



Wastewater and Solid Waste Management in Provincial Centers

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TRAINING REPORT ON ESTABLISHING AND CONDUCTING WