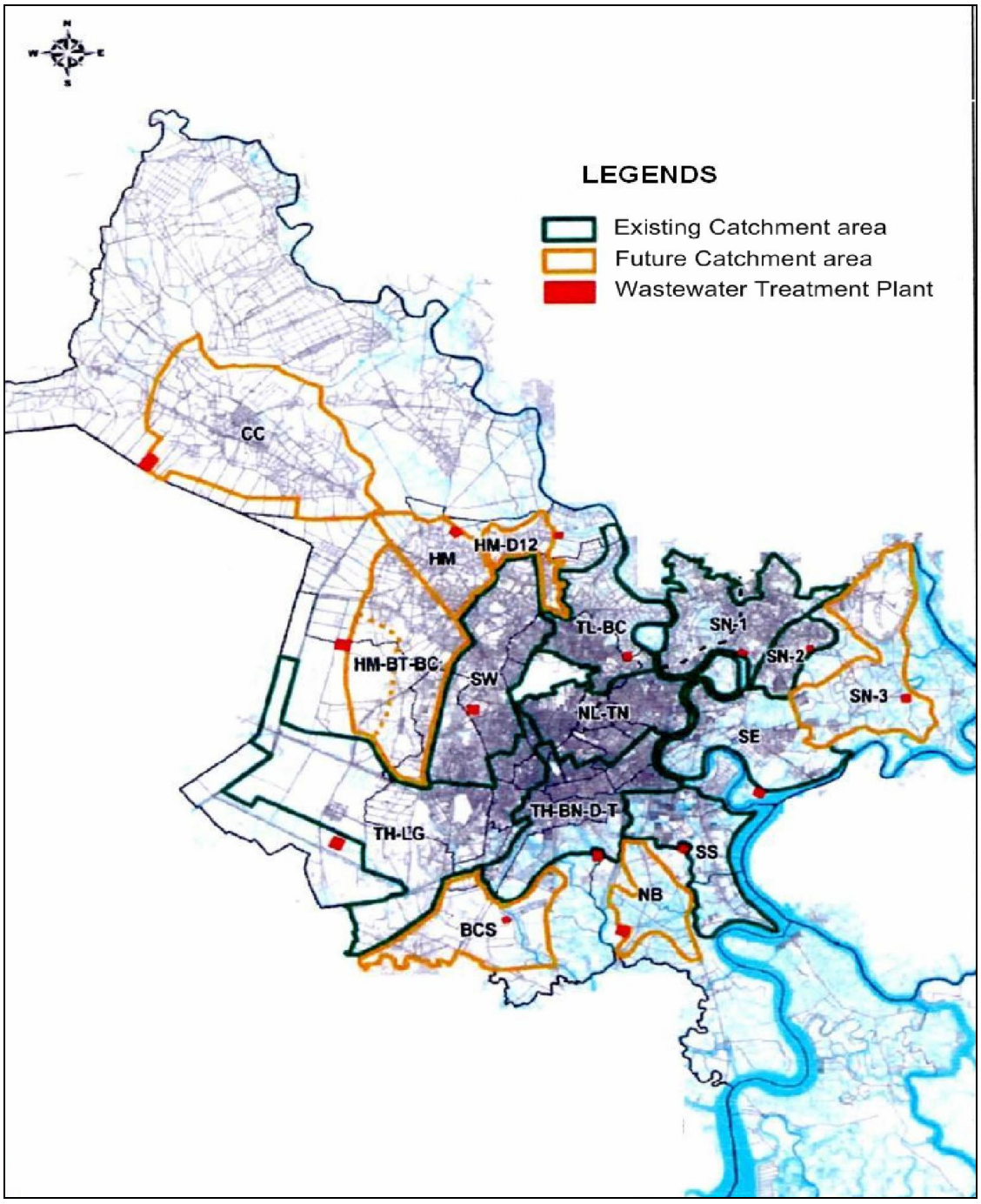

Figure 3.30. Drainage Basins in HCMC

In addition to these catchment areas, seven new catchment areas were drawn up in the latest Construction Master Plan for new urbanized areas.

The locations of WWTPs have been taken from the Sewerage MP were planned WWTPs but most of them have still not been built). Some WWTP locations are out of date and especially the location of NLTN WWTP which has been changed since 1999.

Based on the Sewerage MP (JICA, 2000) and Construction MP (DPA, 2007), the estimated volume of wastewater by catchment area is presented in Table 3.6.

The wastewater total for 2015 is estimated at 1,703,000 m^3/d and 2,817,000 m^3/d for 2025.

The NLTN and District 2 catchment area is expected to account for 20% of total wastewater generated in 2015.

3.3.3.2. Wastewater treatment systems

(1). Existing condition

Two main WWTPs, Binh Hung and Binh Hung Hoa, are currently in operation. Roughly 450,000 in habitants are estimated to be served by municipal WWTPs, which is still quite a low figure in comparison with the total population of the city (about 8,000,000 inhabitants). Current and projected WWTPs for HCMC are shown in the Figure 3.21 and Tables 3.6-3.7 below.

The table 3.6 shown that the NLTN treatment plant has a figure of 380,000 m^3/day. However, the NL-TN WWTP is planning to have a capacity of 430,000 m^3/day because the sewage from District 2 will be conveyed and transferred to the WWTP.

Table 3.6. The estimated volume of wastewater by catchment area

No	Drainage Basin	Area	Waste water volume in 2015 m^3/day		Waste water volume in 2025 m^3/day	
			Single area	Total	Single area	Total
1	Tham Luong – Ben Cat	Existing city center	117.000	-	137.000	214.000
		Developed city center	-		77.000	
2	Nhieu Loc - Thi Nghe	Existing city center	380.000	-	401.000	401.000
3	Tan Hoa - Lo Gom	Existing city center	176.000	-	197.000	356.000
		Outskirts	58.000		84.000	
4	THBNDT	Existing city center	357.000	378.000	512.000	512.000
		Outskirts	-			
5	Tay Sai Gon	Existing city center	122.000	265.000	129.000	297.000
		Developed city center	143.000		168.000	
6	Nam Sai Gon	Developed city center	-	-	103.000	118.000
		Outskirts	-		15.000	
7	Bac Sai Gon 1	Developed city center	144.000	-	182.000	182.000
8	Bac Sai Gon 2	Developed city center	30.000	30.000	31.000	31.000
9	Dong Sai Gon	Developed city center	7.000	7.000	192.000	192.000
10	Hoc Mon	Outskirts	43.000	43.000	54.000	54.000
11	Hoc Mon-Q.12	Developed city center	14.000	20.000	23.000	43.000
		Outskirts	6.000		20.000	
12	HM-BT-BC	Developed city center	10.000	34.000	56.000	144.000
		Outskirts	24.000		88.000	
13	Nam Binh Chanh	Existing city center	-	-	13.000	48.000
		Outskirts	-	-	36.000	
14	Nha Be	Outskirts	5.000	5.000	37.000	37.000
15	Bac Sai Gon 3	Outskirts	17.000	17.000	66.000	66.000
16	Cu Chi	Outskirts	29.000	29.000	122.000	122.000

Table 3.7. Existing WWTPs capacity compared with water consumption

Catchment area	Area served (ha)	WWTP	Capacity (m^3/d)	Inhabitants	Status	Process
HCMC		Water production capacity in 2007	1,201,500	8,000,000		
Tan Hoa-Lo Gom	1,946	Binh Hung Hoa	30,000	120,000	In service in 2006	Ponding
THBNDT	825	Binh Hung	141,000 (phase 1)	425,000	In service in 2009	Activated sludge
HCMC	2,771		171,000	545,000		

Currently, approximately:

- 7% of the population of HCMC is thought to be connected to a WWTP;
- 14% of the water supplied in HCMC is thought to see the corresponding wastewater generated being treated.

On the basis of 8 million inhabitants in HCMC, a load generation of 40 g BOD_5 per capita per day, and a reduction of the pollution load of about 30% due to septic tanks (30 mg BOD5/capita/d is transferred to the network), the total BOD_5 load generated in HCMC is about 240,000 kg BOD_5/d.

The population connected to a WWTP is about 545,000 inhabitants. The pollution load currently treated is about 16,350 kg BOD_5/d (about 7% of the total load). Therefore, on the basis of treated wastewater having a concentration of 20 mg BOD_5/L, the pollution discharged to water bodies can be estimated at about 227,000 kg BOD_5/d.

(2). Future situation

The following table (See Table 3.8) shows the future situation in 2025 based on the implementation of projects which have already been identified.

In 2025, based on the projects currently being studied:

- 40% of the population should be connected to a WWTP;
- 45% of water supplied, and corresponding wastewater generated in HCMC should be treated;
- Nhieu Loc Thi Nghe WWTP will be the main WWTP in HCMC and will treat wastewater from about 17% of HCMC population.

Table 3.8. Future WWTPs capacity compared with water consumption

Catchment area	Area served (ha)	WWTP	Capacity (m^3/d)	Inhabitants	Status	Process
HCMC		Total water consumption(2025 –WS Master Plan)	2,950,000	10,000,000		
Tan Hoa-Lo Gom	1,946	Binh Hung Hoa (only part of the catchment area)	30,000	120,000	In service in 2006	Ponding

THBNDT	2,200	Binh Hung	469,000 (phase 2)	1,421,778	In tendering phase (for phase 2 of WWTP)	Activated sludge
TL-BC	2,058	TLBC (2025)	250,000	793,995	Design phase	SBR
NL-TN + D2	3,300 + 4,500	NLTN (2025)	530,000	1,730,000	In Feasibility Study phase	To be confirmed followed DBO
HCMC	14,595	Total treated wastewater	1,249,000	4,085,773		

The BOD_5 treated in 2025 will be about 33% of the total generated load in HCMC and the pollution discharged to water bodies will be about 200,000 kg/d (See Table 3.8).

The funding of projects is as follows:

- Extension of Binh Hung WWTP financed by JICA. The total amount of phase 1 and phase 2 is estimated at USD 390 million.
- Tham Long – Ben Cat is financed through a Build and Transfer process in which Phu Dien Company is financing the construction against granting of land in HCMC. The estimated project cost is USD 170 million.

According to the Sewerage Master Plan (JICA, 2000), WWTPs must be built for each catchment area by 2020. However, currently, only the aforementioned WWTPs have been planned and will be built in the coming years. Funding for other WWTPs has still not been identified.

Table 3.9. BOD load before and after treatment

Catchment area	**Inhabitants (2025)**	**Daily per capita BOD_5 to network (g BOD_5/c/d in 2025)**	**Total BOD_5 load before treatment (kg/d)**	**BOD_5 load treated(1) (kg/d)**
Tan Hoa-Lo Gom	120,000	30	3,600	3,000
THBNDT	1,421,778		42,653	33,273
TL-BC	793,995		23,820	18,820
NL-TN + D2	1,750,000		52,500	41,900
Total	4,085,733		122,573	96,993
HCMC	10,000,000		300,000	96,993

3.3.4. Conclusions and recommendations on socio-economic conditions

Based on results of direct survey in the project's area from 22-30 May, 2013, some conclusions are made as below:

- Whole area where the project crossing is relatively favorable for land clearance.
- The areas where the drainage lines crossing have been cleared in framework of other urban development projects.
- The project does not impact on local people's life. The area was acquired for the constructions of the wastewater treatment plant are being fallowed; there are no any livelihood and economic development activities.
- The location proposed for WWTP is fitted for master development plan of HCMC.
- The main aspects concerning the construction of the interceptor and the

WWTP are listed below:

- During construction of the interceptor, some people will be temporary affected by the shaft construction sites. Even if the area proposed for WWTP is mainly used for agricultural purpose, resettlement issue will also be needed in the RAP/SA study;
- Even if the project is intended to improve environmental conditions, however, any accidents during the WWTP operation may cause the water pollution. Therefore, incident prevention and control measures should be proposed in the EMP;
- The project will be implemented in the agriculture land, which may cause an adverse impact on biodiversity. However, in this area there are not any rare species, which have to be protected. Therefore, this impact is not significant. But, biodiversity conservation measures still will be proposed in the EMP (See paragraphs 6.2.6, 6.3.5) to minimize the impact.

CHAPTER 4.
ANALYSIS OF ALTERNATIVES

4.1. CRITERIA FOR THE SELECTION OF WWTP LOCATION ALTERNATIVES

Criteria for selection of location alternatives including environmental aspects are presented in Table 4.1.

Table 4.1. Criteria for selection of location alternatives

No.	Object	Criteria for selection
1	Location of NLTN WWTP	• Suitable planning; • Low cost (compensation, clearance); • Minimizing cumulative impacts on the surrounding areas.
2	Location outlet of NLTN WWTP	• Do not affect the water quality of the rivers at the outfall; • Ensure the river's capacity of receiving discharged water (flow and load); • Ensure the distance from the outfall to the positions of water intake for other uses from upstream is at least 500m – 1,000 m.
3	Wastewater treatment technology	• Land requirement and land saving potential; • Environmental and Social Impact; • Treatment performance, process expendability and sensitivity; • Impact of primary treatment; • Easiness of operation and maintenance, gained process know how and experiences; • Nuisance reduction, landscape and architectural integration; • Investment cost (CAPEX), operation cost (OPEX), carbon emission and carbon refund potential.
4	Sludge treatment technology	• Low cost of investment and operation; • Sewage sludge can be reused; • Easy to control and operate; • Less of environmental and social impacts.

4.2. LOCATIONS OF WWTP

4.2.1. Proposed/options for Location of NLTN WWTP

During the FS of HCMCES Phase 1 which was prepared by CDM, two sites were proposed in District 2 for the construction of the NLTN WWTP. The first proposed site was located in Thu Thiem area but it was not selected because this area will become the new main business city center in accordance with the city Urban Master Plan. Another site was also proposed in the Sewerage Master Plan was in Nha Be.

After consideration and discussions with HCMC's authorities, a third site was proposed - Cat Lai site - and selected for the following reasons including environmental aspects:

- The site is located closer to NLTN basin than the proposed Nha Be site and the interceptor route would cross non-urbanized areas as Thu Thiem has not yet been built,
- Thu Thiem location will be the future city business center and not appropriate for construction of the WWTP,
- The Cat Lai Site (in Thanh My Loi ward) is close to Dong Nai River which has a high flow and the impact of the discharge will therefore be significant less than in Saigon River.

Locations of proposed WWTPs are presented in Figure 4.1.

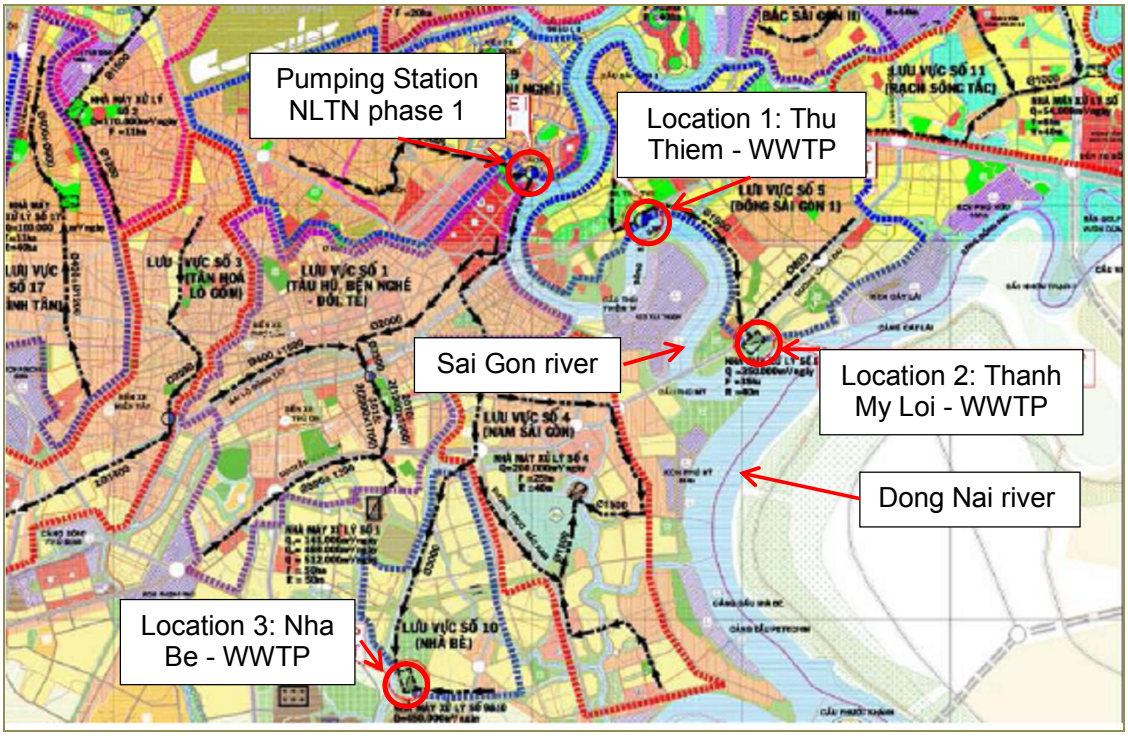

Figure 4.1. Locations of proposed WWTPs

Finally, HCMC PC approved the decision to build the WWTP, to treat wastewater from NLTN and D.2, in Cat Lai (Thanh My Loi Ward). This site has the following advantages compared to the Nha Be site:

- The route of the interceptor is shorter about 10-15 km;
- The pumping station and the Saigon River crossing are already built;
- The construction of the interceptor will be easier as D.2 is currently mostly a rural area;
- Building one WWTP instead of two ones as previously planned is more cost-effective.

4.2.2. Location of Interceptor Sewer

Following the design, the planning interceptor sewer will pass through three areas: Thu Thiem area, future metro crossing and remaining sections connected to WWTP. Option A2 - PO1 -PO3 was rejected as most of this route passes under a main road beneath which several public utilities are located (including a 2.2 meter tunnel). Furthermore, this route would cross a high density area which would make the construction more complicated because of high cost, subsidence, traffic accidents and occupational accidents. This is also

why option A1 - PO1 has not been retained (See Table 4.2 and Figure 4.2 for description of these options).

After discussion with Thu Thiem CESPIMA, the route to have been selected is EBS - A3 - A31 - A34 - PO3, for the following reasons:

- Shortest route;
- No major conflict with main public utilities;
- Parts of the route are under green areas;
- Metro line will be crossed at a location that is further away from the planned metro station (i.e. where the metro line is deeper).

Figure 4.2. Location of selected interceptor route

Table 4.2. Options of Interceptor Sewer

Section	Option	Specification	Selected option/Reason
Thu Thiem area	A2 - PO1	Interceptor route should be under the main road Interceptor route should cross a low density area	Not selected Construction is more complicated because of high cost, subsidence, traffic accidents, and occupational accidents.
	A1 - PO1		Not selected because of high cost, subsidence, traffic accidents, and occupational accidents.
	A3 – A32		Not selected because of high cost, subsidence, traffic accidents, and occupational accidents.

Section	Option	Specification	Selected option/Reason
	A3 – A31 – A33 – A34		Selected
Future metro crossing	PO1	The interceptor sewer should be far away from the planned metro station	Not selected because of high cost, subsidence, traffic accidents, and occupational accidents.
	PO2		Not selected because of high cost, subsidence, traffic accidents, and occupational accidents.
	PO3		Selected
Final section to WWTP	EBS-A3-A33-PO3	Parts of the route should be under green areas and main road	Selected Shortest route, effective cost and no conflict with main public utilities.

4.2.3. Options of outlet locations

According to SCE, there are three options for the outlets for the selected WWTP location, including: Ky Ha Canal, Ngon Ngay Canal and Dong Nai River. Based on screening criteria, 3 discharged points are expected in Table 4.3 as follows:

Table 4.3. Options of outlet

Criteria	Dong Nai River (option 3)	Ky Ha canal	Ngon Ngay canal
Capability in reducing pollution downstream from the outfall	High High rate of water flow → good dilution capability	Medium low rate of water flow, has been receiving wastewater from existing residential areas, industrial parks nearby	Low, canal is narrow, has been receiving wastewater from Cat Lai Industrial Park, handicraft region, etc.
Capacity to receive runoff and wastewater	High	Medium	Low
Distance from the outfall to the positions of water intake for other uses from upstream is at least 500 m – 1,000 m	rather suitable	suitable, because the position of the outfall is near the intersection of Sai Gon – Dong Nai- Nha Be Rivers	Not suitable. This position is located at the upper part from the other two locations

In addition, according to the survey conducted by the EIA preparation consultant, mainly from Nhon Trach side, on the opposite side of WWTP, there are aquaculture households of communes Phu Huu, Phuoc Khanh, Dai Phuoc (See Section 3.3.1.2 on socio-economic conditions); thus, the choice of the location at the lower part further away from these areas will help in reducing impacts on these areas.

From these three options, the position on Dong Nai River is the most suitable option because the ability of dilution at this position is better than the others due to tidal activity, reducing the impact on downstream. This option has been selected based on modeling for the outlet impact.

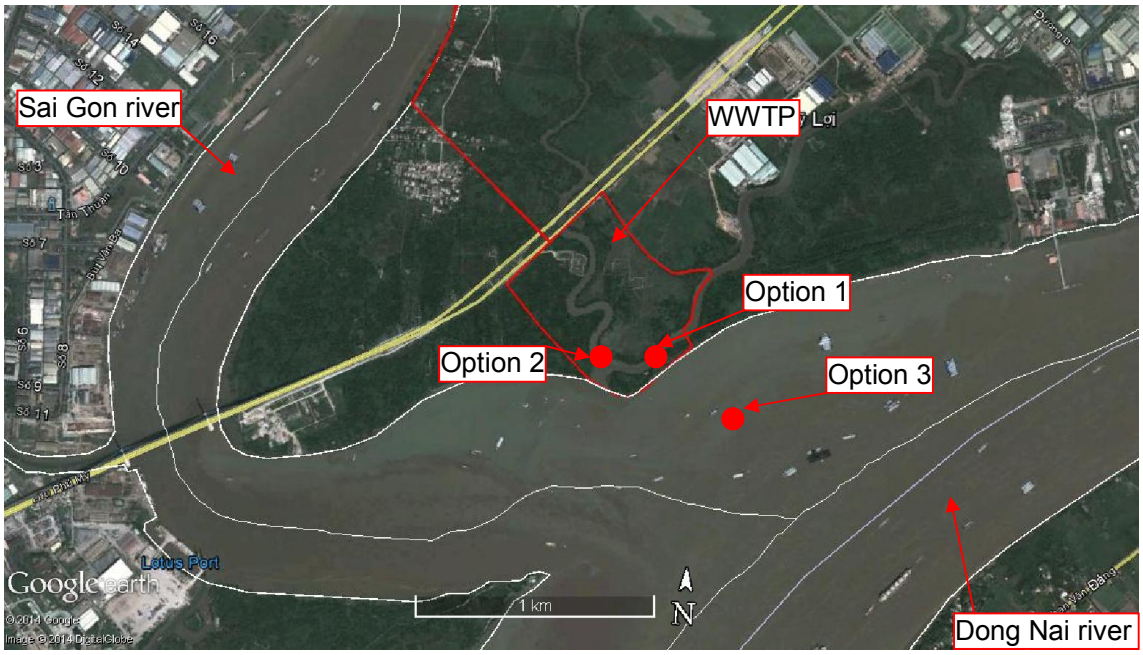

Figure 4.3. Location of selected outlet locations

4.3. INTERCEPTOR CONSTRUCTION TECHNOLOGY

4.3.1. Open Trench Technology

The most common technology used to install pipe work is “open trench” technology (See Figure 4.3). This technology requires the excavation of trenches long and wide enough for the required pipe lengths, diameters and bedding. It should be deep enough to allow suitable bedding material, and compacted backfill.

With increased depth, the excavation can be a main issue because of huge amounts of earth excavation. It may also very probably need to pump and pre-treat a big amount of groundwater during construction works. Note that, in order to ensure the stability of the trench, it is required to ensure a correct slope for the excavation trench or to use sheet piles during construction.

Once the pipe work has been installed, it is also probably necessary to backfill the trench with carefully selected materials in order to limit settling, which can damage the interceptor and road infrastructures.

Another solution for the open trench is to use sheet piles in order to maintain the trench and limit the excavation of soil. This also reduces the amount of water to be pumped and pre-treated, but the installation of sheet piles is costly (sheet piles have a length about 12 to 20 meters).

4.3.2. Pipe Jacking Technology

Pipe jacking is a technique used for installing pipes under the ground using a tunnel boring machine and hydraulic jacks located inside a jacking pit (See Figure 4.3). A stabilized shield (by air or water pressure) inserted into the ground through a drive shaft and cut a bore. As the shield advances forward, excavating the earth in its path, pipe sections are jacked into place directly behind the tunnel boring machine.

This technique is widely used as an alternative to open-trench excavation and other tunneling methods. It is referred to in smaller diameters as micro tunneling. In general, the

technique is used for the installation of utility purpose pipe work such as sewage, oil, gas, electricity, cable and water mains.

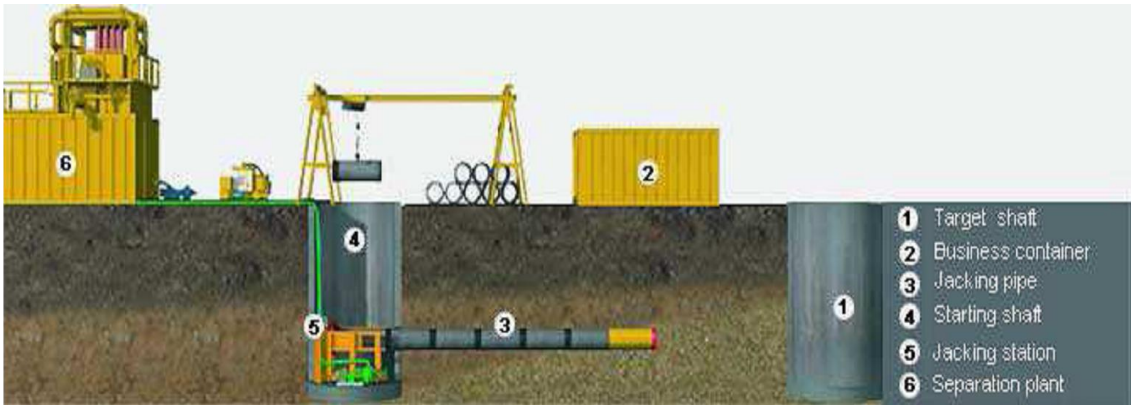

Figure 4.4. Pipe jacking technology

Substantial environmental benefits can be gained by the use of pipe jacking techniques compared with the traditional open trench approach especially with increased pipe depths. Typically, the 'trenchless' method will reduce the quantities of incoming and outgoing materials, avoid groundwater level reduction by pumping and limit nuisances to a minimum

The following table (See Table 4.4) presents a rough comparison of open trench and pipe jacking technologies for HCMCES II.

Table 4.4. Comparison of technologies

Constraints	Open trench without sheet piles	Open trench with sheet piles	Pipe Jacking
Deep and large interceptor route	Complicated to set up, needs deep and huge excavation of soil	Complicated to set up, needs deep and wide excavation of soil	Limited impacts on the construction
Soil (weak conditions and groundwater close to surface)	Excavation and stabilization of the trench are complicated; need to pump and pre-treat groundwater	Installation of sheet piles is costly but reduction of excavation and water to be pumped	Limited impacts on the construction
Environment impact	Very big amount of soil Excavated	Big amount of soil excavated	Limited amount of soil excavated
Surface needed for construction	Important surface area needed in order to build the trench	Limited surface needed for construction	Limited surface needed, only for starting and ending pits
Cost	Depending on the depth and width of the trench.	More expensive than open trench without sheet piles	More expensive than open trench due to equipment needed for construction

The technology chosen could be a combination of pipe jacking and open trench system.

4.4. WASTEWATER TREATMENT TECHNOLOGY

4.4.1. Biological treatment technology

In the framework of HCMCES II Feasibility Study, the Consultant has studied a wide range of treatment processes and finally selected 4 processes relevant for NLTN WWTP, which are as follows: (1), Conventional Activated Sludge (CAS), (2)Sequencing Batch Reactor (SBR), and (3) Bio-filtration (BF),(4) Trickling filter (TF)(See Figure 4.4).

Comparison between possible process for Wastewater Treatment Process (including environmental and technical opinion) is presented in Table 4.5.

A process comparison is based on the following criteria:

- Land requirement and land saving potential;
- Environmental and Social Impact;
- Treatment performance, process expendability and sensitivity;
- Impact of primary treatment;
- The treatment technology with the lowest life-cycle cost.

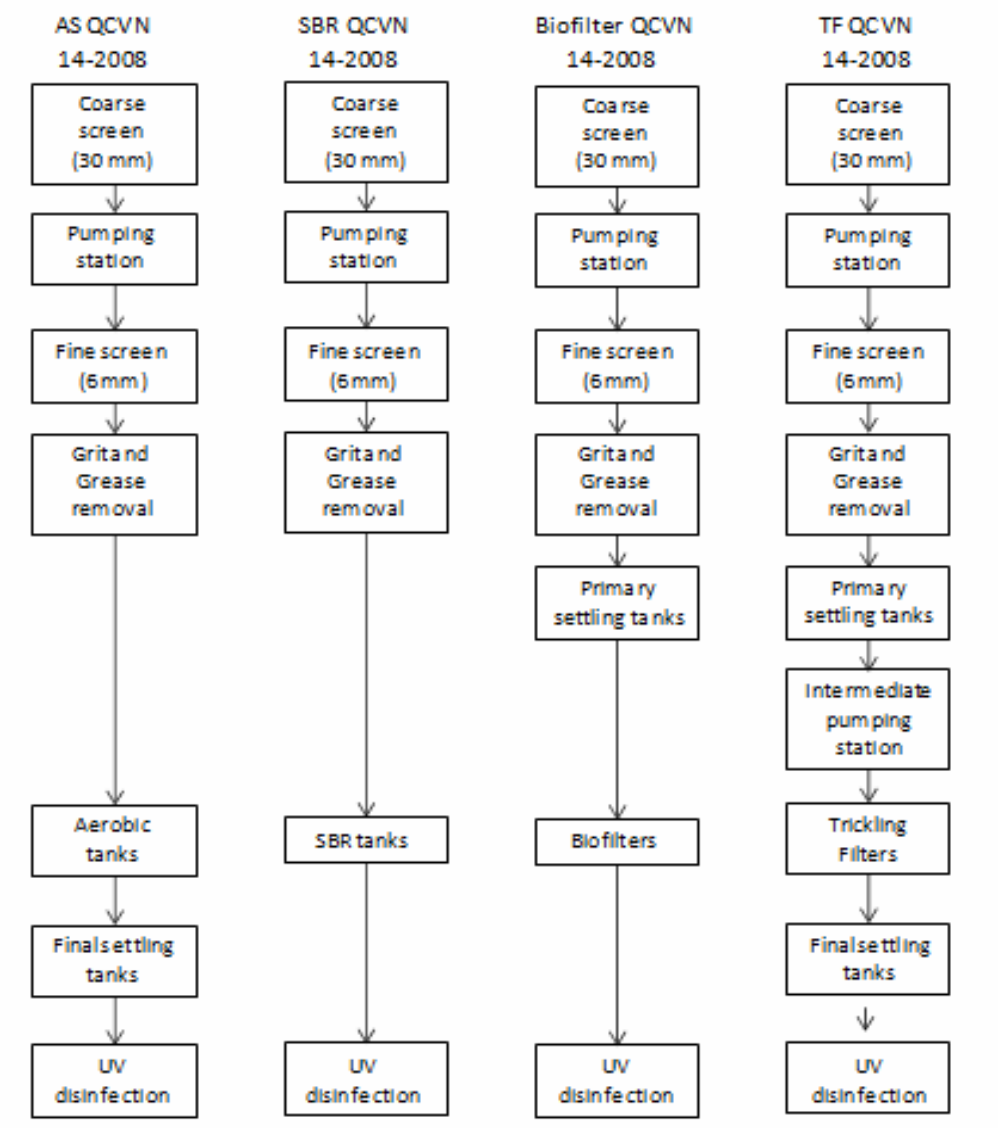

Figure 4.5. Alternative for WWTP treatment process

Table 4.5. Comparison of Wastewater Treatment Processes (including environmental and technical issues)

Selection criteria	CAS with Anaerobic Sludge Digestion Regulation - QCVN 14:2008/BTNMT	SBR with Anaerobic Sludge Digestion Regulation- QCVN 14:2008/BTNMT	Bio-Filtration with Anaerobic Sludge Digestion Regulation – QCVN 14:2008/BTNMT	Trickling Filter with Anaerobic Sludge Digestion Regulation – QCVN 14:2008/BTNMT
CAPEX WWTP and Interceptor Horizon 2020	392.44 million USD	374.51 million USD	365.89 million USD	380.93 million USD
Adaptation to changes of flow and loads	A good modular layout adapts different flow/load condition. (primary settling tanks)	Moderate adaptable PLC controlled sequences	A good modular layout adapts to different flow conditions. (primary settling tanks)	A good modular layout adapts to different flow conditions. (primary settling tanks)
Environmental and social impacts	High impact regarding land requirement Lowest impact regarding sludge elimination	Intermediate impact regarding land requirement. Lowest impact regarding sludge elimination (transport and landfill)	Lowest impact regarding land requirement. No necessary need for filling of existing site traversing canal Sludge elimination (transport and landfill) approximately 12% higher than CAS, TF and SBR	Most significant impact regarding land requirement Lowest impact regarding sludge elimination (transport & landfill)
Land requirement (horizon 2020)	23 ha	20 ha	16 ha	26 ha
Land requirement (horizon 2045)	30 ha	25 ha	20 ha	35 ha
Treatment Performance	Carbon and partial nitrogen removal (nitrification)	Carbon and partial nitrogen removal (nitrification)	Carbon and partial nitrogen removal (nitrification)	Carbon and partial nitrogen removal (nitrification)Due to higher SS concentration in the effluent filtration stage

Selection criteria	CAS with Anaerobic Sludge Digestion Regulation - QCVN 14:2008/BTNMT	SBR with Anaerobic Sludge Digestion Regulation- QCVN 14:2008/BTNMT	Bio-Filtration with Anaerobic Sludge Digestion Regulation – QCVN 14:2008/BTNMT	Trickling Filter with Anaerobic Sludge Digestion Regulation – QCVN 14:2008/BTNMT
				upstream disinfection stage might be required (pilot plant)
Process Expandability	Enhanced nitrogen removal: denitrification possible with additional tank & works (biological tanks, pumping/aeration facilities)	Enhanced nitrogen removal: denitrification possible with existing biological tanks & additional works (pumping/aeration facilities)	Enhanced nitrogen removal: denitrification possible with additional tanks & works (biological tanks, pumping/aeration facilities)	Enhanced nitrogen removal: denitrification possible at horizon 2020 with additional tanks & works (biological tanks, pumping/aeration facilities…); as land availability is limited at horizon 2045 enhanced nitrogen removal may be not possible to implement
Impact of primary treatment	Due to economic reasons and low wastewater concentrations, there is no primary treatment envisaged Lower sludge to be dewatered (only excess sludge with dry solids content of 300 g/l (filter press)) Lowest sludge volume to be eliminated	Due to economic reasons, low wastewater concentrations and hydraulic design of SBR tanks there is no primary treatment envisaged Lower sludge to be dewatered (only excess sludge with dry solids content of 300 g/l (filter press)) Lowest sludge volume to be eliminated	Significant increase of sludge production (+30% compared to CAS and SBR) due to inevitable primary treatment (coagulation, flocculation, sedimentation) Slight increase of sludge volume to eliminate (+12% compared to CAS/SBR) even with higher sludge dewatering potential Further reduction of low wastewater concentrations Very significant increase of methane production (almost the double	Lowest sludge production even with primary treatment (–18% compared to CAS + SBR at horizon 2020) Lowest sludge volume to eliminate (–30% compared to CAS + SBR at horizon 2020) due to higher sludge dewatering potential (dry solids content of 350 g/l (filter press) due to primary and excess sludge) Further reduction of low wastewater concentrations

Selection criteria	CAS with Anaerobic Sludge Digestion Regulation - QCVN 14:2008/BTNMT	SBR with Anaerobic Sludge Digestion Regulation- QCVN 14:2008/BTNMT	Bio-Filtration with Anaerobic Sludge Digestion Regulation – QCVN 14:2008/BTNMT	Trickling Filter with Anaerobic Sludge Digestion Regulation – QCVN 14:2008/BTNMT
	Odor control measure is easily applied (i.e. primary treatment inside building)	Odor control measure is easily applied (i.e. primary treatment inside building)	compared to CAS and SBR) and hence energy recovery. Odor control rather easy to establish (primary treatment inside building)	Significant increase of methane production (+40% compared to CAS + SBR at horizon 2020) and hence energy recovery Odor control (if turned out to be necessary) rather complex to establish (covering of primary treatment tanks)
Operation	Standard level of skill necessary Standard degree of automation.	Intermediate level of skill necessary Rather complex degree of automation	High level of skill necessary Complex degree of automation	Moderate level of skill necessary Standard degree of automation Due to lack of mathematical models and design approaches, operation (and design) is empirical resulting in limited flexibility and control (requirement of pilot plant)
Available experience in Vietnam and Asian countries	Good	Fair	Fair	Fair
Nuisance Control (noise, odor)	No major nuisances to be expected if proper operation is monitored (covering of noisy equipment, odor control of	No major nuisances to be expected if proper operation is monitored	Optimum control of nuisances due to constructing physical treatment units, primary and biological treatment	Like CAS and SBR but additional nuisances (odor) not to be excluded (primary settling tanks, trickling filter)

Selection criteria	CAS with Anaerobic Sludge Digestion Regulation - QCVN 14:2008/BTNMT	SBR with Anaerobic Sludge Digestion Regulation- QCVN 14:2008/BTNMT	Bio-Filtration with Anaerobic Sludge Digestion Regulation – QCVN 14:2008/BTNMT	Trickling Filter with Anaerobic Sludge Digestion Regulation – QCVN 14:2008/BTNMT
	physical treatment unit and sludge line)		units in one enclosed building.	
Landscape and Architectural integration	The process units are not constructed in one enclosed building	Grouping of specific process units (physical and biological) maybe possible	Grouping of process units shall lead to well integrated building(s) linked to the industrial environment (Cat Lai) Possible integration of existing site traversing canal.	Grouping of process units (physical and biological) is limited

- Easiness of operation and maintenance.
- Nuisance reduction, landscape and architectural integration
- Investment cost (CAPEX), operation cost (OPEX), carbon emission and carbon refund potential.

All four processes are considered fully suitable to NLTN WWTP constraints and meet the environmental regulation QCVN 14:2008/BTNMT (Column A). Bidders will have the option to bid on one of 4 alternatives. Technology that has the lowest life cycle cost (CAPEX plus discounted OPEX) will be chosen. Trickling filter has been used as the basis for costing the treatment plant as this is the cheapest option.

4.4.2. Wastewater disinfection technology

Domestic wastewater treated by biological methods should be disinfected to eliminate pathogenic organisms before discharge into receiving sources.

4.4.2.1. Chlorine disinfection

Chlorine (chlorine gas, hypochlorite solutions and other chlorine compounds) often used as disinfectant for municipal wastewater. Chlorine solution destroys microorganisms by oxidizing the cellular material. Advantage of this process consists in its efficient, reliability and reasonable price. However, chlorine creates toxic residuals that may have long-term effects on aquatic life. Moreover, chlorine is very corrosive and poisonous; therefore, the use of chlorine must be handled with high precaution and operational training provided.

4.4.2.2. Ultraviolet (UV) radiation disinfection

UV radiation has proved to be an efficient treatment for bacteria and viruses and does not leave any toxic by product. The effect of a UV disinfection system depends on ingredients of wastewater, intensity of UV radiation and the contact time. However, UV disinfection is limited for water with high turbidity. In this case, sand filtration may need to be installed before the UV disinfection stage.

4.4.2.3. Ozone disinfection

Ozone is a strong oxidant. Like UV disinfection, ozonation does not create harmful residuals. The efficiency of disinfection depends on the dosage, the mixing and contact time of ozone with wastewater. Compared with chlorine and UV disinfection, ozone solution is more complicated and hazardous to operate. It is also rather costly in terms of investment and operation costs. Furthermore, ozone is corrosive; therefore, corrosion-resistant materials and high operational skills are required.

Based on the comparison above, ozone disinfection does not apply to WWTP in NLTN Basin and District 2 because of the complex operational and high cost. The remaining two methods are compared in Table 4.6.

Table 4.6. Comparing methods of chlorine and UV disinfection

Items	Chlorine	UV
Construction Costs (USD)	2,070,000	160,000
Equipment costs	1,730,000	4,140,000
Operating costs (based on the demand for electricity and chemicals)	Applied TCVN 5945:2005 8,098,647 USD/year, in 2045	Applied QCVN14:2008/BTNMT 7,499,519 USD/year, in 2045
The area of land to build	Larger	Smaller
Environmental Impacts	By-products may affect the aquatic animal life	Non-toxic by-products

Source: HCM City environmental sanitation technical assistance project-Phase 2, 2011

Based on this comparison, the investment cost of UV disinfection is 1.13 times higher than chlorine disinfection and chlorine treatment efficiency is higher than UV. However, the necessary land area and environmental efficiency of UV disinfection are more significant than by chlorine disinfection. The SCE project consultants proposed UV disinfection method for WWTP, which is better from environment point of view. Meanwhile, the current drinking water treatment in HCM city still uses chlorine disinfection method and does not have survey data on health effects on residents in the city when using this drinking water.

Vietnam has still limited use of UV disinfection method for wastewater due to high investment costs and complex operation, but in the world, UV disinfection for wastewater is widely used in many different capacities, presented in Appendix 10.

One advantage of UV is that there is no residual chlorine in the water compared with the chlorination method. Both options (chlorination and UV) will be considered and the final decision will be with the bidder for the DBO contract.

In case of UV light failure during WWTP operation, the proposed chlorine solution will be added on the discharge pipe to disinfect wastewater during the replacement of the UV lamp to ensure that the treated wastewater will meet the national technical regulation QCVN 14:2008/BTNMT, column A before discharging into the Dong Nai river.

The disinfection method will be finalized at the bidding stage and the costs of the 2 options (chlorine and UV) may be reviewed at that stage.

4.5. SLUDGE TREATMENT MEASURE

4.5.1. Sludge treatment in WWTP

According to sludge composition, sludge which is formed during treated wastewater has high humidity. To minimize transportation costs, it needs to reduce humidity and apply dehydration process before transporting to disposal site.

Feasible technologies applied for sludge treatment in WWTP are presented in Figure 4.6.

Sludge with high organic content can be utilized for biogas and generators, supporting in saving energy cost and reducing greenhouse gas emissions. Moreover, stabilized sludge after digestion has no more parasites that cause diseases.

The consultant proposes that the following sludge treatment be implemented at the NLTN WWTP without using further chemicals, which will be beneficial to the environment:

- Thickening: Gravity thickening or Gravity Belt Thickener
- Stabilization: Anaerobic Digestion
- Post Thickening and homogenization: Gravity thickening
- Dewatering: Filter Press
- Draining sludge progress (using drying bed and Dryer machine).

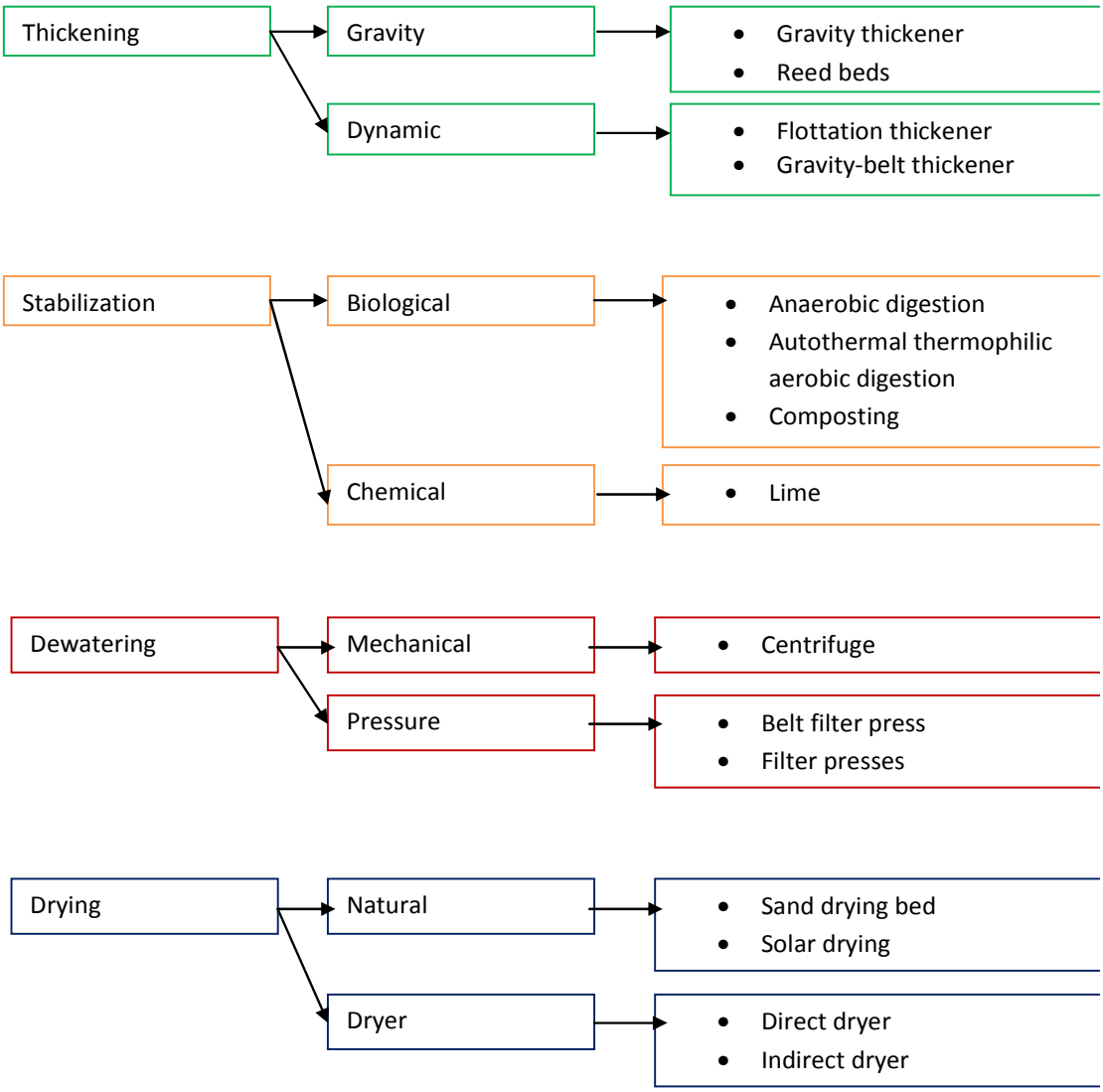

Figure 4.6. Technologies applied for sludge treatment in WWTP

4.5.2. Carbon Impact of the WWTP

The baseline process used in this comparison of processes with and without digestion is SBR QCVN 14:2008/BTNMT, as this process has the lowest footprint carbon without digestion.

In all cases, digestion enables GHG emissions to be reduced by 20 – 30% compared with the baseline scenario (SBR QCVN 14:2008/BTNMT without digestion) and even more (30 to 40%) for the trickling filter option due to the low electricity consumption. After trickling filters, GHG reduction is more favorable for SBR and CAS processes. It is also seen that GHG savings will increase in the coming years with the increased organic load and the resulting increase in concentration. Consequently, the more concentrated the effluent is, the greater the potential is for GHG savings.

In conclusion, out of the four proposed technologies, anaerobic digestion with SBR and CAS should be the most favorable processes in terms of GHG emissions reduction. The environmental benefit of anaerobic digestion is clear; however, the choice of the process needs to be justified in regard to the overall technical and financial characteristics of the plant. Anaerobic digestion may become more attractive once the price increases on electricity and

sludge evacuation as well as higher revenue from the Carbon Finance Fund have been taken into account.

4.5.3. Sludge Disposal Measure

Based on discussion with CESPIMA, sewage sludge from the HCMC ESP2 WWTP will be transported by land ways and treated in Da Phuoc Sludge Treatment Center at the Da Phuc landfill located about 25 km from the new WWTP. A first extension of Da Phuoc Landfill capacity is planned for 2018 (capacity up to 2,600m^3/day). The design of the second phase of Da Phuoc Landfill will considerthe daily amount if sludge from HCMC WWTPs of 250 m^3. By 2020 the Da Phuoc Landfill capacity shall be sufficient to receive stabilized and dewatered (composted) sludge (with a maximum dailycapacity of 5,200) (See Table 4.7).

Table 4.7. Capacity of receiving and treating sludge

No	Type of waste	Da Phuoc Sludge Treatment Plant capacity (m3/day)	
		Construction phase 1 (2014 - 2016)	Construction phase 2 (2017 - 2020)
1	Sludge from drainage system	800	800
2	Sludge from channel dredging	800.6	1700
3	Sludge from other sources (incl sludge from WWTPs)	500	2,200
4	Excreta from livestock and poultry	50	50
5	Sludge from septic tanks	450	450
Total Capacity		**2,600.6**	**5,200**

The Da Phuoc Waste Treatment Complex and Cemetery (the Da Phuoc landfill) activity comprises of Waste Treatment Company (128 ha) treating municipal waste; Peace Company's Project managingseptic tanks sludge; Urban Environmental Company's Project investing in cemetery estate and cremated services (about 57 ha); the Green Saigon's company responsiblefor wastewater sludge treatment (47 ha) and a planned investment for hazardous waste treatment (1.7 ha).

In February 2014, the Green Saigon Co Ltd. was assigned officially by the City (document 110) to be in charge of treating sludge received from various sources in the HCMC area. In July 2014, the Green Saigon company signed an Agreement with IMA to receive and treat the sludge generated by the HCMC ESP2 WWTP (document 32/BB-VSMTTP).

In line with the City's people Committee's decision, the Green Saigon Company has started construction of the Da Phuoc Sludge treatment plant (47 ha) at the Da Phuoc landfill site in April 2014. The company prepared and submitted the required technical documents (e.g., architectural planning, investment report and the EIA) to relevant departments in June 2014. Currently, the EIAis undergoing the appraisal process by MONRE although the construction has started based on a temporary construction certificate issued by the Department of Construction and at HCMC People Committee's request. The construction will be achieved in 2 Phases (see table 4.7) the first one being already under development for an area of 23 ha and planned until 2016.

Currently, the Da Phuoc landfill receives sludge from the Binh Hung WWTP (JICA project)as well as dredging sludge (and excavated materials) from Tan Hao-Lo Gom Canal (WB project), which jointly amounts about 500 m^3/day. The sludge is stored in cells protected by HDPE liner with concrete coated at sides. The sludge treatment by composting method will be expected to start in October 2014 when the composting of the warehouse and the sludge WTP will be finalized. The Green Saigon company has piloted successfully the treatment of sludge received from Binh Hung WWTP using the aerobic composting technology certified by Department of Science and Technology. The company will not treat hazardous waste and the sludge received will be tested before treatment to ensure that it meets the non-hazardous

waste threshold.

The operation of the Da Phuoc landfill is monitored by the Management Board of Waste Treatment Complexes (MBS) under DONRE in HCMC.Two specialists from MBS are inspecting the landfill activity daily in line with the landfill managementplan.The MBS has the mandate to carry out periodical environmental quality monitoring for surface water, groundwater and air quality every 3 months. The first environmental quality monitoring at the Da Phuoc landfill site has been conducted in June 2014; however, results have not been made available yet. According to the EIA for the Da Phuoc Sludge treatment plant prepared by the Green Saigon company, they will also conduct internal environmental monitoringduring the sludge treatment plant operation including air and water quality at various treatment process locations (e.g., storage cells, composting warehouse, plant itself, treated wastewater, electric generators and pumps, etc) every 3 to 6 months/year. The sampling will be done in line with the plant monitoringplan under the supervision of MBS staff and results will be shared with DONRE.

TheDa Phuoc Sludge treatment plant will have in place a sludge management plan before its operation may commence that should include the following steps:

Step 1: Quality Control: Before transporting sludge to Da Phuoc Landfill, quality control is necessary to avoid receiving hazardous waste, and to plan a schedule for receiving and storage.

Step 2: Transporting to treatment facility: Sludge is transported by specialized truck from source to plant. Progress of transportation ensured requirements about environmental protection, (i.e. avoid sludge leakages).

Step 3: Receiving, classification and dewatering: Sludge after transportationto the factory is stored in storage area. equipped with drainage ditches for water which drip from sludge. This water is conveyed into the Concentrated Wastewater Treatment Facility for treatment.

Step 4: The sludge will be disposed in the sanitary landfill built with appropriate liner and monitored for gas and leakages. The leakage sewage is conveyed into the Concentrated Wastewater Treatment Facility for treatment.

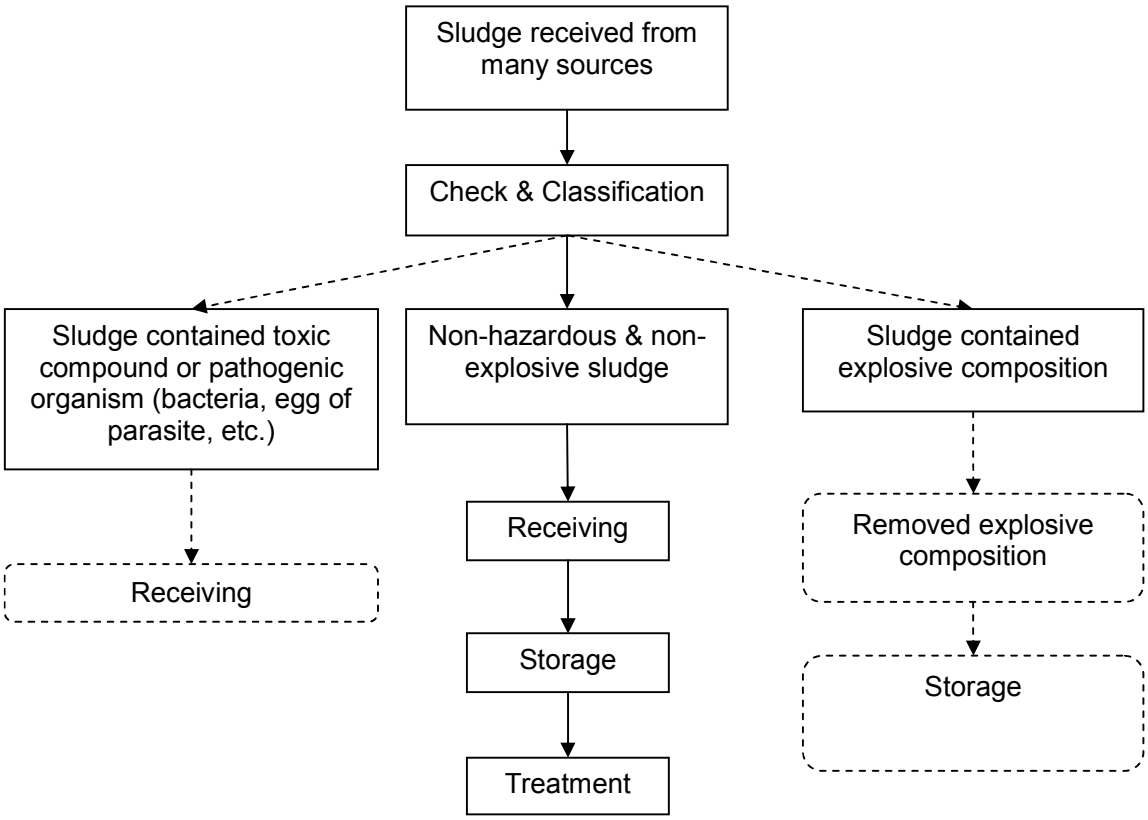

Figure 4.7. Sludge treatment process in Da Phuoc Sludge Treatment Center

CHAPTER 5.
ENVIRONMENTAL AND SOCIAL IMPACTS

5.1. IMPACTS IDENTIFICATION AND CLASSIFICATION

5.1.1. Impacts identification

The project will bring many benefits to the environment. The construction of WWTP will upgrade the environmental quality which is an important contribution in preserving public health and reducing diseases. Wastewater of the entire Nhieu Loc-Thi Nghe basin and District 2 will be treated to reach QCVN 14:2008/BTNMT column A, before discharging into the environment. It will reduce the risk of pollution in groundwater, soil environment, air environment and overall Saigon River ecosystem.

The operation of WWTP will also reduce the construction cost of WWTP for residential areas of District 2. Furthermore, it will improve public health quality. The habit of illegal sewage/solid waste disposal into the canal will be decreased, together with public raising awareness to protect the environment. In general, it helps to reduce costs to improve the environment, protect the natural environment for sustainable development, and increase attraction of trade and tourism on the Saigon River.

Estimated construction cost of wastewater treatment system for residential in District 2 in the case without the HCMC ES2 project is presented in Table 5.1.

Table 5.1. Estimated construction cost of wastewater treatment system for residential in District 2 in the case without the HCMC ES2 project

Year	2020	2045
Sewage flow (m^3/day) by project	83,000	275,000
Cost (Million VND)	371	515

When the interceptors are operated, residential toilets will be connected directly to the drainage system or through septic tanks. The former option helps to save the construction and operation costs of separate septic tanks. In HCM City, about 80% of households equipped with septic tanks, but at least 80% of the toilet sludge is not treated properly because truckers illegally discharge sewerage into rivers (Source: Special Assistance for Project Implementation for HCMC Water Environment Improvement Project Final Report-2008). The amount of sludge is equivalent to 13,000 kg BOD_5/day for HCM City and 2,800 kg/day for NL-TN basin. Since septic tanks may still be operational in most places in the project area, therefore, the plan is to connect the septic tanks to the sewers that would be constructed under the project.

Sources, objects and degree of impacts of NLTN project is presented in Table 5.2.

Table 5.2. Sources, activities and degree of impacts of NLTN project

No.	Sources of impact	Affected objects	Specific impacts	Degree of impacts
1. PRE-CONSTRUCTION PHASE				
1.1	Land acquisition for WWTP construction	Agricultural areas, swamp, irrigation	Affects 63 households and 2 companies.	Mediumlevel, short term
1.2	Clearance and reclaiming of 384,755 m^2	Air, soil, surface water of Ky Ha, Ngon Ngay Canals	Flora of the WWTP area	Medium level, long term
1.3	Means of transport, construction	Air, soil, surface water of Ky Ha, Ngon Ngay	Air pollution	Low level, short term

No.	Sources of impact	Affected objects	Specific impacts	Degree of impacts
		Canals		
1.3	Activities of workers	Air, soil, surface water of Ky Ha, Ngon Ngay Canals	Surface water	Low level, short term
2. CONSTRUCTION PHASE				
2.1	Construction works include pipe jacking and the WWTP	Air pollution, water and solid waste from construction area	Air environment and landscape	High level, short term
2.2	Activities of workers	Air, soil and water environment from workers camp	Surface water	Low level, short term
2.3	Maintenance of equipment and machinery	Surface water, soil pollution	Surface water	Low level, short term and
3. OPERATION PHASE				
3.1	Operation of interceptor and WWTP	Air pollution, surface and underground water, solid waste (sludge treatment system and the dredging of interceptor)	Air of Thanh My Loi B residential area and water Environment (Ky Ha, Ngon Ngay canals, Sai Gon, Dong Nai, Nha Be Rivers)	Medium level, long term
3.2	The transportation of chemicals, sludge	Air pollution, increase traffic density	Air Environment on roads	Low level, long term
3.3	Activities of workers in WWTP	Air, water and soil environment	Sai Gon – Dong Nai – Nha Be Rivers	Low level, long term

5.1.2. Impacts classification

5.1.2.1. Positive impacts

The project is the continuation and completion of the Phase 1's investment. It will improve the wastewater collection and treatment system in the NLTN Basin and in District 2. In addition, it is no need to construct a wastewater treatment plant in the new urban areas in District 2. Furthermore, it can help to further treat the wastewater from other existing WWTPs most of which them now only can treat waste water to meet column B of effluent standards.

Together with on-going similar environmental projects in HCMC, such as Tau Hu - Ben Nghe - Doi - Te basin drainage project, a WWTP (512,000 m^3/day) project; Tham Luong - Ben Cat WWTP (250,000 m^3/day) project, the NLTN project will improve water and air quality, sanitation condition as well as green space for HCM City.

(1). Long term positive impacts on Saigon River water quality

When the project is implemented, Saigon River water quality especially in the dry season will be improved. Water quality in dry season will not meet column B2 of QCVN 08:2008/BTNMT for BOD if wastewater is not treated by 2045. The concentrations of BOD in Sai Gon river will be reduced with about 10 mg/l and can meet column B2 of QCVN 08:2008/BTNMT. The concentration of NH_4 will be lower, although values will stillbe higher than the QCVN 08:2008/BTNMT, column B2. The project will reduce about 4.86mg/l of total nitrogen in 2045 in the Saigon River water compared to the present levels, presented in paragraph 3.1.5.

(2). Long term positive impacts on Da Phuoc landfill

The sludge transferred by land ways to Da Phuoc landfill will be disposed in environmentally

sustainable manner and stored in cells lined with HDPE material. The leakage waste water will be treated in the central WWTP of the landfill, which cumulatively will improve the environment quality surrounding the Da Phuoc landfill. The landfill operation will be monitored by MBS and DONRE in line with the environmental certificate issued at EIA approval process.

(3). Cumulative impacts on the Nha Be River water

Nha Be River is downstream of the Dong Nai and the Sai Gon River. Transferring discharges from the Saigon River to the WWTP and discharged into the Dong Nai River, the water quality of the Nha Be River will be improved. The concentration of pollutants such as BOD, ammonia, total N, total P in the Nha Be River will decrease gradually. Thus, it is expected that there will be no significant impacts on Cultural resources or Natural Habitats in the downstream of the Dong Nai, Sai Gon and Nha Be Rivers.

5.1.2.2. Negative impacts

There will be minimal land acquisition along the proposed interceptor. There will be temporary impacts due to the interceptor installation, which will be addressed by the project Resettlement Policy Framework (RPF). In addition, there will be permanent land acquisition for the 22 shaft locations, but the impact on land owned or used by households is likely to occur only in the case of 3-4 shafts. The exact impact of this will be determined during finalization of design during project implementation, and a Resettlement Action Plan (RAP) will be prepared within the framework of the current project RPF.

In addition, the climate changes may affect Vietnam overall due to impacts of rainfall and sea level rise. The construction area level of WWTP is relatively low. If the river water reaches over 2m, the WWTP operation will be interrupted. Therefore, a separate analysis was carried out to make the treatment plant flood resilient and its findings have been incorporated into the project design to ensure that the flood risks are prevented and/or eliminated. Currently, in the HCMC flooding control program, there are three alternatives proposed to ensure disaster and climate resilience for the investments in wastewater and drainage sector in Ho Chi Minh city, which include design adjustment; land filling (the same land lever of 3m); or diking.

5.2. IMPACT ASSESSMENT IN THE PRE-CONSTRUCTION PHASE

5.2.1. Impacts of Wastewater Interceptor in the pre-construction phase

The construction of interceptor line will not require land clearance. However, temporary acquisition of land to allow construction operations may be anticipated. The interceptor line will be installed below the projected roads and green areas. This is still to be determined as the bidder may want to offer a combination of pipe jacking and open trench technology

5.2.2. Impacts of Wastewater Treatment Plant works during pre-construction phase

5.2.2.1. Land acquisition

WWTP requires an area of 38.47 ha, in which the public land (rivers and ditches) is 6.82 ha (20%), privately owned land is 31.64 ha (0.04 hectares of residential land, accounting for 0.10%), agricultural and crop land is 2.847 ha (74%), with 65 landowners (See Table 5.3). The area includes vegetation characteristic to swamp land (i.e.,t nipa trees and small bushes), as well as former rice paddy fields. The recent surveys and census have identified a **total of 63 households** and 2 Companies that will be affected by the land acquisition for the WWTP.

59 households are land owners, 2 Companies are land owners and 4 households have structures (thatch hut, restaurant, graves) that will be affected by the land acquisition. All

these entities will have to be compensated in accordance with the entitlement matrix detailed in the RAP prepared for this project. The table below summarises the main impacts of the land acquisition on these households.

59 Households owning agricultural land 2 Companies owning agricultural land 4 Households with affected structures **TOTAL: 63 Project Affected Households and 2 companies**

There were six rounds of consultation. 3 were conducted by IMA and 3 by Thanh My Loi Ward Peoples' Committee. The first consultation done by IMA and their consultant was on 25 April 2012 as part of the social assessment done for the entire project. The second consultation was conducted on 18 February 2014 (right after the boundary for the WWTP area was publicly announced by District 2 People's Committee). The third consultation was conducted on 9 August 2014 (in attempt to consult the households who have not been consulted in the previous consultation meetings). In total, 49 (out of total 63) potentially affected households have participated in consultations to date. There is a tracer mechanism currently in place to contact the remaining 14 households and a provision for depositing compensation money into an escrow account in the event they are not contactable at the start of civil works.

All the affected households attending the consultation were informed of the project purpose and the compensation policies, including the key principles of the World Bank's OP 4.12. They all supported the project implementation and their overall expectation is to be adequately compensated for the loss of the land and assets associated to the land. All the affected households consulted (49/63) account for 19.5ha (63%) out of total 31.15ha to be acquired from the local households for the WWTP construction.

Table 5.3. Land acquisition for NLTN WWTP area

Purpose of Land	Crop	Pond	Fishing
Area (m^2)	264,807.71	9,024.55	10,886.74

5.2.2.2. Air Quality Impact

(1). Dust and emissions from the transportation of soil, machinery, equipment and solid waste during the reclamation

The area has mainly bushes, nipa and melaleuca trees, rice,. The volume of solid waste generated from this vegetation clearance is estimated at about 225 tons, equivalent to 44 turns during 3 weeks or 2 turns/day (the truck load of 10 tons). The solid waste will be transported to Da Phuoc landfill by land ways and disposed off in sustainable manner.

If the elevation's option will be selected to avoid flooding, the height at the position of WWTP is currently +0.5m - +1 m and should be increased to +2.5 m to +3m. It required 900,000 m^3 of soil for leveling 384,755.4 m^2. The remaining volume of organic soil/sludge (i.e. 709,091 tons) is transferred from Da Phuoc landfill by land ways. The leveling duration is 6 months. The number of trucks is 788 turns per day (the truck load of 10 tons).

The total number of transport means for pre-construction solid waste and organic soil/sludge is (2+788)=790 turns/day. The transport distance is about 20 km/trip from WWTP to Da Phuoc landfill one way. . The maximum load of emissions by transportation means is predicted following WHO standards and method (S=0.25%) (See Table 5.4).

Table 5.4. Air pollution load as the construction of WWTP

No.	Parameter	Emission factor (g/km)	Pollution loading (kg/day)
1	Dust	0.9	14.62
2	SO_2	4.29S	17.42
3	NO_2	11.8	191.64
4	CO	6	97.44
5	VOC	2.6	42.22

The selected route from WWTP to Da Phuoc landfill and backgoes through Phu My Bridge, Nguyen Van Linh Street, 6-lane Highway 50, mostly outside the city center. This route has been selected since it will help reduce pollution from transportation means in the city.

(2). Emissions from the clearance and excavation
Fuel demand for clearance is estimated at about 65 l/ha. Therefore, total amount of oil is 2,925 liters, equivalent to 2.34 tons of oil. It takes about 3 weeks. Based on NATZ document, estimated results of emission load of construction process (including grading, tilling, stone from digging of the project) shown in Table 5.5.

Table 5.5. The emissions load due to reclamation operation of the project

Oil (ton/day)	The emission content (kg/day)		
	SO_2	NO_2	CO
0.117 (the project)	0.328	1.439	0.0059

Emission loading from equipment is small, besides, the WWTP areas are mainly covered by wood trees; environmental quality of the project area is good and has the strong diffusing capability. Thus the impact on air is reduced. Nevertheless, it will directly impact on worker health on the construction sites.

(3). Dust from the process of reclamation, grading, digging and ground preparation

Following calculation of dust coefficient, a ton of leveling soil produces 0.009 kg of dust.

With 709,091 tons of sand for leveling, the amount of dust generated by the process of leveling and ground preparing is 6,381.82 kg. Leveling time is about 6 months. It will generate 35.45 kg of dust per day in average.

During the transportation soil will generate dust. Maximum affected radius of dust arisen from construction site is 300m in the main wind direction. The impact of dust in the atmosphere is at the medium level if they are not mitigated.

(4). Noise

There are four types of vehicles used in the reclamation area, including bulldozers, roller, excavator, and land scraper machine. Noise level at position 50m far from the source is less than the allowable limit.

5.2.2.3. Water Quality

(1). Domestic wastewater

The number of workers for reclamation activities is about 50 people. Domestic waste water from these workers equal to 80% daily water supply is about 1.6 m^3.

(2). Washing vehicles

The number of vehicles per day is about 20 with washing demand of 40 L/time. During 6 months, the volume of wash water is 144 m^3 (0.8 m^3 per day). It contains sand and oil from vehicles, which must be treated before discharge into receiving sources.

(3). Runoff

The rainfall runoff in the project area is: Q = 40,670 m^2 x 2m /year x 0.7 = 56,938 m^3/year.

Basically, the rain water is considered fresh water, if it doesn't run through the contaminated area. The concentrations of pollutants in runoff are presented in Table 5.6 as follow:

Table 5.6. Concentration of pollutant in rainwater

No.	Parameters	Concentration (mg/l)
1	Total N	0.5 – 1.5
2	Total Phosphorus	0.004 – 0.03
3	COD	10 – 20
4	TSS	10 – 20

Source: Water Supply and Sewerage – Hoang Hue

Reclamation activities will generate waste materials such as leaves, pieces of broken material, sand, soil, gravel and waste oil. In the rain, they will be washed away into the Saigon River, Dong Nai River and Ngon Ngay Canal, and affect the water quality of these water sources. Therefore, it is necessary to separate rain water and solid waste in order to avoid adverse impact on water sources.

5.2.2.4. Solid waste

(1). Solid waste from the reclamation

The volume of solid waste generated is about 225 tons of biomass during 3 week of land clearance, which is equivalent to 11 tons/days [22]. Large amounts of wastes can block the drainage system and pollute surface water.

(2). Domestic solid waste

The generation rate of domestic solid waste is 0.35 kg/person/day. With 50 workers in site, its amount is 17.5 kg/day, which contains 60-70% organic matter.

5.2.2.5. Other impacts

The labors come mainly from local areas. Transportation of material for leveling at the project area and useless waste to the landfill is about 788 turns/day. Besides, WWTP area is located on low ground with the height from 0.5 - 1m from the sea, so flooding and subsidence during leveling will be of concern.

The other potential impacts during site clearance period are listed in Table 5.7 as follows:

Table 5.7. Other impacts during the site clearance

No.	Components	Impacts	Degree
1	Ecosystem	Change of ecosystem	Low
2	Flora, fauna, fish in the river	Change of water quality	Low
3	Microclimate condition	Change of temperature and humidity	Low
4	Soil	Change of the nature of soil environment	Low
		Environmental pollution due to waste from	Low

No.	Components	Impacts	Degree
		activities of workers	
5	Social condition	Security by 50 workers' activities	Low
		Traffic jam by vehicles (788 turns/day)	High
6	Rainy runoff	Flooding	Medium
		Water quality of receiver	Low

5.3. IMPACT ASSESSMENT IN CONSTRUCTION PHASE

5.3.1. Impacts of Wastewater Interceptor in the construction phase

5.3.1.1. Impact on air environment

Air environment will be affected during the interceptor construction by dust, exhaust gases and noises from construction means. However, those impacts do not retain for a long time and continuously; most of them are temporary.

(1). Emissions from the transport of materials and operation machines

Based on similar projects, the total volume of raw materials used for construction of interceptor is about 112,500 tons. Construction work will be done within a year. Thus, the estimated number of 10 ton vehicles is 75 turns/day. Based on WHO calculation, the emission load by transportation of construction materials is presented in Table 5.8 below.

Table 5.8. Emission load by transportation of construction materials

No.	Parameter	Pollution load (kg/day)
1	SO_2	8.04
2	NOx	88.50
3	CO	45.00
4	VOC	19.50

(2). Emissions from the mechanical operation

Welding fume components such as metal oxides (Fe_2O_3, SiO_2, K_2O, CaO) and CO, NOx can be determined in Table 5.9.

Table 5.9. The Concentration of toxic gases during the welding of metal materials

Pollutants	Diameter of welding rod				
	2.5	3.25	4	5	6
Metal oxides (mg/welding rod)	285	508	706	1,100	1,578
CO (mg/welding rod)	10	15	25	35	50
NOx (mg/welding rod)	12	20	30	45	70

Source: Pham Ngoc Dang (2000), air environment, scientific and technical publishers

However, this work happens in a short time and the impact is localized and temporary, so negative impacts on worker is limited with appropriate labor protection.

(3). Noise pollution

The following activities such as transportation of construction materials, hammering, laying the asphalt will cause noise. Maximum noise level from construction means is presented in Table 5.10.

Table 5.10. Maximum noise level from construction means

No.	Machine	Noise level at position 1 m from source		Noise level at position away from source	
		Range	Average	20m	50m
1	Bulldozer		93,0	67,0	59,0
2	Roller	72,0 – 74,0	73,0	47,0	39,0
3	Land scraper machine	80,0 – 93,0	86,5	60,5	52,5
4	Truck	82,0 – 94,0	88,0	62,0	54,0
5	Concrete mixer machine	75,0 – 88,0	81,5	55,5	47,5
6	Excavator	72,0 – 84,0	78,0	52,0	44,0
7	Sawing machine (*)	80 – 120	100	83	65
8	Crane	76,0 – 87,0	81,5	55,5	47,5
QCVN 26:2010/BTNMT		**70 dBA**			

Source: Mackernize, 1985, (*)Institute for Environment and Resources, National University

Noise level at position 50 m from the noise source is less than the allowed limit. Therefore, this pollution source will only affect people at the construction area.

5.3.1.2. Impacts on water environment

(1). Domestic wastewater

Wastewater is arisen mainly from the worker activities. It is estimated about 50 workers with an average supply water of 40 L/day. The ratio of wastewater and water supply is 80%. Thus, the domestic wastewater volume is 1.6 m^3 per day. The entire amount of this waste is collected by mobile toilets (hired by contractors).

(2). Wastewater from construction activities

Construction wastewater is arisen from washing machines, transportation means and concrete mixing. It causes pollution in the local area with suspended solids and oil. Without appropriate treatment, it will cause turbidity in the receiving water sources and block the flow of water.

(3). Runoff

Rainwater running through construction areas will be contaminated by oil and grease, sand, grit, cement, and open dumpsite. It will pollute surface water, soil and groundwater in the area. However, with the pipe jacking technology, the pollution caused by runoff is reduced significantly.

5.3.1.3. Solid waste

(1). Construction waste

The installation of interceptor will generate construction wastes such as typical construction waste (paper, sand and stone, steel), mud, bentonite which will affect commercial activities along the roads as well as the surrounding area.

At the beginning and ending pits, total volume of excavated soil is 1,440 m^3 x 19 = 27,360 m^3 while disposal soil in the installation of the interceptor is 25,600 m^3 with 3.2 m diameter and 8 km length. The abundant soil will be transported to the leveling purpose or used for flood protection purposes in the WWTP.

(2). Domestic solid waste

With 50 workers, the amount of domestic solid waste is about 17.5 kg/day, contains 60-70%

organic matter. Without collection, it could become an open dumpsite and will create a favorable condition for pathogenic vectors. The entire amount of this waste is collected and periodically rent units processing functions.

(3). Hazardous waste

On average, oil replacement for vehicles is carried out quarterly. There are about 10 vehicles on the site. The amount of discharged oil should be 640 L/year, equivalent will be collected and handled according to the regulation.

5.3.1.4. Land subsidence by constructing sub-items in the interceptor

Because information on geological conditions in the project area is very poor, it may cause subsidence due to excavation activities, as follows:

- Excavation could reach the aquifer level.
- Vibration or pressure on piling wall will break the soil structure.
- When draining out groundwater for pit construction, the water table is lowered. This increases the land subsidence.
- When recovering sheet piles, the soil moves into the empty slots left by the piles, sunk the surrounding areas.

The construction does not regularly follow strictly due to the design that can deteriorate construction quality. In addition, construction in a long duration can cause land stagnant, soil muddy locally in the project area.

5.3.1.5. Impacts to the traffic

Phase 1 was constructed in a dense part of the City, therefore, impact on traffic was significant. The slow or improper road rehabilitation causes traffic jams and accidents. Furthermore, the transportation of soil, waste, sewage sludge, bentonite also increases traffic density in project area. The impacts on traffic in phase 2 is less significant comparing with one in phase 1, since the construction of WWTP and inceptor will be implemented in the less dense part of the city.

5.3.1.6. Social impacts

In the next three years, some residential areas are expected to construct with an estimate of 60,000 residents by 2020. Therefore, the interceptor sewer line under HCMCES 2 project will be scheduled from 2014 to 2019 to reduce unexpected impacts on local residents. Some adverse impacts may include:

- Risk of increased accidents caused by damaged roads. Roadways narrowed by barriers at the positions of pipe jacking may cause traffic congestion in peak hours. In addition, if the holes around the positions of pipe jacking are not covered and fenced carefully, children and pedestrians may be at the risk of accidents, particularly in the rainy seasons with slippery roads;
- Noise and air pollution affecting people's health: Noise and vibration from construction machines at the construction site, dust from vehicles may make the local residents susceptible to respiratory diseases, especially during the dry season. The vulnerable groups are the elder and children;
- Narrowed home access will affect the income of households engaged in commercial activities and services at home. The prolonged execution time can temporarily affect the land prices in these areas;
- Occupied public space if the positions of pipe jacking are located in green parks,

trees. This results in intermittent local recreational activities.

5.3.2. Impacts of Wastewater Treatment Plant in the construction phase

5.3.2.1. Impact on air environment

(1). Emissions from the transport of materials and operation machines

Based on similar projects, the total volume of raw materials used for construction of WWTP is about 112,500 tons. Construction work will be done within a year. Thus, the estimated number of 10 ton vehicles is 75 turns/day. Based on WHO calculation, the emission loading by transportation of construction materials is presented in Table 5.11 below.

Table 5.11. Emission load by transportation of construction materials

No.	Parameter	Pollution load (kg/day)
1	SO_2	8.04
2	NOx	88.50
3	CO	45.00
4	VOC	19.50

On average, if you move 1 km, the amount of dust generated by transport approximately 0.082 kg/vehicle turn/ km[7]

(2). Dust and emissions during construction phase

The concentration of dust in the construction period ranges from 0.75 to 2.94 mg/m^3, higher 2.5 to 9.8 times than permitted levels. However, emissions are only generated during construction. It only affects to workers and does not affect the surrounding residential areas which are 625m away from the WWTP.

(3). Noise pollution

Activities such as transportation of construction materials, hammers, pneumatic, laying the asphalt (spreader, pneumatic), execution of work items will cause noise. There are no residents surrounding the WWTP region, so it will only affect workers at the site.

Harmful effects of noise include reducing auditory function; affecting psychological state of human; reducing labor capacity of workers and increasing the rate of occupational accidents.

5.3.2.2. Impacts on water environment

(1). Wastewater from construction activities

The wastewater from construction activities is estimated at 10 m^3/ha [22]. The construction area of 384,755m^2 and the amount of the wastewater is 407m^3. In one year, the project will generate average 1.2 m^3 per day in the construction phase.

(2). Runoff

The amount of storm water runoff in a relatively large area. However, rain water does not contain ingredients of high pollution, mainly containing inorganic suspended solids.

[7]It is means that pollution load: Q = E * d. with: E is pollution factor, d is distance of transport and supplies. Distance transport of materials is about 10 km, so the amount of dust generated during transport is: Q = 0.082 x 10 x 75 = 61.5 kg/day.

Rainwater drainage, if not cleared will cause flooding in the project area affecting construction activities and activities of workers.

Water flooding increases the likelihood of water pollution and environmental development of parasitic disease. However, this effect will only take place in a short time due to priority project owner will complete construction of drainage works right from the start of construction of the project.

5.3.2.3. Solid waste

(1). Construction waste

The generation rate of construction waste is 0.05kg/1kg raw materials [22]. The amount of material needed for the project is about 112,500 tons (mainly cement, steel, stone and sand). Thus, the volume of construction waste: 112,500 x 0.05 = 5,625 tons. For one year of construction, the amount of construction waste is 19 kg/day.

(2). Domestic solid waste

With 50 workers, the amount of domestic solid waste is about 17.5 kg/day, contains 60-70% organic matter. Without collection, it could become an open dumpsite and will create a favorable condition for pathogenic vectors.

5.3.2.4. Impact on the ecosystem in the WWTP area

The major impact is removing the existing green areas, leading to change in temperature and humidity of sub-region. Similarly, construction process could cause the loss of terrestrial ecosystems and aquatic systems. The loss of wetland vegetation increases the river flow rate and reduces water regulation in the dry season.

In addition, soil washed into the lakes and canals will increase turbidity, affecting aquatic species.

5.3.2.5. Impact on the traffic

Traffic density will be increased, affecting road quality across Phu My Bridge. This also increases the risk of congestion and traffic accidents.

5.3.2.6. Risk and accidents

(1). Risks of increased accidents

- Heavy vehicles increase risks of accidents to road users. During the construction period 75 turnsof vehicles per day is a impressive number (See paragraph 5.3.1.1). It may cause congestion in the area near Phu My Bridge. Heavy vehicles may also cause road damages, especially in Thanh My Loi Ward where most public roads are gravel roads or soil roads. The damaged roads will soon become muddy, slippery in rainy seasons, resulting in significant risk of accidents;
- If the construction site is not covered and fenced carefully, accidents are likely to happen to the residents such as falling into holes, especially in rain. This case happens many times in HCM City when the poor collect discarded bottles and wastes, or children take a bath or swim in the rain;
- The workers are not trained in labor safety regulations. This mostly affects unskilled short-term workers;
- Employers and employees do not follow the requirements of wearing protective clothes.

(2). Health risks

- Dust will cause respiratory diseases for people living near project areas.
- Regular noise of construction machines easily cause stress for people living near the site, especially on the elderly and children.
- Temporary huts and tents built for workers' accommodations have no relevant latrines, so the risks of diseases will increase when a large number of workers Infectious viruses will be passed through water and air environment.
- Domestic wastes of workers living in huts and tents are normally controlled in an improper way, so rats, bugs, insects carry germs to human beings.

(3). Risks of increased social evils

- At construction sites, many building materials are gathered, but the warehouses and yards are simple, sometimes they are just open-tents. It may cause bad security issues;
- Workers often live far from home, so their entertainment hobbies are mainly drinking and gambling. It will cause bad effect on social condition.

5.3.2.7. Creek diversion at WWTP site

In line with feasibility study, during the construction of wastewater treatment plant,diversion of an existing creek could beneeded in order to allow proper construction activities (Figure 5.1).

Figure 5.1. Creeks (including the diversion creek) located at WWTP site

At the wastewater treatment plant area (38 ha) there are 3 creeks namely, (i) Phu My (47.5 m^3/s; 4.5 m depth and 50 m wide; (ii) Ngon Ngay (no flow, primarily mud of 1 m depth and 20 m wide), and (iii) Ky Ha (65 m^3/s; 5.5 m depth and 50 m wide) as presented above. Based on the latest FS information, there are several options includingthe proposal to eliminate the Phu My creek and divert its flow to the one of the Ngon Ngay creek in order to ensure the integrity of the WWTP construction. A preliminary survey and the basic designof the creek diversion concluded that a final design would need to take in consideration the additional flow, which would call for an increased depth and proper embankment of the Ngon Ngay creek.

However, this would be confirmed later at the detailed project design stage. The diverted Ngon Ngay creek is relatively small (150 m length) and its impact primarily on Ky Ha is not significant. Potential impacts of the creek diversion include erosion and sedimentation along the Ngon Ngay creek and at its confluence with Ky Ha, as well as an increased flow and slightlyenhanced traffic (mainly by local personal boats) on Ky Ha. The actual impacts of re-channeling on hydrology and water flow at the WWTP site will be confirmed during the detail design stage. No impacts are expected on aquatic fauna or other habitats at the WWTP site, which is characterized by swamp land conditions primarily including small bushes.

5.4. IMPACT ASSESSMENT IN OPERATION PHASE

5.4.1. Impacts of Wastewater Interceptor in the operation phase

5.4.1.1. Impact on air environment

Aerosols and odors (H_2S, NH_3, amino acid and mercaptan) from manholes and the interceptor line will be released when the dredging and repair are carried out. It can cause discomfort to local residents living in the radius of 10m, but is expected to cause little harm to public health. The gas only affects the workers, who dredge manholes without preventive measures.

5.4.1.2. Solid Waste

Amount of sludge will increase when the interceptor route will be installed:

The interceptor route has 8 km in length and inside diameter is 3,200 mm.

Volume of the interceptor route is $\pi R^2 * h$ = 257,359 m^3; Volume of sludge = ½ volume of the interceptor route = 128,680 m^3/year

With coefficient of sludge is 1m^3 = 1.6 tons; amount of sludge are (128,680 m^3 x 1.6 m^3/ton)= 205,888 tons/year.

Sewage sludge in manholes containing pathogens, unstable sediment can still decompose naturally, is the source of harm to health and the environment. For a long time, sludge will obstruct the flow of wastewater, congestion drain. The amount of sludge has to be dredged periodically and treated properly.

Composition of sludge generated in the interceptor similar sludge components shown in Table 5.12.

Table 5.12. Composition of sewage sludge in HCM City

Position	Humidity (%)	Inorganic (%)	Organic (%)	Total N mg/kg	Total P mg/kg	Heavy metals (mg/kg dry weight)				
						Cd	Ni	Zn	Pb	Cu
Chu Van An, Binh Thanh District	26.7	68.5	4.8	1,618	1,415	0.38	23.1	1.4	1.8	41.2
Vo Thi Sau, D.3	38.8	57.2	4	498	536	0.14	18.2	0.8	0.9	23.1
Cao Thang, D.3	22.4	71.7	5.9	445	803	0.05	16.4	2.3	1.2	85.0
To Hien Thanh, D.10	20.8	74.3	4.9	532	653	0.08	16.4	0.3	0.7	12.3
Effect level (PEL)	-	-	-	-	-	3.53	50	315	91.3	197
QCVN 03:2008/ BTNMT	**-**		**-**	**-**	**-**	**5**	**-**	**200**	**120**	**70**

Source: CENTEMA, 2007

Note: QCVN 03:2008/BTNMT the permissible limits of heavy metals in soil.

5.4.1.3. Impacts of Risk and Accidents

- The interceptor blocked or broken down: When the interceptor is blocked and/or broken down, overflowed wastewater in the blocked or broken areas will affect surface water or contaminate soil.
- The health risk to O&M workers: Workers who dredge sludge or repair pipes often face with toxic gases. They are susceptible to be poisoned if they do not strictly follow the safety regulations.
- The risk of temporary odor emissions at the manhole at O&M: The periodical O&M of manholes will release toxic substances and odors that cause discomfort for people living or working in the neighborhoods.

5.4.2. Impacts of Wastewater Treatment Plant in the operation phase

5.4.2.1. Impact on air environment

(1). Air emission

Based on statistics of the FS Report, the number of trips transporting chemical, sand and sludge from WWTP is calculated in the below table. About 17 - 27 trips/day will generate significant emissions and the investors will take measures to reduce these impact resources. Number of trips transporting chemical, sand and sludge from WWTP is presented in Table 5.3. Air pollution load from transportation in WWTP is presented in Table 5.14.

Table 5.13. Number of trips transporting chemical, sand and sludge from WWTP

Volume of transport	Year			
	2020	2025	2035	2045
Chemical (ton)	2,574	2,726	3,452	3,594
Residual sludge (ton)	15,525	18,630	24,820	25,185
Sand (ton)	40,950	49,207	63,700	66,430
Total (ton/year)	59,049	70,563	91,972	95,209
Total (ton/day)	162	193	252	261
Number of trips/day	17	19	26	27

Table 5.14. Air pollution load from transportation in WWTP

No.	Parameter	Pollution loading (kg/day)				
		2015	2020	2025	2035	2045
1	Dust	0.25	0.31	0.34	0.47	0.49
2	SO_2	0.30	0.36	0.41	0.56	0.58
3	NO_2	3.30	4.01	4.48	6.14	6.37
4	CO	1.68	2.04	2.28	3.12	3.24
5	VOC	0.73	0.88	0.99	1.35	1.40

Odors and aerosols released in anaerobic digestion tanks, pumping stations, sewage screen, and sludge collecting tank in WWTP often contain H_2S, NH_3, amino acids, and mercaptans. Unfortunately, in the dry season from March to May, North - North West wind will spread the odor from the WWTP to Thanh My Loi B residential area, with the radius of 300m if no mitigation measures are taken (See Figure 5.2).

Besides, the aerosols containing bacteria (E. coli, intestinal bacteria) and fungi in also can

spread by wind with the radius of 50m which will affect directly to workers (See Table 5.15).

Table 5.15. Concentration of aerosols released from WWTP (bacteria/m^3)

Position relative to the wind	Distances			
	0 m	50 m	100 m	> 500 m
End wind direction	100 – 650	50 – 200	5 – 10	No detected
Head wind direction	100 – 650	10 – 20	no detected	No detected

The biogas generated by the sludge decomposition composes CH_4 (65-70%) and CO_2 (25-30%). Estimation of biogas production in 2045 is equivalent to 39,000 m^3 of which 25,000 m^3 CH_4, releasing about 35,800 KJ/m^3 x 25,000 m^3/day ÷ 1000 MJ/KJ = 895,000 MJ/day. This gas could be utilized for power generation.

In all cases, digestion enables GHG emissions to be reduced by 20 – 30% compared with the baseline scenario (SBR QCVN 14:2008/BTNMT without digestion). GHG reduction is more favorable for SBR, CAS and TF processes. It is also seen that GHG savings will increase in the coming years with the increased organic load and the resulting increase in concentration. Consequently, the more concentrated the effluent is, the greater the potential is for GHG savings.

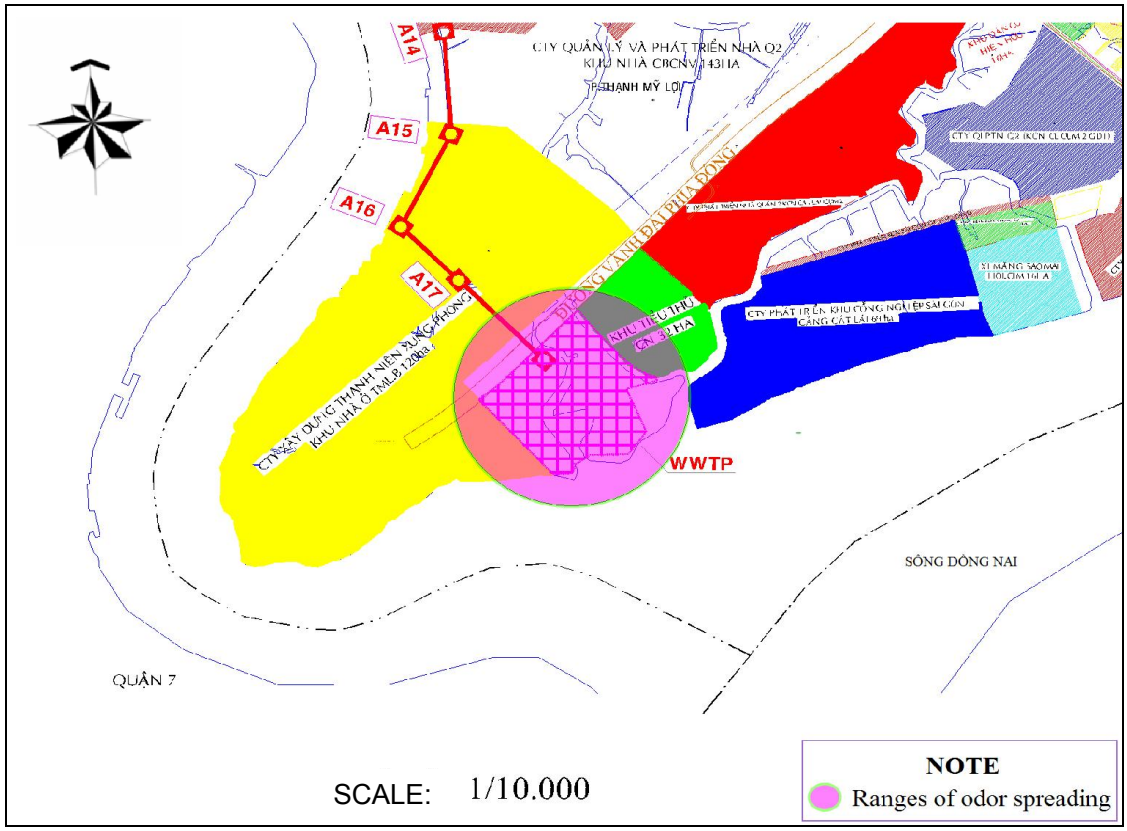

Figure 5.2. Area is affected by influence of wind direction

(2). Noise

Noise generated mainly from air blowers, pumping stations is about 90 - 95dBA that exceeds permitted standards. So it will be the source of noise pollution affected on surrounding areas, especially workers.

In addition, noise is also generated from transportation of chemicals and residual activated

sludge from sludge dewatering machine in the WWTP. However, this noise source is insignificant, so the impact is negligible.

5.4.2.2. Impact on water environment

(1). Domestic wastewater

The number of workers in 2025 will be about 78, up to 91 people in 2045 [20]. Domestic wastewater generation rate is 32L/person/day. The volume of domestic wastewater per day is 2.5 m^3 in 2025 and 2.91 m^3 in 2045. This water will be collected and recycled.

(2). Wastewater from other activities

Wastewater could come from laboratory works, which is about 80% of water supply for laboratory operation (10% of the water supply). Volume of wastewater is presented in Table 5.16.

Wastewater collected from sludge treatment system, laboratory, and washing machine contains many different pollutants. If not treated before discharge, it will have adverse impacts on the receiver.

Table 5.16. Volume of technology wastewater of WWTP

Item	2015	2020	2025	2035	2045
Water supply for the plant operation (m^3/year)	40,539	57,309	74,008	101,554	114,898
Water for laboratory operation (m^3/year)	4,054	5,731	7,401	10,155	11,490
Technology wastewater (m^3/day)	8.9	12.6	16.2	22.3	25.2

(3). Runoff

Content and volume of runoff in WWTP is similar to rainfall runoff during construction.

(4). Treated wastewater

The treated wastewater of the WWTP will be discharged near the river junction of Sai Gon - Dong Nai - Nha Be, where there are some wards of District 9, District 7, District 4, Nhon Trach, Nha Be located along the river. However, the calculated data of maximum concentration in receiving water of the project shown that the water quality of the Sai Gon, Dong Nai, Nha Be rivers meet Column B2 of QCVN 08:2008/BTNMT. In addition, waste water after treatment to meet column A of QCVN 14:2008/BTNMT should hardly affect the water quality of these rivers. Therefore, the WWTP hardly impact on the people living in the downstream of the discharging point.

(5). Impact on water quality of the receiving water

(a). Input parameters for the model

The hydraulics, hydrology data are collected from different sources and from monitoring results from the CDM Consultant.

Flow and water levels in the Sai Gon and Dong Nai River segments, passing through the project's area are significantly changed in the rainy and dry seasons. In particular, the average flow is about 93 m3/s on the Sai Gon River and 980 m3/s for the Dong Nai River flowing through the project area. The sudden increase in flow during the rainy season can cause inundation poured into the project area, which affects the project's works as well as the transportation system. Especially it causes some difficult for household's travel and

environmental pollution. Therefore, design calculation of elevation for the project area must take into account the flooding.

Besides that, in the vicinity of the project area there are also tributaries discharging into the Sai Gon river as Nhieu Loc -Thi Nghe, Tau Hu canals etc. Those canals are seriously contaminated by the waste waters. This river's water also significantly increases the Sai Gon River water quality.

(i). The hydraulic parameters

The hydraulic input parameters for water quality modeling are presented as the following table (Table 5.17):

Table 5.17. The hydraulic input parameters for water quality modeling

Name	Boundary flow (m^3/s)	Elevation (m)	Manning factor	Width (m)	River bank's slope (%)	Longitudinal diffusion (m^2/s)
Sai Gon River	93	10.0	0.03	209	2.0	0.45
Dong Nai River	980	6.0	0.03	754	2.0	0.45
NL-TN Canal	1.16	8.0	0.05	68	1.0	0.45
Tau Hu Canal	1.51	4.0	0.05	77	1.0	0.45

(ii). Data cross section the river bottom topography

Traffic parameters cross section the river bottom topography referenced from actual observation data in the Saigon River section of CDM consultant on February 2013. Actual monitoring data fact as follows (Figure 5.3 – Figure 5.7):

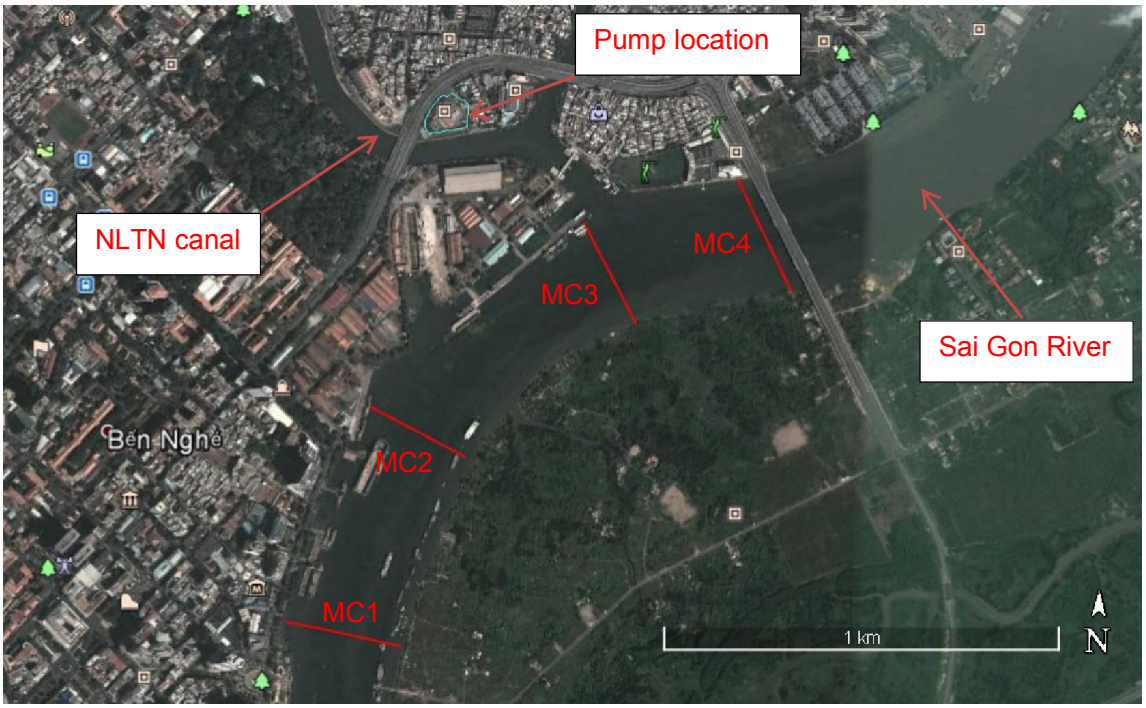

Figure 5.3. Cross sectional location on the Saigon River

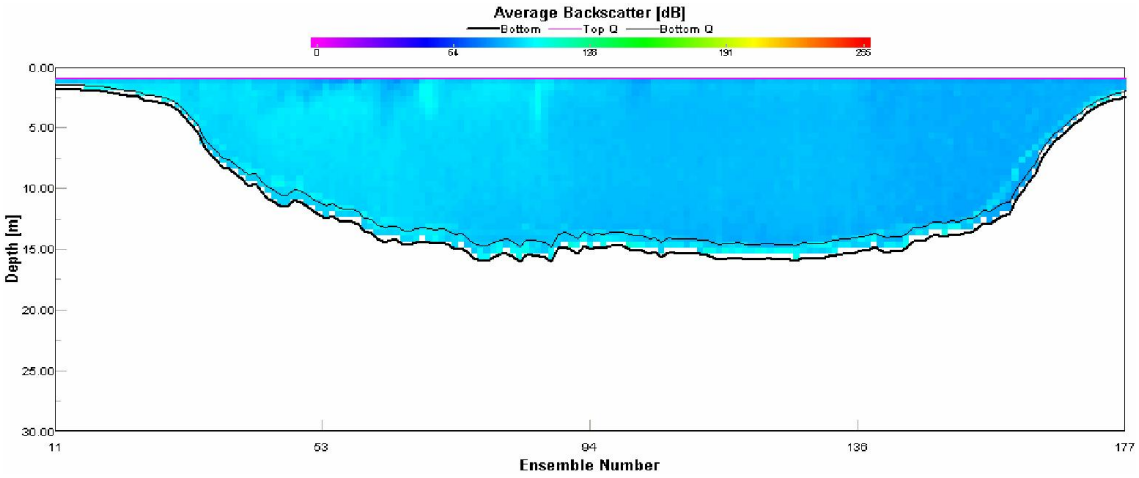

Figure 5.4. Shape cross section 1 (MC1) measured 02/3013

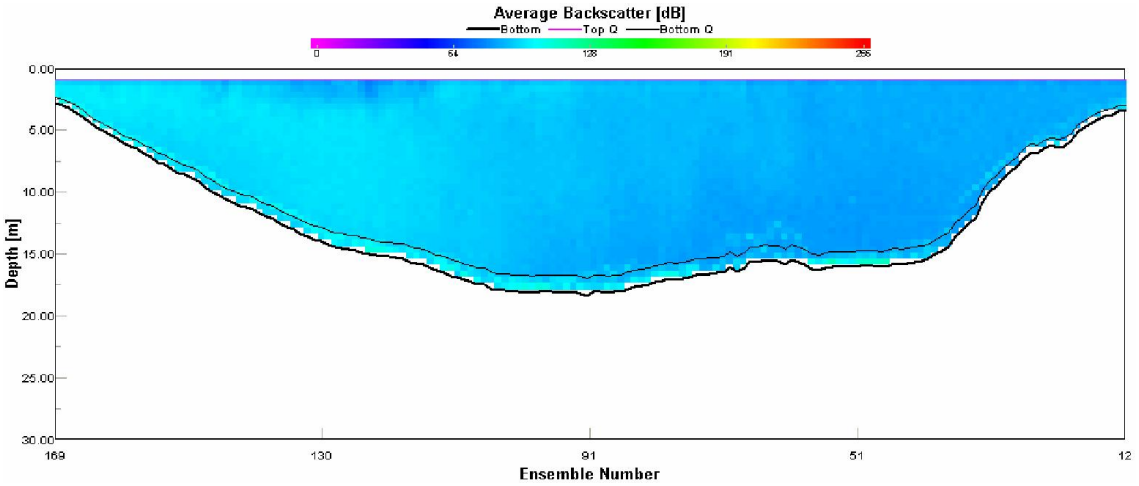

Figure 5.5. Shape cross section 2 (MC2) measured 02/3013

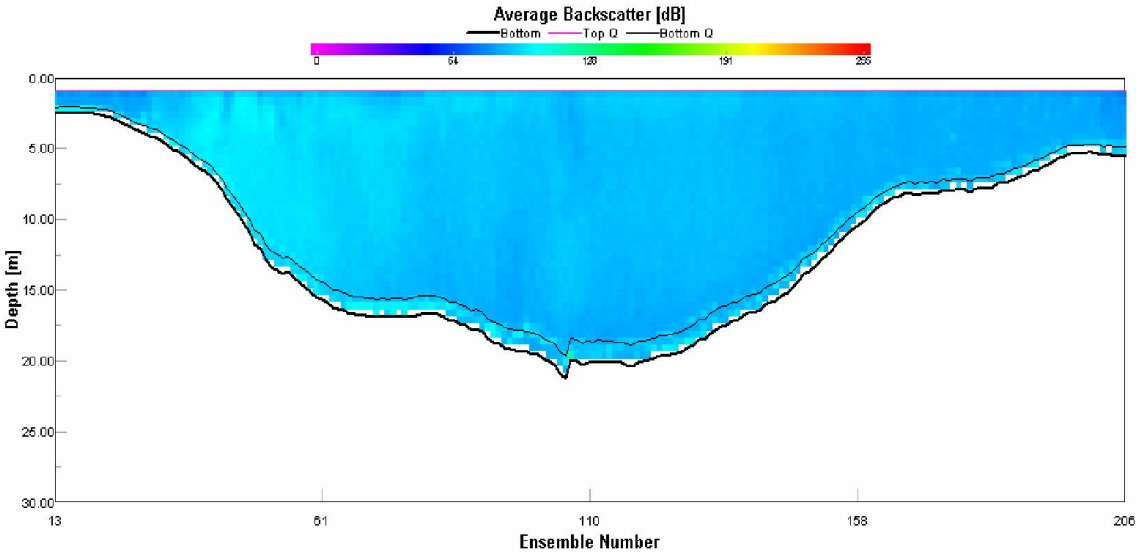

Figure 5.6. Shape cross section 3 (MC3) measured 02/3013

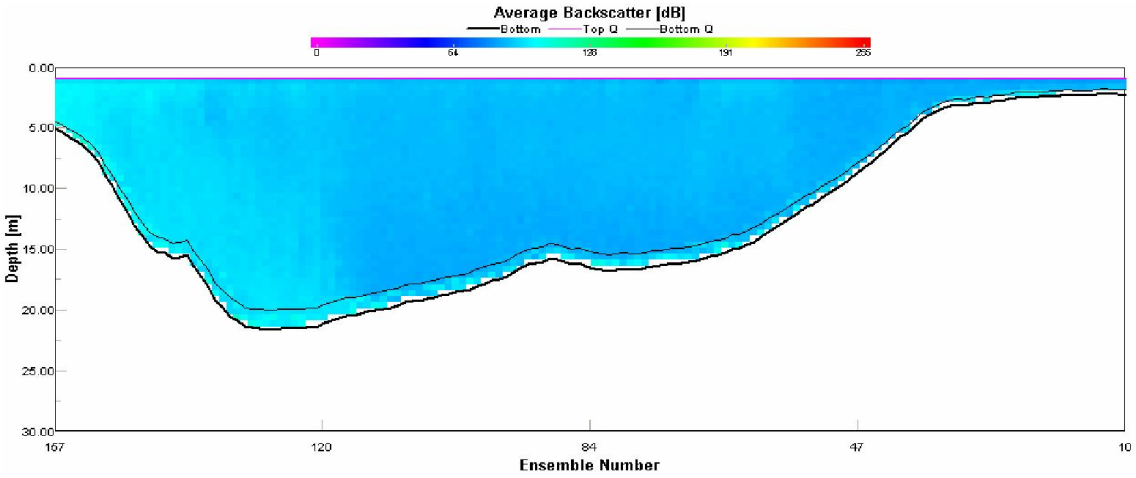

Figure 5.7. Shape cross section 4 (MC4) measured 02/3013

(iii). Data flow, cross-sectional area

Data flow, cross-sectional area, cross-sectional width provided by the CDM consultant from February 2013

Table 5.18. Data flow, cross-sectional area and cross-sectional width

Name of section	Flow (m^3/s)	cross-sectional area (m^2)	cross-sectional width (m)	Average velocity cross (m/s)
Low tide				
MC 1	2721,693	3167,83	283,24	0,86
MC 2	2911,738	3760,48	286,08	0,77
MC 3	3077,124	3447,41	268,35	0,89
MC 4	3034,661	3697,16	290	0,82
High tide				
MC 1	-2932,728	3491,07	286,69	0,84
MC 2	-2840,798	3897,88	288,19	0,73
MC 3	-2810,523	4328,18	270,35	0,65
MC 4	-2794,197	4034,56	292,27	0,69

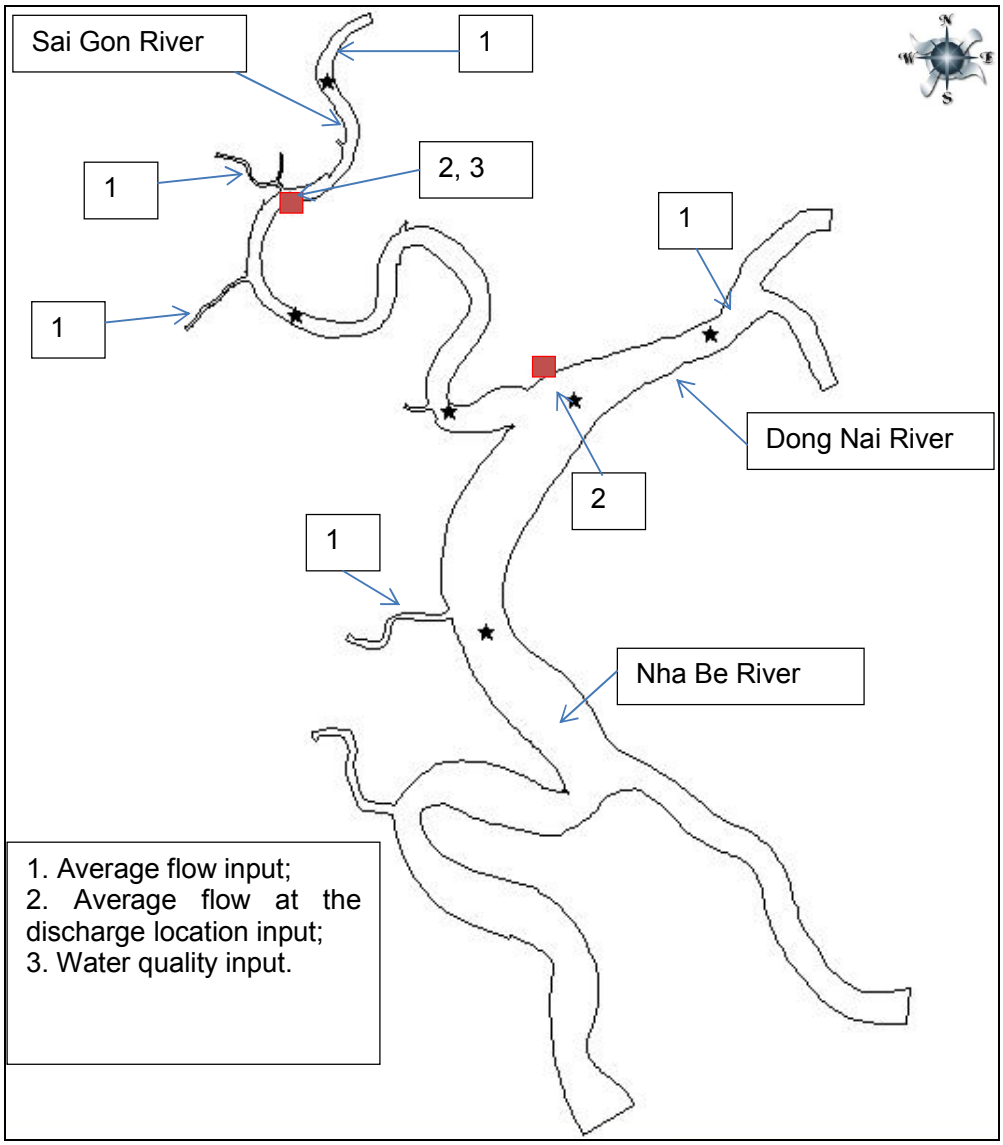

Figure 5.8. The calculation network diagram and locations for data inputs for the model

(iv). The climatic parameters

The meteorological data (air temperature, dew point temperature, wind speed, cloud cover, darkness etc.) are referenced from data measured at the stations in the project area.

(v). The coefficient values

Set of input coefficients for QUAL2K model includes: Set of coefficients for oxygen regeneration model; Set of coefficients of the wind's influence model in oxygen regeneration; Set of coefficients related to oxygen regeneration such as BOD, COD, nitrate, nitrate reduction; Set of light coefficient model.

The coefficients of the QUAL2K model inputs selected based on the experimental study combined with the results of water quality analysis of the Sai Gon -Dong Nai rivers of CDM consultant, the values of input coefficients for the Sai Gon-Dong Nai Rivers are determined through a process of model's calibration.

(vi). Water quality parameters

Data on water quality in the Sai Gon - Dong Nai rivers are taken from actual observation data

of CDM consultant. The water quality parameters were simulated in the model including: BOD, COD, N-NH4+, and TSS. The water quality parameters used calibrate the model are taken from actual observation data of CDM in February 2013 the following results:

Table 5.19. Range of targets under the tidal regime in place MC1

Tide	Parameter			
	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	N-NH_4(mg/L)
Low tide	28 - 149	11 - 41	5 - 16	0,40 – 1,72
High tide	13 - 73	9 - 29	5 - 16	0,20 – 1,92

Table 5.20. Range of targets under the tidal regime in place MC2

Tide	Parameter			
	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	N-NH_4(mg/L)
Low tide	23 - 155	9 - 84	5 - 17	0,61 – 1,72
High tide	13 - 61	9 - 26	5 - 13	0,50 – 1,51

Table 5.21. Range of targets under the tidal regime in place MC3

Tide	Parameter			
	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	N-NH_4 (mg/L)
Low tide	25 - 149	9 - 44	4 - 20	0,61 – 2,22
High tide	14 - 87	9 - 34	5 - 17	0,71 – 2,22

Table 5.22. Range of targets under the tidal regime in place MC4

Tide	Parameter			
	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	N-NH_4 (mg/L)
Low tide	20 - 134	11 - 62	5 - 18	0,40 – 2,62
High tide	16 - 113	11 - 32	5 - 21	0,71 – 1,72

(vii). Pollution source parameters

Pollution sources in the QUAL2K model are divided into untreated waste waters at the pump station (i.e. discharge into the Sai Gon River) and treated waste waters at the WWTP's outlet (i.e. discharge into the Dong Nai river).

QUAL2K model have been applied for the Sai Gon-Dong Nai rivers according to geographical coordinates, setting the boundary conditions, initial conditions, the characteristics of morphology, hydraulics, pollution sources etc. and parameters/coefficients have been calibrated on the base of the results of river water quality survey/sampling/analysis obtained by CDM Consultant and Institute for Environment and Natural Resources (i.e. EIA report's executing agency). Flow and concentrations of emission sources input for the model is presented in Table 5.23 and Table 5.24.

Table 5.23. Flow of emission sources

No.	Name of emission sources	Unit	Flow	Location
Without project (waste water is not treated and discharged directly into the river Saigon)				
1	NLTN	m^3/day	394.000	Sai Gon river
2	D2	m^3/day	86.000	Sai Gon river
Project (wastewater treatment to meet column A of QCVN 14:2008/BTNTM)				
1	WWTP	m^3/day	480.000	Dong Nai river

Table 5.24. The concentration of pollutants in the waste source

No.	Name of emission sources	BOD	COD	TSS	NH_4^+
Without project (waste water is not treated and discharged directly into the river Saigon)					

1	NLTN	85	165	171	9,24
2	D2	85	165	171	9,24
Project (wastewater treatment to meet column A of QCVN 14:2008/BTNTM)					
1	WWTP	30	75*	50	5

Note: * QCVN 40:2011/BTNMT, column A.

(b). Simulation results

(i). Without project scenario

The entire effluent from NL-TN canal is discharged into the Sai Gon river through NLTN pumping station at Nguyen Huu Canh street. For this scenario the concentration of pollutants in the river water tends to decrease gradually from pump stations to downstream position due to the self-purification ability of the Sai Gon River. The concentration of pollution parameters in river water is increased by untreated waste waters discharged directly into the river. Most of the simulated values (BOD, COD, TSS, NH_4^+) on the Sai Gon river are exceeded QCVN 08:2008/BTNMT column B1, especially in the discharge position, where pollutants concentrations are high over QCVN 08:2008/BTNMT, column B2. In the Dong Nai and Nha Be river segments (where the wastewater treatment plant will be located) concentrations of pollutants are significantly reduced because of high self-purification ability and high flow of the river. The simulated parameters of the model are achieved QCVN 08:2008/BTNMT, column B1. At the position where the NLTN, Tau Hu Canals discharged into the concentrations of pollutants in the river water significantly are increased because of the contaminated waters from these canals.

In the rainy season, the concentrations of pollutants in the river water are slightly decreased comparing to those in the dry season, except for the TSS concentration, which is increased in the rainyseason. The simulated values are slightly increased comparing with the current state of the water quality because of the high water flow in both rainy and dry seasons and high self-purification ability of the Sai Gon-Dong Nai rivers. The calculated results shown that, in the without-project scenario, wastewater from the NLTN basin is directly discharged into the Sai Gon River, which cause strong impact on the Sai Gon river water quality. Besides that, the loads of pollutants from urban, residential, sand exploiting, industrial sources etc. in the upstream may accumulatively impact on the Sai Gon River water quality as well as the Nha Be river water quality in the downstream in the future. Simulated results of the Sai Gon, Dong Nai and Nha Be river water quality in the without-project scenario related to the basic parameters such as BOD, COD, TSS and NH_4^+ are shown in Figures 5.9 – 5.12.

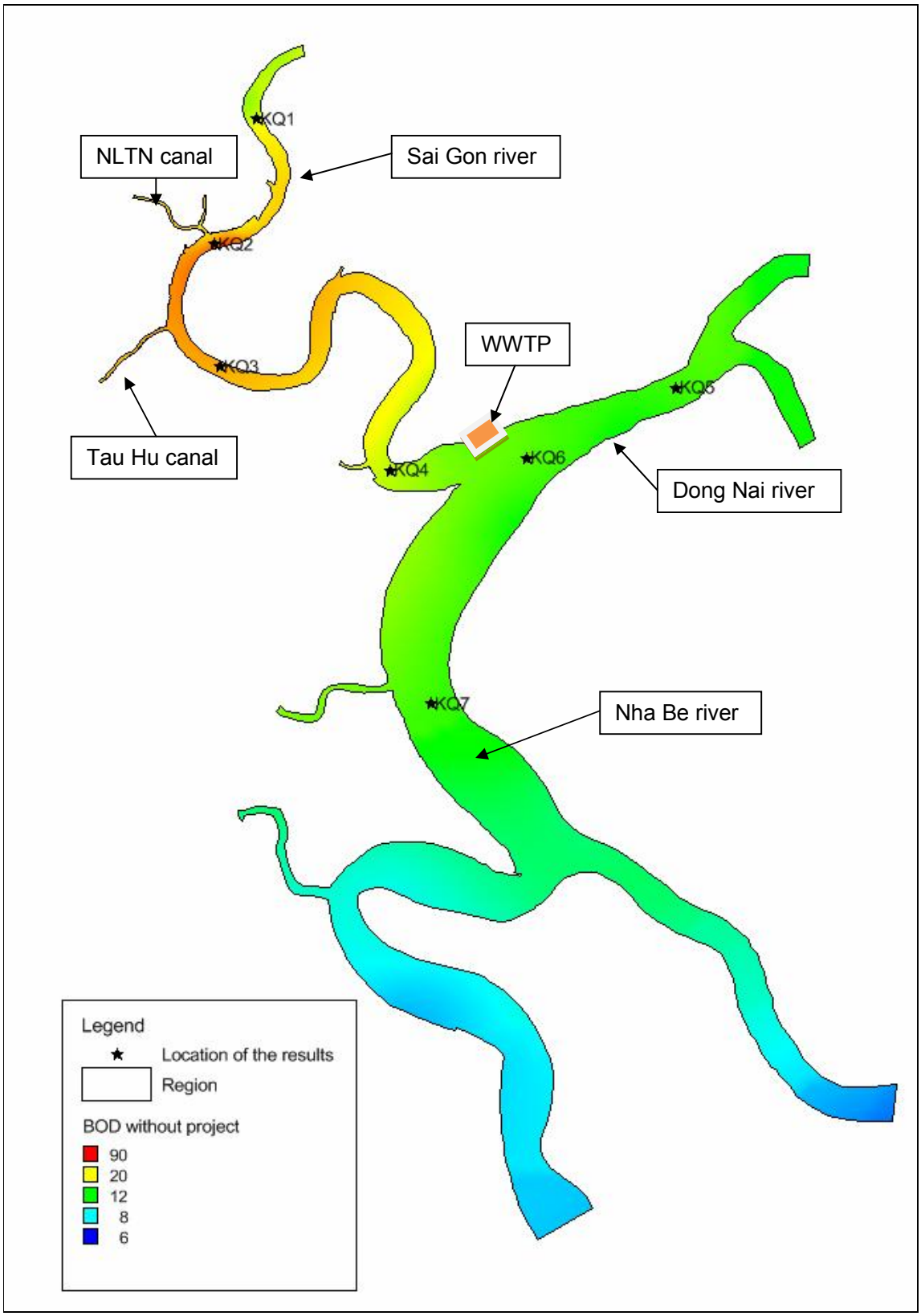

Figure 5.9. Predicted average BOD_5 concentrations in the Sai Gon - Dong Nai - Nha Be rivers in the without – project scenario

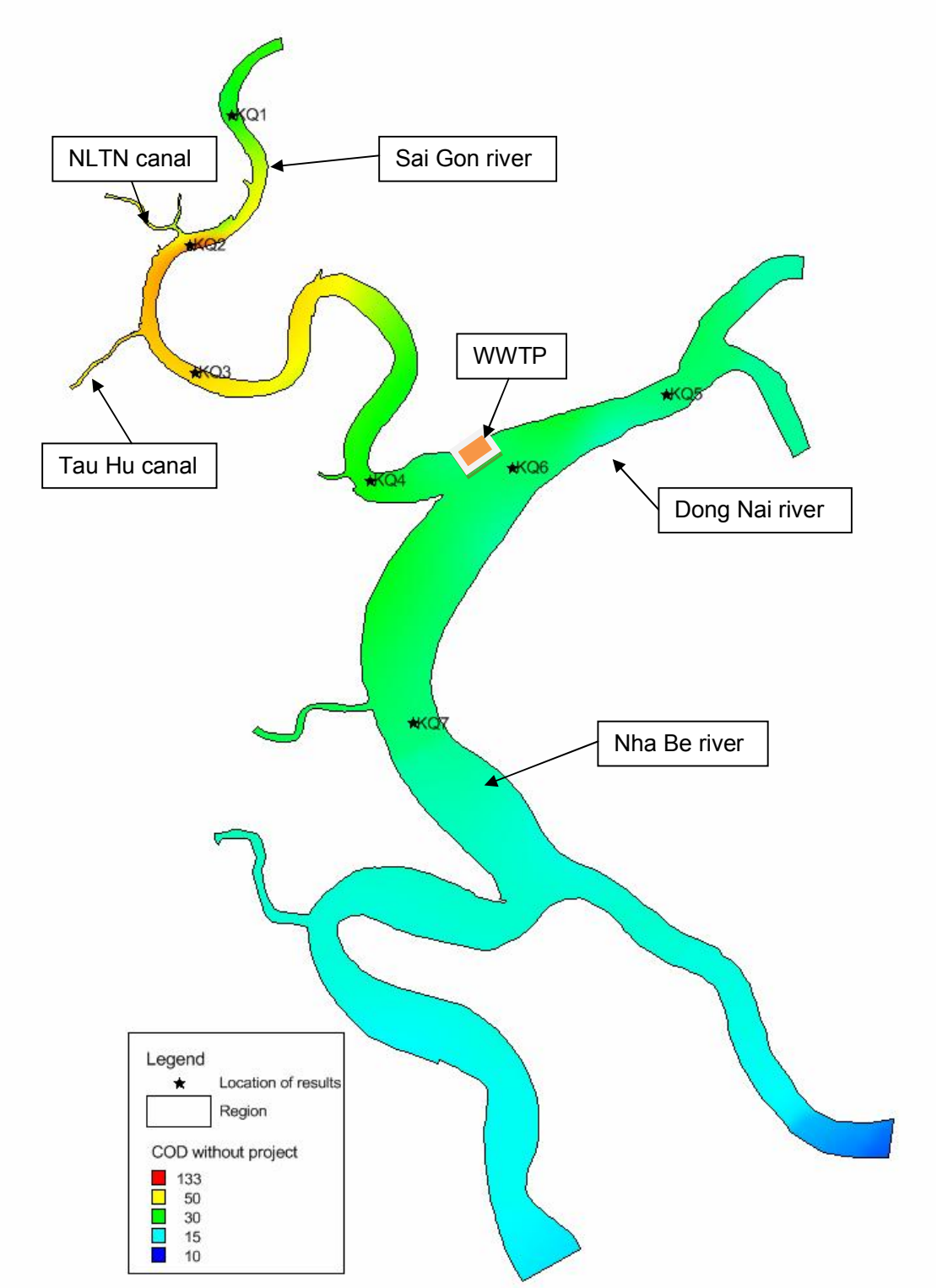

Figure 5.10. Predicted average COD concentrations in the Sai Gon - Dong Nai - Nha Be rivers in the without – project scenario

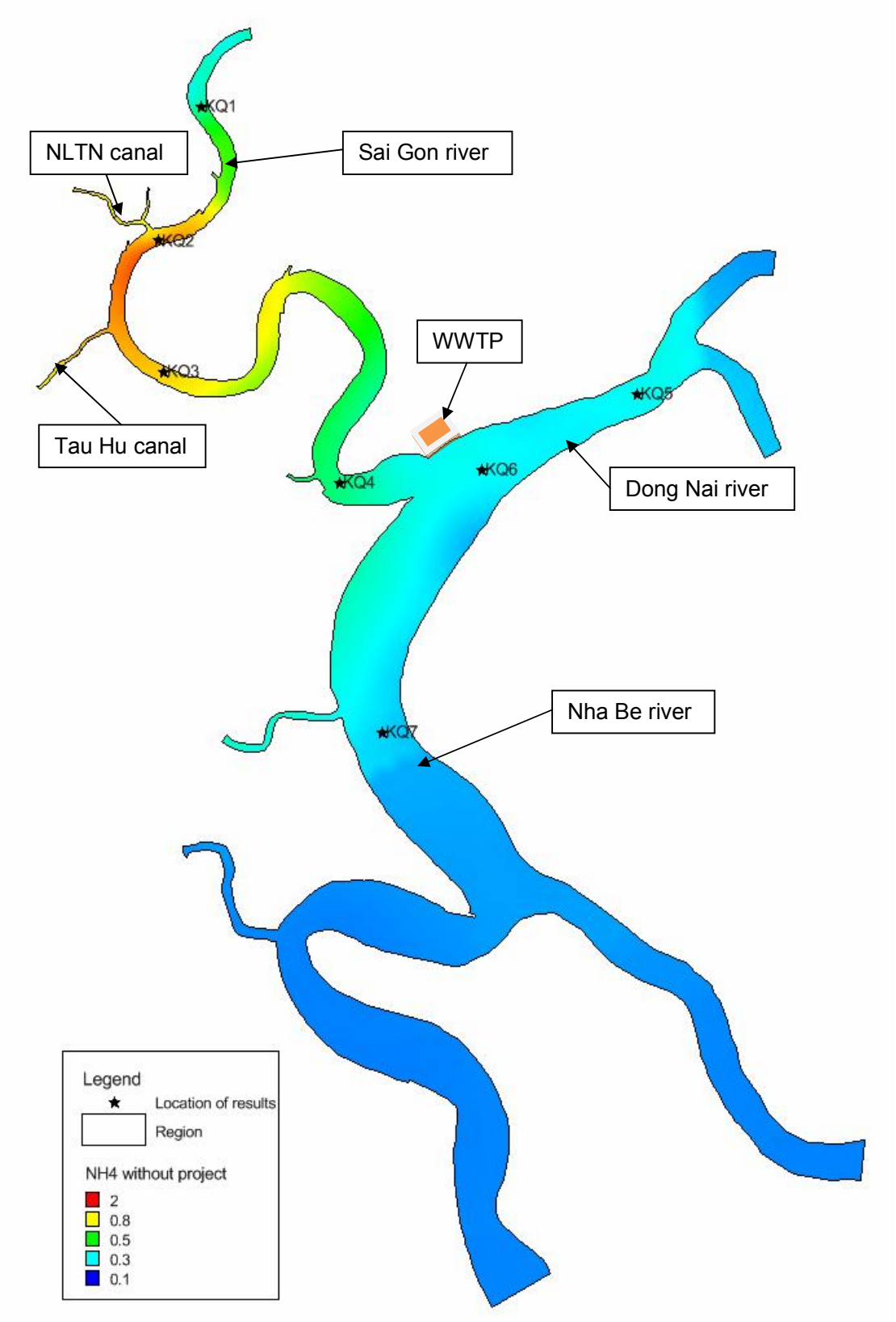

Figure 5.11. Predicted average NH_4^+ concentrations in the Sai Gon - Dong Nai - Nha Be rivers in the without – project scenario

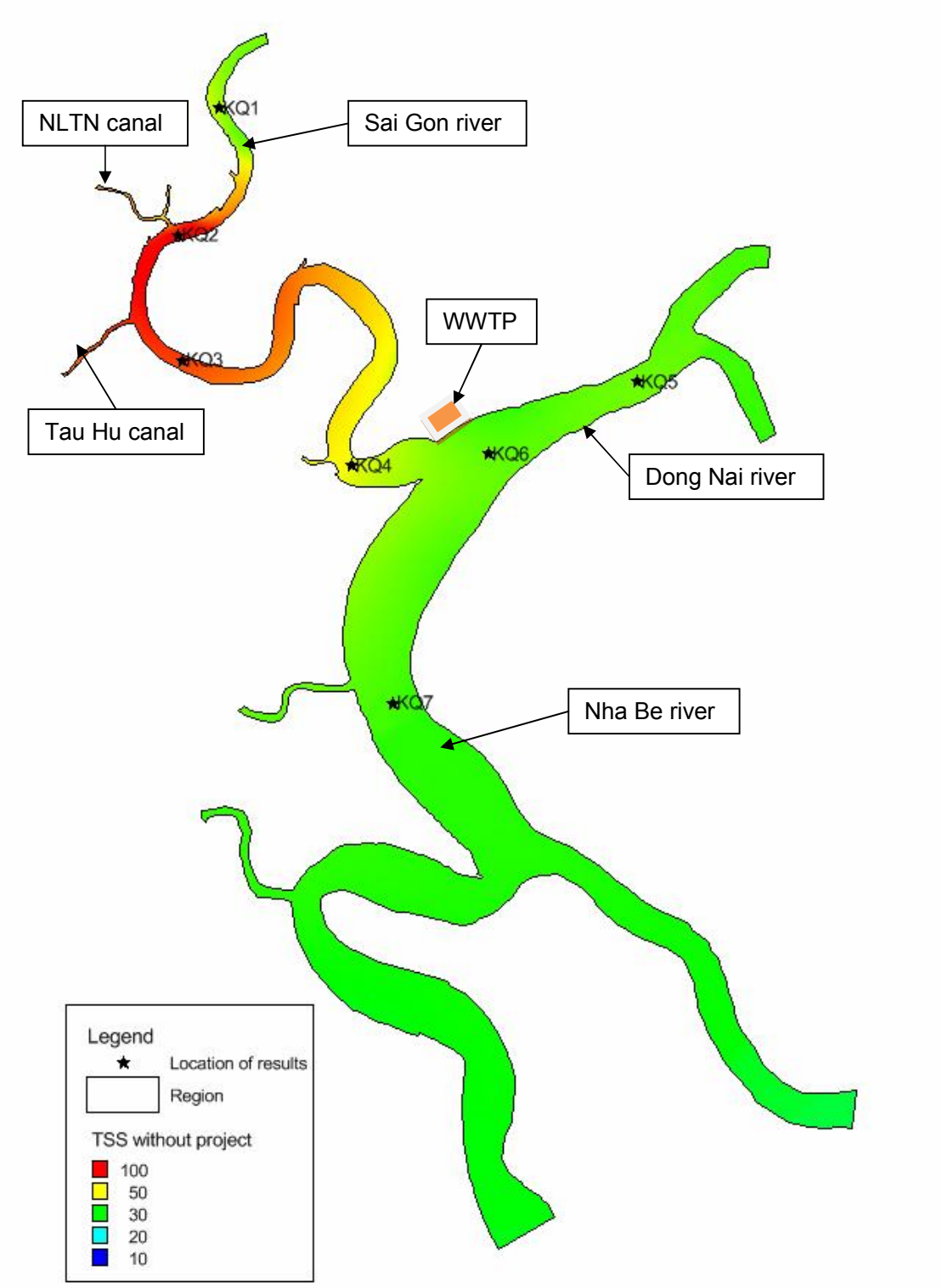

Figure 5.12. Predicted average TSS concentrations in the Sai Gon - Dong Nai - Nha Be river in the without – project scenario

(ii). With project scenario

In with-project scenario, the concentrations of pollutants in the Sai Gon river significantly decreased (Table 5.25, Table 26), especially at the pump station location (KQ2 point). In this position, BOD, COD, NH4+, TSS concentrations are decreased by about 3.8, 3.7, 2.3, 1.9 times, respectively (based on modeling results). The Sai Gon River water quality is betterand meet QCVN 08:2008/BTNMT, column B1.

The Dong Nai River water quality at the discharge location of the wastewater treatment plant is slightly decreased. In particular, concentrations of BOD, COD, NH_4^+, TSS increased by 1.8, 0.6, 0.06, 3 mg/l, respectively. The concentrations of the pollutants meet QCVN 08:2008/ BTNMT, column B1.

The Dong Nai river quality at the upstream ofthe WWTP discharge location of (KQ5 point), is almost the same in the with-project scenario during the low tide. However, during high tide, there is a slight increase in the concentrations BOD, COD, and TSS by 0.3; 0.1 and 0.6 mg/l respectively(as shown by modeling results).

The Nha Be River water quality is slightly better. Concentrations of BOD, COD, NH_4^+, TSS are decreased by 1.0, 1.5, 0.005, 1.4 mg/l, respectively.

With the influence of the tide, the water quality along the Saigon River, Dong Nai and Nha Be change. Model results show that for high tide, water quality reduction Saigon River than at low tide and the reverse, Dong Nai river tends to rise higher. However, this increase and reduce were not significantly.

Calculated results shown that in the with-project scenario, the Sai Gon river water quality will be improved. In addition, the construction of wastewater treatment systems and wastewater collection line will bring many benefits for the protection of the environment as well as reduce the pollution loads to the Sai Gon-Dong Nai rivers.

Simulated results of the Sai Gon, Dong Nai and Nha Be river's water quality in the with-project scenario related to the basic parameters BOD, COD, TSS and NH_4^+ are shown in Figures 5.13 – 5.16.

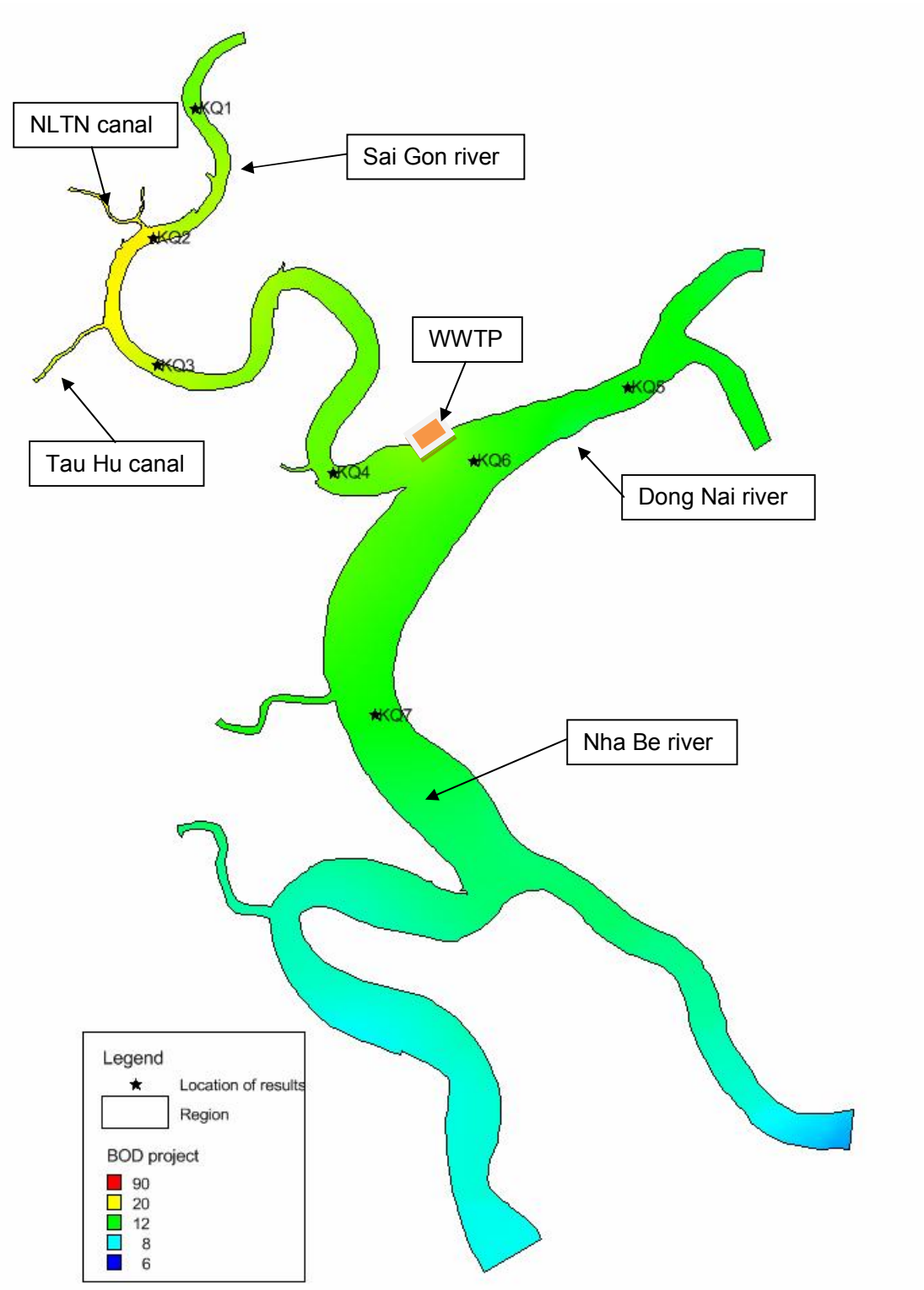

Figure 5.13. Predicted average BOD_5 concentrations in the Sai Gon - Dong Nai - Nha Be rivers in the with - project scenario

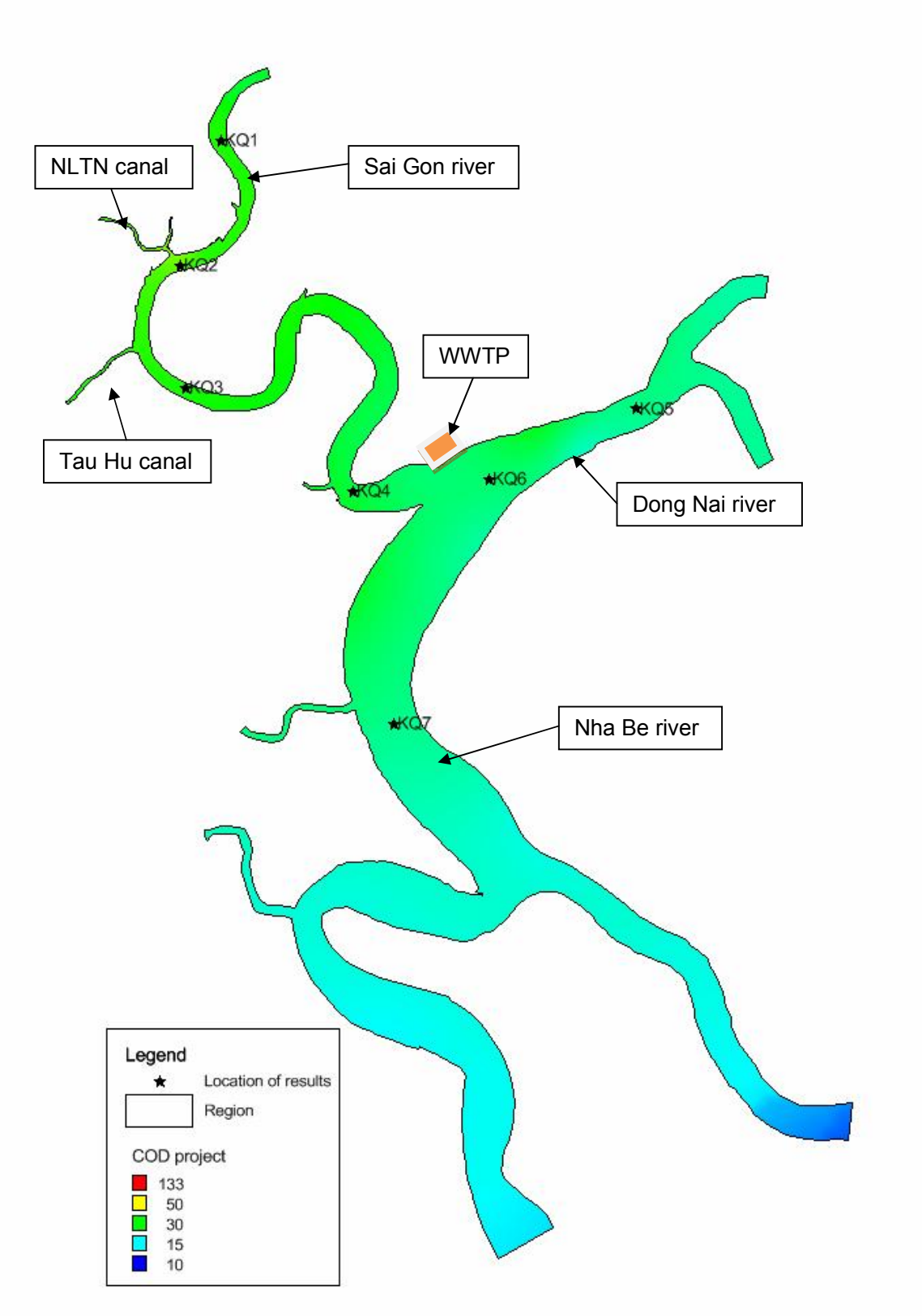

Figure 5.14. Predicted average COD concentrations in the Sai Gon - Dong Nai - Nha Be rivers in the with - project scenario

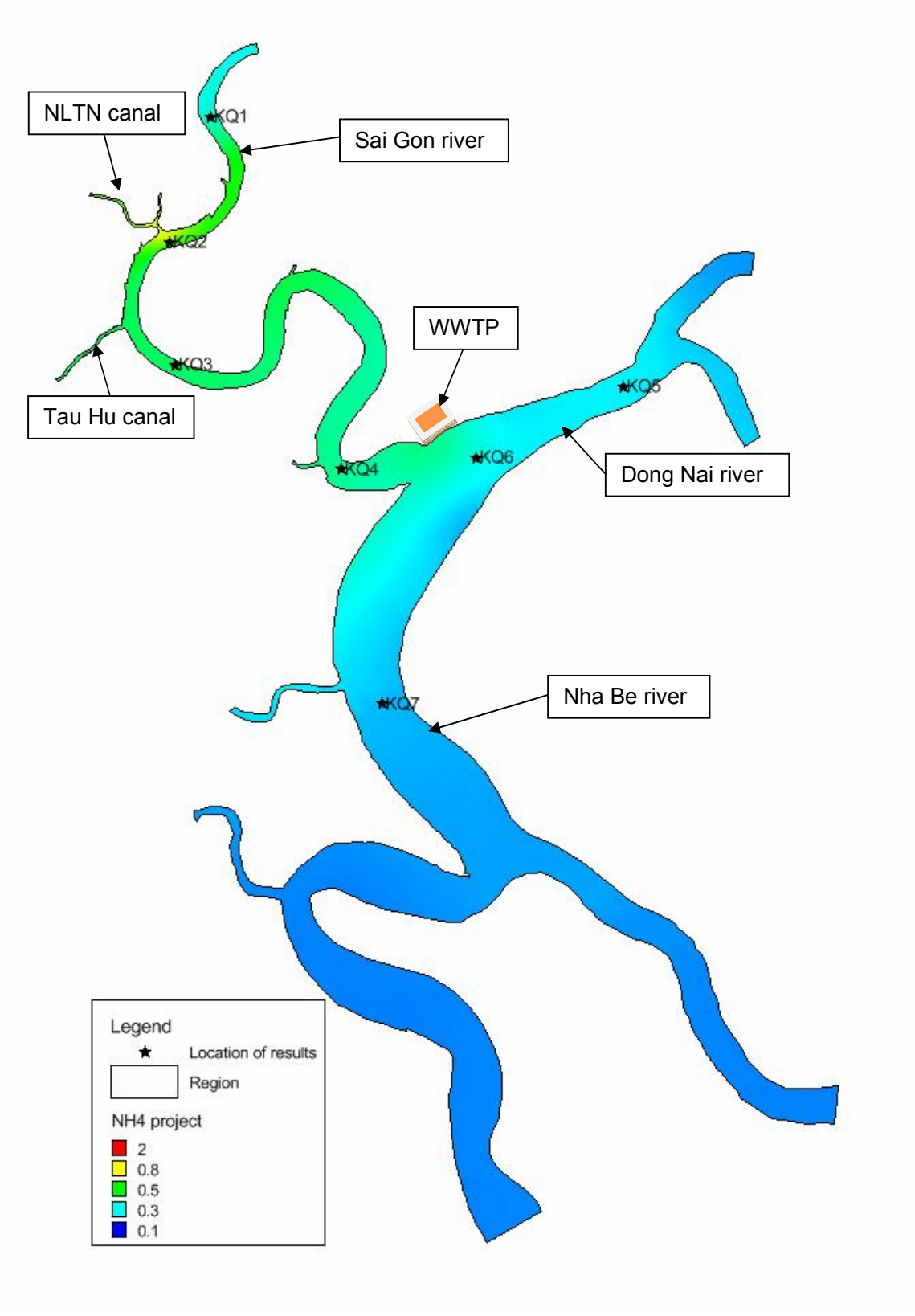

Figure 5.15. Predicted average NH_4^+ concentrations in the Sai Gon - Dong Nai - Nha Be river in the with - project scenario

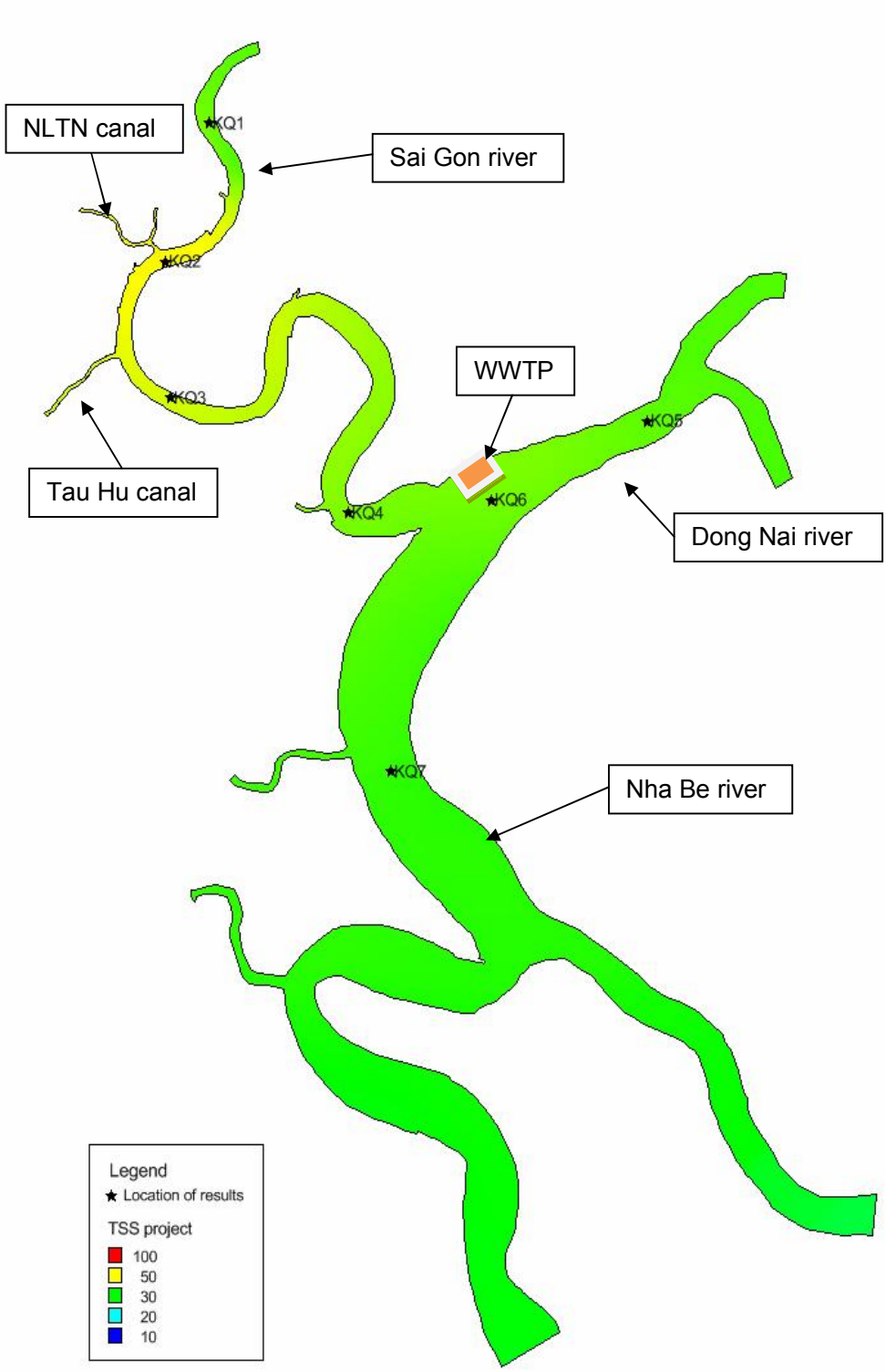

Figure 5.16. Predicted average TSS concentrations in the Sai Gon - Dong Nai - Nha Be river in the with - project scenario

Simulated results at some positions on the Sai Gon-Dong Nai rivers are presented in Table 5.25 and Table 5.26..

Table 5.25. Simulated results at some positions on the Sai Gon-Dong Nai rivers (low tide)

No	Symbol	Coordinates		BOD (mg/l)			COD (mg/l)		
		X	Y	Without project	Project	Change	Without project	Project	Change
1	KQ1	106.72263	10.80752	22.67	22.58	-0.09	32.59	32.18	-0.41
2	KQ2	106.71530	10.78467	92.58	23.97	-68.62	133.62	35.71	-97.91
3	KQ3	106.71616	10.76225	40.32	18.17	-22.16	69.03	31.52	-37.51
4	KQ4	106.74656	10.74327	18.48	15.10	-3.38	28.22	23.99	-4.24
5	KQ5	106.79787	10.75837	12.27	12.2	-0.06	22.15	22.10	-0.05
6	KQ6	106.77114	10.74543	12.37	14.26	1.89	22.99	23.67	0.68
7	KQ7	106.75389	10.70059	12.67	11.66	-1.00	22.39	20.82	-1.56
No	Symbol	Coordinates		NH_4^+ (mg/l)			TSS (mg/l)		
		X	Y	Without project	Project	Change	Without project	Project	Change
1	KQ1	106.72263	10.80752	0.3754	0.3563	-0.0191	41.42	40.65	-0.77
2	KQ2	106.71530	10.78467	1.7924	0.7637	-1.0287	96.23	50.47	-45.76
3	KQ3	106.71616	10.76225	0.8984	0.4228	-0.4756	78.48	46.19	-32.29
4	KQ4	106.74656	10.74327	0.3635	0.3146	-0.0489	43.89	38.69	-5.20
5	KQ5	106.79787	10.75837	0.3082	0.2934	-0.0148	37.37	37.56	0.21
6	KQ6	106.77114	10.74543	0.2996	0.3666	0.0670	36.05	39.18	3.13
7	KQ7	106.75389	10.70059	0.2372	0.2325	-0.0047	35.70	34.29	-1.41

Table 5.26. Simulated results at some positions on the Sai Gon-Dong Nai rivers (high tide)

No	Symbol	Coordinates		BOD (mg/l)			COD (mg/l)		
		X	Y	Without project	Project	Change	Without project	Project	Change
1	KQ1	106.72263	10.80752	21.8642	21.0786	-0.7856	30.8571	30.1592	-0.6979
2	KQ2	106.71530	10.78467	91.8876	22.2371	-69.6505	125.5670	32.7581	-92.8089
3	KQ3	106.71616	10.76225	39.4872	17.1501	-22.3371	67.6548	29.3541	-38.3007
4	KQ4	106.74656	10.74327	17.5321	14.8806	-2.6515	26.2347	22.6871	-3.5476
5	KQ5	106.79787	10.75837	11.0482	11.3579	0.3097	20.7843	20.8921	0.1078
6	KQ6	106.77114	10.74543	11.4728	12.0542	0.5814	20.1498	21.1437	0.9939
7	KQ7	106.75389	10.70059	11.7256	10.5463	-1.1793	20.1573	18.9751	-1.1822
No	Symbol	Coordinates		NH_4^+ (mg/l)			TSS		
		X	Y	Without project	Project	Change	Without project	Project	Change
1	KQ1	106.72263	10.80752	0.3845	0.3671	-0.0174	42.3214	41.7461	-0.5753
2	KQ2	106.71530	10.78467	1.6715	0.7872	-0.8843	92.2041	47.8921	-44.3120
3	KQ3	106.71616	10.76225	0.8751	0.4143	-0.4608	74.1244	44.1436	-29.9808
4	KQ4	106.74656	10.74327	0.2701	0.2146	-0.0555	40.8713	35.5422	-5.3291
5	KQ5	106.79787	10.75837	0.2991	0.3934	0.0943	38.0124	37.4472	-0.5652
6	KQ6	106.77114	10.74543	0.2579	0.3512	0.0933	36.1453	39.1956	3.0503
7	KQ7	106.75389	10.70059	0.1426	0.2523	0.1097	34.4762	33.0548	-1.4214

Conclusions: Flow and water levels of the Sai Gon and Dong Nai rivers are significantly changed in the rainy and dry seasons, especially in the flooding months. At the present the Sai Gon River water quality only meet QCVN 08:2011/BTNMT, column B2. Therefore, the construction of the wastewater treatment plant is needed to minimize the negative impact on the Sai Gon River water quality, as well as on the Nha Be river water quality. The calculated results show that the construction of the wastewater treatment plant will have important implications in limiting the Sai Gon River water pollution.

In addition, the waste water treatment plant not only collects and treats the wastewaters from NL-TN basin, but also the wastewater generated from District 2. Therefore, the projects will benefits not only for people living in Ho Chi Minh city, but also for the people living in the downstream of the Sai Gon-Dong Nai river basin.

5.4.2.3. Solid waste

(1). Domestic solid waste

Based on the number of workers in WWTP, the estimated solid waste generated is about 28 kg/day in 2020 and 31.5 kg/day in 2045. The impact is negligible.

(2). Sludge

Sludge generated from WWTP includes waste from the screen, sand in the grit tank and biological sludge from the anaerobic tank and the aerobic tank. The amount of solid waste generated during wastewater treatment and sludge treatment as follows:

- Sludge thickened in the settling tank: 1,100 m^3/day;
- Dewatered and thickened sludge: 100 m^3/day;
- Waste disposal generated from screening: 37 m^3/day in 2045;
- The sand volume generated from grit removal tank: 37 m^3/day in 2045.

The quality of sludge could be referenced to Binh Hung WWTP because of the same treatment technology. Characteristics of sludge from the Binh Hung WWTP stations in 2008 year are presented in Tables 5.23-5.24.

Table 5.27. Characteristics of sludge from the Binh Hung WWTP stations in 2008 year

Parameter	Unit	Sludge	QCVN 50:2013/BTNMT
Hg	mg/kg	0,34	4
Pb	mg/kg	25	300
Cd	mg/kg	KPH	10
Ni	mg/kg	19	1.400
Cr	mg/kg	34	100
Zn	mg/kg	199	5.000
Cu	mg/kg	48	-
Fecal Coliform (*)	MPN/100ml	$6x10^6$	-
Worm (*)	egg/g	17.600	-

Source: Binh Hung WWTP, 2009 (*) University of Technology, 2008

Table 5.28. Characteristics of sludge from the Binh Hung WWTP stations in 2011

Parameter	Unit	Dewatered sludge	QCVN 07:2009/BTNMT
Hg	mg/l	KPH (<0,004)	0,2
Pb	mg/l	0,003	15
Cd	mg/l	KPH (<0,0002)	0,5
Cu	mg/l	0,01	-
Zn	mg/l	0,794	250
Ni	mg/l	0,06	70
Cr	mg/l	0,011	-

Source: Binh Hung WWTP, 2011

Notes:

- QCVN 03:2008/BTNMT: the permissible limits of heavy metals in soils - Agricultural land
- U.S.EPA standards, type A: requirement of pathogens in sludge in the United States
- QCVN 07:2009/BTNMT National technical regulation on hazardous waste

Compare to QCVN 07:2009/BTNMT, sludge from domestic WWTP is not hazardous. WWTP sludge contains microorganisms such as typhoid viruses, protozoa, E. coli, Klebsiella sp.,

Yersinia, Aspergillus fumigates, Listeria. However, the WWTP uses anaerobic decomposition for sludge treatment that can reduce bacteria.

(3). Hazardous waste in the WWTP

Based on Table 5.25, amount of packaging and chemical container used for plant operations account for about 0.5% of chemical weight.

Table 5.29. Amount of packaging, chemical containers in WWTP

Item	Year				
	2015	2020	2025	2035	2045
Total chemical (ton/year)	2,118	2,574	2,726	3,452	3,594
Total chemical (ton/day)	5.8	7.1	7.5	9.5	9.8
Amount of packaging, chemical containers (kg/day)	29.0	35.3	37.3	47.3	49.2

Additionally, in the WWTP, the amount of oil and grease cloth is estimated about 1-2 kg/day used in the maintenance and repair of operation machines in factory. Packages and containers of chemicals, oil and grease cloths should be separately collected and stored in warehouses.

5.4.2.4. The impact on the traffic

In the construction phase, about 75 turns of vehicles per day will increase the traffic density in the local areas and affect the road quality across Phu My Bridge. This also increases the risk of traffic jams, increasing traffic accidents.

5.4.2.5. Impacts of Risk and Accidents

(1). Flooding

A part of Ngon Ngay canal will be filled. In heavy rains and high tides, WWTP can be flooded. Assuming the maximum rainfall when rainfall was 10 mm per min, 80% rain water does not flow into the river when the high tide and heavy rainfall, in 30 minutes. The maximum rainfall in the stations:

10mm/min x 36 ha x 80% = 3600 m^3/min = 216,000 m^3/h

Therefore, 4 pumps with a capacity of 55,000m^3 per one, which can pump out rain water in the WWTP to river. Without the pump, the maximum level of flooding expected as follows: 10 mm/minute x 30 minutes x 80% = 240 mm = 0.24 m.

Also, filling part of Ngon Ngay canal near the mouth discharges into Sai Gon - Dong Nai River, when heavy rains occur, the neighboring areas may be flooded deeper and longer. Therefore, investors must have mitigation measures (See paragraphs 6.2.9, 6.3.7, chapter 6).

(2). Operational issues

In the operation of WWTP, incidents such as equipment damage, clogged pipes, improper operation, problems with UV systems may happen. If the problem occurs, the efficiency of WWTP will be decreased. In this case, it will increase levels of organic matter in the surface water; increasing algal development or eutrophication status of water resources; increase harmful bacteria to aquatic life living in the river, causing spread of cholera to the people living along the river.

(3). Spillage of sludge

In the sludge thickener, sludge could spill out by the gravity rule, resulting in negative impacts on the environment.

(4). The chemical leakage

Common reasons causing chemical leakages in WWTP are: the barrel contains leaks due to defects in the cap or not-tight covering; carelessness in the transport, chemical spills when moving containers. The chemical leakage will affect directly to the workers by inhalation or dermatological adsorption.

(5). Explosion/Fire incidents

In the WWTP, the causes of fire/explosion could be:

- Fire and inflammable materials in fuel storage, storehouses; Pumps, air blowers, clogged pipes or continuous operation for a long time
- Carelessness of staff and technicians such as smoking and cigarette ash;
- Open spaces in the storehouses is not designed improperly; Electrical overloading.

(6). Working accidents

The probability of these risks depends on the awareness of workers on labor safety. The impacts could be injury, occupational diseases and even death. These impacts only affect in the inner area of WWTP; however the plant will also need a number of preventive measures of this problem.

(7). Risks of environmental pollution at the position of pumping station

- Because the pumping station is relatively close to the residential area, the collection of wastes from screened wells can produce odors and infectious viruses, it makes bad impacts on life quality (bad feelings, high risks of digestive and respiratory diseases) of local people, particularly the elderly, women, and children. Now the pumping station does not operate, so it is impossible to calculate daily waste volume retained by the screen;
- Polluted environment may be a basic reason, which results in reduced real estate price and decreased revenues of food & drink and entertainment services due to the declining amount of tourists in this area; Solid waste blocks screen or prevent pump operation are certainly high risks in Nhieu Loc Thi Nghe canal which may take place in HCMES phase 2.

(8). The health risk for workers in the WWTP

Chemical leaking, pipe blockage, toxic and flammable gases (CH_4, NH_3...) arise in the treatment of sewage and sludge by biological methods…

5.5. SOCIAL IMPACT

The social assessment exercise for the project was undertaken separately. However, in addition to the identified social impact related to land acquisition, the social impact was also examined in relation to the environmental impact assessment, and in line with the area of influence defined in the EIA. Details of the social impact assessment -- for the entire project, were provided in the Social Assessment report (Please see the SA report for details). In this section, the results of the social impact assessment for the entire project is summarized (both positive and negative), along with how the identified negative impacts are addressed, as per

Bank's social safeguards requirements.

The SA exercise was initiated in 2010. It was updated in subsequent years – from 2011 to 2014, to reflect the development of the project activities and environmental assessment results as the project preparation evolves. The purpose of the SA is two-fold: a) examine the potential impacts of the project –positive and negative (on the basis of planned project activities), and b) inform the design of mitigation measures that address identified potential adverse impact and propose other community development activities (i.e. gender mainstreaming, behavior change communication…) to enhance project's development effectiveness. The SA confirms that the overall social impact of the project is positive - because the project will improve the environmental sanitation for the two target catchment areas - Nhieu Loc – Thi Nghe area (Phase 1) and District 2 area (Phase 2).

5.5.1. Positive impact

The SA confirms that the overall social impact of the project is positive - because the project will improve the environmental sanitation for the two target catchment areas - Nhieu Loc – Thi Nghe area (Phase 1) and District 2 area (Phase 2). Specifically, the project will bring about significant benefits that meet the demand in the wastewater treatment for over 2 million of people in Nhieu Loc – Thi Nghe canal basin and District 2, with estimated 20% wastewater volume in Ho Chi Minh city, reducing the surface water pollution in Saigon river and canals in District 2, preventing the discharge of waste into river and increasing the dilution of the river, improving the living quality for people, and promoting the development of commercial and tourist activities on and along the Saigon river. In addition, through the connection with Phase 2 Interceptor, District 2 would potentially save cost of individual wastewater treatment for the inhabitants in District 2.

5.5.2. Negative impact

The SA confirmed that although effort made, some anticipated negative impact - as a result of permanent land acquisition, primarily for the construction of the WWTP within the proposed area of 38.47hacould not be avoided. However, the magnitude of impact is minimal, given consideration of the other technical alternatives during the Feasibility Study stage.

5.6. CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROJECT

The overall environmental impact of the project is strong. Table 5.30shows that the construction and operation phase of WWTP has potential impacts on the air, land and ecological resources.The negative impacts on the environment are mainly from the clearing and reclamation process; construction activities; sludge production from the plant operation. The positive effects are mostly from improving water quality of Sai Gon - Dong Nai River and reducing wastewater treatment costs for companies, thereby raising awareness of environmental protection of the people.

Other existing and planned interventions/activities/investments that are/will be developed at the project area in line with the city master plan or other relevanttechnical documents will bring in specific impacts that in long term will have a cumulative effect on water quality, ecology and overall surroundings and downstreamof the WWTP site.Additionally, climate change impacts will add to the overall effects of project interventions in the HCMC area. Currently, the impact of climate change on wastewater management in Ho Chi Minh City is implemented by Asian Development Bank (ADB) in collaboration with the HCMC Peoples Committee and DONRE through various interventions [17].

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Table 5.30. Matrix of cumulative impacts caused by Nhieu Loc Thi Nghe sanitary project –Phase 2

The activities of the project	The parameters of the environment, economy and society																									
	Natural resources						Ecological resources					Development of economy and human									Value and quality of life						Note
	Air		Soil		Water																						
	Air	Noise	Erosion	Quality	Hydrology	Quality	Plant on land	Aquatic	Animal	The species is threatened	Protected areas	Employment	Infrastructure	Industry	Agricultural activities	Handicraft	Order and security	Traffic	Land use planning	Travel resources	Economic activity	Public health	Entertainment sources	The cultural value	The historical	The aesthetic value	
A. Phase of clearance, reclamation																										
Clearance, leveling	-M	-M	-L	-M	0	-L	-M	0	-M	0	0	+L	+L	0	-L	0	0	-L	+L	0	+L	0	0	0	0	0	
Activities of workers	0	0	0	-L	0	-L	0	0	0	0	0	+L	0	+M	0	0	-L	0	0	0	+M	-L	0	0	0	0	
Transporting soil for leveling	-M	-L	0	0	0	0	-L	0	0	0	0	+L	0	+M	0	0	0	+H	+L	0	+L	-L	0	0	0	0	
Total points of part A	0	0	0	0	0	0	0	0	0	0	0	+H	+L	+H	0	0	0	+M	+L	0	+H	0	0	0	0	0	
B. Construction Phase																										
Constructions	-M	-M	+L	0	0	-L	-L	0	-L	0	0	+L	+L	+L	0	0	0	-L	0	+L	+L	0	0	0	0	0	
Transporting materials	-M	-L	0	0	0	0	-L	0	0	0	0	+L	0	0	0	0	0	-L	0	0	+M	-L	0	0	0	0	
Activities of workers	0	0	0	-L	0	-L	0	0	0	0	0	+M	0	0	0	0	-L	0	0	0	+M	-L	0	0	0	0	
Total points of Part B	0	0	+L	0	0	0	-M	0	-L	0	0	+M	+L	+L	0	0	0	0	0	+L	+H	0	0	0	0	0	
C. Phase of plant operation																										
Operation of plant	-L	-L	-L	-L	0	+M	0	-L	0	0	0	+M	+M	+M	0	0	0	0	+L	+L	+L	+M	+M	0	0	0	
Activities of workers	0	0	0	-L	0	-L	0	0	0	0	0	+M	0	+M	0	0	-L	0	0	0	+M	-L	0	0	0	0	
Transportin	-L	-L	0	0	0	0	-L	0	0	0	0	+L	0	0	0	0	0	+H	0	0	0	0	0	0	0	0	

The activities of the project	The parameters of the environment, economy and society																											
	Natural resources						Ecological resources					Development of economy and human								Value and quality of life						Note
	Air		Soil		Water																							
	Air	Noise	Erosion	Quality	Hydrology	Quality	Plant on land	Aquatic	Animal	The species is threatened	Protected areas	Employment	Infrastructure	Industry	Agricultural activities	Handicraft	Order and security	Traffic	Land use planning	Travel resources	Economic activity	Public health	Entertainment sources	The cultural value	The historical	The aesthetic value		
g chemicals and sludge																												
Total point of part C	0	0	-L	0	0	+L	-L	-L	0	0	0	+H	+M	+H	0	0	-L	-L	+L	+L	+H	+M	+M	+M	0	+M		
The total of A + B + C	-H	-H	-L	-M	0	-L	-L	0	-L	0	0	H	+L	+H	-L	0	-L	+M	+L	+L	+L	-L	+L	0	0	+L		

- 0 points: no effect or impact is negligible;
- L: little impact;
- M: medium impact; H: strong impact;
- The "-": negative impact; The "+": positive impact.

5.6.1. Wastewater Management

Industrial waste is a major contributor to cumulative water pollution in the HCMC area. Only 38% of IZs and EPZs have wastewater treatment facilities – and many of those are not functioning effectively. Most industrial waste is discharged without treatment into the HCMCrivers and canal systems. IZs and EPZs discharge 120,000m^3/day of wastewater into the DNRB; approximately 25% of this effluent is generated within HCMC. Additionally, poor management and maintenance of the HCMC drainage system has resulted in unprocessed residential and industrial wastewater flowing directly into the canals and rivers causing severe pollution levels and blockages to water flow (MOC, 2006).

Current planning states that by 2040 to 2050, 100% of industrial and domestic wastewater in the urban areas of HCMC is to be treated (MOC, 2006). Calculations carried out by the study team indicate that beyond 2030, however, high population growth, combined with increased migration from the south from climate change impacts, may result in the treatment plants (including the new plants) reaching their capacity by 2035. Around 0.5 billion m^3 of untreated wastewater may be generated and discharged annually by 2050 unless additional treatment capacity is built.

5.6.2. Wastewater Infrastructure situation in HCMC area

There are nine wastewater treatment plants in HCMC with a capacity to treat wastewater discharge until 2010-15 (MOC, 2006) (Figure 5.31).

There are 27 main canal systems and 16 smaller branch systems, including 412 drainage gates. The service ratio in urban districts such as District 1, 3, 5 is 100%, while for other districts like District No. 4, 6, 8, 10, 11, Tan Binh, Phu Nhuan, Binh Thanh it is from 80% to 90%. In the remaining districts the service ratio is lower at 30% to 70%. For suburban districts like Binh Chanh, the service ratio is 0.3% and in Can Gio District it is very low. Sewers of usable quality make up 70 % of the total system, medium quality sewers comprise 11% of the system; and sewers of low quality comprise 12%. During the monsoon season large parts of the sewerage are flooded to depths of up to 100 to 150 cm. Such flooding can last for several hours to a day.

An additional 8 wastewater treatment plants are proposed to be constructed and will increase the upgraded capacity of the existing 9 treatment plants to 1.03 billion m^3 (MOC, 2006) (Figure 5.31). In the industrial zones, smaller site-specific collective treatment plants are being built and proposed while the larger plants are being constructed, to reduce industrial wastewater discharge. The large plants are not expected to be completed and operational by 2025. The experience with collective treatment in industrial zones has not been good – with enterprises tending to avoid the costs and bypass the facilities.

All current and planned wastewater treatment plants will be affected by inundation from regular and extreme flooding predicted for 2050, except for the plants located in basins 2 and 14 (Figures 5.19 and 5.20). Under extreme flooding, wastewater treatment plants near the main Saigon and Dong Nai River channels are likely to be most affected, specifically those in basins 5, 6, 7, 8, 11 and 15 (Figures 5.32and 5.33), where water levels may reach 1 - 2m. The planned flood control system may prevent flooding around the three most southerly treatment plants (i.e. those located in basins 1, 4 and 9), downstream from where the two rivers connect (Table 5.27; Figures 5.23and 5.33). Impacts will include disruption to operation. For example, it may not be possible to discharge treated sewage during extreme flooding events, unless raised infrastructure is built to allow discharge from the flooded areas. Flooding will also potentially cause overflows of polluted effluent from the wastewater treatment plants to the surrounding environment.

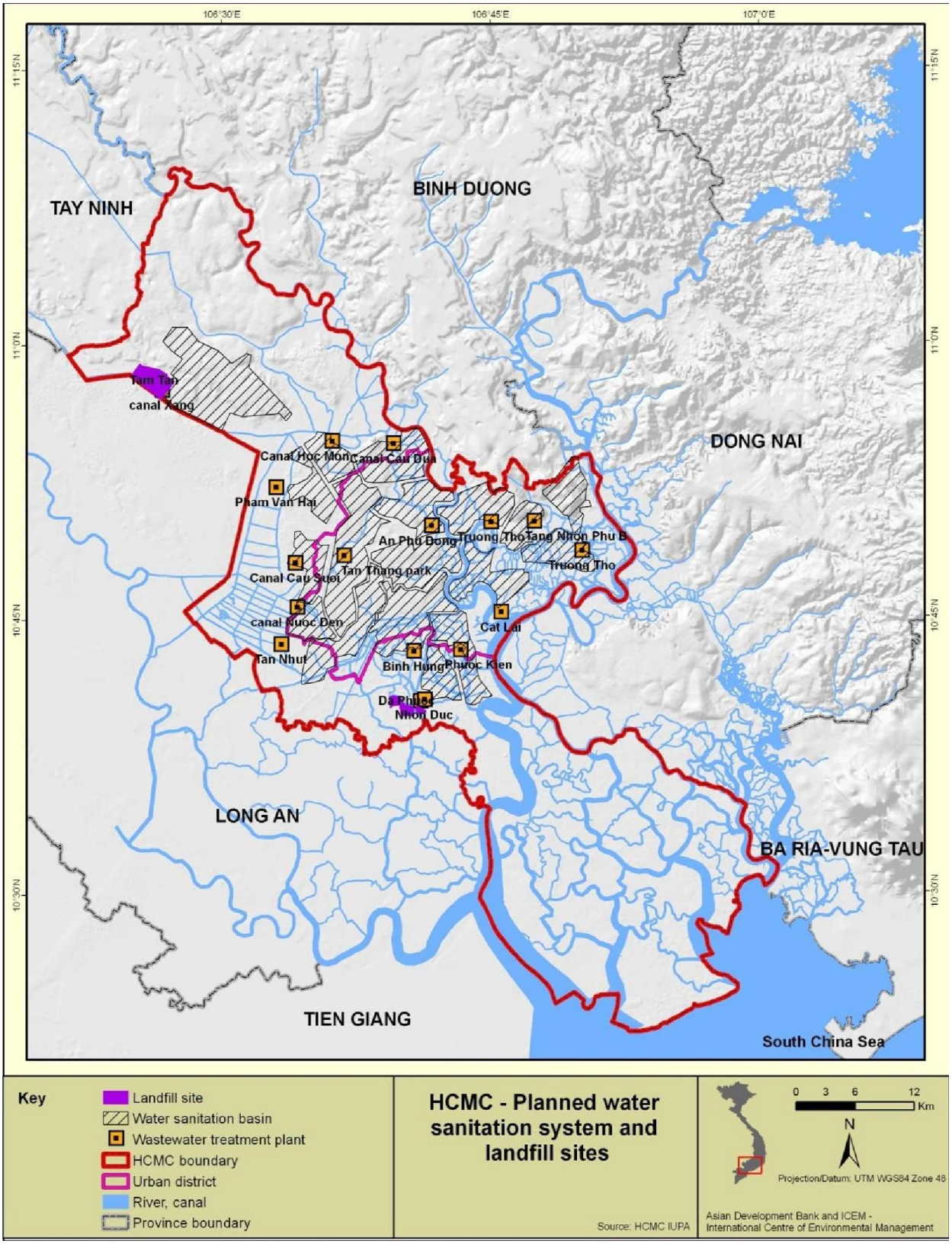

Figure 5.17. Existing and planned wastewater and landfill infrastructure

Table 5.31. Climate change effects on wastewater treatment plants

Wastewater Treatment Plant and Catchment/Basin Location	Area (ha)	Flooded area (ha)	Percent affected area (%)		
			Regular flood (high emission)	Extreme flood (high emission)	Extreme flood (high emission) with control flood system
Basin 1, THBNDT	2374	1635.52	25	69	35
Basin 2, West HCMC	3078	2107.08	0	68	3
Basin 3,THLG	2831	1727.95	38	61	35
Basin 4, South HCMC	2101	2100.52	67	100	41
Basin 5, East HCMC	3752	2893.9	56	77	60
Basin 6 North HCMC II	5070	721.86	4	14	16
Basin 7 North HCMC I	1526	78.75	57	5	66
Basin 8, Go Vap and Binh Thanh	1440	111.68	58	8	64
Basin 9, NLTN	1206	187.59	6	16	27
Basin 10, Nha Be	1438	1438.34	100	100	72
Basin 12, Ba Diem, Nga Ba Dong	6837	1691.91	5	25	8
Basin 13, canal Hoc Mon, Hoc Mon Dist.	2238	1952.44	8	87	8
Basin 14, Binh Tan and Binh Chanh	2412	1682.97	4	70	4
Basin 15, canal Cau Dua, Hoc Mon Dist.	3149	917.48	58	29	61
Basin 16, Cu Chi	3855	2126.3	13	55	30

Source: ADB(2009). HCMC Adaptation to Climate Change Study Report-Volume 2: Main Report - Final Report.

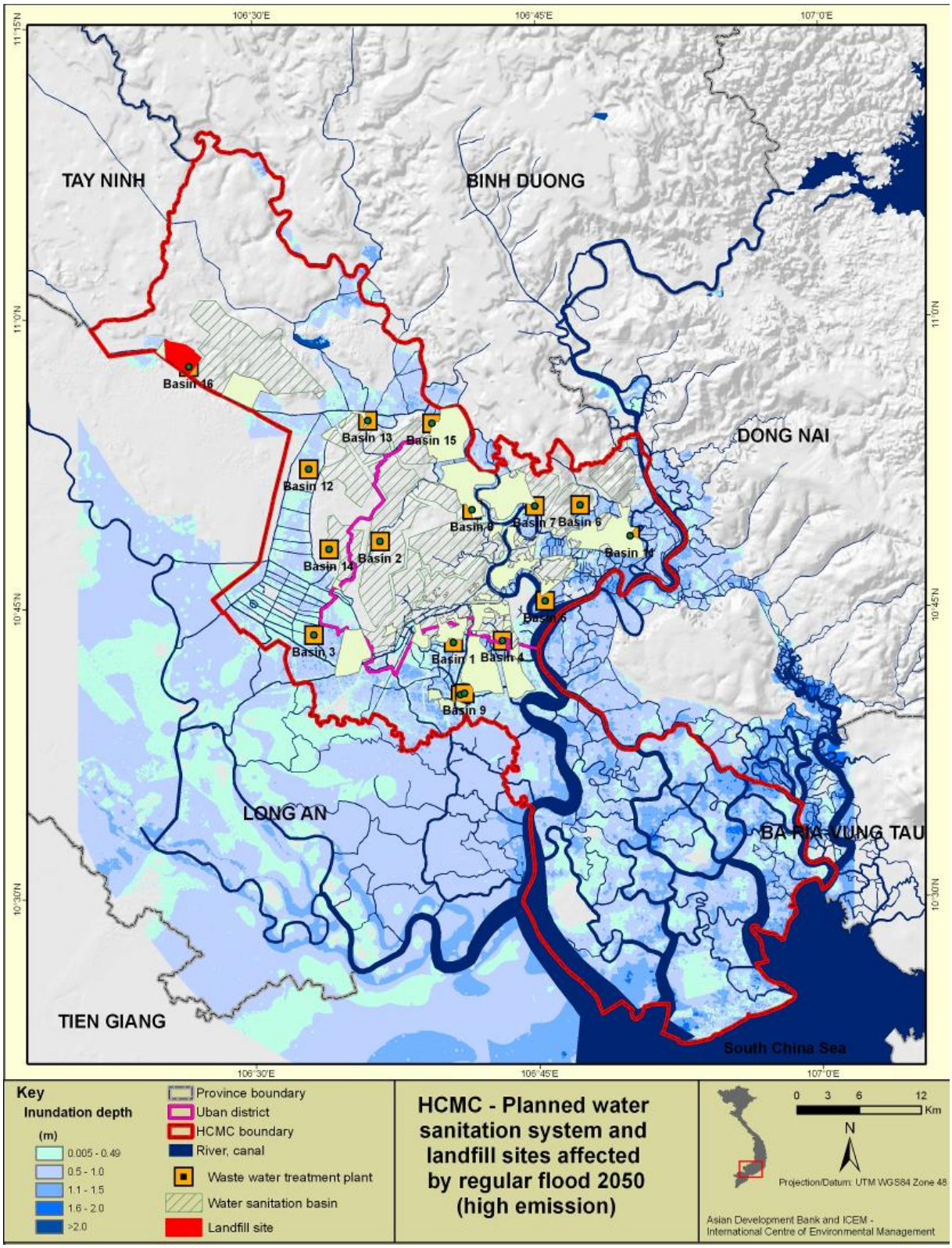

Figure 5.17. Overlay of regular flooding in 2050 with wastewater treatment and landfill sites

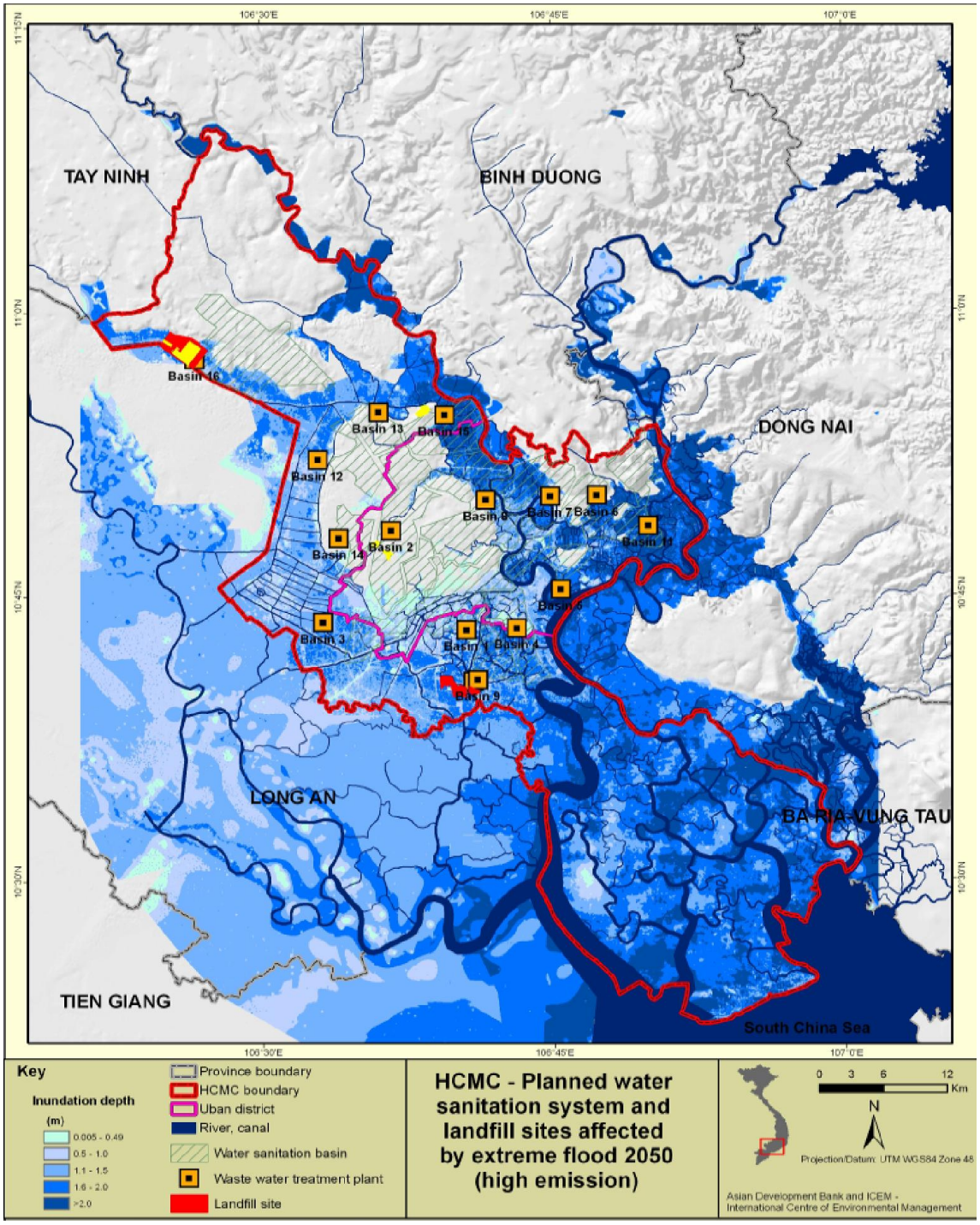

Figure 5.18. Overlay of extreme floods in 2050 with wastewater treatment and landfill sites

The storm drainage network has the potential to be affected by flooding during both regular and extreme events. Flooding may cause overflows of the open drainage system resulting in disruption to flows and overflows of polluted wastewater. The prolonged flooding of sea water within the City (without the proposed dyke system) may also increase the potential of corrosion of both surface and underground drainage lines, sluice gate mechanisms and other infrastructure.

CHAPTER 6.
MITIGATION MEASURES FOR POTENTIAL NEGATIVE IMPACTS

The Client and relevant contractorshave the responsibility to develop and implement mitigation measures that are practical and feasible and do take in consideration the national regulations, the World Bank Group performance standards and Health, Safety and Environmental management procedures during construction as well as operation phases of this investment.

6.1. MITIGATION MEASURES IN THE PRE-CONSTRUCTION PHASE

6.1.1. Dust, air emissions control in pre-construction phase

- Ensure that all trucks, vehicles, and electrical devices used in the project area willcomply with technical and environmental safety regulations.
- Install dust cover on vehicles atthe construction sites and during transportation in the city.Dust control (watering dusty areas) on non-paved access roads
- Schedule the operation times for vehicles, machines working in the construction area to reduce air emissions
- Use of adaptedProtective Personal Equipment (ear plugs, goggles, helmets, gloves, masks) where necessary.

6.1.2. Noise pollution control in pre-construction phase

- Performthe pre-construction activities within day time and minimize work done during night.
- Regulate the speed limitation for traffic inside the site and in the surrounding areas in the reclaiming region.
- Construct the sound walls as feasible in selected areas.
- Regularly carry out maintenance and routine inspections on vehicles to ensure that they are meeting the technical standards. Old vehicles and construction machineries with poor quality shall be prohibited for being used within project‘s activities.
- Noise volume will not exceed 55 dBA at the nearest off-site reception location.

6.1.3. Water pollution control in pre-construction phase

6.1.3.1. Domestic wastewater

To prevent the contamination of surface water by discharged domestic wastewater due to increased number of workers in the project area (1.6 m^3/day), the investor should arrange mobile toilets for these workers onsite.. The rest will be disposed by contractors. The investor will remove the toilet when the project construction is completed.

6.1.3.2. Water from vehicles washing

Water from truck washing shall be collected into pitches to separate sediment and oil before running into temporary drainage ditches and discharged into the Ngon Ngay canal. Oil and sludge are collected and stored in containers and collected for treatment or disposed by contracted functional unit and in accordance with the regulations.

6.1.3.3. Runoff

Runoff with low pollution level is a distributed source and is therefore difficult to collect for

treatment. The most effective method is to limit the environmental impact due to runoff byrestricting oil, fuel spillage and clean-up spillage after an incident.

Fuel and materials shall not be stored near the drainage system. Drainage ditches should be constructed with settling pitches to be able to remove the sediment before being discharged into the Ngon Ngay canal. Maintenance should be executed regularly and avoid fuel and oil seeping or spilling into the drainage system.

6.1.4. Solid waste and hazardous waste disposal in pre-construction phase

6.1.4.1. Vegetation cover

The volume of Solid Waste is estimated to be approximately 11 tons per day. Twigs and leaves will be collected and disposed daily at the da Phuoc landfill.

6.1.4.2. Domestic waste

The estimated volume of domestic waste is 17.5 kg/day. Domestic waste of workers is collected by mobile trash system and buried in sanitary landfill, in accordance with the national regulations.

6.1.4.3. Oil waste

Contractors will be assigned to carry out maintenance on vehicles and machines which are operating on-site. Waste oil will be collected and disposed of site in accordance with the regulations.

6.1.5. Flooding control in pre-construction phase

WWTP foundation will be elevatedup to2.5 - 3 m in order to create proper drainage condition for the project area into the Dong Nai River through the Ngon Ngay canal. This will protect the site against flooding during high tide and heavy rains.

6.1.6. Mitigation measures on ecosystem including water and soil conservation measures in pre-construction phase

Environmental preconstruction surveys undertaken at the site identified only common swamp vegetation such asbushes and nepa tree and shrubs, which will need to becut down to prepare for the construction site (i.e. land clearing and leveling)., The contractor must follow measures such as avoid burning vegetation at the site; avoid extensive excavation of materials from former paddies; and practice minimum tillage of the brushed perimeter vegetation. Also, if large unsuitable soil conditions are encountered, the contractor should import soil from outside the site and encourage progressive improvements to land.

As one of the three creeks at the WWTP site needs to be either eliminated and/or its flow diverted, it is important tocontrol the water flow and quality at the site in order to avoid large site disturbances; the contractor should begin work in upstream reaches first; clarify responsibility for maintenance/adjustment, use stable materials in construction, and build site head dyke away from obstructions. In order to avoid exposure to flood risks, the construction period should be during the dry seasons.

6.1.7. Risk management in pre-construction phase

- Specific rules and regulations in working field have to be required, including rules for entering and leaving, workplace safety; traffic safety, fire handling safety, etc;
- Design lighting system for working at night or underground (pipe work, transmission line);

- Organize meetings to enforce rules over workers with writing, signs and boards in working, and camping site;
- Control occupational accidents, defining causes and appropriate recovery measure;
- There is prohibition notices for inflammable area (petrol tank, chemical storage, inflammable material storage and transformer station);
- Supply and enforce the use of Labor Protection equipment. Worker working without Labor Protection equipment will be suspended;
- Setting up a medical aid station to take care of sickness, supply medicine for workers. This station will also aid workers in simple occupational accident or first aid to the heavily occupational accident, respectively;
- Delivering emergency medical box atwork sites.

In order to provide successful implementation, the project owner needs to pay attention to environmental protection and worker's health and safety. Workers have also to pay their own attention in order to avoid accidents. In addition, control and monitoring program from People's Committee of District 2 will be needed.

6.2. MITIGATION MEASURES DURINGTHE CONSTRUCTION PHASE

During pre-construction and construction, the IMA and relevant contractorsshould ensure constant communication with the local communities while conducting mitigation measures and reducing social impacts during works.

6.2.1. Mitigation measures on air quality and noise pollutionduringconstruction phase

To reduce air pollution during works, the contractorshould apply following measures:

- Use onlyregistered vehicles that meet required standards by law;maintain machines regularly for smooth operation (within quality check period)
- Maintain water spraying at the construction areas, materials yard and traffic hubs (especially during the dry season or sunny days with less wind);
- Use canvas to cover top of vehicles that transport equipment and construction materials;
- Arrange appropriate timetable to avoid working during rest hours and transporting materials during peak hours. Control appropriate running speed of vehicles (< 30km/h) to minimize noise generation, especially when passing through residential areas or during resting hours;
- Conduct regular maintenance of vehicles and construction machines to minimize noise, vibration and emissions; strictly comply with standards and maintenance schedule to reduce air and noise pollution; follow regulations on maximum load;
- Develop and implement a traffic management plan (e.g.,organize traffic flows to/from the construction site as by laws; provide reasonable routes to travel and transportation of materials and machineries within the construction site, etc). Use dust control measures (cover the areas that generate dust; use water trucks to spray onto roads to minimize dust, especially in dry seasons);
- Check noise and vibration level during construction, and based on which, set out appropriate schedule to ensure noise and vibration levels lower than permitted in QCVN 26:2010/BTNMT, QCVN 27:2010/BTNMT; and WBG performance standards;

6.2.2. Mitigation measures on water quality duringconstruction phase

- During construction, it is not allowed to discharge wastewater directly into the water bodies surrounding the plant area. All types wastewater generated during construction period of the plant is gathered and treated before being discharged into the environment.
- Minimize water stirring activities, which cause increased turbidity and mitigate oil contents in the process of dredging and construction under water; prevent any debris, contaminated soil, cement, oil or other toxic compounds for entering into waters;
- Provide boundary fences or partition blocking the plant area from the outside, fences between the area under construction and areas not yet constructed; avoid useof toxicchemicals.;
- Arrange for mobile toilets (10-12) to serve workers' personal hygiene needs; sign contract with HCMC Urban Environment Management Company for routinely gathering and treatment. Design storm drainage trenches at the construction site and gathering system for sediment and grease settling to prevent oil pollution in the surrounding waters
- Consider hydrology in design of creek diversion; such diversion shall commence only when all necessary permits have been obtained; begin work in upstream reaches first; use sturdy materials for diversion spillway. Prior to diversion, submit a compliance plan, satisfactory to the relevant local authorities, which describes how the diversion flows required by the conditions of this permit will be measured and maintained.

6.2.3. Mitigation measures on ecosystems during construction phase

- Wastewater pollution control in construction and activities generated from operation of residential area;
- During construction, wastewater should be treated before discharged into receiving sources at Ngon Ngay canal - Saigon River water;
- Follow good management of solid waste resources, primarily domestic solid waste, do not allow outspreading, leading to contamination of soil, water and air.

6.2.4. Worker's health protection and labor safety in construction phase

- Provide safe drinking water during works;
- insecticides spraying if neededto prevent malaria;
- Supply and enforce the use of Labor Protection equipment (work without Labor Protection equipment will be suspended);
- Setting up a medical aid station to take care of sickness, supply medicine for workers. This station will also aid workers in simple occupational accident or first aid to the heavily occupational accident, respectively;
- Deliver emergency medical box for working sites;
- Making sanitation and cleaning drains to prevent stagnant water in the project area.

To reduce accidents during construction works, the contractor needs to establish clearly plans for construction, including building place to dispose construction and domestic waste. Construction only starts after construction plan is compiled to environmental commitments and approved by the investor. Furthermore, after completing installation of each interceptor sections, the contractor is in charge of recovering original landscape as before building.

6.2.5. Traffic management in the project areas in construction phase

To minimize impacts on security and traffic order in project regional, contractors will implement a traffic management plan:

- Carry out consultations with local government and community and with traffic police.
- Significant increases in number of vehicle trips must be covered in a construction plan previously approved by the CESPIMA. Routing, especially of heavy vehicles, needs to take into account sensitive sites such as schools, hospitals, and markets
- To reduce traffic accidents with clear construction plan; Arrangement for signs around construction area to facilitate traffic movement, provide safety advice and warning, and notice driver to lower the speed when going into the areas;
- Cooperating with local authorities to manage the migrant workers, who participate in the project during construction phase.
- Avoid material transportation for construction during rush hour.
- Provide temporary passageways for pedestrians and vehicles within and outside construction areas should be segregated and provide for easy, safe, and appropriate access. Signpost shall be installed appropriately in both water-ways and roads where necessary.

6.2.6. Measures for flooding control in construction phase

Location of WWTP is affected by flooding due to tidal effects of Sai Gon- Dong Nai River. To avoid flooding, the Feasibility study suggests to have raised height of plant from +2.5 m to +3 m. Foundation in NLTN pumping stations and in Thu Thiem are +2.5 m. According to a report responding to climate change in the city funded by Asian Development Bank (ADB) [17], they need height of +3 m above ground to avoid flooding in 2050. Regarding groundwater level, geological survey, and average depth of groundwater level above sea level will be directly affected by high tide. WWTP should be built with concrete to avoid erosion.

In addition, drainage capacity of the surrounding area will be affected by Ngon Ngay Canal. As a result, investors will survey drainage ability of Ngon Ngay canal and plan to build sewers or pumping stations and gates with equivalent drainage capacity from Ngon Ngay canal into the Saigon River. Collection system and drainage of WWTP must not affect flood in surroundings areas.

6.2.7. Prevention of land subsidence by constructing sub-items in the interceptor

The Contractor has to follow construction methods that minimize the chance of land subsidence of the surrounding area of existing buildings. To prevent these problems during the construction phase, the appropriate measures for embankment protection are needed including regular inspection of the temporary structure that has to avoid land subsidence. When land subsidence occurs, mitigation measures and repair works have to be executed promptly to avoid the land subsidence area to increase.

6.2.8. Risk management in construction phase

- Specific rules and regulations in working field have to be required, including rules of entering and leaving, working at construction site; rules of labor protection clothes; rules on use of lifting equipment cranes, electric safety rules; traffic safety rules, fire safety rules, etc.;
- Organize awareness campaign linked to possible health concerns for local communities to inform them of potential odor nuisance;
- Design lighting system for working at night or underground if required (pipe work, transmission line).
- Organize meetings to enforce rules over workers with writing, signs and boards in working, and camping site
- Control occupational accidents, defining causes and appropriate recovery measure.

- There is prohibition notices for inflammable area (petrol tank, chemical storage, inflammable material storage and transformer station);
- Equipping the fire protection devices for storehouses (foam and CO2 fire extinguisher, sand, water, etc.);
- Useappropriate measures for embankment protection, regular inspection of the temporary structure that has to avoid land subsidence. When land subsidence occurs anyway, mitigation measures and repair works have to be executed promptly to avoid the land subsidence area to increase.

In order to provide successful implementation, the project owner needs to pay attention to environmental protection and worker's health. Workers have also to pay their own attention in order to avoid workplace risks. In addition, control and monitoring program from People's Committee of District 2 will be needed.

6.2.9. Mitigation measuresduring creek diversion at the 38 ha WWTP site

It is necessary to apply works in accordance with the natural conditions in the area in order to minimize effects on hydrology and cumulative waterflow at the site.;

- Provide creek banks stabilization in areas where there is potential of erosions
- ensure favorable for upstream drainage;
- In the areas near the shore, filling scour to the reasonable height;
- Re vegetate areas on the banks;
- Improve access into tributaries downstream;
- Ensure unimpeded passage and provide spawning pools if necessary for any fish access into tributary streams
- Provide alternative solution to local residents accessing their homes on the creek by personal boats;

6.2.10. Potential Impacts on Physical Cultural Resources (PCR)

The implementation of the project will impact 6 burial sites, which will require proper resettlement in line national regulations and the Bankoperational policies. As the project involveslarge scale of excavation activities, the works contract will also include a standard clause on "chance find" procedures to guide actions if any artifacts are found during construction.

If the Contractor discovers archeological sites, historical sites, remains and objects, including graveyards and/or individual graves during excavation or construction, the Contractor shall:

- Stop the construction activities in the area of the chance find;
- Delineate the discovered site or area;
- Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a night guard shall be arranged until the responsible local authorities or the Department of Culture and Information takes over;
- Notify the Construction ManagementConsultant who will notify responsible local or national authorities in charge of the Cultural Property of Viet Nam (within 24 hours or less);
- Relevant local or national authorities 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;

- 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;
- 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;
- Decisions concerning the management of the finding shall be communicated in writing by relevant authorities;
- Construction works could resume only after permission is granted from the responsible local authorities concerning safeguard of the heritage.

6.3. MITIGATION MEASURES IN THE OPERATION PHASE

6.3.1. Mitigation of negative impacts on air quality in operation phase

Isolation of green belt is implemented by QCVN 07:2010/BXD - National technical regulations of urban infrastructure works. In a safe environmental distance, the investor must plant trees over a width of 10m. Minimum distance between pumping stations, wastewater treatment works is presented in Table 6.1 as follows:

Table 6.1. Minimum distance between pumping stations, wastewater treatment plant and residential area, hospitals, schools, public works

No.	Type of construction	Distance to ensure safety and environmental sanitation (m)
1	A sewage pumping station	30
2	Wastewater treatment plant without sludge drying, sludge dewatering, with odor treatment equipment, closed building	40

According to drainage and sewerage – External networks and Facilities design standard of Building Ministry, with WWTP capacity over 50,000 m3/day, mechanical and biological works have sludge treatment equipment by mechanic, safe distance to the boundary of houses and food factory has to be at least 400 m. Investors raised distance of trees to at least 200 as Thanh My Loi B area have 200m safe distance of trees away from residential house to main road.

- Exhaust ventilation system is installed and designed;
- Air pollutants causing by odor from anaerobic tank and anaerobic sludge decomposition tank are filtered cleanly, biogas is the fuel input of the generator, and amount of surplus gas will be burnt;
- The contractors have to have an approved Sludge Management Plan before operation can start.
- For solid waste, sludge from sludge dewatering machine, screening, sediment settling tank is collected and stored in sludge storage. Sludge has been stabilized after going through anaerobic sludge decomposition tank, so it does not generate odors, is stored, daily transported to treatment place.

6.3.2. Noise pollution control in operation phase

To reduce noise in treatment plant, besides green belt isolated to residential areas, it is necessary to apply additional measures such as:

- Using 100% new equipment from well-known manufacturers;
- Regularly planning maintenance of machinery by oiling and replacing parts;
- Air pump, sludge dewatering, sludge pumps are put on pedestal attached to a large basement structure with rubber base;
- Pumping stations are located in soundproof room, to minimize noise to surrounding areas from 10 to 15 dBA;
- Workers in pumping station are equipped with ear plugs to reduce noise;
- Making routes of transporting sludge and schedule for sludge trucks activities to minimize noise caused by traffic.

6.3.3. Mitigation of negative impacts on water quality in operation phase

The designed treatment capacity is 430.000 m3 per day in 2020 and 830,000m^3 per day in 2045. The treatment process ensures that the wastewater reaches QCVN 14:2008/BTNMT, column A before the effluent will be discharged into the Dong Nai River.

In addition, the following measures will be implemented during operation of WWTP:

- Establish operational procedures, monitoring the parameters input and output of the plant with automatically monitoring and management program i entire plant;
- Providing operational guidelines of each system, regularly organizing training sessions, operating instructions for plant workers;
- Installing auxiliary pumps, air pump, generators to avoid stop operation;
- Domestic wastewater from factory workers are treated in septic tanks and leading to collection pits of sewage plant;
- Technological wastewater and sludge arising from the lab are surveyed to the collecting tank for disposal;

6.3.4. Solid waste and hazardous waste pollution control in operation phase

6.3.4.1. Domestic solid waste

Garbage shall be stored separately in containers and collected for disposal and treatment every day by contractors. Waste at the WWTP can be stored in 20- liters tanks and 120-liters tanks by 2020. The plant will contract with HCM City Urban Environmental Limited Company for daily collecting along with hazardous waste.

6.3.4.2. Residual sludge from WWTP

Based on the composition of the sludge and the proposed sludge management plan, there will be 3 methods for handling sewage sludge from WWTP after water separation. The table below shows evaluation of characteristics of methods with scoring from 0 (very bad) to 5 (excellent). Comparison among sludge treatment methods is presented in Table 6.2. The Sludge ManagementPlan must be approved by DONRE of Ho Chi Minh city prior to the wastewater treatment plant in operation.

Table 6.2. Comparison among sludge treatment methods

Method	Humidity	Environmental issues	Area	Investment costs	Operating costs

Method	Humidity	Environmental issues	Area	Investment costs	Operating costs
Composting	15% – 30%	5	2	4	2
Landfill	≥ 30%	2	2	2	3
Burning	≥ 25%	0	3	1	1

Source: HCM City environmental sanitation technical assistance project-Phase 2, 2013

Although Vietnam currently has no specific regulations on the handling of sludge from the WWTP, but are considered that waste should be handled. According to Decree 59/2007/ND-CP, waste disposal methods include incineration, composting, recycling and sanitary landfill.

The results indicated that WWTP dehydrated sludge is good for production of compost because it does not contain pollutants from industrial waste source, and has high organic content.

Because sludge has been stabilized in anaerobic decomposition tank, most pathogenic microorganisms are killed; volume of sludge is decomposed by 65%. Sludge from WWTP has a high nutritional content, so it can be applied as fertilizer for crops, fields.

However, the project area currently is located at the foot of Phu My Bridge, internal roads must be built to transport sludge and chemicals into and out the project area to avoid effects to surrounding residential areas, especially Thanh My Loi B residential area. The proposed technical design should coordinate with transportation planning of District 2 to design these internal roads.

Furthermore, the sludge can only be used as fertilizer if the concentrations of heavy metals in the sludge meet the standards QCVN 03:2008/BTNMT and QCVN 50:2013/BTNMT. Simultaneously, according to the EPA standard, limits levels of heavy metals in sludge is presented in Table 6.3 as follows:

Table 6.3. Limited concentrations of heavy metals in sewage sludge applied to land

Source: 40 CFR Part 503

Pollutants	Limited concentration (mg/kg dried material)	Limited concentration (mg/kg dried material) (monthly average)	Load rate of pollutants accumulated in the soil (kg/ha)	Load rate of pollutants accumulated in each year (kg/ha/365 days)
As	75	41	41	2.0
Cd	85	39	39	1.9
Cu	4300	1500	1500	75
Pb	840	300	300	15
Mo	57	17	17	0.85
Ni	75	-	-	-
Se	420	420	420	21
Zn	7500	2800	2800	140

Based on the calculation in new issued Feasibility Study in September, 2012, the average amount of dewatered sludge (to 2020) is about 100 m^3/day. SCE consultant envisaged that sludge from NLTN WWTP will be transported to Da Phuoc Landfill, located about 25 km by land roads. (Detail on Da Phuoc Landfill is on Chapter 3 – Sludge Treatment). Air pollution load from transport sludge is presented in Table 6.4.

Table 6.4. Air pollution load from transport sludge

No.	Parameter	Emission factor (g/km)	Pollution loading (kg/day)
1	Dust	0.9	0.18

No.	Parameter	Emission factor (g/km)	Pollution loading (kg/day)
2	SO_2	4.29S	0.22
3	NO_2	11.8	2.36
4	CO	6	1.2
5	VOC	2.6	0.52

According to the proposed sludge management plan, the selected route from WWTP to Da Phuoc landfill is from Phu My Bridge to Nguyen Van Linh Street, turn to Highway 50 with 6-lanes, mostly outside the city center. This will reduce pollution from transportation means (See Figure 6.1).

Figure 6.1. Routes of Sludge Transportation

6.3.4.3. Residual sludge from interceptor

According to the proposed sludge management plan, sludge will be dredged by sludge collecting truck in 3 months per time. Unit managing activities of the interceptor will contract with functional collection units to collect sludge periodically and transported to Da Phuoc solid waste treatment area to produce compost.

6.3.4.4. Hazardous waste

- Commercial contractor is required to clean contained bag, container and ensure bags, boxes are properly sealed when storage;
- Treatment chemicals are arranged and stored in chemical storage. After use, mixing tanks and chemical packs should be kept tightly or sealed;
- Use chemical packs, containers are returned to suppliers;
- Regularly cleaning chemical storage and mixing area.

6.3.5. Measures for mitigation of negative impacts on biological ecosystems in operation phase

- Treating the collected wastewater in WWTP to meet the QCVN 14:2008/BTNMT, column A before discharging into receiving sources at Dong Nai River to minimize the impact on survival of aquatic species;
- Good management of solid waste, primarily domestic solid waste, does not allow

waste widespread causing environmental contamination of water quality.

6.3.6. Measures for worker's health protection and labor safety in operation phase

- Workers are trained to deal with unexpected situation when working in a hazardous environment; Staff should be assigned to follow up the sanitation and labor safety at the Plant to ensure that all workers comply with regulations on labor protection and safety;
- Workers working in areas exposed to hazardous chemicals/gases are provided with special protective clothes as required; Workers working in pumping stations are provided with ear buds, headphones to reduce noise;
- Workers working in hazardous conditions are provided with special working schedule to remedy their health and mitigate labor accidents from intense labor works;
- First aid is provided to workers in charge of sludge removal and sewer maintenance when they must work in the fields by themselves. Team of 2-3 persons/team is assigned so that they can support each other in case of emergencies;
- In the wastewater treatment plant, a medical station must be made available with medical staff, equipment, and medicines so that emergencies can be handled in a timely manner;
- All workers working in the plant need to be trained and they have to perform regular drills of first aid methods in case of emergencies (gas contamination, chemical contamination, labor accident, fire and blast);
- Workers and staff of wastewater treatment plant are entitled to regular medical check every month/quarter so as to detect professional diseases and provide timely medications.

6.3.7. Measures for flooding control in operation phase

Plant designed to create drainage slope in area while avoiding local flooding in rainy season, using synchronized discharge solution. Foundation is raised from 2m to 3 m above sea level to avoid flood.

To prevent flooding, investors will hire workers dredging and clearing Ngon Ngay canal in early rainy season. Combined with local authorities to enforce local people to avoid land encroachment that will block the flow and causing flooding. During heavy rain, wastewater will be stored temporarily in conditioning tank and disinfection tank.

Also to prevent flooding the investors construct on a pumping station at the gate of Ngon Ngay canal and Saigon River, to quickly discharge to the Dong Nai River.

This should be included in the design and as mitigation measure in EMP.

6.3.8. Odor Control Measures

The following measures will be adopted to minimize the generation of odors:

- Maintain adequate dissolved oxygen in gravity sewers by ensuring steep enough grades to produce sufficient velocities, and by the provision of natural ventilation;
- Provide turbulence in upstream areas of catchment but eliminate turbulence in the lower reaches where the sewage may contain hydrogen sulphide;
- Minimize detention time in pumping stations and rising mains;
- Design rising mains which have the smallest diameter and shortest practical length to minimize detention and slime development; and

- If necessary the addition of facilities to control hydrogen sulphide generation in longer rising mains; Ensure the design of the WWTP taken into account the measures to control odor.

6.3.9. Risk management in operation phase

6.3.9.1. Measures for mitigation of impacts on environmental pollution at the pumping station

- Compliance with noise, vibration, air quality and occupational health protection standards
- Influent to the pumping station will be monitored semi-annually to verify the quantity and quality of the wastewater collected from the NLTN basin. Measurements are to be taken every three hours over a complete tidal cycle that coincides with the canal and river water quality measurements.
- Pump station flow and water quality will be estimated based on pump operation logs and flow measurement devices. The following parameters will be monitored: flow, BOD, DO, fecal coliform, suspended solids, ammonia and pH.
- Records are to be kept by the pumping station operator of the quantity and type of scum, grease and oil skimmed from water surface of the pump station. Measurements are to be taken during all maintenance activity.
- Any accidental spill that reaches the pump station should be thoroughly documented. Toxic or hazardous chemicals that are captured at the pumping station should be sampled and analyzed for chemical content.

6.3.9.2. Measure for flooding control

A flood monitoring program is proposed to evaluate the actual flood reduction and hydraulic capacity improvements achieved by the project. Simple mechanical tide gauges should be installed to record weekly high and low water levels at six locations along the length of the canal.

6.3.9.3. Risk of accidental chemical leakage

Measures to reduce solid waste will be also applied. In addition, regular checking of using and storing chemicals should be done. In order to monitor required chemical amount, quality of wastewater should be regularly tested. When a risk occurs, it is required to solve immediately in order to minimize the loss.

Safety in contact with chemicals used for WWTP based on chemical safety and compliance with Decree No. 68/2005/ND-CP and Decision 136/2004/QD-BCN, namely:

- Safety measures during transportation and storage of chemicals.
- Amount of chemicals stored in the warehouse not exceeding 6 months of use.
- Chemical safety label is attached on boxes or containers of chemicals. Workers who are in contact with chemicals are provided with safety instruction in case of exposure.
- When working with chemicals, workers must comply with occupational safety standards and procedures. Aid instruments are placed in positions contact with chemicals.

6.3.9.4. Mitigations for the blocked or broken wastewater collection system

- In the WWTP, valves of discharge rate as well as flow meter along water pipes will be installed in order to detect blocked, filled and broken water pipes.

- To regularly monitor and test water sample at connecting points to ensure that quality of influent source which may affects sewage treatment system.
- To equip mobile pump and plastic pipe to drainage when it is needed.
- In the operation of WWTP, incidents such as equipment damage, clogged pipes, improper operation, problems with UV systems may happen. The regular repair and maintenance plan will be implemented to be avoided the impacts.

6.3.9.5. Fire and explosion's mitigation measures

Educate and enhance awareness of staff on environmental protection activities regularly:

- To prevent fire, the WWTP will apply technical, training and legal measures.
- In particular, the WWTP will coordinate with fire agencies in localities to establish specific measures for fire protection, calculate number of firefighting equipment needed, building regulations, the position of warning signs in each department, and conduct training sessions for fire protection for all workers in the factory.
- For electrical equipment, safety rule will follow standard rules. High temperature areas or underground wires must be protected carefully.
- WWTP should have in place a fire safety emergency plan.
- When discovering fire and fire risk, following standard fire orders described in the fire safety emergency plan. Phone and announce to the nearest local fire station, conducted emergency response with provided firefighting equipment (pressure pump, CO2 extinguisher, bottle of sand).

6.3.9.6. Install warning signs at the WWTP outlet

The investor need to install signs at the WWTP outlet to avoid people trespassing or be unaware of the outlet site. If without signs, there is a danger for local people to use it for drinking or cooking, poses health risk and affects WWTP reputation.

6.4. MITIGATION MEASURES FOR SOCIO-ECONOMIC IMPACT AND RESETTLEMENT PLAN

Because land acquisition is required to construct the WWTP (38.47ha), and some temporary land acquisition may be required for the installation of the Interceptor and the sewerage in the District 2 area, the World Bank's OP 4.12 on Involuntary Resettlement is triggered. A Resettlement Policy Framework (RPF) has been prepared in accordance with the World Bank's OP 4.12 to guide the preparation of Resettlement Action Plan (RAP) for any site-specific civil works under the project that requires land acquisition. The RPF specifies steps to be taken for preparation, review, and clearance of a RAP when required during project implementation. It also specifies how compensation would be made to local people who are affected with loss of land, structures, crops, businesses during project implementation, and how livelihood restoration of local people will be supported, and monitored. In addition to RPF, an Environmental Social Management Framework (ESMF) has been prepared in accordance with the World Bank's OP 4.01 (Environmental Assessment), and OP 4.12 (Involuntary Resettlement). The ESMF provides guidance on how environmental and social impact will be addressed in an integrated manner.

6.4.1. Social safeguards implementation:

HCMC People's Committee (HCMC PC) is primarily responsible for the implementation of the RAP(s) to be carried out under this project. The costs for compensation payment/livelihood restoration will be financed by HCMC People's Committee. During project implementation, IMA, as assigned by HCMC PC, will do the day-to-day RAP implementation in collaboration

with District 2 People's Committee, and other relevant governmental agencies. A social staff will be appointed at IMA to provide technical support to relevant government agencies to ensure the RAP is implemented in accordance with the RPF. An independent price appraisal and a monitoring agency will be engaged by IMA to assist in carrying out necessary tasks to ensure the compensation payment is made at the replacement costs and that the compensation payment and livelihood restoration are monitored appropriately in line with the objectives of the RPF.

6.4.2. Measures for mitigation of negative socio-economic impacts in pre-construction phase

6.4.2.1. Compensation measures in pre-construction phase

Compensation and support for households who own land within the area required for the construction of the WTTP will be compensated as per the project' RPF and RAP for the Interceptor area and WWTP (Please see the RAP for details) [25].

6.4.2.2. Interceptor

For locations which require temporary (laying of interceptor) and permanent (22 shafts) land acquisition, the investor must comply with the World Bank Policy OP.4.12 strictly. We do not know at the moment the exact alignment of the Interceptor. Thus, we will use project's RPF if compensation is required to acquire the land for the Interceptor [25]. A RAP will be prepared prior to any temporary or permanent land acquisition.

6.4.2.3. WWTP

Minimize project impacts to property and livelihoods of households.

The current socio-economic study done as part of RAP preparation for the WWTP area shows that the 63 affected households and 2 companies are not currently using the land for productive purposes (aside from 2 affected businesses on rented land). Most of this land has been purchased for speculative purposes and is currently unused. Hence it is likely that land acquisition will negatively affect the development prospects of households because most of them bought land for assets/heritage for their children.

A RAP has been prepared for the project. Six rounds of consultation were carried out with identified potentially affected households. The RAP identifies the affected households and assets and lays out the detailed entitlement matrix for determining compensation payments. In addition, the RAP contains details of monitoring impacts, grievance redress procedures, legal framework and implementation arrangements. There is a focus on ensuring restoration of livelihoods.

The following measures will be applied:

- If possible, the State should apply the "land exchange land" method, compensating by other plots of land in surrounding areas which have the same conditions;
- The State should apply the policy that converts agricultural land to 20-30% residential land to allocate them with other plots of land in the residential area planning projects in District 2;
- If the 2 plans are not possible, the compensation at replacement cost should be made, so that people can buy equivalent land in District 2. In case of compensation in cash, when the negotiation is complete, it is necessary to pay the compensation in cash immediately due to risk of inflation.

6.4.3. For mitigation of negative socio-economic impacts in construction phase

6.4.3.1. Interceptor

- The investor is required to distribute all information to households in terms of negative impacts of the project (noise, dust, houses shaken by construction…) and policies of the project in case of emergencies especially if cooperation is needed for countermeasures/mitigation measures (watering for dust reduction, closing doors for noise elimination…);
- Selecting qualified and skilled contractors with full financial capacity to ensure scheduled construction progress;
- Package sizes should be suitable for existing contractors' competency;
- Sanctions are provided against contractors that fail to ensure the progress;
- Relevant compensation/support policies are made available to households and organizations losing incomes due to construction, which affects their commercial/service activities;
- In case of losses incurred by households due to construction failure (wall cracking, settlement, etc), compensations are required;
- The road surface is reconstructed right after completion. Supervisors are needed to ensure the reconstructed road surface quality as it was before project implementation.

6.4.3.2. WWTP

- All compensation will be paid to affected households and companies prior to any commencement of civil works.
- The local people living near construction sites are warned about the problems to be faced before the commencement; relevant measures are proposed to mitigate these negative impacts (watering for dust reduction, closing doors for dust and noise elimination…);
- Households are entitled to a relevant cash support to apply measures to mitigate the impacts of dust and noise during construction of plant (e.g. rooms are enclosed to prevent dust, air conditioners are used to prevent heat as a result of enclosed houses or payments are used to pay the cost of increased water consumptions for road washing);
- The group of workers living and working in construction sites assigns a person in charge of supervision of cleaning tents, clearing stagnant water, discharging domestic wastes.

6.4.4. Mitigation of negative socio-economic impacts in operation phase

6.4.4.1. Interceptor

Minimizing healthy risk for workers operating the interceptors:

- Workers dredging sludge or repairing pipes must be trained to respond to unexpected situations while working in the hazardous environments;
- Workers should wear protective clothing, masks and are equipped with special devices to treat in place in case of exposing H2S, NH3;
- When working in the pipe work, two people should work together to be able to support each other in case of incidents.

6.4.4.2. WWTP

Elimination of diffusion of bad smells and dust generated by wastewater treatment plant towards residential areas nearby:

- Apply odor control measures;

- The Investor commits to apply necessary technical measures to ensure post-treatment emissions in accordance with QCVN 19:2009/BTNMT and QCVN20: 2009/BTNMT;
- Plant trees in high density around the plant (within the safety corridor with a radius of 300m from the plant to the nearest residential area) to prevent dust diffusion in residential areas. According to the design, the green corridor is 10 m in thickness as expected to ensure that diffusion of dust and stink (smell) in residential areas are prevented. Besides, public green space may be arranged in adjacent public lands in the "buffer zone" between the safety corridor of the plant and residential areas;
- Removal of sludge out of the plant in the appropriate time, when the traffic density is at the lowest level. There should be special-purpose vehicles (closed tanks) to reduce smell and dust emissions during transportation.

6.5. CLIMATE CHANGE ADAPTATION MEASURES

6.5.1. Broad Approach to Adaptation

A fundamental adaptation measure relates to effective upstream management of water resources and of the overall watershed. The large number of dams under development will make water management and quality control more complex in HCMC – with many unknown implications when overlaid with the planned flood control system within the City. The impact of continuing watershed degradation and forest loss are other complicating factors with uncertain repercussions for the City as climate change takes hold. It is sure that Dong Nai River Basin (DNRB) water resource managers need to build in systematic and coordinated 'remedial' allocations when developing water operational rules to provide for environmental flows and 'flushing' to off-set salt and pollution concentrations in the City's waterways.

Retrofitting existing water supply infrastructure is also a high priority so that it can be operational under the predicted extreme flood events for 2050.Retrofitting includes the capping (and extension) of open bores to reduce salinization and contamination of the groundwater. Existing infrastructure needs to be reviewed, and potentially upgraded, to ensure water users are able to dispose of wastewater and for wastewater treatment plants to receive, treat and appropriately dispose the treated wastewater under the predicted flooding regimes for 2050.

Another complex but fundamental issue is the establishment of water markets and variable pricing mechanisms to assist in more efficient allocation and increased security of water during extreme flooding events where supply of clean water is reduce, but not demand.

Future land use developments should be required to demonstrate how water supplies will be accessed under the predicted flooding events for 2050, especially those developments in high impact zones (e.g. the central urban districts and Can Gio).

Comprehensive and reliable water quality monitoring networks and monitoring programs need to be established for the major water systems in HCMC (i.e. rivers, canals and groundwater). Semi-annual monitoring data needs to be analyzed regularly to determine water quality trends, to develop a better understanding of the location-specific causes of poor water quality, and keep track of changes for targeted adaption responses. Publicly available (e.g. via the internet), free of charge, water quality data registers need to be established for keeping a regular record of monitoring data to increase awareness of the condition of the water sources.

Decentralized approaches to service delivery, including water supply and wastewater treatment would distribute the risks associated with future climate scenarios and would allow localized approaches to adaptation to be developed and implemented. Such a service delivery model would represent a fundamental change in the way HCMC is planned and

serviced but its progressive adoption would have long term benefits in the face of climate change.

6.5.2. Protection

Retrofitting of wastewater infrastructure is required. Existing wastewater infrastructure (e.g. pipes, outlets) must be functional at water levels predicted for the extreme flooding scenario (i.e. ~1.5m), which is likely to occur in many areas of HCMC by 2050. This includes access for water users to take water as well as dispose of wastewater without impacting inland water systems (e.g. river, canals and local storages); and for wastewater treatment plants to be able to receive, treat and dispose the treated wastewater away from any inland water sources (including temporary flooded areas). Underground pipes will need to be monitored regularly to check for leakage. More localized, smaller, wastewater treatment plants should be built in areas less likely to be impacted by flooding from climate change. They will be built to a standard suitable for effluent reuse and/or release to receiving waters, to reduce costs of piping wastewater to larger plants along the main rivers, and hence the risk of major contamination from leakage.

6.5.3. Creating Resilience

Wastewater infrastructure design codes should be revised to ensure infrastructure is designed to operate under the predicted inundation levels.

Natural systems management should be improved. The increase in extent and duration of flooding will require natural resource managers to improve their understanding of the 'resilience' levels of natural ecosystems along DNRB, in HCMC rural and urban districts (e.g. wetlands, agricultural areas, rivers), and in Can Gio to be able to allocate water more efficiently. Adaption steps include:

- Improve basin wide monitoring (and metering of water use) systems to increase understanding of annual and seasonal rainfall variability (i.e. intensity, frequency, timing, duration and volume), and the extent of droughts (i.e. timing and duration);
- Improve understanding of the 'environmental flow' requirements and the 'sustainable levels of extraction' to better understand the supply limitations of the water resource (both surface and groundwater), particularly during stressed periods (e.g. extreme flooding from sea-level rise). This will require engaging 'communities' to identify key environmental assets, and scientists for understanding the water regime options; and
- Improve modeling systems to assist in the development of 'water operation rules' to best utilize current and future water storages.
- Introduce water sensitive urban design planning processes: Water sensitive urban design is about understanding the urban 'natural' water cycle – the water flow paths (e.g. precipitation, infiltration) given the existing structural aspects (e.g. roads, seal drainage systems) of a city and incorporating water supply, wastewater, runoff and groundwater treatment, urban design and environmental protection to manage the whole system as a resource. This approach builds greater flexibility and resilience compared with the more traditional, separate potable, wastewater, and runoff systems approach to urban water management, particularly where the water resources are under stress from existing conditions and more so with climate change.

The broad objectives of this approach are to:

- Reduce potable water demand, and wastewater produced, in existing and new city developments – 'responses' include:

    - Designing and applying localized water storage, treatment and reuse technologies;
    - Minimizing wastewater generation;
    - Treatment of wastewater to a standard suitable for effluent reuse and/or release to receiving waters;
    - Optimizing the use of water sources from within the development to minimize potable water inflows and water outflows; and
    - Promoting a significant degree of water self-sufficiency within a development.
- Increase understanding the downstream natural hydrological cycles, to reduce impact from runoff pollution.
- Reduce development costs (e.g. more targeted, localized, and site-specific investments, and less dependence on large-scale infrastructure where disruption to operations would have wide spread repercussions).
- Reduce urban institutional and regulatory complexities through:
    - Flexible institutional arrangements to cope with increased uncertainty and variability in climate; and
    - Identifying a diverse portfolio of water sources, supported by both centralized and decentralized water infrastructure.
- Some specific Water Sensitive Urban Design adaptation responses include:
- Ensuring that the water regime coming from the development site is equivalent to the undeveloped site (e.g. may require an increase in retention times):
    - Ensuring that peak runoff flows do not exceed those of the pre-existing condition of the site; and
    - Reuse, storage and infiltration of runoff, instead of drainage system augmentation
- Provide for infiltration to ensure maintenance of groundwater systems.
- Substitution of potable water supply (e.g. provision of a third pipe recycled water system to industrial users; use of collected rainwater for domestic toilet flushing, hot water supply, external applications etc).
- Encourage potable water demand reduction techniques:
    - Use of water efficient appliances and rainwater, runoff, wastewater, groundwater and grey water reuse as alternative sources of water to conserve potable supplies
    - Water use education programs; and
    - Aquifer storage and recovery (aka MAR - Managed Aquifer and Recovery).

6.5.4. Preparedness

Land use planning for future developments needs to focus on areas where the supply of water is less likely to be affected by extreme flooding events and other climate change impacts – i.e. zones in the center and to the north of HCMC. New industrial and residential developments should rely less on groundwater supplies, as the resources are already under stress and are likely to become further stressed through salt intrusion from flooding. Sewage recycling and more efficient local storage and use of rain water needs to be explored. Any planning proposals along the coast of Can Gio should demonstrate how water supply needs will be met if the area is inundated for long periods (e.g. raised infrastructure, localized desalination plant, rainfall storage). The location, volume and quality of wastewater, and type

of discharge (i.e. point or diffused) need to be recorded and monitored for surface and groundwater systems.

New developments of commercial activities that are known to discharge high volumes of pollutants (e.g. hospitals, residential complexes, industrial areas) should not to be approved unless they can demonstrate (e.g. through EIA, EMPs, localized treatment plants) avoidance and mitigation of discharges to water systems (e.g. through tertiary level treatment). Future development proposals (including residential, industrial and hospitals) should provide for localized wastewater treatment plants that optimize the use of the water source within the development, to minimize potable water inflows. However, to better understand the extent of impact of flooding, future monitoring will need to assess and report on water quality before, during and after flood events.

Planning of future wastewater discharge infrastructure needs to focus on vulnerable communities and areas, particularly in the southern and south-western zones of HCMC, where they may not be able to dispose their wastewater via the reticulated network. Focus needs to be on assessing the potential discharge volumes from these communities and its impact on neighboring water resources so that structural (e.g. supply, treatment and discharge infrastructure) and non-structural (e.g. capacity and awareness) requirements can be defined. A risk assessment approach would enable targeted support to the most likely affected communities. Decentralized models of wastewater management and servicing should be considered for these areas.

Future planning of water supply systems needs to take into account population movements due to climate change. For example, communities in areas around the HCMC dyke enclosure may have difficulty accessing clean water as supply connections and open bores are sub-merged. Flood duration, depth and salinity would increase in those areas as incoming tidal flooding and storm surge in extreme events is forced around the City. Communities may need to move away from the worst affected areas – the direction and magnitude of this and other climate related migration – for example, from the Mekong Delta or even from Can Gio, where increased flood duration will also make habitation difficult, needs to be assessed and anticipated. Water supply lines to areas receiving migrants would need to provide for the increased demand. Decentralized models of water supply servicing should be considered for these areas.

Development of markets for water supply Water markets may provide a useful tool for allocating and increasing water security for HCMC consumers. For example, an allocation could be set for environmental flows. Preliminary market responses could include:

- Identification and clarification of all current and potential water user types in both rural and urban areas
- Improving and extending the metering system to determine annual water use trends by the various water user types, particularly how the major water supply plants for HCMC are affected by climate changes
- Treating HCMC as a high priority “user” and setting operational rules for regular environmental flow releasing during the year.

Improved water user pricing systems should be investigated. In HCMC, increased intensity of regular and extreme flooding is likely to reduce access to water supply, but not water use demand. Currently, there is a charge for domestic water use but not commercial water use. A two-tiered pricing mechanism could be established to provide greater security of water supply during extreme flooding events. The first tier would be for setting a minimum individual allocation per year, for basic human needs. The second tier would be for the remaining allocation for domestic and commercial use, where a variable pricing approach could be used and determined on factors such as the users location relative to water supply access points (e.g. higher price to supply water in areas that are flooded and not close to water supply

plants). Both the water markets and pricing approaches to increasing water use efficiency are supported by the 'Law on Water Resources', the 'National Water Resources Strategy towards 2020' policy and the draft National Target Program for Sustainable Water Sector.

Improved wastewater licensing schemes should be investigated. A more effective licensing mechanism for discharging wastes into water sources needs to be established as a means for controlling discharge. Licenses may need to be regionally capped, depending on the severity of pollution, and compliance systems need to be established that can enforced.

6.5.5. Prediction

Warning systems and response measures should be implemented at WWTPs to ensure appropriate protective measures are taken in case of flood to avoid damage to infrastructure and pollution of the surrounding environment.

Warning systems in the event of pollution overflows from WWTPs should be implemented in areas of environmental sensitivity or where public health effects are likely to be experienced.

6.5.6. Implement Arrangements

The following table (See Table 6.5) identifies key departments and organizations that have a responsibility for water supply management.

Table 6.5. Responsibility for water supply management

Recommended adaptation measure	Institutions with some responsibility
Protection	
Retrofitting of existing water supply and wastewater infrastructure	SAWACO DOC
Creating resilience	
Water supply and wastewater infrastructure design codes	DOC
Natural systems management should be improved.	DONRE
Introduce water sensitive urban design planning processes	Department of Planning and Architecture (DAP) Institute of Urban Planning (IUP)
Preparedness	
Land use planning for future developments	Department of Planning and Architecture (DAP) Institute of Urban Planning (IUP)
Planning of future wastewater discharge infrastructure	DOC
Future planning of water supply systems	DOC
Development of economic water markets	DARD
Improved wastewater licensing schemes should be investigated	DONRE
Prediction	
Warning systems and response measures should be implemented at WWTPs	District and commune PCs WWTP operators
Warning systems in the event of pollution overflows from WWTPs	District and commune PCs WWTP operators

Source: ADB (2009). HCMC Adaptation to Climate Change Study Report-Volume 2: Main Report - Final Report.

CHAPTER 7.
PUBLIC CONSULTATION

7.1. PUBLIC CONSULTATION AND DISSEMINATION

Public consultation activities as part of EIA report preparation for HCMCES II need to be designed to ensure requirement as following:

- Based on this concept, and in accordance with regulations as stated at Clause 8, article 20 of the Law on Environmental Protection passed in November 29th 2005 by the National Assembly of the Socialist Republic of Vietnam.
- Meet the requirements of Circular No. 26/2011/TT-BTNMT on July18th, 2011of the Minister of Natural Resources and Environment regarding instructions on preparing strategic environmental assessment report, environmental impact assessment report, and environmental protection commitment.
- Decision No. 80/2005/QD-TTg of the Prime Minister dated April 18th, 2005 regarding Regulations on community investment supervision;
- Decree No. 79/2003/ND-CP of the Government promulgating Regulations on democracy implementation at the commune level;
- Ordinance No. 34/2007/PL-UBTVQH11 dated April 20th, 2007 of the National Assembly's Standing Committee regarding the democratic regulation implementation at commune and ward levels;
- Joint Resolution No. 09/2008/NQLT-UBTWMTTQVN of Government - the Central Committee of Vietnam Fatherland Front dated April 17th, 2008 regarding guidelines on implementation of Articles 11, 14, 16, 22 and 26 of the Ordinance on democracy implementation at commune, ward, and town levels;
- In addition, public consultation for this project's environmental impact assessment report must also meet the requirements of the Safeguard Policy on Environment Assessment of the World Bank (under OP 4.01 http://go.worldbank.org/OSARUT0MP0).

7.2. PURPOSE OF COMMUNITY CONSULTATION

Objective of this consultation is:

- To inform local authorities and residents to a on the projects components and activities and its potential impacts on the environment and society in construction and operation of the project, especially on water quality and sludge management.
- To collect opinions; understand the concerns of local authorities and community on potential environmental problems created in project area; especially problems which are not recognized by EIA team. Based on this, public concerns can be reasonably solved during the project design and EMP preparation.
- Public consultation is part of the environmental assessment in the Project. It is carried out in co-operation by the Project owner, Social consultant, Environmental consultant, local authorities, and residential communities in the area. Outcome of such consultation shall be used to assess designing plan, and propose minimizing solutions, and express the public's supporting during the course of the project.

For category A project, the public consultation needed to be conducted at least two times:

- First time: As soon as environmental screening is completed and TOR draft on environmental impact assessment is ready.
- Second time: After EIA draft is prepared;

7.2.1. The purposes of community consultation

- Sharing all information about Project activities with the community living in the project site and stakeholders.
- Understanding public opinions and concerns for the Project, especially those who are directly impacted by the Project construction and operation, to determine selection of designing solutions during the course of setting up the Project..
- Listening to public opinions and their concerns toward the Project, come up with solutions for problems that directly impact the community on a daily basis.
- Settling conflictions that arise among public proposals for environmental issues and delays in implementing the construction schedule of authority bodies.
- Meeting reasonable demand of residents, and considering public proposal and from the authority.
- Understanding major difficulties that residents living in area being subjected to
- Initially, public consultation activities also help to consider the issues and concerns of the community in the process of project design in order to increase confidence and support for the project. In this way, effective public consultation can reduce the risk of conflicts and delays in project implementation process and can improve the overall sustainability of the project.

7.2.2. The principle of public consultation in the EIA

- Information dissemination: Information about the project should be communicated to the local community and affected groups under several suitable approach forms. Needing to conduct communications from early stage so that the people have time to consider problems related the EIA process and form their own views. Provided information need clearly to define the affected area, both the advantages and disadvantages of proposed activity;
- Gathering information: It's necessary to discuss and exchange with the authorities of and community representatives (People's Committee, Council, Investment Supervisory Board and community's organization); the local may be affected by the project are benefits to know their views and their contributions for the projects and the works of EIA;
- Integrating in the evaluation process: The views and concerns of the community and stakeholders should be considered when: (1) Identify key issues need consider in; (2) Assessment and predict the effects and risks directly / indirectly may happen from the project; (3) Assess the impact and risk level; (4) Develop monitoring, management and mitigation programs appropriately. Ideally, the consultation processes should be started from the stage of determining the scope of EIA;
- Coordination: The public consultation activities should be related to the region being affected by the project and they should be notified soon about any proposed changes in the operation of the project;
- Connecting people in a dialogue: Need to apply suitable method of public consultation to bring people into dialogue, focusing on the sources of information and multi-dimensional ideas between the project and stakeholders.

7.3. PUBLIC CONSULTATION

The methods of public consultation are often used including quick assessment method including:

- Community meetings, group meetings and focusing group discussions;

- Conducting investigation and interview number of households in the community to assess their opinions and concerns about the project;

Center for Environmental Technology (CEFINEA) carried out the survey on the affected area at upstream, middle stream and downstream of WWTP discharged point;

Under the HCMC ES2 Projects, Public Consultation was conducted three times. The first and 2nd public consultations were carried out by CEFINEA and the third public consultation was implemented by Meinhard Ltd.

7.3.1. First public consultation

The first public consultation was held during first phase of EIA preparation. The mission deployed campaigns to provide two rounds of information distribution to the project area:

Round 1: From December 24th, 2010 to December 26th, 2010: The implementation contents during this phase included project information dissemination, questionnaire-based interviews with approx. 10% households living in the proposed project area – Thanh My Loi ward;

Participants: representatives of local authorities (commune level), household.

Round 2: From December 20th, 2011 to December 23th, 2011: Consultants organized additional meetings to consult and seek opinions of local authorities and residents in wards/communes where are affected by WWTP discharged point;

Participants: affected household, representatives of local authorities (commune level).

In addition, Centre for Environmental Technology also carried out consultations with:

- Households living in areas of WWTP;
- Households located in Thanh My Loi B;
- Thanh My Loi Primary School;
- Health center of the Thanh My Loi Ward (immunizations for children, no patients stay in the clinic).

Main Opinion:

- Most of people agree and support project execution, eager to improve the environment better;
- The investor selects advanced technology and safe construction to less affect residents;
- Request to handle of the bad impacts when WWTP goes into operation.

The result of the first public consultation is summarized in Figure 7.1 and Tables 7.1, 7.2 as following:

Table 7.1. Comments of Affected Person at Upstream of outlet of WWTP

Location/ Time of consultation	Interviewed households	Career activity	Status	Opinion	Commitment & Respond from Contractor
Thanh My Loi Ward – District 2 (From Dec 24th – Dec 26th, 2010)	68 (interview/ consulting)	Crop:30 Crop and fishing: 12 Pond: 2	- Main trees: swampland, fallow land. - Low population - Part of living residents, are rice field, so land recovery will affect income, changes their living conditions - The land of 68 households is mostly agricultural land and fallow land, without surrounding residents.	- The project and the contractor should provide full information to people in affected areas so that people can limit crop damage - Duration of construction needs to be short and synchronous, avoiding lengthening the duration and influence local traffic, especially the roads going through the newly constructed road. - Construction work needs to limit environmental impact, limiting the effects of noise, especially during late night.	- The opinion was taken into account in EMP. - The information on project will be disseminated to local communities 6 months before implementation - The construction time will be shortening as much as possible. - The issue will be addressed in feasible study and as mitigation measures in EIA report - The issue will be addressed mitigation measures in EIA report.
Ward 18 - District 4 (On Dec 21th, 2011)	10 (along the Te Channel)	Retirement (5) Housework (1) Renting Business(1) Mechanic (1) Masons (1) Bread making (1)	- Income does not depend on Te Channel - The air: fresh, not pollute - Water environment: as high tide or low tides water quality and quantity are different (odor during low tide, flood during high). River water cannot use for living purpose.	- 100% agreed with the execution of projects. - Issues in construction phase: Noise; Air pollution; Compensation policy; Traffic; Issues in operation phase; Quality of treated water; Sludge treatment -Mitigation measure in construction phase: Labor safety; Signage; Camps for workers; Watering to prevent dust; Low-speed; Register workers with local governments -Mitigation measures in operation phase: Follow the regulations on water quality Treat the sludge properly	- The opinion was taken into account in EMP: - More mitigation measures on dust pollution in the construction and transportation such as cleaning the streets frequently and watering the surface. - Providing mobile toilets or septic tank in worker camp. - Providing signage and fencing system to prevent the trespassing. - Recover the road surface as before construction. - Follow the treatments and discharge standard in WWTP.

Table 7.2.Comments of Affected Persons at Middle stream of WWTP Outlets

Area	Interviewed households	Career activity	Status	Opinion	Commitment & Respond from the contractor
Long Truong ward – District 9 (On Dec 21th, 2011)	7 (along the Ong Nhieu river)	- Fishing, (3) - Horticulture (2) - Transporter (1) - Worker (1)	- Income depends on Ong Nhieu river (except worker) - The air: polluted by cement dust from Ha Tien cement, dust from movement of materials for North - South Highway construction project - River water: contaminated by sewage of cement, chemicals used in fishing from people outside the region	- When project causes river pollution: residents want to move house and changed economic structure - some peoples concerned about affects from the construction site: noise, wastewater, garbage, etc.	The consultant will address these issues as mitigation measures in EIA report.
Phu Huu commune - Nhon Trach district (On Dec 23th, 2011)	10 (Dong Nai River).	Fishing (6) Traditional fishing (2) Shrimp farming (1) Farming Shrimp, Fish, Chicken, Duck (1) Rice farming	- Income depends on Dong Nai River and Bay canal - The air: not polluted - The water environment: bad smell, turbidity Water cannot be used for living purposes. Production of fish and shrimp are declined due to river pollution.	- People want the road in construction site not be affected too much by the activities of the contractor. - Locals want to be compensated for pollution damage caused by the project.	The issue will be addressed in feasible study and as mitigation measures in EIA report
Ben Co Hamlet Dai Phuoc commune - Nhon Trach district (On Dec 23th, 2011)	10 (Dong Nai River border Cat Lai port)	Rice, farming Shrimp, Duck (2) Growing Rice, raising duck, chicken (3) Growing Rice, lotus; farming shrimp, duck (2) Growing Rice; Farming Fish, Duck (1) Growing Rice; Farming Fish, Shrimp (2)	- Income from Rice farming, livestock - The air: less pollution, is affecting mainly due to spread of dust from Ha Tien Cement Factory - The water environment: less polluted and smelly, but can still be used in aquaculture and rice growing.; characteristics of water is 6-month salty and 6-month sweet	- Households have agreed pollution mitigation measures that were given by the investors - Some people want to be compensated for pollution damage caused by the project. - the contractor must make sure the construction is safe for people living near by	The issue will be addressed in feasible study and as mitigation measures in EIA report

Table 7.3. Comments of Affected individuals at the Downstream of WWTP outlets

Area	Interviewed households	Career activity	Status	Opinion	Respond from the contractor
Nha Be District (On Dec 20th, 2011)	5 (near Phu Xuan river bank).	Housework (2) Small business (2) Officer (1)	- mainly small business and workers - The air: not polluted. - - Water environment: as high tide or low tides water quality and quantity are different (odor during low tide, flood during high). River water cannot use for living purpose.	- Households have agreed pollution mitigation measures that were given by the investors - No feedback about project causes river pollution	The issue will be addressed in feasible study and as mitigation measures in EMP
Hamlet 4 Phu Xuan ward – Nha Be district (On Dec 20th, 2011)	6 (near the Phu Xuan river bank).	Retirement (1) Labor (1) Housework (1) Maritime Staff (1) Small business (1) Worker (1)	- mainly small business and workers - Environment in the region is often polluted by petroleum depots - Water environment: unpleasant odors, oil scum - Atmospheric is affected by petroleum vapors, and unpleasant odors.	- People want the investors to make more opportunity for local labor. - When the project causes river pollution, people wishes to relocate or compensation from the project owner	The issue will be addressed in feasible study and as mitigation measures in EMP
Hamlet 2 Phuoc Khanh commune - Nhon Trach district (On Dec 22th, 2012)	10 (near Long Tau river bank).	Traditional fishing (3) Shrimp farming (2) Labor (3) Housework (1) Worker (1)	- Income depends on river (expect workers) - The air: not polluted - Surface water: bad smell, river - bank area is usually eroded when large vessels pass through, strong waves. When tide high up, flooding is into houses	- Households understand and support the mitigation measure by the investors - Some people want to be compensated for pollution damage caused by the project; or resettlement.	
Phu Dong commune - Nhon Trach district (On Dec 23th, 2012)	6 Nha Be River - outside dike	Growing rice (1) Growing rice, farming Shrimp, fish (1) Growing rice, farming fish (2) Growing rice, raising duck (1)	- Most households moved into embankment to live. - The air: not polluted. - The quality of waters: bad smell, turbidity; but can still be used in aquaculture and rice growing.	- 100% Households have agreed a pollution mitigation measures given by the investors - Some people want to be compensated; or economically restructuring;	The issue will be addressed in feasible study and as mitigation measures in EMP

7.3.2. The 2nd public consultation

The 2nd public consultation was performed after the draft EIA report was prepared. The 2nd public consultation was implemented from February 9th, 2012 to February 24th, 2012.

The objective of the 2nd consultation was to present the main findings of EIA reports and to get feedback from affected household (PAHs). In addition, to comply with Circular No. 26:2011/BTNMT and Decree No. 29:2011/ND-CP, we also consulted to collect opinion from leaders (People's Committee, Fatherland Front's Committee) of Wards and Communes, of representative of affected people.

Place, time, participants and the content of the 2nd public consultation are presented in Table 7.4.

7.3.3. The 3rd public consultation

The 3rd public consultation was performed after EIA Draft Report, the Executive Summary and the ESMF for the construction of D2 sewerage network were revised following the Bank's comments. The Consultation meeting was held on 04-24-2014 at Hall of the People's Committee of Thanh My Loi Ward, District 2. The minutes of the meeting is presented in Appendix 5.

The consultation was available:

- 65 households who have land inside and surround the project area (Please find more detail in the consultant meeting minute);
- Five representatives of the companies affected by the project:
    - Representative of Investment and Building Management Board of Thu Thiem New Urban Area;
    - Representative of District 2 Public Service Company Limited , Ho Chi Minh City;
    - Representative of 21st Century Corporation , 41 Nguyen Thi Minh Khai Street, District 1, HCMC;
    - Representatives of Saigon Water, Environment and Infrastructure Joint Stock Company;
    - Representatives of the Youth Volunteers Investment and Construction Company in Ho Chi Minh City.
- Representatives of 6 non-governmental organizations in the Ho Chi Minh City:
    - Representatives of the Water and Environmental Technology Institute (WETI), Vietnam Association for Conservation of Nature and Environment;
    - Representatives of the Vietnam Environment and Sustainable Development Institute (VESDI), Ho Chi Minh City;
    - The Association of Science and Technology of Ho Chi Minh City;
    - Representatives of Environmental Technology Center (ENTEC);
    - Representatives of Institute for Environment and Resources (IER), National University of Ho Chi Minh City;
    - Representatives of Institute of Meteorology, Hydrology, Oceangraphy, and Environment (IMHOEN).
- Local government representatives (7 wards in District 2), the project owner and consultant.

Most of the comments in this consultation were supportive of the project. Implementation should minimize the impact on the environment as well as the lives of local people.

To perform better in environmental protection and welfare of the people the project area, project owners and contractors need to perform the following tasks:

- Limiting the impact of pollution and dust emissions: Requires vehicles must be carefully concealed to avoid dust, soil, and material spillage during transportation; and all regions gathered material or gravel should be covered.
- Limiting the impact of water pollution: Need to set the public toilets on the scope and frequent cleaning; and prioritize the recruitment of workers near the project area, to reduce the number of workers in the camps, reduce the amount of wastewater generated.
- For the problem of solid waste generated: Need to coordinate with local governments to collect and treat waste generated on the construction site and signed a contract with the company functions to transport and dump in dump waste was licensed.
- Restrict traffic accidents in the construction phase of the project: It avoids the transport process during peak hours; Installation of lights in the night time, and guiding lights or other warning lamps operate 24 hours per day.
- Board of Investment Management Projects also need to consider the issues of security, health and safety for workers and residents in the project area;
- Board of Investment Management Project and local government commitment to ensure order and security in the building project and local people;
- Equipping and building infrastructure to minimize the impact of the project on the environment and people's lives;
- Owner when construction schedules to ensure no impact to water, electricity and highway traffic.

Declared the meeting

Counseling presents a summary of the project

Listen attentively consultants presented

People's opinions

People's opinions

Explanation of project owner

Figure 7.1. Image consultation on 24/04/2014

Table 7.4. Place, time, participants and the content of the 2nd public consultation

Content / Time/ Place	Public consultation			
	The number of participants	**Participants**	**Opinions of Participants**	**PPU and Consultant's response**
14h February 9th, 2012 at the meeting hall of Ben Co Hamlet, Dai Phuoc Ward, Dong Nai Province	22	Representatives of local government, Representatives of households living in the project area	- Treated wastewater must meet the standard, leaving no negative effect on the environment... - Treated Wasted water discharged into Sai Gon Dong Nai River should not cause any impacts on the environment. - It is also noticed that traffic safety during construction. - During the project implementation: safeguard environment, and security. There should be close cooperation with the local authorities.	- These issues were addressed in EIA report - The treat wastewater must meet National Regulations QCVN14:2008/BTNMT - The technology was selected to guarantee the quality of effluent meet the National Standard - The traffic issues will be included as requirements in bidding documents - CESPIMA agrees with this opinion.
14h February 13th, 2012 at the meeting hall of Area 5, Cat Lai Hamlet, Phu Huu Ward, Dong Nai Province	29		- Treated wastewater must meet the standard. - Fully compensation when happens accident of WWTP	- These issues were addressed in EIA report
13h February 10th, 2012 at the meeting hall of Truong Luu Hamlet, Long Truong ward, District 9.	14		The project follows up the right schedule, ensuring environmental sanitation, mitigate environment pollution that put bad impacts on the livelihood of people.	- These issues were addressed in EIA report and will be addressed as requirements in bidding documents
14h February 24th, 2012 at meeting hall of Thanh My Loi ward, District 2.	48		- During the project implementation, it is necessary to ensure environmental sanitation such as dust and noise control, etc.	- These issues were addressed as mitigation measures in EIA report and will be addressed as requirements in bidding documents

7.4. OPINIONS FROM LOCAL GOVERNMENTS

7.4.1. Opinions of People's Committee of Thanh My Loi Ward

According to Document No. 1026/TTCN-HTKT dated 04/10/2010 of the CESPIMA Technical Assistance for construction of Nhieu Loc - Thi Nghe wastewater treatment plant - the project owner informed main investment items, environmental issues, environmental protection measures of the project "HCMC Environment Sanitation Technical Assistance - Phase 2: Feasibility Study for construction of Nhieu Loc Thi Nghe wastewater treatment plant" People's Committee of Thanh My Loi Ward, District 2, HCM City had feedback in document No. 72/UBND, signed on 28/02/2011 as follows:

- Agreeing with impact assessments of concentration, waste load of the plant affects to natural environment and social of projects.
- Agreeing with contents presented in summary EIA report of projects. Requested the investor to comply with environmental protection commitments, apply appropriate technologies to implement measures to minimize bad effects, prevent and respond to environmental incidents.
- Requesting investor must comply with commitment contents in EIA report was approved. During construction if any problems arise, must have the quick overcoming solutions.
- Establishing good relationships with local authorities to manage involved issues Also, hiring local workers to create jobs for people in the project area and managing well security and others in project area.

7.4.2. Opinions of Fatherland Front Committee of Thanh My Loi Ward

According to Document No. 1026/TTCN-HTKT dated 04/10/2010 of the CESPIMA Technical Assistance for construction of Nhieu Loc - Thi Nghe wastewater treatment plant - the project owner informed main investment items, environmental issues, environmental protection measures of the project" HCMC Environment Sanitation Technical Assistance - Phase 2: Feasibility Study for construction of Nhieu Loc Thi Nghe wastewater treatment plant" Fatherland Front Committee of Thanh My Loi Ward, District 2, HCMC had the feedback in document No. 02/UBMTTQ, signed on May 26th, 2011 as follows:

- Agreeing with EIA contents of plant to natural environment and socio-economic as mentioned in summary report on environmental impact assessment.
- Agreeing with mitigation measures adverse effects, prevent and respond to environmental incidents.
- Requesting investor must comply with commitment contents of the EIA report was approved. Applying appropriate technologies to implement measures to minimize adverse effects prevent and respond to environmental incidents such as quality of treated wastewater, waste gas, chemical leaks, security and public order local... in process of construction, production organization and business if any problems arise, must quickly have overcoming measures.
- Coordinating with commune, departments in town and local people to deal and handle the relevant issues when implementing project locally.

7.4.3. Feedbacks and commitments of investor before the opinion of the People's Committee and Fatherland Front Committee of Thanh My Loi Ward

After receiving the support and approval with the summary EIA report for projects from The People's Committee and Fatherland Front Committee of Thanh My Loi Ward, The investor's feedback as follows:

- The comment from PC are taken into account in the project Environmental Management Plan (EMP)
- Investors will acquire and supplement following comments of the Committee and Fatherland Front Committee of Thanh My Loi Ward.
- Investors will invest new equipment used for the project. Most of equipment is imported from abroad.
- During operation of the project, they will give priority to hire local labor, contribute to upgrade economic condition of the ward.
- The investor will strictly supervise activities of the worker; reduce bad effects on social condition of wards.
- The investor will carefully operate the WWTP to avoid the failure of WWTP.
- The investor is committed to fully implement measures to protect environment, to reduce impacts on natural environment and society in accordance with the report.
- Investors hope to receive cooperation and assistance from Ward Fatherland Front Committee and the project is going to be started soon and completed on schedule to contribute for city development.

7.5. COMMITMENTS OF THE PROJECT OWNER

Basing on analysis of environmental impact assessment of projects and develop a feasible plan to control and minimize negative impacts of project activities. The investor would commit as follows:

- Complying with the laws of Vietnam and the International Convention on protection of the environment.
- Complying with the standards of Vietnam in process of monitoring and protecting the environment as environmental monitoring program outline in Chapter 6.
- Developing and applying methods of controlling pollutants in accordance with the plan proposed in Chapter 4 to control pollutants negatively impact the environment.
- Committing to complete environment works and is certified by the authorities prior to formal operation
- Being responsible for implementation of environmental commitments for the entire project "HCM City Environment Sanitation Technical Assistance - Phase 2: Feasibility for the construction of Nhieu Loc Thi Nghe wastewater treatment plant" in Thanh My Loi Ward, District 2, HCMC.
- Committing to do program monitoring and operation of environmental treatment facilities and coordinate with local governments in management of social security and order.

7.6. INFORMATION DISCLOSURE

According to requirements for information disclosure in 4.01 (http://go.worldbank.org/OSARUT0MP0), the CESPIMA, as the representative of the project owner will:

- Submit three sets of EIA report in Vietnamese language and a summary to HCMC People's Committee Office, as well as districts and wards/communes in HCMC city where the project is in effect.
- Make public notice via media or through the information committee under the city/districts two months before about the dissemination of the EIA report and an executive summary of the report. Local community can have full access to the EIA

report in about two months during work hours in the following places: 1) Office of Ward People's Committee under the coverage of the project and 2) the CESPIMA.

- Both English and Vietnamese versions of the environmental impact assessment report will also be sent to the Vietnam Development Information Center at 63 Ly Thai To, Hanoi for access by communities and non-governmental organizations
- The English version of the EIA including the EMP report will be submitted to WB for disclosure in the WB Info shop.

After the dissemination of reports in the places mentioned above, the project owner will collect all comments (if any) and consider a reasonable revision if necessary

CHAPTER 8.
ENVIRONMENTAL and SOCIAL MANAGEMENT PLAN (ESMP)

8.1. ORGANIZATION OF ENVIRONMENTAL MANAGEMENT AND RESPONSIBILITY

Environmental management plan (EMP) consists of the set of mitigation, monitoring, and institutional measures to be undertaken during project implementation and operation, in order to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels. EMP also includes the actions needed to implement these measures. The full EMP, which is presented in chapter 8 of the EIA report, has to be a standalone document as it would be eventually attached to the contract of the DBO operator.

The structure of environmental management organization for the project is presented in Figure 8.1.

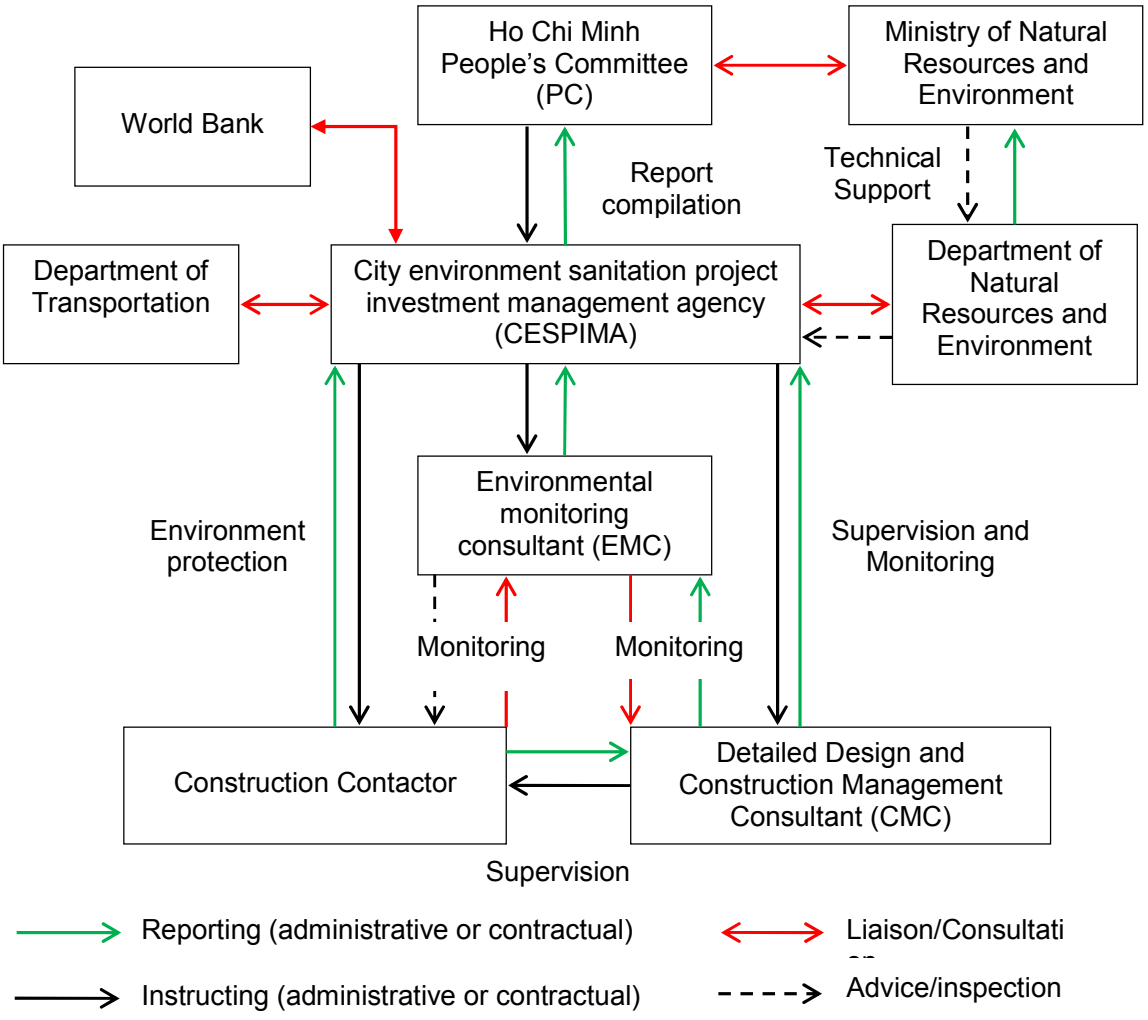

Figure 8.1. The structure of environmental management organization

Responsibilities of agencies, departments during WWTP construction are shown in table 8.1.

Table 8.1. The responsibilities of stakeholders in environmental management system

No.	Organization	Responsibility
1.	Ho Chi Minh City People's Committee (PC)	• Approve the contents of the project, • Play the key role in public environmental management • Make decision that allows the implementation of project
2	Department of Natural Resources and Environment (DONRE)	• Approve environmental impact assessment report of the project; responsible for receiving and investigating the environmental monitoring reports from CESPIMA • Inspect the compliance with the environmental regulations during the project's construction and operation • Certify the completion of environmental protection measures and facilities before going into official operation. • Make recommendations for project owners on the environmental improvement measures
3.	City environment sanitation project investment management agency (CESPIMA) (Project Owner)	• CESPIMA has the overall responsibility for implementing the project in accordance with current regulations and the project documents including the EMP during the detailed design and construction stages. EMP implementation during operation stage is the responsibility of the facilities operators. CESPIMA will set up an Environmental and Social Unit (ESU) to ensure timely and effective implementation of the EMP, including preparation of periodical reports on safeguard compliance as required by Government and WB. • CESPIMA responsible for ensuring that the related sections in the Contract Documents for the detailed design consultant and on the bidding packages for construction items of the project are in compliance with the EMP. • Responsible for coordinating with other organizations in the implementation of EMP including local and national departments especially local DONRE, and the concerned wards/communes, local communities during planning, monitoring, operation, and management. • CESPIMA will coordinate closely with relevant enterprises on water supply, environmental sanitation, and solid waste collection and to monitor operation and maintenance during project implementation. • Directly participate into identify and resolve the related problems and reduce the loss when there are problems • To ensure effective monitoring and timely implementation of the EMP, CESPIMA will hire CMC and environmental monitoring consultant to assist in

		carrying out and monitoring the EMP implementation.
4.	Detail Design Consultant	• Consultancy by designing and offer optimal solutions to mitigate potential environmental impacts during the operation and construction.
5	Construction Management Consultant	• Ensure that the construction process is in accordance with current regulations, the approved EMP, relevant indicators and standardized operation in documents for environmental impact mitigation and monitoring. • Monitoring the process and procedure of basic constructions, technological standards and construction rate of contractors • Monitoring the implementation of environmental mitigation measures by contractors on the daily basis • CMC: also approve the construction method and the site EMP prepared by contractors. • Supervision of construction work including safeguard implementation by contractors on daily basis. • Recommend CESPIMA to suspend partially or completely construction work if labor safety and environmental protection requirements of the contract are not complied with; • Make action plans/urgent solutions to cope with environmental problems, urgent situation and damages happening in construction; • Preparing report on environmental supervision and monitoring as a part of CMC reports. Generally, CMC reports are required monthly; • CMC: responsible for monitoring environmental quality during construction phase
6.	Construction Contractors	• Before construction, the construction contractors are responsible for development of the site EMP (also called site-specific EMP or contractor EMP) as part of their method statement and submit to CMC and CESPIMA for reviewing and approval; • The contractor has to submit a monthly report on safeguard issues, mitigation, and results throughout the construction period. In case of unexpected problem, the contractor will consult CMC/CESPIMA; • Ensure that the construction work will complied with the approved EIA/EMP and the site EMP; • Control and minimize environmental impacts; • Ensure all the construction activities having sufficient license/permits from the related organization; • Implement all the mitigation measures to prevent adverse impacts and protect the environment; • Ensure that all staff and workers understand the procedure and their tasks in the environmental management program;

		• Report to the CESPIMA and CMC about difficulties and their solutions; • Report to stakeholders as having environmental accidents and coordinate to resolve these issues; • Ensure environmental hygiene.
7.	Environmental Monitoring Consultant	• Provide qualified members as their environmental staff and environmental supervisors.- • Quarterly supervise the implementation of mitigation measures by the contractors; • Monitor the project progress indicators related to environmental issues; • Closely work with the Districts and Wards Environmental Officials in the environmental management; • Consultation, assessment and prediction of environmental problems occur during project implementation and propose solutions, monitoring program; • Reporting periodically (every 3 months) to the CESPIMA on the actual EMP performance of the project.- Assess the effectiveness of CESPIMA, CMC, and contractors in implementing EMP requirements; providing proposals and recommendations to the CESPIMA on necessary improvement and supplementation to meet the safeguard requirements; • Assisting the CESPIMA's environmental staff to review and check the related sections in the Contract Documents on the bidding packages for construction items of the project to ensure compliance with environmental protection policies and impact mitigation and monitoring requirements; • Via CESPIMA, discussing with relevant enterprises (if necessary) to find suitable solutions for unexpected risks relating to environmental sanitation; • Responsible for guiding and training on safety and environmental issues for employees and stakeholders. • Carry out environmental quality monitoring during the first year of WWTP operation
8.	Public representatives	• Given the requirements during project implementation, proposals for the project owner.

HCM ESP 2 is classified as Category A project, according to Operational Policy (OP)/Bank Procedure (BP) 4.01: Environmental Assessment (http://go.worldbank.org/OSARUT0MP0). Therefore, a full-scale EIA is required as well as minimum 2 public consultations.

As cited by the Law on Environment Protection, dated November 29, 2005 of the National Assembly and came into effect from July 1, 2006; Decree No. 29/2011/ND-CP dated April 18, 2011 issued by the Government on strategy environment assessment, environmental impact assessment and environment protection commitment; the CESPIMA have to prepare and

submit an EIA report of HCM ESP 2 to the Department of Natural Resources and Environment of Ho Chi Minh City for review and appraisal.

Before the project is put into official operation, CESPIMA will be responsible for construction and application of environmental protection measures and works; undertaking the trial operation of waste treatment facilities and compiling dossiers to request examination and certification of the implementation of environmental protection measures and works for the operation phases of projects submitted to the DONRE of Ho Chi Minh City for getting the certificate (Article 35, Circular 26/2011/TT-BTNMT).

During project pre-construction, construction and first year of operation phases, CESPIMA will be responsible for the implementation of EMP and monitoring programs as a part of the EIA report. As regulated in the Circular 26/2011/TT-BTNMT, frequency of monitoring waste sources is 4 times/year and 2 times/year for monitoring the surrounding environment.

8.2. TRAINING PROGRAM

In phase 1 of this project's the drainage system construction, gaps between environmental protection and occupational safety was shown. Most workers and engineers, those who directly work on the projects, are not conscious about environmental preservation. Therefore, providing knowledge about labor safety; waste collection and treatment; and environmental protection is essential. At the same time, a contract between the investor and contractor (to make sure that knowledge will be provided) needs to be clearly and strictly applied to minimize environmental impacts. Any violation must be immediately punished and not repeated in other construction projects.

For people who have their land at the WWTP construction site, the investor must commit to compensate and support career for affected households.

8.2.1. Environmental education and training program in the construction phase

The training will be conducted by EMC for objects related to the project.

8.2.1.1. Objective

Educating knowledge of environmental protection for workers and related stakeholders (such as suppliers of building materials) to protect the environment during construction and preventing incidents.

8.2.1.2. Implementation contents

Disseminating general regulations to construction workers. (about provisions for solid waste management, sewage, oil pollution collection and disposal; labor safety; and fire prevention).

8.2.1.3. Implementation methods

- The Project Management Unit of the HCMC ES2 project will require the contractor to work on these contents through bidding documents. The winning bidder is required to commit to this program and integrate it into a safety program;
- Disseminating general regulations (about provisions of collection and disposal for solid waste, sewage, oil pollution; labor safety; and fire prevention) to construction workers.

8.2.2. Environmental education and training program for workers in the operation stage

The training will be conducted by operational unit during the operation period.

8.2.2.1. Objectives

- Enhancing knowledge about environmental preservation and health protection for workers and communities, related to the WWTP, in compliance with Environmental Protection Acts and regulations;
- Training workers to operate the wastewater treatment system correctly.

8.2.2.2. Implementation contents

- Disseminating about WWTP regulations on environmental protection; collection system of sludge, solid waste, hazardous waste; and working safety.
- Providing skills of operating wastewater treatment system for each department and officials;
- Creating operational Log for the system of wastewater and sludge treatment.

8.2.2.3. Implementation methods

- Training employees and officials, who work directly in the project, especially the operation team.
- Combining with the consultants for environmental protection plan and requesting for technology transfer and training of operating workers of the project.
- Encouraging officers to attend training courses of environmental agencies.
- Apply policies about rewarding/warning/sanction for environmental protection or environmental risks response activities.

8.3. PUBLIC INFORMATION PROGRAM AND COMMUNITY RELATION

Public and, especially, media reaction have been excessively and increasingly negative towards public services infrastructure projects. This is because the public agencies in Vietnam are generally not well-acquainted with the implementation of large-scale urban infrastructure projects. While lessons have been learned and there have been progresses, there is still much to improve, particularly, public relations mechanism strengthening.

Considering its scale and nature, specifically the potential impacts that could be caused to the urban areas public during the project construction, a Public Information Program (PIP) has been proposed during the construction stage to:

- Inform the public about NL-TN 2 Project's objectives, targets and forthcoming activities (e.g., in road closure, traffic diversion, service interruption, etc.);
- Appeal for cooperation and understanding from the public;
- Entice better public cooperation and support so as to avoid or reduce damage to project properties (equipment vandalism, material theft, hindrance to work); and
- Assure the public that adverse impacts to the environment are minimized through stringent management and control.

It is proposed that the PIP should be a sustained effort in the CESPIMA, possibly handled by professionals engaged specifically for this purpose. Target audiences would include:

- Elected officials and heads of departments and agencies;
- Technical specialists within city/district departments;
- Business leaders, factory managers, trade associations;
- Construction managers and developers;

- Neighborhood groups;
- Schools and other youth activities; and
- Media: newspapers, radio.

The following activities might be considered:

- Prepare and distribute pamphlets during the construction phase of drainage improvements
- Prepare press releases;
- Hold workshops for people in the construction trades;
- Prepare and distribute posters and billboards;
- Make presentations at public events (fairs, trade shows, etc.).
- Organize tours of facilities when they are completed.

8.4. ENVIRONMENTAL MITIGATION MEASURES PLAN[8]

8.4.1. Summarized plan for mitigation measures during three principal project stages

Summarized plan for mitigation measures during three principal phases is shown in Tables 8.2

Table 8.2. Summarized Plan for mitigation measure during pre-construction, construction and operation phases

Issues	Mitigation measures	Vietnamese code/regulation	Execution	Supervision
Detailed design phase				
	Ensure that the detailed design will incorporate to adequately reduce odor, noise impacts during the operation of the WWTP, and to prevent flood and land subsidence at the location of the WWTP		Detailed Design Consultant	CESPIMA, EMC
Pre-construction and construction phase				
Air pollution (noise, vibration and contaminants)	- Construction vehicles must undergo a regular emissions check and get certified with the: "Certificate of conformity from inspection of quality, technical safety and environmental protection" following Decision No. 35/2005/QD-BGTVT; - Do not leave machines running without load; - Maintaining vehicles and equipment daily and every 6 months (or 8.000 km on the road);	- TCVN 6438-2005: Road vehicles. Maximum permitted emission limits of exhaust gas; - Decision No. 35/2005/QD-BGTVT on inspection of quality, technical safety and environmental protection; - QCVN	Contractors	CESPIMA CMC EMC HCM DONRE

[8] To be updated once detailed design is available

	- Do not burn waste on site; - Loaded weight must not exceed the standard limit; - All vehicles must comply with Vietnamese regulations on controlling allowable emission limits of exhaust gases.	05:2013/BTNMT: National technical regulation on ambient air quality; - QCVN 26:2010/BTNMT: National Technical Regulation on Noise.		
Dust generation	- - Covering the transport means to avoid dust, soil and building materials scattering during transportation; - The Contractor shall implement dust suppression measures as required (e.g. watering roads with spraying vehicles, covering of material stockpiles, etc.).	QCVN 05: 2013/BTNMT: National technical regulation on ambient air quality	Contractors	CESPIMA CMC EMC HCM DONRE
Disruption of vegetative cover and ecological resources	- When needed, erect temporary protective fencing to efficiently protect the preserved trees before commencement of any works within the site; or planting trees in buffer zone of the construction site; - The Clearance Plan must be approved by CESPIMA and followed strictly by contractor. Clearing areas should be minimized as much as possible; - The application of chemicals for vegetation clearing is not permitted; - - No area of potential important ecological resource should be disturbed, unless there is prior authorization from the local government. This could include areas of breeding or feeding of birds or animals, fish spawning areas, or any protected green space area;	Law on Environment protection No. 52/2005/QH11	Contractors	CESPIMA CMC EMC HCM DONRE
Domestic wastewater of workers	- Build portable toilets or use temporary toilet in the construction site; - Constructing septic tank; withdraw wastewater and sewage when the	QCVN 14:2008/BTNMT: National technical regulation on domestic wastewater	Contractors	CESPIMA CMC EMC HCM DONRE

	construction is completed; - Wastewater, that exceeds permissible values set by relevant Vietnamese technical standards/regulations, must be collected in a specialtank and removed from site by licensed waste collectors.			
Drainage and sedimentation control	- Periodic dredging sewers; - Ensuring that drainage system would always be maintained; cleared of mud and other obstructions; and periodically check the status of the drainage system; - Not throwing garbage into drains; - Site de-watering and water diversions: In the case that construction activities require work to be carried out within the watercourse (e.g. retaining wall construction, erosion protection works), the work area must be dewatered to provide for construction in dry conditions. - Stream diversions or construction of cofferdams would require site-specific mitigation measures in the EMP; - The Investor would follow all details of the drainage design, which included in the construction plans. This helps to prevent storm water from causing local flooding or scouring slopes and areas of unprotected soil, which is resulted by heavy sediment loads affecting local watercourses.	TCVN 4447:1987: Earth works-Codes for construction; Decree No. 22/2010/TT-BXD on regulation of construction safety; QCVN 08:2008/BTNMT – National technical regulation on quality of surface water.	Contractors	CESPIMA CMC EMC HCM DONRE
Solid Waste Management	- Before construction, a solid waste control procedure must be prepared by Contractors and it must be carefully followed with the construction activities. - Using excavated materials for land leveling;	Decree No. 59/2007/ND-CP on solid waste management	Contractors	CESPIMA CMC EMC HCM DONRE

	-Collecting sand stone, digging materials scattered and clean construction sites daily. Recyclable materials such as wooden plates for trench works, steel, scaffolding material, site holding, packaging material, etc. would be collected and separated on-site from other waste sources for reusing, using as fill, or scrap selling; - Before construction, all necessary waste disposal permits or licenses must be obtained; - Solid waste may be temporarily stored on site at a designated area, which is approved by the local Government, for collection and disposal by a licensed waste collector. In case, if not removed off site, solid waste or construction debris would be disposed only at areas which are identified and approved by the Government; and included in the solid waste plan. the contractor should not dispose any material in environmentally sensitive areas, such as in areas of natural habitants or in watercourses; - Waste storage containers must be covered, tip-proof, weatherproof and scavenger –proof; - No burning, on-site burying or dumping of solid waste shall occur; - Residual sludge from WWTP:A sludge management plan needs to be prepared; contract with the Da Phuoc complex solid waste treatment area in Binh Chanh District to send biological sludge from WWTP to the mentioned area; and produce compost following current regulations;			

	- Residual sludge from interceptor: periodically dredged by sludge suction car every 3-monthtime, contracts with function units which periodically dredged mud and transported to Da Phuoc solid waste treatment complex area to produce compost.			
Chemical or hazardous wastes	- Chemical waste of any kind must be disposed of at an approved appropriate landfill site; and in accordance with local legislative requirements. The Investor need to obtain needed disposal certificates; - Used oil, lubricants, cleaning materials, etc. from the maintenance of vehicles and machinery would be collected in holding tanks and removed from site by a specialized oil recycling company for disposal at an approved hazardous waste site; - Relevant agencies (DONRE, environmental police office and EPA) shall be promptly informed of any accidental spill or incident. Prepare and initiate a remedial action following any spill/ incident. In this case, the contractor would provide a report to explain the reasons for the spill/ incident, remedial action taken, consequences/damage from the spill, and proposed corrective actions; - Proposing open Training programs will prepare workers to recognize and respond to workplace chemical hazards.	Circular No. 12/2011/TT-BTNMT on management of hazardous substance	Contractors	CESPIMA CMC EMC HCM DONRE
Chance findings	If the Contractor discovers archeological sites, historical sites, remains and objects, including graveyards and/or	Law on Cultural Heritage (2002)	Contractors	CESPIMA CMC EMC HCM DONRE

	individual graves during excavation or construction, the Contractor shall: - Stop the construction activities in the area of the chance find; -Delineate the discovered site or area; - Secure the site to prevent any damage or loss of removable objects. - In cases of removable antiquities or sensitive remains, a night guard shall be arranged until the responsible local authorities or the Department of Culture and Information takes over; -Notify the CMC who in turn will notify responsible local or national authorities in charge of the Cultural Property of Viet Nam (within 24 hours or less); - Relevant local or national authorities 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; - 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	Law on Cultural Heritage (2009) for supplementary and reformation		

	archeological importance) conservation, preservation, restoration and salvage; - If the cultural sites and/or relics are of high value and site preservation is recommended by the professionals and required by the cultural relics authority, the Project's Owner will need to make necessary design changes to accommodate the request and preserve the site; -Decisions concerning the management of the finding shall be communicated in writing by relevant authorities; - Construction works could resume only after permission is granted from the responsible local authorities concerning safeguard of the heritage.			
Operation phase				
Outlet discharge	- Regular monitoring the effluent and river quality at the outlet discharge in line with national standards; - Installing warning signs "DISCHARGE LOCATION OF WWTP" at suitable locations; - Reducing the spilling of wastewater - Avoiding soil erosion, land slide by planting vegetation at river banks nearby outlet.	QCVN 14:2008/BTNMT: National technical regulation on domestic wastewater	WWTP Operation Unit	HCM DONRE
Groundwater contamination	- Monitoring and controlling the quality of area groundwater; - Preventing leakage at connections or transitions of the wastewater pipe.	QCVN 09:2008/BTNMT – National technical regulation on quality of ground water	WWTP Operation Unit	HCM DONRE
Operational problems	- Noise pollution reduction measures will be applied. - Monitoring of water quality to evaluate the efficiency of the WWTP operation; - Installing signs to warn	QCVN 08:2008/BTNMT – National technical regulation on quality of surface water.	WWTP Operation Unit	HCM DONRE

	people about the risks of contacting the water bodies; - Noticing by the communication means; - Make daily working records, regularly discharge reports submit to environmental supervising agency; - Have back-up system and restoration ponds if possible, in cases of accidents or operation failure. - Oil and chemical spill prevention and control measures will be applied - Firefighting plan will be prepared and approved by the Fire Fighting Police. - Regular repair and maintenance plan will be implemented			
Odour	- Ensuring the radius of buffer zone at least 300 m. The nearest house is 0.5km far away from the WWTP; - Planting trees in the buffer zone to create landscape and prevent odor dispersion; - Regular maintenance of treatment units; - In the concentrated sewage wells on the sewer line, the emission gas in wells will be suctioned by pump and led through the activity charcoal filter to completely absorb odors air; - Clearance of surroundings of the ponds.	QCVN 06:2009/BTNMT: National technical regulation on organic pollutant in the ambient air.	WWTP Operation Unit	HCM DONRE
Waste from the operation	- A good plan of collection and treatment; - Equipped with about 6 tanks (20 liter) and 1 tank (120 liter) in 2020 and invest more 1 tanks (20 liter) in 2045 at WWTP; - Regular collection of sludge; - Hazardous waste: sanitary packaging, chemical containers	Circular No. 12/2011/TT-BTNMT on management of hazardous substance	WWTP Operation Unit	HCM DONRE

	returned to the supplier as soon as enter the new chemicals stage; - Workers working in pumping station is equipped with earplugs, head phone to reduce noise; - Keeping good personal hygiene.			

8.4.2. Safety, Health, Environment and Transport program

Implementation plan for Safety, Health, Environment and Transport program during pre-construction, construction and operation phases is shown in Table 8.3.

Table 8.3. Implementation plan for Safety, Health, Environment and Transport program during pre-construction, construction and operation phases

Issues	Mitigation measures	Vietnamese code/regulation	Execution	Supervision
Pre-construction and construction phases				
Traffic management	- Streamline traffic and navigation with consultations with local government and community, and traffic police; - Significant increases in number of vehicle trips must be covered in a construction plan previously to be approved. Routing, especially of heavy vehicles, needs to take into account the sensitive sites such as schools, hospitals, and markets; - Avoid transportation during rush hour and arrange transportation instructors at the start and the end position of construction areas to avoid congestion at peak hours; - Installation of necessary lighting at night must be done to ensure safe traffic circulation; - Sign post shall be installed appropriately in both necessary water-ways and roads.	Law on traffic and transportation No. 23/2008/QH12 Law on construction No. 16/2003/QH11 Decree No. 22/2010/TT-BXD on regulation of construction safety	Contractors	CESPIMA CMC EMC

Issues	Mitigation measures	Vietnamese code/regulation	Execution	Supervision
Pre-construction and construction phases				
Health and safety working	- Limit speed at the construction site; - Avoid transportation during rush hours; - Provide temporary passage through the dug trench as needed; - Installation of lighting at night; - Equipping workers with labor safety protection equipment; - Avoid long exposure to waste; - Training workers about occupational safety regulations; - Preparing and implementing action plan to cope with risk and emergency; as well as preparing emergency aid service at the construction site; - Installing fences, barriers, 'dangerous' warning site around the construction area to show potential danger to local public. The contractor would provide safety measures, like installing fences, barriers warning signs, lighting system to avoid traffic accidents, as well as other dangerous risk to people and sensitive areas; - Put signals or warning symbols near the outlets of WWTP	Decree No. 22/2010/TT-BXD on regulation of construction safety Instruction No. 02 /2008/CT-BXD on safety and sanitation issues in construction agencies TCVN 5308-91: Technical regulation on safety in construction Decision No. 96/2008/QD-TTg on clearance	Contractors	CESPIMA CMC EMC
operation phase				
Health and working safety	- Training and providing enough equipment for labour health checks; - Workers working in pumping station is		WWTP Operation Unit	

Issues	Mitigation measures	Vietnamese code/regulation	Execution	Supervision
Pre-construction and construction phases				
	equipped with earplugs, headphones to reduce noise;			

8.4.3. Proposal measures for Sensitive Receptors Protection

The project will be constructed in the area with relatively low population. A sensitive receptor has been surveyed, identified, and divided into 4 types as follows:

- Schools, colleges and kindergartens;
- Religious sites;
- Residential buildings, recreational areas;
- Hotels and restaurants.

The contractor should include in the site-specific EMP details of the plan in order to meet requirements for sensitive receptors. This also includes construction permit application at some intensive security areas. Main aspects are discussed here below:

(1). Schools, colleges and kindergartens:

- Inform and get agreement on the time and duration of work;
- Provide accesses with high safety for children;
- Minimize mechanical works;
- Handle the works with maximum care to minimize the noise and dust.

(2). Religious sites (pagodas/temples and churches...):

- Inform and get agreement on the time and duration of work;
- Provide appropriate accesses;
- Keep the work tidy.

(3). Residential buildings:

- Inform and get agreement on the time and duration of work;
- Provide accesses with high safety for ambulances and patients;
- Minimize mechanical works;
- Handle the works with maximum care to minimize the noise and dust.

(4). Hotels and restaurants, recreation sites:

- Inform and get agreement on the time and duration of work;
- Handle the works with maximum care to minimize the noise and dust;
- Minimize mechanical works.

8.5. ENVIRONMENTAL QUALITY MONITORING PROGRAM

Environmental quality monitoring program for the project during pre-construction, construction and operation phases is shown in Table 8.4.

Table 8.4. Environmental quality monitoring program for the project during pre-construction, construction and operation phases

Content	Parameters	Frequency	Positions	Compared to
Pre-construction and construction phase				
Monitoring of air quality	PM_{10}, noise, NO_x, SO_2, CO.	Once for 6 months	- 2 points at interceptor route building area; - 4 points on the land to build WWTP; - 3 points on the land of D2.	QCVN 05:2009/BTNMT 06:2009/BTNMT, QCVN 26:2010/BTNMT
Monitoring of surface water quality	Temperature, pH, DO, BOD_5, COD, TSS, NH_4^+, Cl^-, NO_3^-, PO_4^{3-}, surfactant, oil and grease, Fecal coliform	Once for 6 months	3 points on Dong Nai River; and 3 points at Sai Gon river: - The surface water at the outlet discharge expected; - The surface water, 500m far from the outlet discharge, the upstream; - The surface water, 500m far from the outlet discharge, the upstream. 3 points in the canal in District 2.	QCVN 08:2008/BTNMT, column B1
Operation phase				
Monitoring of air quality	Temperature, humidity, dust, noise, CO, SO_2, NO_2, NH_3, H_2S, CH_4,	Once for 6 months	8 points: - At water collecting manhole, - At aerobic tank, - At sludge handling area, - At operation house - At gate of WWTP - Thanh My Loi residential of Young Volunteers construction company - Cat Lai port - The handicraft region	QCVN 05:2013/BTNMT, 06:2009/BTNMT, QCVN 26:2010/BTNMT.
Monitoring of surface water quality	Temperature, pH, DO, SS, COD, BOD_5, NH_4^+, Cl^-,	Once for 6 months	3 points on Dong Nai River:	QCVN 08:2008/BTNMT, column B1

Content	Parameters	Frequency	Positions	Compared to
	NO_2-, PO_4^{3-}, Fe, As, surfactant, oil and grease, fecal coliform		- The surface water at the outlet discharge; - The surface water, 500m far from the outlet discharge, the upstream; - The surface water, 500m far from the outlet discharge, the upstream.	
Monitoring of sediment quality	AS, Cd, Cu, Pb, Zn	Once for 6 months	3 points on Dong Nai River (Similar to surface water sampling locations)	QCVN 43:2013/BTNMT
Monitoring of treated waste water	pH, BOD, TDS, TSS, S^{2-}, NO_3^-, $N\text{-}NH_4^+$, PO_4^{3-}, total N, total P, total oil and grease, total surfactant, total coliform.	Once for 3 months	2 points: - Wastewater input; - Wastewater output.	QCVN 14:2008/BTNMT, column A
Monitoring of groundwater quality	pH, hardness, SS, COD, ammonia, Nitrite, Nitrate, Sulfate, Fe, As, Mn, Fecal Coliform	Once for 6 months	Well in the WWTP area.	QCVN 09:2008/BTNMT
Monitoring of sludge quality	pH, Pb, As, Cd, Hg, Al, total Fe, Ni, Cu, Zn, Mn, phenols, total nitrogen, total phosphate, cyanide.	Once for 3 months	At sludge disposal sites	QCVN 50:2013/BTNMT

Table 8.5. Basic cost for chemical analyses (Exchange rate: 1 USD = 21,000 VND)

No.	Sample	Price (VND)	Quantity (Sample)	Total (VND)	Total (USD)
I	**Air sample**				
1	TSP	300,000	68	20,400,000	971
2	CO	300,000	68	20,400,000	971
3	NO2	300,000	68	20,400,000	971
4	SO2	300,000	68	20,400,000	971
5	HC	600,000	68	40,800,000	1,943
6	Noise	100,000	68	6,800,000	324
II	**Waste/ Surface water sample**				
1	Temperature	70,000	65	4,550,000	217
2	pH	70,000	65	4,550,000	217
3	DO	100,000	65	6,500,000	310
4	TSS	100,000	65	6,500,000	310
5	BOD_5	150,000	65	9,750,000	464

6	COD	150,000	65	9,750,000	464
7	NH_4^+	150,000	65	9,750,000	464
8	Cl^-	100,000	65	6,500,000	310
9	NO_3^-	150,000	65	9,750,000	464
10	PO_4^{3-}	150,000	65	9,750,000	464
11	Surfactant	100,000	65	6,500,000	310
12	Oil/Grease	350,000	65	22,750,000	1,083
13	Coliform	150,000	65	9,750,000	464

Table 8.6. Estimated number for soil, water, and air sampling and analysis for environmental monitoring during construction

Construction / Item	Interceptor	WWTP	D2	Other	Total
Total time of Construction (month)	24	42	24		
Total waste/surface water samples	12	21	12	20	**65**
Total air samples	8	28	12	20	**68**

Table 8.7. Estimated cost for samples collection and analysis

No	Content	Unit	Quantity	Price (VND)	Total (VND)	Total USD)
1	Water sample	Sample	65	1,790,000	116,350,000	5,540
3	Air sample	Sample	68	1,900,000	129,200,000	6,152
4	Others			84.000,000	-	4,000
Total					**329,550,000**	**15,693**
Total cost (after being rounded-up)						**16,000**

8.6. ENVIRONMENTAL REPORTING

The Project Environmental Performance Reporting System (PEPRS) Manual will be prepared by EMC, as a guide for contractors, construction monitoring consultant, CESPIMA to report to the DONRE of Ho Chi Minh City and World Bank.

The reporting system includes:

- During the construction, CMC will supervise construction work including safeguard implementation by contractors on daily basis. Thus, the CMC should prepare report on environmental supervision and monitoring as a part of CMC reports. Generally, CMC reports are required monthly. The CMC report on environmental safeguard implementation will also include the environmental quality monitoring results.
- EMC will carry out quarterly monitoring and prepare reports on the effectiveness of EMP implementation to send to CESPIMA. Based on that, the EMC will assist the CESPIMA to prepare the biannual environmental monitoring report for submission to the local DONRE and the World Bank prior to the Bank's implementation support mission. The report will cover monitoring results, environmental quality by the CMC and the assessment safeguard compliance including the effectiveness of CESPIMA, detailed design consultant, CMC, and contractors in implementing EMP.

A Final Report at the end of the construction phase by EMC will summarize the completed environmental monitoring and provide recommendations for continuous monitoring in operation phase.

8.7. COST ESTIMATION FOR ENVIRONMENTAL MANAGEMENT PROGRAM AND MONITORING

A summary of the budgets for recommended environmental management, mitigation and monitoring measures presented for each of the following key EMP implementation activities:

- Implement mitigation measures;
- Environmental training;
- Environmental monitoring cost during construction and operation cost of project.

Estimated Budget for EMP Implementation (in USD) is presented in Table 8.8.

Table 8.8. Estimated Budget for EMP Implementation

No.	Description	Cost(USD)	Source ofBudget
1	Environmental Safeguard Unit (ESU) of CESPIMA	80,000	Counterpart fund
2	Implementation of Mitigation Measures (per year)	Part of construction contracts and contract for detailed design consultancy	WB
3	Environmental Training during construction (per year)	Part of EMC cost	WB
4	Environmental Monitoring Consultant (EMC)	220,000	WB
5	Supervision of safeguard during construction	Part of CMC cost	WB
6	Environmental quality monitoring during construction	Part of CMC cost	WB
7	Environmental quality Monitoring during operation NLTN WWTP (per year)	20,000	Operation cost
8	Environmental Training during Operation (per year)	20,000	Operation cost

CONCLUSION

(1). The interceptor and WWTP are designed and constructed in the locations same as planed in the Master Plan of HCMC. The areas where the project develops are relatively favorable for land clearance. The area acquired for the construction of the wastewater treatment plant is being fallowed, no livelihood activities and not economic development.

(2). The construction stage of the project will cause certain temporary negative impacts on local socio-economic and environmental conditions unless adequate measures are implemented to prevent, control and handle emerging issues. Specific impacts include:

- Land acquisition and resettlement would disturb the lives of local residents in the project area, especially in households targeted for relocation and resettlement;
- The project may cause of air pollution in the area due to dust, emissions, noise and vibration from construction activities;
- Ground leveling and digging may cause local inundations;
- The project may cause environmental pollution due to discharged solid wastes during construction and operation stages;
- The project may obstruct movement of the people.

(3). During construction and operation, the project owner commits to apply the site-specific measures for mitigation of negative impacts in order to meet Vietnamese standards and regulations and applicable Bank safeguard policies.

(4). The Project owner shall apply all measures stated in the SEIA to prevent, mitigate, and deal with accidents. Workers shall be trained to enhance managerial capabilities, ensure operational safety and effectively, and control environmental pollution. The Project will bear responsibility for any breach of Vietnamese law.

(5). The Project Owner will coordinate with authorities during the construction and operation stages of the project to fully implement pollution control and harmful environmental impacts mitigation measures, and to prevent environmental incidents.

APPENDICES

APPENDIX I:
ENVIRONMENTAL IMPACT ASSESSMENT PERSONNEL

No	Full name	Unit	Position
01	Helen Cochrane	Meinhardt (Singapore) Ltd	Lead Consultant – Environmental Expert
02	Arsad Hossain	Meinhardt (Singapore) Ltd	Sanitation Expert
03	Tim Hendriks	Meinhardt (Singapore) Ltd	Authorized representative
04	Van Viet	Meinhardt (Singapore) Ltd	Expert
05	Pham Mai Duy Thong	Meinhardt (Singapore) Ltd	Expert
06	Le Thanh Trang	Meinhardt (Singapore) Ltd	Expert
07	Do Ngoc Anh Dung	Meinhardt (Singapore) Ltd	Expert

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APPENDIX III
METEORO-HYDROLOGCAL CONDITIONS

Table III.1. Monthly Average Temperature (^{0}C)

Year	Month												Yearly average
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2005	26,2	27,7	28,4	29,8	29,7	28,9	27,5	28,4	27,9	27,6	27,5	262	28,0
2006	27,2	28,2	28,6	29,5	29,2	28,4	27,9	27,6	27,6	27,7	28,9	27,3	28,2
2007	27,3	27,2	28,8	30,1	28,9	28,7	27,7	27,7	27,7	27,5	26,9	27,6	28,2
2008	27,2	27,3	28,2	29,5	28,2	28,6	28,3	27,7	27,7	28,0	27,2	26,9	27,9
2009	25,9	27,7	29,3	29,4	28,5	29,2	28,0	28,6	27,6	27,7	28,4	27,5	28,1
2010	27,3	28,4	29,4	30,3	31,3	29,3	28,3	27,9	28,6	27,5	27,2	27,4	28,6
2011	26,9	27,6	28,3	29,1	29,5	28,5	27,9	28,4	28,1	28,1	28,1	27,2	28,1
2012	26,7	27,5	28,7	29,3	29,1	28,2	27,5	28,8	28,4	28,3	28,5	27,3	28,2

Source: Ho Chi Minh City Statistical Yearbook 2012, Tan Son Hoa Station

Table III.2. Monthly average sunshine hours in Ho Chi Minh City

Year	Month												Yearly average
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2005	164.8	215.3	252.9	225.6	200.4	185.6	153.1	178.1	142.2	138.8	124.6	90.5	2,071.9
2006	131.0	157.7	221.6	213.4	208.7	161.5	140.2	157.2	141.4	127.2	142.1	121.2	1,923.9
2007	113.3	193.6	229.5	213.5	182.5	128.0	147.7	135.8	130.8	1470	127.5	141.8	1,891.1
2008	156.3	135.6	216.7	188.3	165.7	172.8	218.7	161.0	142.6	152.4	145.4	134.1	1,989.6
2009	174.4	168.1	236.9	186.7	155.9	191.6	149.2	155.7	116.9	132.3	147.7	187.6	2,003.2
2010	157.1	245.3	239.6	240.8	210.4	177.0	150.0	141.2	155.2	102.7	130.6	123.8	2,073.7
2011	120.1	188.9	157.8	187.0	165.0	163.6	162.6	198.1	144.8	154.3	141.0	109.7	1,892.9
2012	130.3	205.7	215.2	222.2	178.5	193.2	168.1	184.3	154.7	134.5	131.4	112.5	2,030.6

Source: Ho Chi Minh City Statistical Yearbook 2012, Tan Son Hoa Station

Table III.3. Monthly Average Humidity in Ho Chi Minh City (%)

Year	Month												Yearly average
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2005	69	69	67	70	74	77	81	78	80	82	79	77	75
2006	73	68	71	73	75	81	81	82	81	81	75	73	76
2007	69	68	71	69	80	80	83	82	83	82	76	72	76
2008	71	69	71	73	81	78	79	83	83	81	79	73	77
2009	70	73	71	76	81	77	79	80	83	80	73	74	76
2010	71	70	68	70	70	76	79	80	76	79	80	73	74
2011	70	68	67	70	75	77	79	80	81	80	77	70	75
2012	72	69	71	72	74	73	79	82	80	83	78	71	75

Source: Ho Chi Minh City Statistical Yearbook 2012, Tan Son Hoa Station

Table III.4. Monthly Average Rainfall in Ho Chi Minh City

Unit: mm

Year	Month												Yearly average
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2005	-	-	-	9.6	143.6	273.9	228.0	146.3	182.9	388.6	264.5	105.4	1,742.8
2006	-	72.7	8.6	212.1	299.2	139.4	168.6	349.0	247.7	256.1	16.1	28.9	1,798.4
2007	0.4	-	59.3	7.7	327.9	188.8	414.3	301.0	495.4	391.2	147.1	7.1	2,340.2
2008	9.5	1.5	58.9	127.0	246.9	147.2	331.2	297.8	202.6	165.6	167.1	57.8	1,813.1
2009	0.3	21.4	57.8	187.0	318.5	83.2	223.0	323.9	325.1	249.0	141.2	49.5	1,979.9
2010	23.0	-	3.9	9.9	8.8	160.0	294.3	400.6	373.7	321.8	379.9	40.3	2,016.2
2011	9.4	-	40.3	181.9	124.4	213.1	281.5	244.4	232.1	232.6	321.1	73.0	1,953.8
2012	8.4	-	41.3	167.9	224.4	243.1	284.5	246.4	322.1	275.6	341.1	75.1	2,229.9

Source: Ho Chi Minh city Statistical Yearbook 2012, Tan Son Hoa Station

Table III.5. Monthly Average Wind Speed in Tan Son Hoa Station

Year	Month												Yearly average
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Wind speed (m/s)	2.5	2.8	3.2	3.2	2.7	3.1	3.2	3.3	2.9	2.5	2.3	2.3	2.8
Wind direction	NE	SE	SE	SE	S	SW	SW	WSW	W	W	N	N	

Source: Ho Chi Minh city Statistical Yearbook 2012, Tan Son Hoa Station

Table III.6. The lowest monthly average water level of the Saigon River

Year	Month Unit: m)											
	I	II	III	IV	V	IV	VII	VIII	IX	X	XI	XII
2005	-1.94	-2.12	-1.80	-2.10	-2.28	-2.50	-2.56	-2.39	-2.18	-1.72	-1.86	-1.83
2006	-1.86	-1.70	-1.92	-1.82	-2.11	-2.38	-2.48	-2.40	-2.23	-1.83	-1.97	-1.80
2007	-1.83	-2.06	-1.87	-1.90	-2.10	-2.37	-2.46	-2.33	-1.97	-1.74	-1.74	-1.88
2008	-1.83	-1.70	-1.80	-1.92	-2.08	-2.27	-2.33	-2.06	-2.20	-1.64	-1.72	-1.72
2009	-1.65	-1.80	-1.78	-1.80	-2.06	-2.27	-2.21	-2.13	-1.80	-1.80	-1.63	-1.80
2010	-1.75	-1.94	-1.66	-1.63	-2.06	-2.11	-2.22	-2.18	-1.99	-1.71	-1.61	-1.65
2011	-1.70	-1.47	-1.45	-1.77	-2.05	-2.27	-2.16	-2.11	- 1.91	-1.69	-1.52	-1.47
2012	-1.72	-1.56	-1.42	-1.73	-2.07	-2.25	-2.23	-2.15	- 1.93	-1.67	-1.55	-1.45

Source: Ho Chi Minh city Statistical Yearbook 2012, Phu An Station

Table III.7. The highest monthly average water level of the Saigon River

Unit: m

Year	Month											
	I	II	III	IV	V	IV	VII	VIII	IX	X	XI	XII
2005	1.42	1.32	1.13	1.13	0.99	1.03	1.04	1.17	1.33	1.39	1.41	1.35
2006	1.39	1.35	1.41	1.19	1.13	1.02	0.99	1.16	1.32	1.42	1.47	1.44
2007	1.29	1.21	1.37	1.21	1.30	1.09	1.03	1.35	1.45	1.49	1.48	1.39
2008	1.41	1.43	1.37	1.28	1.25	1.23	1.16	1.27	1.32	1.48	1.54	1.55
2009	1.54	1.43	1.39	1.37	1.26	1.17	1.28	1.37	1.37	1.42	1.56	1.46
2010	1.47	1.44	1.42	1.32	1.29	1.18	1.25	1.35	1.35	1.49	1.55	1.49
2011	1.45	1.47	1.40	1.29	1.19	1.12	1.13	1.34	1.50	1.57	1.58	1.59
2012	1.48	1.47	1.42	1.30	1.21	1.16	1.14	1.37	1.51	1.57	1.56	1.57

Source: Ho Chi Minh city Statistical Yearbook 2012, Phu An Station

APPENDIX IV
SAMPLING POINTS AND ANALYTICAL DATA

Table IV.1. The analyzed results of the ambient air quality

Parameter	Unit	Sample symbol															QCVN 05:2009/BTNMT
		K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14	K15	
Temperature	^{0}C	32.68	32.6	32.1	32.1	32.3	31.5	31.2	31.2	31.4	31.2	31.5	29.5	28.9	29.3	29.8	-
Humidity	%	67.72	68.2	68.6	68.4	68.9	68.5	65.4	66.5	68.7	67.5	69.8	72.3	72.8	72.5	72.3	-
Wind speed	m/s	0.25	1.2	0.85	0.73	0.76	0.6	1.2	1.12	1.15	0.8	0.76	1.18	0.65	1.2	0.91	-
SPM	µg/m^3	103	124	195	124	113	154	184	121	127	138	115	121	114	114	102	300
SO_2	µg/m^3	32	26	37	31	34	32	29	31	27	31	38	28	26	32	34	350
NO_X	µg/m^3	93	78	89	92	95	95	65	67	71	76	74	79	87	85	89	200
CO	µg/m^3	3.394	3.485	3.412	3.845	3.741	3.754	3.451	3.327	3.211	3.184	3.175	3.184	3.124	3.754	3.414	30000
NH_3	µg/m^3	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND	ND	200 (*)
H_2S	µg/m^3	-	-	-	-	-	-	-	-	-	-	-	ND	ND	ND	ND	42 (*)
Noise	dBA	58.7	59.3	57.4	56.9	57.7	54.8	65.7	67.5	69.4	67.9	58.7	55.6	59.4	55.7	67.5	70 (**)
Vibration	mm/s	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	75 (***)

Note:

- ND: Not detectable
- QCVN 05:2009/BTNMT: National Technical Regulation on Ambient Air Quality
- (*) QCVN 06:2009/BTNMT: National Technical Regulation on some toxic air pollutants
- (**) QCVN 26:2010/BTNMT: National Technical Regulation on Noise level
- (***) QCVN 27:2010/BTNMT: National Technical Regulation on Vibration

Table IV.2. The air sampling points in the project area

Code	Sample location	Longitude	Latitude
KK1	Adjacent to Luong Dinh Cua road, surrounding residential area being cleared and relocated.	106°42'58.08"	10°46'41.07"
KK2	On interceptor area, option A1	106°43'26.22"	10°47'2.35"
KK3	On interceptor area, option A1	106°43'43.00"	10°47'20.55"
KK4	In interceptor construction area- option A2	106°43'46.73"	10°46'53.81"
KK5	In interceptor construction area- option A2, near Luong Dinh Cua street	106°44'5.18"	10°47'13.67"
KK6	On interceptor area-option A3	106°43'36.18"	10°46'36.02"
KK7	On interceptor area-option A3	106°44'1.21"	10°46'49.93"
KK8	On interceptor area-option B1	106°44'21.58"	10°47'1.98"
KK9	On interceptor area-option B2	106°44'48.35"	10°47'11.99"
KK10	On the general interceptor area leading to treatment station, located near the Saigon River, in front of Thanh My Loi Ward People's Committee	106°45'19.61"	10°46'22.44"
KK11	On the general interceptor area leading to WWTP near to Saigon Riverside, in Thanh My Loi residential area.	106°45'26.52"	10°45'48.32"
KK12	On the WWTP area, located in the project area, besides Cat Lai Industrial Zone, toward to Phu My Bridge.	106°45'39.51"	10°45'10.37"
KK13	On the WWTP area, located in the project area, besides Cat Lai Industrial Zone, in front of Phu My Bridge	106°45'25.48"	10°45'5.51"
KK14	On the WWTP area, located in the project area, besides Cat Lai Industrial Zone, in front of Phu My Bridge	106°45'30.87"	10°45'1.50"
KK15	On the WWTP area, located in the project area, besides Cat Lai Industrial Zone, in front of Phu My Bridge	106°45'34.43"	10°45'14.51"

Table IV.3. The analyzed results of surface water quality in the project area (Shifting tide)

Parameter	Unit	Sample symbol										QCVN 08:2008/BTNMT. column A2
		NM1	NM2	NM3	NM4	NM5	NM6	NM7	NM8	NM9	NM10	
Temperature	^{o}C	30.3	30.3	30.4	30.4	30.4	30.4	30.4	30.5	30.3	30.3	-
pH	-	6.72	6.49	6.52	6.61	6.48	6.48	6.61	6.40	6.49	6.50	6 – 8.5
DO	mg/l	1.15	0.77	0.71	0.55	1.12	0.75	2.4	2.18	0.6	2.5	≥5
COD	mg/l	40	17	19	27	19	20	26	24	20	12	15

BOD	mg/l	21	9	9	13	10	11	13	13	11	7	6
TSS	mg/l	36	28	24	25	27	25	31	29	24	27	30
$N\text{-}NH_4^+$	mg/l	2.26	1.31	1.12	1.72	ND (<0.1)	0.73	ND (<0.1)	ND (<0.1)	0.37	0.84	0.2
$N\text{-}NO_2^-$	mg/l	0.04	0.06	0.07	0.09	0.09	0.11	ND (<0.01)	0.01	0.06	0.04	0.02
$N\text{-}NO_3^-$	mg/l	4.06	3.09	1.98	3.82	3.18	3.27	1.66	3.22	2.87	4.01	5
$P\text{-}PO_4^{3-}$	mg/l	0.16	0.13	0.18	0.16	0.26	0.14	0.23	0.15	0.14	0.14	0.2
Cl^-	mg/l	90	90	220	165	105	200	115	625	135	95	400
As	mg/l	ND (<0.001)	0.013	ND (<0.001)	0.022	ND (<0.001)	0.021	0.011	0.018	0.025	ND (<0.001)	0.02
Cd	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.005
Pb	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND	0.02
Cr3+	mg/l	ND	ND	ND	ND	ND	ND	0.002	ND	ND	ND (<0.01)	0.1
Cr6+	mg/l	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.001)	0.02
Cu	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.2
Zn	mg/l	ND (<0.001)	0.006	0.003	0.005	0.016	0.029	0.037	ND (<0.001)	0.006	ND (<0.001)	1.0
Ni	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.1
Fe	mg/l	1.53	2.44	2.21	2.44	1.01	2.24	4.05	3.85	2.06	0.62	1
Hg	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.001
Oil and grease	mg/l	0.24	ND (<0.01)	0.14	0.17	0.13	0.13	0.16	0.14	0.13	ND (<0.01)	0.02
Coliforms	MPN/ 100ml	7.5×10^5	7×10^3	1.2×10^3	9.3×10^3	3×10^3	4×10^3	6×10^4	1.2×10^4	1.5×10^3	2.1×10^3	5000

Table IV.3. (Cont.) (Shifting tide)

Parameter	Unit	Sample symbol										QCVN 08:2008/BTNMT. column A2
		NM11	NM12	NM13	NM14	NM15	NM16	NM17	NM18	NM19	NM20	
Temperature	^oC	30.3	30.3	30.3	30.3	30.3	30.3	30.4	30.4	30.5	30.3	-
pH	-	6.64	6.49	7.07	6.91	6.47	6.55	6.52	6.44	6.46	6.75	6 – 8.5
DO	mg/l	0.77	1.0	2.12	0.38	0.47	1.07	0.57	2.74	2.3	1.92	≥5
COD	mg/l	17	18	17	19	18	20	26	13	18	33	15
BOD	mg/l	8	10	8	9	10	10	14	6	9	17	6
TSS	mg/l	26	31	25	28	25	35	31	25	27	23	30
$N\text{-}NH_4^+$	mg/l	2.22	0.37	2.03	1.87	ND (<0.1)	1.70	1.49	ND (<0.1)	ND (<0.1)	ND (<0.1)	0.2
$N\text{-}NO_2^-$	mg/l	0.04	0.06	0.05	0.06	0.10	0.06	0.08	ND (<0.01)	ND (<0.01)	ND (<0.01)	0.02
$N\text{-}NO_3^-$	mg/l	2.97	2.24	3.81	3.48	3.16	4.05	2.83	2.94	3.06	1.33	5
$P\text{-}PO_4^{3-}$	mg/l	0.12	0.12	0.16	0.18	0.14	0.14	0.15	0.12	0.16	0.22	0.2
Cl^-	mg/l	100	470	105	125	125	160	200	85	335	495	400
As	mg/l	ND (<0.001)	ND (<0.001)	0.027	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.009	ND (<0.001)	0.018	ND (<0.001)	0.02
Cd	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.005
Pb	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.02
Cr3+	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.035	0.1
Cr6+	mg/l	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	0.02
Cu	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.2
Zn	mg/l	0.003	0.002	0.005	0.010	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.015	0.009	0.030	1.0
Ni	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.1
Fe	mg/l	1.34	1.18	0.97	1.82	1.66	2.66	1.52	3.40	4.03	3.04	1
Hg	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.001
Oil and	mg/l	0.11	ND	0.12	0.14	ND	0.19	0.17	ND	0.12	0.20	0.02

Parameter	Unit	Sample symbol										QCVN 08:2008/BTNMT. column A2
		NM11	NM12	NM13	NM14	NM15	NM16	NM17	NM18	NM19	NM20	
grease			(<0.01)			(<0.01)			(<0.01)			
Coliforms	MPN/100ml	4×10^3	9×10^3	30	1.2×10^3	6×10^3	3×10^3	5.3×10^3	2×10^3	1.2×10^3	2.1×10^4	5000

Table IV.3. (Cont.) (Rising tide)

Parameter	Unit	Sample symbol										QCVN 08:2008 / BTNMT A2
		NM1	NM2	NM3	NM4	NM5	NM6	NM7	NM8	NM9	NM10	
Temperature	°C	29.3	29.3	29.5	30.1	19.3	29.7	29.7	29.8	29.8	29.6	-
pH	-	6.42	6.45	6.43	6.25	6.40	6.31	6.43	6.32	6.15	6.20	6 – 8.5
DO	mg/l	0.43	1.35	1.0	2.02	0.74	3.23	2.15	2.35	1.98	1.65	≥5
COD	mg/l	18	14	16	22	9	15	18	23	19	10	15
BOD	mg/l	10	8	9	11	5	8	10	12	11	6	6
TSS	mg/l	36	27	29	26	28	29	29	33	37	28	30
$N\text{-}NH_4^+$	mg/l	0.75	0.73	0.20	0.80	ND (<0.1)	ND(<0.1)	0.17	ND (<0.1)	0.19	0.73	0.2
$N\text{-}NO_2^-$	mg/l	0.06	0.08	0.11	0.04	0.09	0.03	ND(<0.01)	ND<0.01)	0.035	0.04	0.02
$N\text{-}NO_3^-$	mg/l	2.10	2.76	2.70	2.60	2.05	3.45	1.79	3.02	2.78	3.25	5
$P\text{-}PO_4^{3-}$	mg/l	0.13	0.14	0.15	0.12	0.13	0.10	0.10	0.05	0.12	0.13	0.2
Cl^-	mg/l	165	170	190	350	180	439	175	475	360	145	400
As	mg/l	ND (<0.001)	0.012	ND (<0.001)	0.018	0.008	ND (<0.001)	0.020	0.012	0.018	ND (<0.001)	0.02
Cd	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.005
Pb	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.02
Cr3+	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1
Cr6+	mg/l	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	0.02
Cu	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2

Parameter	Unit	Sample symbol										QCVN 08:2008 / BTNMT A2
		NM1	NM2	NM3	NM4	NM5	NM6	NM7	NM8	NM9	NM10	
		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	
Zn	mg/l	ND (<0.001)	0.003	0.012	0.002	0.009	ND (<0.001)	0.030	ND (<0.001)	ND (<0.001)	ND (<0.001)	1
Ni	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.1
Fe	mg/l	2.98	2.94	2.50	2.10	3.03	2.28	1.27	1.10	2.75	2.56	1
Hg	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.001
Oil and grease	mg/l	ND (<0.01)	ND (<0.01)	0.13	0.14	ND (<0.01)	ND (<0.01)	0.17	0.16	ND (<0.01)	ND (<0.01)	0.02
Coliforms	MPN/100ml	3.4×10^3	3×10^3	2.5×10^3	5×10^3	2.7×10^3	4.2×10^3	3×10^4	2.4×10^4	2.5×10^3	3×10^3	5000

Table IV.3. (Cont) (Rising tide)

Parameter	Unit	Sample symbol										QCVN 08:2008/ BTNMT. column A2
		NM11	NM12	NM13	NM14	NM15	NM16	NM17	NM18	NM19	NM20	
Temperature	^oC	19.8	29.5	29.4	29.5	29.8	29.8	30.1	29.9	29.8	29.7	-
pH	-	6.39	6.34	6.62	6.36	6.29	6.19	5.86	6.42	6.36	6.44	6 – 8.5
DO	mg/l	0.76	1.76	1.55	1.98	2.02	3.02	2.35	2.22	2.37	2.36	≥5
COD	mg/l	9	13	17	13	18	22	20	20	16	32	15
BOD	mg/l	6	7	9	7	10	12	11	11	10	17	6
TSS	mg/l	27	34	33	29	36	27	25	30	34	36	30
$N\text{-}NH_4^+$	mg/l	2.02	ND	ND	ND	ND (<0.1)	ND (<0.1)	ND (<0.1)	0.19	ND (<0.1)	ND	0.2
$N\text{-}NO_2^-$	mg/l	0.03	0.12	0.07	0.04	0.04	0.03	0.03	ND	ND	ND	0.02
$N\text{-}NO_3^-$	mg/l	1.89	3.20	2.68	4.02	3.67	2.74	2.57	1.89	2.94	2.96	5
$P\text{-}PO_4^{3-}$	mg/l	0.09	0.13	0.16	0.13	0.13	0.11	0.12	0.09	0.06	0.08	0.2
Cl^-	mg/l	175	220	233	313	380	435	333	164	450	568	400

Parameter	Unit	Sample symbol										QCVN 08:2008/ BTNMT. column A2
		NM11	NM12	NM13	NM14	NM15	NM16	NM17	NM18	NM19	NM20	
As	mg/l	ND (<0.001)	0.023	0.024	0.006	0.020	ND (<0.001)	ND (<0.001)	0.027	0.014	0.016	0.02
Cd	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Pb	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.02
Cr3+	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1
Cr6+	mg/l	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	0.02
Cu	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.2
Zn	mg/l	ND (<0.001)	0.005	ND (<0.001)	0.011	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.036	ND (<0.001)	ND (<0.001)	1
Ni	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.1
Fe	mg/l	2.94	2.46	1.69	2.69	2.73	1.08	1.37	1.23	1.21	0.96	1
Hg	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.001
Oil and grease	mg/l	0.13	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	0.16	0.13	0.15	0.14	0.22	0.02
Coliforms	MPN/100ml	3.6×10^3	2.3×10^3	3.9×10^3	1.5×10^3	9×10^3	5.3×10^3	7×10^3	4×10^3	2.4×10^3	4×10^4	5000

Note: - ND: Not detectable

Table IV.4. Surface water sampling locations on the Sai Gon - Dong Nai River

Code	Location	Longitude	Latitude
NM1	Left bank canal (near pump station), under Sai Gon bridge	106°42’46,7’’	10°47’14,8’’
NM2	Ben Nghe canal (the preventing stream work)	106°42’26,5’’	10°46’07,5’’
NM3	Te channel	106°43’15,8’’	10°45’26’’
NM4	Right bank, Giong Ong To canal	106°44'44,60"	10°46'47,69"
NM5	Right bank canal	106°42’44,8’’	10°46’53’’
NM6	Canal, foot of the Phu My bridge	106°44’31,6’’	10°44’39,6’’
NM7	Nha Be river	106°47’24,0’’	10°45’05,0’’
NM8	Right bank, near Phu Xuan bridge	106°44'47,78"	10°42'12,37"
NM9	Big Catfish canal	106°44’06,2’’	10°46’40,0’’
NM10	Foot of the Sai Gon bridge	106°43'35,60"	10°47'54,87"
NM11	Near Ba Son port	106°42’36,8’’	10°46’48,7’’
NM12	Near Nha Rong port	106°42’45’’	10°45’49,6’’
NM13	Near Tan Thuan bridge	106°43’27,1’’	10°45’36,2’’
NM14	Near Small Catfish canal	106°44’01,7’’	10°46’15,3’’
NM15	Near to Container port (Tan Thuan port)	106°44’16,2’’	10°46’40,4’’
NM16	Middle stream, Giong Ong To canal upstream	106°44’37,1’’	10°46’38,6’’
NM17	Near to Tan Thuan Export Processing Zone	106°45’04,4’’	10°45’30,3’’
NM18	Middle stream, Cat Lai ferry upstream	106°47’20’’	10°45’10,5’’
NM19	Middle stream, near Petrol depot B - left bank	106°45’17,3’’	10°41’50,6’’
NM20	Middle stream, nearby 67	106°44’57,0’’	10°42’49,9’’

Table IV.5. The analyzed results of surface water quality in the project area

Parameter	Unit	Sample symbol										QCVN08:2008/BTNMT Column A2
		NM 21	NM 22	NM 23	NM 24	NM 25	NM 26	NM 27	NM 28	NM 29	NM 30	
pH	-	6.13	5.66	5.90	6.00	6.41	6.04	6.23	6.35	6.61	6.57	6 – 8.5
DO	mg/l	2.30	2.10	1.30	1.02	0.52	1.2	0.82	1.20	0.80	1.10	≥ 5
COD	mg/l	26	25	26	30	21	19	20	30	24	22	15
BOD_5	mg/l	11	10	10	13	8	7	8	14	10	9	6
TSS	mg/l	21	33	27	35	27	17	26	23	22	18	30
$N\text{-}NO_2^-$	mg/l	0.14	0.19	0.09	0.056	0.21	0.02	0.01	0.02	0.01	0.01	0.02
$N\text{-}NO_3^-$	mg/l	0.60	1.20	2.34	1.98	1.37	1.99	1.77	1.64	1.54	1.23	5
$N\text{-}NH_4^+$	mg/l	4.72	1.29	3.51	ND (<0.1)	ND (<0.1)	1.75	1.27	0.75	1.34	1.04	0.2
$P\text{-}PO_4^{3-}$	mg/l	0.22	0.32	0.36	0.16	0.14	0.06	0.08	0.10	0.07	0.01	0.2
Cl^-	mg/l	128	152	237	315	268	697	826	789	168	144	400
As	mg/l	0.119	0.196	ND (<0.001)	ND (<0.001)	0.004	0.082	0.060	0.015	0.005	ND (<0.001)	0.02
Ni	mg/l	0.118	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.1
Fe	mg/l	2.93	1.16	1.12	3.93	2.59	1.99	1.20	2.84	1.05	1.11	1
Zn	mg/l	0.129	0.046	0.036	0.027	0.040	0.016	0.024	0.031	0.014	0.021	1
Cu	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.2
Cd	mg/l	0.005	0.005	0.004	0.004	0.004	0.005	0.006	0.005	0.007	0.005	0.005
Pb	mg/l	0.003	0.004	0.026	0.003	0.016	0.009	0.004	0.028	0.005	0.009	0.02
Cr^{3+}	mg/l	0.046	0.020	0.008	0.011	0.012	0.005	0.004	0.010	0.010	0.014	0.1
Cr^{6+}	mg/l	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	0.02
Hg	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.001
Oil and grease	mg/l	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	0.02
Coliforms	MPN/100ml	$3x10^3$	$1.7x10^3$	3.9×10^4	9×10^3	4.3×10^3	2.4×10^3	1.2×10^4	2.3×10^4	2.4×10^3	2.1×10^3	5000

Note: - ND: Not detectable (ND <0.001)
QCVN 08:2008/BTNMT: National Technical Regulation on Surface Water Quality

Table IV.6. The surface water sample locations in the project area

Ode	Position	Longitude	Latitude
NM 21	Small canal, near to Bac Nhieu Loc bridge, District 2.	106°43'30.83"	10°47'12.67"
NM 22	Surface water of canal which near to the interceptor option A. near to Luong Dinh Cua road.	106°43'31.41"	10°46'58.97"
NM 23	Surface water at canal near to the intersection of two interceptors: option A and option B. Near to Binh Khanh shrine (about 150m), in distance of 90 m from Luong Dinh Cua street	106°43'57.2"	10°47'09.03"
NM 24	Surface water of the area, which belong to interceptor B1.	106°44'32.46"	10°46'49.59"
NM 25	Small canal which through to Giong Ong To river, near to option B1.	106°44'53.23"	10°46'44.21"
NM 26	At canal, Thanh My Loi ward, near to option C.	106°45'27.70"	10°46'10.80"
NM 27	Region of Ky Ha 4 bridge.	106°45'33.33"	10°45'13.86"
NM 28	Surface water at region for building balance lake.	106°45'34.85"	10°45'6.79"
NM 29	The expected location discharge of the treatment plant.	106°45'35.94"	10°44'57.43"
NM 30	The expected location to discharge of treatment station. Position is in the project area,	106°45'40.06"	10°44'57.79"

Table IV.7. Monitoring Results of the Sai Gon River Water Quality

Parameter	Period	Time	NM1-SG	NM2-SG	NM3-SG	NM4-SG	Tidal condition	QCVN 08:2008 (B2)
pH	Background	1	7.1	7.2	7.1	7.0	Low tide	5.5-9.0
		2	7.1	7.1	7.0	7.1	Rising tide	
	June/ 2012	1	6.6	6.4	6.4	6.6	Low tide	
		2	6.5	6.6	6.6	6.7	Rising tide	
	March/2013	1	6.6	6.6	6.6	6.6	Low tide	
		2	6.5	6.5	6.5	6.5	Rising tide	
TSS (mg/l)	Background	1	133	141	126	150	Low tide	100
		2	31	26	46	42	Rising tide	
	June/ 2012	1	18	27	19	19	Low tide	
		2	23	23	23	20	Rising tide	
	March/2013	1	60	60	50	69	Low tide	
		2	34	39	36	31	Rising tide	
DO (mg/l)	Background	1	1.27	1.6	1.37	1.9	Low tide	≥ 2
		2	2.1	2.05	1.43	2.06	Rising tide	
	June/ 2012	1	2.1	2.0	2.2	2.4	Low tide	

Parameter	Period	Time	NM1-SG	NM2-SG	NM3-SG	NM4-SG	Tidal condition	QCVN 08:2008 (B2)
		2	2.3	2.7	2.4	2.5	Rising tide	
	March/2013	1	2.9	2.8	2.8	2.9	Low tide	
		2	3.1	3.1	3.1	3.1	Rising tide	
COD (mg/l)	Background	1	19	17	20	19	Low tide	50
		2	53	46	43	46	Rising tide	
	June/ 2012	1	25	20	23	23	Low tide	
		2	19	15	23	41	Rising tide	
	March/2013	1	20	24	21	24	Low tide	
		2	17	19	19	17	Rising tide	
BOD (mg/l)	Background	1	17	15	16	15	Low tide	25
		2	21	18	16	18	Rising tide	
	June/ 2012	1	23	23	23	20	Low tide	
		2	9	14	8	14	Rising tide	
	March/2013	1	4	11	9	10	Low tide	
		2	10	10	9	8	Rising tide	
Ammonia (mg/l)	Background	1	ND	ND	ND	ND	Low tide	1.0
		2	ND	ND	ND	ND	Rising tide	
	June/ 2012	1	1.0	1.0	1.0	1.0	Low tide	
		2	0.2	0.4	0.5	0.5	Rising tide	
	March/2013	1	1.0	1.2	1.2	1.2	Low tide	
		2	1.2	1.3	1.3	1.2	Rising tide	
Fecal coliforms (MPN/100m)	Background	1	$46x10^4$	$46x10^4$	$46x10^4$	$46x10^4$	Low tide	10.000
		2	$46x10^4$	$46x10^4$	$46x10^4$	$46x10^4$	Rising tide	
	June/ 2012	1	$21x10^2$	$15x10^2$	$46x10^2$	$15x10^2$	Low tide	
		2	$46x10^2$	$24x10^2$	$24x10^2$	$15x10^2$	Rising tide	
	March/2013	1	$99x10^2$	$179x10^2$	$87x10^2$	$168x10^2$	Low tide	
		2	$80x10^2$	$89x10^2$	$82x10^2$	$84x10^2$	Rising tide	

Source: CDM Consultant, 03/2012

Note:

- NM1-SG: the surface water at 0.2 m depth, 500m far from the outfall, the upstream;
- NM2-SG: the surface water at 0.2 m depth at the outfall, the mid-stream;
- NM3-SG: the surface water at 0.2 m depth at 500m far from the outfall, the downstream;

- NM4-SG: the surface water at 0.2 m depth at the highest polluted place, (Sai Gon Port);
- ND: Not detectable ; the detectable limit of NH_4 = 0.11 mg /l;
- QCVN 08:2008/BTNMT, the National Technical Regulation on Surface Water Quality, Column B2: using for waterway transport and other purposes which need poor quality standard.

Table IV.8. Surface water quality of the Nhieu Loc Thi Nghe Canal (March 15-16, 2013)

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	$N.NH_3$ (mg/L)	Fecal Coliform (MPN/100mL)
Thi Nghe 1 Bridge									
1	7:00	Low tide	6,5	2,1	24	26	17	0,67	$75x10^3$
2	8:00	Low tide	7,4	1,9	128	41	17	6,61	$15x10^4$
3	9:00	Low tide	7,4	1,9	97	53	17	0,67	$24x10^4$
4	10:00	Low tide	7,2	2,0	119	68	22	5,38	$21x10^4$
5	11:00	Low tide	7,2	1,9	103	60	19	5,23	$15x10^4$
6	12:00	Low tide	7,2	1,9	110	38	23	2,13	$24x10^4$
7	13:00	Rising tide	7,2	1,6	45	45	18	0,78	$11x10^3$
8	14:00	Rising tide	7,2	1,3	58	38	16	0,67	$24x10^3$
9	15:00	Rising tide	7,2	2,5	29	45	18	0,67	$24x10^3$
10	16:00	Rising tide	7,2	2,6	19	45	16	0,67	$46x10^3$
11	17:00	Rising tide	7,2	3,4	18	30	16	0,45	$24x10^3$
12	18:00	Rising tide	7,1	2,2	11	53	19	0,34	$24x10^3$
13	19:00	Rising tide	7,2	2,3	13	38	16	0,56	$21x10^3$
14	20:00	Low tide	7,2	2,5	49	38	19	0,56	$24x10^4$
15	21:00	Low tide	7,3	2,1	19	68	24	0,45	$46x10^4$
16	22:00	Low tide	7,1	2,4	18	38	16	0,78	$21x10^4$
17	23:00	Low tide	7,3	2,5	24	53	17	0,78	$21x10^4$
18	00:00	Low tide	7,4	2,1	19	45	17	1,01	$23x10^3$
19	01:00	Rising tide	7,3	1,6	32	53	17	0,90	$43x10^3$
20	02:00	Rising tide	7,4	1,2	12	38	16	0,56	$15x10^3$
21	03:00	Rising tide	7,3	0,9	20	53	17	0,56	$21x10^3$
22	04:00	Rising tide	7,3	0,8	12	38	16	0,45	$21x10^3$
23	05:00	Rising tide	7,4	0,8	26	38	19	0,56	$23x10^3$

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	N_NH_3 (mg/L)	Fecal Coliform (MPN/100mL)
24	06:00	Rising tide	7,3	0,7	18	38	17	0,45	$43x10^3$
25	7:00	Rising tide	7,4	0,7	8	38	16	0,45	$23x10^3$
26	8:00	Low tide	7,3	0,7	15	23	16	0,45	$43x10^3$
27	9:00	Low tide	7,3	0,9	12	38	18	0,34	$43x10^3$
28	10:00	Low tide	7,2	1,2	29	53	25	0,45	$23x10^3$
29	11:00	Low tide	7,5	1,4	37	30	16	0,45	$15x10^4$
30	12:00	Low tide	7,1	1,6	43	38	19	0,78	$21x10^4$
31	13:00	Low tide	7,0	2,3	15	38	16	0,45	$46x10^3$
32	14:00	Rising tide	7,0	2,2	14	38	16	0,56	$21x10^3$
33	15:00	Rising tide	7,0	0,6	20	23	16	0,45	$24x10^3$
34	16:00	Rising tide	7,0	0,7	5	23	16	0,34	$24x10^3$
35	17:00	Rising tide	7,0	1,5	9	23	17	0,45	$24x10^3$
36	18:00	Rising tide	7,1	0,9	25	38	18	0,34	$46x10^3$
37	19:00	Rising tide	7,0	0,9	20	30	16	1,46	$46x10^3$
38	20:00	Low tide	7,0	0,9	19	23	17	0,34	$46x10^4$
39	21:00	Low tide	7,0	1,2	7	30	17	0,67	$24x10^4$
40	22:00	Low tide	7,0	1,2	6	30	16	0,56	$15x10^4$
41	23:00	Low tide	7,0	0,6	25	38	17	0,67	$24x10^4$
42	00:00	Low tide	6,9	0,6	25	45	17	1,46	$21x10^4$
43	01:00	Low tide	6,9	0,5	43	83	30	0,90	$11x10^4$
44	02:00	Rising tide	6,9	0,4	8	30	16	0,34	$46x10^3$
45	03:00	Rising tide	6,9	0,5	5	83	31	0,45	$46x10^3$
46	04:00	Rising tide	6,9	0,4	18	45	17	0,34	$21x10^3$
47	05:00	Rising tide	7,1	0,4	14	38	16	0,45	$24x10^3$
48	06:00	Rising tide	7,0	0,5	10	45	21	0,45	$24x10^3$
Dien Bien Phu Bridge									
1	07:20	Low tide	6,7	2,3	23	27	18	0,67	$43x10^3$
2	08:20	Low tide	7,3	1,7	36	62	26	4,03	$93x10^3$
3	09:20	Low tide	7,4	2,1	39	60	19	4,48	$24x10^4$
4	10:20	Low tide	7,3	1,9	32	38	18	4,26	$93x10^3$
5	11:20	Low tide	7,2	2,1	30	45	16	1,40	$24x10^4$
6	12:20	Low tide	7,3	1,9	64	68	20	0,56	$24x10^4$

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	N_NH_3 (mg/L)	Fecal Coliform (MPN/100mL)
7	13:20	Rising tide	7,5	1,3	31	30	18	0,56	$46x10^3$
8	14:20	Rising tide	7,2	1,3	25	30	17	0,56	$46x10^3$
9	15:20	Rising tide	7,3	2,6	18	38	17	0,67	$24x10^3$
10	16:20	Rising tide	7,1	3,7	15	45	16	0,22	$24x10^3$
11	17:20	Rising tide	7,2	3,4	22	38	17	0,67	$46x10^3$
12	18:20	Rising tide	7,2	2,3	27	53	21	0,56	$11x10^4$
13	19:20	Rising tide	7,2	2,1	16	68	17	0,67	$11x10^4$
14	20:20	Low tide	7,2	2,3	32	53	17	0,56	$93x10^3$
15	21:20	Low tide	7,2	2,2	32	68	22	1,01	$43x10^3$
16	22:20	Low tide	7,2	2,2	28	53	21	1,01	$43x10^3$
17	23:20	Low tide	7,4	2,8	26	53	20	1,34	$43x10^3$
18	00:20	Low tide	7,0	2,1	54	120	42	0,56	$21x10^3$
19	01:20	Rising tide	7,4	1,5	22	38	16	0,90	$24x10^3$
20	02:20	Rising tide	7,3	1,0	25	60	21	0,45	$21x10^3$
21	03:20	Rising tide	7,3	0,7	31	30	18	0,45	$21x10^3$
22	04:20	Rising tide	7,3	1,0	22	30	16	0,45	$24x10^3$
23	05:20	Rising tide	7,3	1,1	20	30	18	0,67	$24x10^3$
24	06:20	Rising tide	7,2	0,7	24	38	16	0,45	$21x10^3$
25	07:20	Rising tide	7,3	0,6	13	30	16	0,45	$23x10^3$
26	08:20	Low tide	7,2	0,7	8	38	16	0,00	$46x10^4$
27	09:20	Low tide	7,2	0,8	22	30	19	0,67	$46x10^4$
28	10:20	Low tide	7,2	1,2	4	38	22	0,56	$24x10^4$
29	11:20	Low tide	7,3	1,5	39	45	20	1,12	$46x10^4$
30	12:20	Low tide	7,1	1,7	16	38	25	0,78	$46x10^4$
31	13:20	Low tide	7,1	2,1	33	53	25	0,67	$11x10^4$
32	14:20	Rising tide	7,1	2,2	60	38	17	0,34	$46x10^3$
33	15:20	Rising tide	7,1	0,6	26	38	16	0,34	$21x10^3$
34	16:20	Rising tide	7,1	1,2	19	38	17	0,56	$24x10^3$
35	17:20	Rising tide	7,0	1,4	54	30	17	0,67	$24x10^3$
36	18:20	Rising tide	7,0	0,9	16	30	18	0,56	$11x10^4$
37	19:20	Rising tide	7,0	1,2	9	38	16	1,68	$11x10^4$
38	20:20	Low tide	7,0	1,3	11	30	17	0,45	$46x10^4$

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	$N.NH_3$ (mg/L)	Fecal Coliform (MPN/100mL)
39	21:20	Low tide	6,9	1,3	24	60	18	1,01	$24x10^4$
40	22:20	Low tide	7,0	1,4	9	38	17	0,67	$24x10^4$
41	23:20	Low tide	6,9	0,5	10	30	16	0,78	$21x10^4$
42	00:20	Low tide	6,9	0,7	22	45	17	2,02	$24x10^4$
43	01:20	Low tide	6,9	0,7	14	38	17	1,23	$46x10^3$
44	02:20	Rising tide	6,9	0,5	18	83	25	1,01	$24x10^3$
45	03:20	Rising tide	6,9	0,4	6	23	10	0,56	$21x10^3$
46	04:20	Rising tide	6,9	0,4	8	30	18	0,45	$24x10^3$
47	05:20	Rising tide	7,1	0,5	19	30	16	0,67	$21x10^3$
48	06:20	Rising tide	7,0	0,6	43	38	20	0,45	$21x10^3$
Kieu Bridge									
1	7:40	Low tide	7,0	2,1	18	47	20	2,46	$93x10^3$
2	8:40	Low tide	7,3	1,8	24	71	21	6,94	$24x10^4$
3	9:40	Low tide	7,4	2,0	24	45	24	23,74	$21x10^4$
4	10:40	Low tide	7,2	1,8	18	68	26	12,54	$21x10^4$
5	11:40	Low tide	7,2	2,1	21	68	28	27,07	$46x10^4$
6	12:40	Low tide	7,2	1,7	34	98	29	5,38	$46x10^4$
7	13:40	Rising tide	7,3	1,4	35	45	19	1,68	$24x10^4$
8	14:40	Rising tide	7,4	2,0	36	75	20	1,79	$11x10^4$
9	15:40	Rising tide	7,2	3,1	44	38	18	1,23	$21x10^3$
10	16:40	Rising tide	7,2	3,3	14	38	16	1,12	$15x10^3$
11	17:40	Rising tide	7,2	3,4	18	38	18	1,01	$21x10^3$
12	18:40	Rising tide	7,2	3,1	24	38	16	1,01	$46x10^3$
13	19:40	Rising tide	7,3	3,5	32	45	16	1,46	$11x10^4$
14	20:40	Low tide	7,3	1,9	11	98	38	2,58	$46x10^4$
15	21:40	Low tide	7,2	2,1	22	60	24	2,91	$46x10^4$
16	22:40	Low tide	7,4	1,4	26	83	22	4,93	$11x10^5$
17	23:40	Low tide	7,3	1,7	9	68	24	7,50	$24x10^4$
18	00:40	Low tide	7,4	1,6	44	83	22	7,73	$24x10^4$
19	01:40	Rising tide	7,5	1,6	52	60	19	3,81	$46x10^3$
20	02:40	Rising tide	7,3	0,9	26	53	18	1,68	$24x10^3$
21	03:40	Rising tide	7,3	0,9	24	38	18	1,23	$15x10^3$

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	$N.NH_3$ (mg/L)	Fecal Coliform (MPN/100mL)
22	04:40	Rising tide	7,4	1,1	8	38	16	1,01	$15x10^3$
23	05:40	Rising tide	7,4	0,8	13	30	18	10,19	$15x10^3$
24	06:40	Rising tide	7,3	0,8	7	30	18	0,90	$21x10^3$
25	7:40	Rising tide	7,2	0,9	10	38	17	1,23	$93x10^3$
26	8:40	Low tide	7,2	1,3	23	45	17	1,68	$93x10^3$
27	9:40	Low tide	7,1	1,7	24	38	19	1,79	$15x10^4$
28	10:40	Low tide	7,2	1,8	5	53	19	3,36	$21x10^4$
29	11:40	Low tide	7,2	2,1	9	38	22	5,94	$46x10^4$
30	12:40	Low tide	7,2	2,2	11	53	34	11,87	$46x10^4$
31	13:40	Low tide	7,1	2,2	11	45	18	0,00	$11x10^4$
32	14:40	Rising tide	7,0	2,4	19	45	18	1,46	$46x10^3$
33	15:40	Rising tide	7,0	0,9	11	23	17	0,90	$21x10^3$
34	16:40	Rising tide	7,1	1,3	9	30	17	1,23	$21x10^3$
35	17:40	Rising tide	7,0	1,2	41	30	16	1,34	$24x10^3$
36	18:40	Rising tide	7,0	1,1	32	38	16	1,23	$46x10^3$
37	19:40	Rising tide	7,0	1,0	13	30	16	2,69	$11x10^4$
38	20:40	Low tide	7,0	1,1	11	45	18	2,69	$21x10^4$
39	21:40	Low tide	7,0	0,6	25	30	17	2,80	$46x10^4$
40	22:40	Low tide	7,0	0,7	12	30	16	0,90	$46x10^4$
41	23:40	Low tide	6,9	0,7	34	38	17	1,12	$24x10^4$
42	00:40	Low tide	6,9	0,7	12	30	16	2,35	$21x10^4$
43	01:40	Low tide	6,9	0,6	17	53	20	1,46	$11x10^4$
44	02:40	Rising tide	6,9	0,7	15	23	16	1,57	$21x10^3$
45	03:40	Rising tide	6,9	0,8	28	23	11	1,57	$21x10^3$
46	04:40	Rising tide	7,0	1,0	8	38	16	1,46	$15x10^3$
47	05:40	Rising tide	7,1	1,0	8	30	18	9,97	$15x10^3$
48	06:40	Rising tide	7,0	0,7	39	38	21	0,78	$24x10^3$
Le Van Sy Bridge									
1	7:00	Low tide	7,3	1,6	19	75	48	16,69	$46x10^4$
2	8:00	Low tide	7,4	1,7	23	68	46	10,75	$46x10^4$
3	9:00	Low tide	7,4	1,7	25	75	54	23,33	$24x10^4$
4	10:00	Low tide	7,1	1,9	23	98	68	18,67	$46x10^4$

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	$N.NH_3$ (mg/L)	Fecal Coliform (MPN/100mL)
5	11:00	Low tide	7,2	2,1	25	90	67	44,24	$11x10^5$
6	12:00	Low tide	7,2	2,2	21	113	68	7,84	$11x10^5$
7	13:00	Rising tide	7,1	1,9	16	60	44	14,56	$11x10^4$
8	14:00	Rising tide	7,2	2,0	32	60	44	9,24	$21x10^3$
9	15:00	Rising tide	7,2	3,4	28	68	41	5,23	$21x10^3$
10	16:00	Rising tide	7,2	3,1	20	60	43	3,55	$15x10^3$
11	17:00	Rising tide	7,2	3,2	20	83	47	3,36	$21x10^3$
12	18:00	Rising tide	7,2	3,2	17	83	42	8,59	$24x10^3$
13	19:00	Rising tide	7,2	3,2	16	68	45	15,68	$24x10^3$
14	20:00	Low tide	7,3	2,8	17	75	42	16,24	$93x10^3$
15	21:00	Low tide	7,2	3,1	21	90	52	44,05	$24x10^4$
16	22:00	Low tide	7,2	3,0	19	98	40	37,80	$46x10^4$
17	23:00	Low tide	7,1	1,8	19	113	58	19,88	$46x10^4$
18	00:00	Low tide	7,2	2,4	38	113	66	32,20	$24x10^4$
19	01:00	Rising tide	7,2	3,0	30	83	50	21,84	$11x10^4$
20	02:00	Rising tide	7,3	2,4	41	75	47	14,56	$46x10^3$
21	03:00	Rising tide	7,2	2,1	11	68	42	4,48	$46x10^3$
22	04:00	Rising tide	7,2	2,5	20	75	43	4,20	$21x10^3$
23	05:00	Rising tide	7,2	2,7	20	83	41	3,08	$24x10^3$
24	06:00	Rising tide	7,2	2,2	28	68	42	3,64	$46x10^3$
25	7:00	Rising tide	7,3	3,2	18	75	41	4,76	$24x10^4$
26	8:00	Low tide	7,3	2,7	11	45	17	40,04	$46x10^4$
27	9:00	Low tide	7,3	2,0	14	68	42	9,24	$46x10^4$
28	10:00	Low tide	7,3	2,0	24	68	41	32,48	$46x10^4$
29	11:00	Low tide	7,3	2,8	53	83	49	16,52	$11x10^5$
30	12:00	Low tide	7,3	2,5	35	83	46	13,16	$11x10^5$
31	13:00	Low tide	7,3	3,5	26	75	48	13,72	$11x10^4$
32	14:00	Rising tide	7,3	3,2	18	60	44	11,20	$46x10^3$
33	15:00	Rising tide	7,3	3,2	21	68	41	4,20	$24x10^3$
34	16:00	Rising tide	7,3	5,0	47	68	42	1,96	$21x10^3$
35	17:00	Rising tide	7,3	4,8	18	53	16	2,24	$24x10^3$
36	18:00	Rising tide	7,3	3,8	14	53	17	0,84	$11x10^4$

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	N_NH_3 (mg/L)	Fecal Coliform (MPN/100mL)
37	19:00	Rising tide	7,3	1,8	25	60	41	4,76	$11x10^4$
38	20:00	Low tide	7,2	1,6	27	38	19	6,44	$21x10^4$
39	21:00	Low tide	7,3	1,7	20	45	16	7,84	$46x10^4$
40	22:00	Low tide	7,3	1,7	12	45	17	12,32	$11x10^5$
41	23:00	Low tide	7,3	2,8	25	83	46	26,04	$11x10^5$
42	00:00	Low tide	7,3	3,2	25	30	16	21,56	$46x10^4$
43	01:00	Low tide	7,3	3,4	39	83	49	14,28	$11x10^4$
44	02:00	Rising tide	7,3	3,3	16	53	17	34,16	$46x10^3$
45	03:00	Rising tide	7,4	3,1	17	68	31	5,88	$46x10^3$
46	04:00	Rising tide	7,4	3,2	17	38	17	4,76	$24x10^3$
47	05:00	Rising tide	7,3	3,7	24	38	19	3,36	$24x10^3$
48	06:00	Rising tide	7,3	3,2	12	68	39	2,52	$11x10^4$
Xe Lua Bridge									
1	7:20	Low tide	7,3	1,4	16	77	40	14,90	$24x10^4$
2	8:20	Low tide	7,4	1,3	18	83	42	15,46	$46x10^4$
3	9:20	Low tide	7,4	1,1	15	98	47	40,51	$46x10^4$
4	10:20	Low tide	7,2	1,1	16	83	57	18,29	$11x10^5$
5	11:20	Low tide	7,3	2,4	15	90	57	33,32	$11x10^5$
6	12:20	Low tide	7,3	2,4	18	150	50	39,20	$11x10^5$
7	13:20	Rising tide	7,2	2,4	17	98	55	28,84	$11x10^4$
8	14:20	Rising tide	7,3	2,4	22	75	45	28,56	$46x10^3$
9	15:20	Rising tide	7,2	2,6	27	83	49	15,68	$46x10^3$
10	16:20	Rising tide	7,2	2,9	51	75	40	38,08	$46x10^3$
11	17:20	Rising tide	7,2	2,6	33	83	42	24,92	$46x10^3$
12	18:20	Rising tide	7,1	2,7	43	90	58	16,24	$11x10^4$
13	19:20	Rising tide	7,1	2,6	20	90	43	19,88	$11x10^4$
14	20:20	Low tide	7,3	3,1	35	98	56	18,20	$21x10^5$
15	21:20	Low tide	7,2	2,9	22	105	56	15,40	$24x10^5$
16	22:20	Low tide	7,3	2,8	23	113	46	37,80	$46x10^5$
17	23:20	Low tide	7,2	2,1	71	98	46	20,44	$46x10^5$
18	00:20	Low tide	7,2	1,8	24	113	61	19,60	$46x10^5$
19	01:20	Rising tide	7,2	2,1	16	113	50	35,56	$11x10^5$

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	$N.NH_3$ (mg/L)	Fecal Coliform (MPN/100mL)
20	02:20	Rising tide	7,3	2,0	37	113	48	31,92	$46x10^4$
21	03:20	Rising tide	7,1	2,0	34	83	48	14,56	$46x10^4$
22	04:20	Rising tide	7,1	1,9	31	60	43	13,16	$24x10^4$
23	05:20	Rising tide	7,2	1,8	31	83	42	19,88	$21x10^4$
24	06:20	Rising tide	7,2	1,8	24	120	48	15,68	$21x10^4$
25	7:20	Rising tide	7,2	2,5	22	68	43	11,76	$24x10^4$
26	8:20	Low tide	7,1	2,3	21	90	57	13,16	$46x10^4$
27	9:20	Low tide	7,3	2,5	18	90	55	14,84	$11x10^5$
28	10:20	Low tide	7,3	2,0	16	98	61	28,28	$24x10^5$
29	11:20	Low tide	7,3	3,2	42	83	63	27,44	$46x10^5$
30	12:20	Low tide	7,4	2,4	30	98	42	19,04	$46x10^5$
31	13:20	Low tide	7,4	2,5	26	90	44	15,68	$11x10^5$
32	14:20	Rising tide	7,3	2,3	24	83	43	17,36	$46x10^4$
33	15:20	Rising tide	7,3	1,6	31	53	17	13,72	$24x10^4$
34	16:20	Rising tide	7,2	1,2	36	75	44	36,40	$24x10^4$
35	17:20	Rising tide	7,2	1,6	28	68	43	24,36	$46x10^4$
36	18:20	Rising tide	7,2	1,6	36	38	16	19,04	$11x10^5$
37	19:20	Rising tide	7,2	1,9	16	60	43	15,40	$11x10^5$
38	20:20	Low tide	7,2	1,3	37	83	47	17,92	$46x10^5$
39	21:20	Low tide	7,3	1,9	31	60	41	12,04	$46x10^5$
40	22:20	Low tide	7,3	1,4	33	75	41	16,24	$24x10^5$
41	23:20	Low tide	7,3	2,8	40	90	51	17,08	$24x10^5$
42	00:20	Low tide	7,3	3,0	38	75	40	22,12	$21x10^5$
43	01:20	Low tide	7,3	2,6	44	68	41	26,04	$46x10^4$
44	02:20	Rising tide	7,3	2,9	27	38	17	35,56	$21x10^4$
45	03:20	Rising tide	7,3	2,8	28	113	49	13,44	$21x10^4$
46	04:20	Rising tide	7,3	2,5	39	45	19	11,48	$15x10^4$
47	05:20	Rising tide	7,3	2,7	51	45	17	21,28	$11x10^4$
48	06:20	Rising tide	7,3	2,7	43	45	19	16,80	$11x10^4$
Pham Van Hai Bridge									
1	7:40	Low tide	7,4	1,8	14	75	42	15,68	$15x10^4$
2	8:40	Low tide	7,5	1,7	15	90	48	11,20	$21x10^4$

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	N_NH_3 (mg/L)	Fecal Coliform (MPN/100mL)
3	9:40	Low tide	7,5	1,6	13	83	42	26,32	$21x10^4$
4	10:40	Low tide	7,2	1,7	27	90	64	17,17	$24x10^4$
5	11:40	Low tide	7,3	2,1	16	75	54	22,96	$46x10^4$
6	12:40	Low tide	7,3	2,1	13	83	54	29,68	$11x10^5$
7	13:40	Rising tide	7,4	2,7	10	75	53	7,84	$46x10^4$
8	14:40	Rising tide	7,3	3,3	15	68	42	18,48	$24x10^4$
9	15:40	Rising tide	7,2	2,4	40	90	44	19,04	$24x10^4$
10	16:40	Rising tide	7,2	3,0	32	75	43	28,28	$21x10^4$
11	17:40	Rising tide	7,2	2,9	24	75	40	1,96	$21x10^4$
12	18:40	Rising tide	7,2	2,9	42	90	59	16,80	$24x10^4$
13	19:40	Rising tide	7,3	3,6	46	83	57	18,48	$46x10^4$
14	20:40	Low tide	7,2	2,6	62	60	45	19,32	$21x10^5$
15	21:40	Low tide	7,3	2,9	35	75	40	15,96	$21x10^5$
16	22:40	Low tide	7,2	2,6	17	90	44	24,64	$24x10^5$
17	23:40	Low tide	7,2	2,3	14	98	43	19,04	$24x10^5$
18	00:40	Low tide	7,2	2,0	14	98	49	19,32	$15x10^5$
19	01:40	Rising tide	7,1	2,4	37	98	46	3,92	$21x10^4$
20	02:40	Rising tide	7,2	2,0	37	98	40	27,72	$46x10^3$
21	03:40	Rising tide	7,2	2,1	45	83	48	19,04	$46x10^3$
22	04:40	Rising tide	7,2	2,4	10	83	44	15,40	$24x10^3$
23	05:40	Rising tide	7,2	1,8	53	83	49	15,96	$46x10^3$
24	06:40	Rising tide	7,2	2,2	36	75	45	15,40	$11x10^4$
25	7:40	Rising tide	6,9	2,9	5	68	48	15,40	$15x10^4$
26	8:40	Low tide	7,3	2,7	29	75	54	16,24	$21x10^4$
27	9:40	Low tide	7,3	3,0	15	120	60	16,24	$24x10^4$
28	10:40	Low tide	7,2	2,4	87	83	53	18,48	$24x10^4$
29	11:40	Low tide	7,3	2,8	18	83	59	16,80	$46x10^4$
30	12:40	Low tide	7,3	2,6	53	83	41	15,96	$11x10^5$
31	13:40	Low tide	7,3	2,8	20	83	44	15,96	$11x10^4$
32	14:40	Rising tide	7,3	2,1	14	68	41	28,84	$11x10^4$
33	15:40	Rising tide	7,3	1,7	35	68	42	17,92	$46x10^3$
34	16:40	Rising tide	7,2	1,3	25	75	41	26,88	$24x10^3$

No.	Period	Tidal condition	pH	DO (mgO_2/L)	TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	$N.NH_3$ (mg/L)	Fecal Coliform (MPN/100mL)
35	17:40	Rising tide	7,2	1,5	12	60	44	4,76	$24x10^3$
36	18:40	Rising tide	7,2	1,3	19	68	45	13,16	$46x10^3$
37	19:40	Rising tide	7,2	1,6	26	53	30	13,44	$11x10^4$
38	20:40	Low tide	7,2	1,7	32	45	18	15,12	$21x10^5$
39	21:40	Low tide	7,3	2,0	61	120	52	11,48	$24x10^5$
40	22:40	Low tide	7,3	1,5	19	90	46	14,84	$24x10^5$
41	23:40	Low tide	7,4	3,0	26	83	48	19,32	$46x10^5$
42	00:40	Low tide	7,3	3,1	16	83	41	18,76	$46x10^5$
43	01:40	Low tide	7,3	3,0	30	45	16	24,64	$11x10^4$
44	02:40	Rising tide	7,3	2,6	75	98	58	28,84	$11x10^4$
45	03:40	Rising tide	7,4	3,2	13	53	39	13,16	$46x10^3$
46	04:40	Rising tide	7,3	2,5	35	38	18	10,64	$46x10^3$
47	05:40	Rising tide	7,4	3,1	42	45	19	14,84	$11x10^4$
48	06:40	Rising tide	7,3	3,0	40	53	20	16,52	$11x10^4$
QCVN 08:2008/BTNMT (B2)			5,5 - 9	≥ 2	100	50	25	1	-

Source: CDM Consultant, March 2013

Table IV.9. The analyzed results of ground water quality in the project area

Parameter	Unit	Sample symbol					QCVN 09:2008/BTNMT
		NN1	NN2	NN3	NN4	NN5	
pH		5.30	5.60	5.00	5.22	5.31	5.5 - 8.5
Total hardness	mg $CaCO_3$/l	88	93	530	72	68	500
Electric Conductivity	mS/cm	1.12	0.95	4.13	1.03	1.18	-
COD	mg/l	1	0.73	1	1	0.69	4
TSS	mg/l	1	1	2	1	1	-
$N\text{-}NO_2^-$	mg/l	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	1
$N\text{-}NO_3^-$	mg/l	1.74	1.69	4.48	1.53	1.69	15
SO_4^{2-}	mg/l	113	135	215	68	101	400
CN^-	mg/l	ND (<0.1)	ND (<0.1)	ND (<0.1)	ND (<0.1)	ND (<0.1)	0.01
Cl^-	mg/l	255	227	965	243	267	250

Parameter	Unit	Sample symbol					QCVN 09:2008/BTNMT
		NN1	NN2	NN3	NN4	NN5	
As	mg/l	0.029	0.002	0.004	0.061	0.013	0.05
Zn	mg/l	0.109	0.166	0.141	0.174	0.108	3
Cu	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	1
Cd	mg/l	ND (<0.001)	0.008	0.006	0.004	ND (<0.001)	0.005
Pb	mg/l	0.009	0.010	0.006	0.005	0.008	0.01
Cr^{3+}	mg/l	0.010	ND (<0.001)	0.006	0.009	0.009	-
Cr^{6+}	mg/l	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	0.05
Hg	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.001
Se	mg/l	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	0.01
Fe	mg/l	0.052	0.058	14.26	0.04	0.04	5
Mn	mg/l	0.21	0.02	0.**63**	ND (<0.01)	ND (<0.01)	0.5
Ecoli	MPN/100ml	ND	ND	ND	ND	ND	ND
Coliforms	MPN/100ml	6	5	3	9	5	3

Table IV.10. Description of groundwater sample location

Code	Position	Longitude	Latitude
NN1	21/2, An Khanh ward, D.2, depth of the drilled wells about 40 m	106°42'40.44"	10°46'29.48"
NN2	1B, Ha Noi highway, Thao Dien ward, D.2, depth of the drilled wells about 30 – 40m	106°43'45.86"	10°47'59.27"
NN3	Near Cat Lai ferry, Cat Lai ward, D.2, depth of the wells about 40 m	106°46'37.76"	10°45'16.90"
NN4	702/11, Nguyen Thi Đinh street, Thanh My Loi ward, D.2, depth of the wells about 40 m	106°46'1.93"	10°46'32.67"
NN5	The groundwater surveyed wells near the land of treatment station, depth of the drilled wells about 40 m	106°45'16.04"	10°45'17.50"

Table IV.11. The analyzed results of soil quality in the project area

Parameter	Unit	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	QCVN 03:2008/BTNMT Agriculture land
pH_{KCl}	-	4.45	4.84	3.74	8.04	7.68	6.86	5.12	6.54	6.67	7.02	-
Humidity	%	46.51	24.84	40.84	39.36	42.54	43.15	40.26	45.81	42.35	44.16	-
P_2O_5	%	0.141	0.12	0.176	0.187	0.074	0.053	0.088	0.051	0.046	0.051	-
K_2O	%	0.45	0.28	0.48	0.38	0.52	0.36	0.41	0.31	0.301	0.388	-

Total N	%	0.604	0.418	0.530	0.361	0.262	0.314	0.248	0.154	0.133	0.154	
Total P	%	0.061	0.052	0.076	0.081	0.032	0.023	0.038	0.022	0.020	0.022	-
Na	mg/kg dry soil	76.1	14.4	137.5	401.1	460.5	74.3	142.1	101.2	168.1	162.4	-
Zn	mg/kg dry soil	25.8	4.86	11.6	47.2	47.4	36.1	12.1	24.3	41.2	22.1	300
Pb	mg/kg dry soil	9.43	3.01	7.07	6.55	7.48	6.62	5.12	7.41	5.57	6.87	200
Cu	mg/kg dry soil	2.26	2.31	2.07	1.01	0.49	0.94	1.12	1.42	0.81	1.22	100
As	mg/kg dry soil	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
Cd	mg/kg dry soil	ND	ND	ND	0.08	0.082	ND	ND	ND	ND	ND	5
Cr	mg/kg dry soil	10.5	4.33	10.7	15.2	13.1	5.84	10.2	6.14	4.47	6.04	-
Phosphorous pesticide	mg/kg dry soil	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
Chlorinated pesticide	mg/kg dry soil	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-

ND: Not detected.

Table IV.12. Description of soil sampling locations (18 August 2011)

Code	Sampling locations	Longitude	Latitude
D1	Near the interceptor-building region, option A1. Locations in the land have more trees, to Saigon River about 380m.	106°43'33.98"	10°47'05.68"
D2	Near the interceptor-building region, option A2. Vacant land to the An Khanh market about 160m	106°43'34.11"	10°46'55.10"
D3	Near the interceptor-building region, option A3. Vacant land, near the East - West Highway, without surrounding residents.	106°43'48.37"	10°46'45.52"
D4	Near the interceptor-building region, option B1. Vacant land, 400m distance from Binh Khanh shrine, without surrounding residents in here.	106°44'13.40"	10°47'8.77"
D5	Near the interceptor-building region, option C, and Giong Ong To river. This position is near the East - West Highway, without surrounding residents, to Giong Ong To river about 700m.	106°44'22.54"	10°46'56.22"
D6	Near the interceptor-building region, option C, and residential area of Thanh My Loi ward. In residential areas of Thanh My Loi Ward, to Highway 25B about 200m	106°45'48.02"	10°46'28.90"
D7	Near the wastewater treatment station, on the interceptor leading to treatment station, there are no surrounding residents, Besides the land is Cat Lai Industrial Zone and the way up Phu My Bridge	106°45'31.80"	10°45'10.72"
D8	Near Ky Ha bridge	106°45'41.46"	10°45'11.37"
D9	Near the wastewater treatment station area	106°45'41.73"	10°45'4.02"
D10	The wastewater treatment station has no inhabitants trees grow luxuriant.	106°45'28.13"	10°44'59.44"

APPENDIX V

MINUTES OF MEETING COMMUNITY CONSULTATION SANITATION PROJECT HO CHI MINH CITY - PHASE 2

Today at 8:30 am April 24, 2014, in Hall's Committee of Thanh My Loi Ward, District 2, Ho Chi Minh City CESPIMA held a community consultation meeting of the Environmental Sanitation Project Ho Chi Minh City - phase 2.

1. The participants

1.1. Representatives of stakeholders

1.1.1. Representatives of organizations and companies of District 2

1. Mr Dang Trung Thien – Representative of Investment and Building Management Board of Thu Thiem New Urban Area;
2. Mrs Trieu Thi Thu Thủy – Representative of District 2Public Service Company Limited , Ho Chi Minh City;
3. Mr Huynh Tan Hung – Representative of 21st Century Corporation , 41 Nguyen Thi Minh Khai Street, District 1, HCMC;
4. Mrs Nguyen Thi Nhat – Representatives of SaigonWater, Environment and Infrastructure Joint Stock Company ;
5. Mr Vo Pham Nhut Anh – Representatives of the Youth Volunteers Investment and Construction Companyin Ho Chi Minh City.

1.1.2. Representatives of affected households

65 households in Thanh My Loi ward, where WWTP will be located and affected by the project. The list of participants and some pictures are attached in appendix.

1.1.3. Representatives of the Center, Research Institute, Non-Governmental Organizations

1. Prof. Dr. Lam Minh Triet – Representatives of the Water and Environmental Technology Institute (WETI), Vietnam Association for Conservation of Nature and Environment;
2. Mr Pham Van Mien – Representatives of the Vietnam Environment and Sustainable Development Institute (VESDI), Ho Chi Minh City;
3. Mr Phung Manh Tien – The Association of Science and Technology of Ho Chi Minh City;
4. Mrs Vo Thi Thanh Thuy – Representatives of Environmental Technology Center (ENTEC);
5. Ms Hoang Thi Kieu Oanh – Representatives of Institute for Environment and Resources (IER), National University of Ho Chi Minh City;
6. Mr Nguyen Van Bo – Representatives of Institute of Meteorology, Hydrology, Oceangraphy, and Environment (IMHOEN).

1.2. Project's Investment Management Agency

1. Mr Ung Nho Can – Deputy of City Environment Sanitation Project Investment Management Agency;
2. Mrs Phung Phuong Phi – City Environment Sanitation Project Investment Management Agency;
3. Mrs Tran ThiDai Loan – City Environment Sanitation Project Investment Management Agency;

4. Mr Ngo Tuong Anh Triet – City Environment Sanitation Project Investment Management Agency;
5. Mr Nguyen Thanh Khue – City Environment Sanitation Project Investment Management Agency.

1.3. Consultant (Meinhardt Vietnam)

1. Mr Le Thanh Trang – Meinhardt Vietnam;
2. Mr Luu Duc Trung – Meinhardt Vietnam.

1.4. Representatives of local government

1. Mr Doan Phuoc Luong – Representative of People's Committee of Thanh My Loi Ward, District 2, Ho Chi Minh;
2. Mr Nguyen Truong Ninh – Representative of People's Committee of Binh Khanh Ward, District 2, Ho Chi Minh;
3. Mr Nguyen Van Hoang – Representative of People's Committee of An Khanh Ward, District 2, Ho Chi Minh;
4. Mr Huynh Cong Nghia – Representative of People's Committee of An Loi Dong Ward, District 2, Ho Chi Minh;
5. Mr Truong Anh Kiet – Representative ofPeople's Committeeof Binh Trung DongWard, District2, HoChi Minh;
6. Mr Nguyen Van Tai – Representative of People's Committee of Thu Thiem Ward, District 2, Ho Chi Minh;
7. Mr Nguyen Ha Duy – Representative of People's Committee of Binh An Ward, District 2, Ho Chi Minh.

2. Meeting's Contents and Agenda

2.1. Introduction of the meeting's objective, the participants and agenda

Mr. Bui Anh Tu – Representative of the People Committee of Thanh My Loi Ward introduced the meeting objective, the participants including representatives of the ward's People Committees in District 2, Ho Chi Minh City, representatives of Companies, the households affected by the project, representatives of the centre, research institutes and non-government organizations, representatives of the CESPCESPIMA, EIA consultants, the chairmanof the meeting (Mr. Doan Phuoc Luong - Vice Chairman of Thanh My Loi Ward, District 2, Ho Chi Minh City).

- CESPIMAandconsultantpresents a summary ofthe contents of the investment projectand EIA report;
- The participantshave askedtheCESPIMAabout the unclear problemsandhave got the feedbackfrom theCESPIMA;
- CESPIMA and consultant have answered the questions from the participants;
- The participants have disccused with CESPIMA and consultant.
- Chairman of the meetinghave made conclusions.

2.2. CESPIMA and consultant presented the EIA report's contents

Representative of Project Owner (i.e. CESPIMA) Mr Ung Nho Can (Deputy Director of Project's InvestmentManagement Agency) introduced about the project origin, summary of project's components, thenauthorized the consultant to present the main contents of EIA report.

Mr. Le Thanh Trang, representative of consultant summarized the main contents of the EIA report.

2.3. Discussion and consultation

2.3.1. Opinion of stakeholders

1. ***Dr Phạm Van Mien – Representatives of the Vietnam Environment and Sustainable Development Institute (VESDI), Ho Chi Minh City***

- The investor should study the aerobic digestion condition in Thanh My Loi area, because the weak digestion of sewage waste waters may cause the contamination to the water sources
- Please consider if the waste waters discharged from WWTP should meet QCVN 14:2008/BTNMT, column A.
- It is necessary to apply the measures and solutions to properly operate the WWTP, otherwise, the Dong Nai river may be contaminated. At the present, there are many existing wastewater treatment plants, those are not well operated, even not operated at all.

2. ***Prof. Dr. Lam Minh Triet – Representatives of the Water and Environmental Technology Institute (WETI), Vietnam Association for Conservation of Nature and Environment***

- Please review if the SBR method is suitable for the capacity of the stage of 2020 - 2045?
- Please provide more detailed information on the fuel and materials use, demands of labor, electricity, water as well as inlet waste water quality etc.;
- It is recommended to provide the additional sections ontreatment of waste sludge and soil, waste waters as well as environmental risk control, monitoring environmental quality and compensation commitments in the construction phase;
- The water use demand should be estCESPIMAted based on water use factors issued by the Ministry of Construction.

3. ***Mr Phung Manh Tien – The Association of Science and Technology of Ho Chi Minh City, Center for Development Consulting***

- Please check again the safety distance from the interceptor to the Metro and specify the affected areas;
- Please contact the relevant authorities to consider the appropriateness of the measures for odor's and sludge treatment in the future, there should be consistency between the CESPIMA and Da Phuoc Solid Waste Disposal Complex before transporting the sludge to the complex.

4. ***Mrs Vo Thi Thanh Thuy – Representatives of Environmental Technology Center (ENTEC)***

The project's implementation will cause the negative impacts such as increasingthe air emission, wastewater and solid waste pollution etc.. The mitigation measures presented by the consultant in the above statement is quite detailed and completed.

To ensure the better performanceof the environmental protection measures and welfare benefits to the people living in the project area, the project owner and contractors should implement the following tasks:

- Mitigating the impact of dust and emission'spollution: The transportation means should be carefully covered to avoid dust, soil and material spillage; the material or gravel storage yards should be covered.
- Mitigating the impact of water pollution: the mobile toilets should be installed in the fields and frequentlybe cleaned. Besides that, it is prioritized to hire the workers, who living near the project area in order to reduce the number of workers staying in the camps, therefore, to reduce the amount of the generatedwastewaters.

- Mitigating the solid waste pollution: it is necessary to coordinate with local government to collect and treat the solid waste generated in the construction areas and to sign the contract with the funtionized companies to transport and dump in the planned solid waste landfills.
- Minimizing the traffic accidents in the project;s construction phase: It is recommended to avoids the transporting process during peak hours; to sufficiently install the lights in the night time, and to operate the guiding lights or other warning lamps over 24 hours per day.

5. ***Mrs Hoang Thi Kieu Oanh – Representatives of Institute for Environment and Resources (IER), National University of Ho Chi Minh City***

- It is recommended to regularly dredge the drainage systems to avoid clogging and flooding. Dredged materialsare transported by the appropriatedmeans and disposed in the landfills or appropriated areas;
- During the project's construction phase, the constructors must apply the waste treatment measure to ensure the safety environment;
- To ensure the environmental quality and appropriated waste treatment
- To equip and build the infrastructure facilities to minimize the project;s impact on the environment and people's lives;
- To strictly follow the construction schedule to ensure the safety to water, electricity and traffic roads;
- To apply the the reasonable policy to stablize the life of the resettled households.

6. ***Mr Nguyen Van Bo – Representatives of Institute of Meteorology, Hydrology, Oceanography, and Environment (IMHOEN)***

We agreed with the measures to mitigate the projec's adverse impacts proposed by the consultant. The waste disposal problem, especially the waste collection and disposal need to be more focused, ensuring the output levels of pollutants reaching the standards and regulations issued by the Ministry of Natural Resources and Environment. During the construction phase, the project owner and contractors should apply the following maesures:

- It is recommended the CESPIMA to pay more attention onthe security, health and labor safety for workers and residents in the project area;
- The CESPIMA should cooperate with the local government to ensure security order in the project's comstruction area and surrounding.
- The workers coming from the elsewhere during the project'sconstruction must be temporarily registrated at the commune's police to ensure the security and to prevent the social evils;
- Project's owner must properly and sufficiently comply with the proposed environmental protection measures in the project implementation phase;
- Project owner must committo perform the proposed measures to reduce environmental and socio-economic impacts.
- Project owner have to apply the supporting policies for the resettled people to stablize their life;
- Project owner have to regularly cooperate with local government to solve the problems related to the project.

7. ***Mr Dang Trung Thien – Representative of Investment and Building Management Board of Thu Thiem New Urban Area***

- Please check if there is any conflict when explaining that the construction of the project will facilitate the development of water transport, while there isthe measure for tide sluices to be

built?

- Please check the work's construction elevation of 2 m, since it will quickly overflooded in the near future.Besides that, please review the base and leveling elevation, which can affect the environment and flooding elsewhereif leveling is too much.
- It is recommended to build the enclosed waste water treatment systems, based on the improved SPR, which located in minimum distance of 30 meters from the nearest residential areas.
- The plan for the centralized WWTP's construction have been approved by the People Committee of Ho Chi Minh City for a long time ago, it's slow implementation may affect the schedule of other projects. Therefore, the construction of the WWTP is in urgent need. which should be taken immediately. It is necessary to accelerate the construction phaseand shorten the construction schedule;
- It is more convenient if the WWTP'sconstruction should be combined with renovating canals .

8. ***Mr Nguyen Van Hoang – Representative of People's Committee of An Khanh Ward, District 2, Ho Chi Minh***

- The project's implementation will affect the residential areas, therefore, it is necessary to get more detailed information on the current state of the residential areas;
- The interceptor would be shortened and easily repaired if passing along the edges of the canal. However, it is necessary to carefully survey the route;
- Project owner should closely cooperate with local authorities in order to limit the impact on the public order and social safety in the project area;
- It is necessary to have the warning signs to ensure safety for local peopleduring the construction phase;
- All the construction works must be done in accordance with appropriate standards, technical specifications, and tender documents/contracts during the construction phase,

9. ***Mr Truong Anh Kiet – Representative of People's Committee of Binh Trung Dong Ward, District 2, Ho Chi Minh***

- Project owner should remodelethe infrastructure facilities such as power stations, roads, water supply and drainage systems to address flooding in the rainy season, which are necessary works to ensure environmental hygiene, creating a positive conditions for marketing the tourism development and for the people, relocted in the resettlement areas;
- Project owner should facilitate and support the jobs for therelocated households in the new resettlement areas;
- Project's owner should require the contractorsto apply the appropriate measures to control and minimize the adverse environmental impact;
- The constructors should spary waters on the surface of the main roads to reduce the dust pollution caused by traffic;
- It is necessary to apply the measures to raise public awareness about the environmental protection and to guide the residents to have responsiblitiesto protect the clean environment; to avoid negative impacts on the environment, to do not throw garbage everywhere, and those who use public toilets should be aware of good hygiene.

10. ***Mr Nguyen Truong Ninh – Representative of People's Committee of Binh Khanh Ward, District 2, Ho Chi Minh***

- It is necessary to choose the appropriate waste storage areas to avoid the contaminating the environment and affacting the local life;
- It is necessary to associate closely with local authorities in order to limit the impact on public

order and social security in the project area;

- It is recommended to hire the local labor to create jobs for local people in the construction phase ;
- It is necessary to inplement the measures for good hygiene, occupational safety and fire fighting in the project area and surrounding ;
- It is necessary to well manege the solid waste and waste waters to avoid the polluting the environment around the project area.

2.3.2. Opinion of communities affected

1. ***Mr Phan Van Hien***

- It is recommend to tightly control the construction process to avoid affecting the people living around the project area as well as to create new jobs for local people;
- It is recommended to satifactorily compensate for the affected people .

2. ***Mrs Le Minh Thu***

- Currentlyin District 2, the domestic wastewatersare being discharged to the roads, many households have septic tanks, which leach into the groundwater. Therefore, the construction of the WWTP project is very good, very welcome;
- It is necessary to complete the project early, rapidly and adequately compensate for the affected people;
- It is necessary to avoid impacts to the environment and the activities of the local people.

3. ***Mr Duong Van Hoang***

- Sewerage in District 2 is slightly backwards, the WWTP primarily collect and treat the wastewater from the NL-TNbasin. So, the people in District 2 will meet some disadvantage because of transferring the polluted waters from elsewhere. Therefore, it is recommended to apply the right solutions to avoid the affect the life as well as the rights of the people living in District 2.

4. ***Mr Vo Huu Nguyen***

- Transferring the wastewaters fromthe NL-TN basin to District 2 will affect the people living in District 2 ;
- It is necessary to implement the project step by step. Firstly the fist step of WWTPwill be built and operated. If the results of the fist step will be good, then the second step of WWTP will be build .

5. ***Mr Nguyen Van Nam***

- It is recommended to the project owner to apply the mitigation measures to avoid the negative impact onthe people living in Thanh My Loi Ward;
- It is necessary to appy the adequate compensation measures for people in the clearance process as well as during the project's construction ;
- It is recommended to appropriately phase the project and to apply the advanced methods to avoid the impacts on the environment.
- It is necessary to implement the project step by step. Firstly the fist step of WWTPwill be built and operated. If the results of the fist step will be good, then the second step of WWTP will be build .

6. ***Mr Nguyen Van Tinh***

The project's construction will cause traffic congestion, potential air and water pollution. In addition, Theconstruction of the project will cause adverse impacts to the natural environment, socio-economic condotions, so project owner should focus on mitigation measures to control the following issues:

- Noise caused by cars and other vehicles transporting construction materials affecting the daily life of the people;
- Dust pollution caused by transportation means;
- Traffic congestion affecting the movement as well as activities of the people;
- The complication of the political security, social order and safety caused by the project in construction phase;
- Life disturbance of the people living in the project's area .

2.4. Opinion of the project owner

Projects Investment Management Agency explained some issues as follows :

- The base elevation of the project is 3 m as designed;
- The advanced technology for odor control will be applied;
- The closed transportation means will be used to avoid falling down the sludge and soil materials on the roads;
- Project's Investment Management Agency has contacted the Da Phuoc Solid Wasye Disposal Complex to ensure that the waste sludge and soils generated from the project will be sanitarily disposed;
- Project's Investment Management Agency are waiting for District 2 People's Committee to review how to select the most appropriate route for the interceptor;
- Since wastewater treatment plant collecting and treating wastewater from NL-TN basin and from District 2, therefore, all people in this position are beneficiaries;
- Project's Investment Management Agencyhave invited the affected people to attend in 02 consultation meetings to discuss on the compensation issues already.

Consultant explaned about environmental issues, location for wastewater treatment plant, measures for mitigating environmental impacts, the land clearance and compensation plans.

2.5. Conclusion

- The agreed contents : Most people, organizations, agencieswhere the project passing through support the project.The expression of their opinions to early implement the project to improve the hygine and environmental conditions in the project's area, which will be beneficiant for the people, institutions, companies, enterprises.
- The unagreed contents if any): None.

The Minutes of the public consultation meeting of the Ho Chi Minh City Environmental Sanitation Project - Phase 2 have been finished at 11h00 am. The main contents of the minutes of the meeting has passed all participants.

Secretary of the meeting (signed) Mr Luu Duc Trung	**Representative of Consultation agency Deputy Director (signed) Mr Ung Nho Can**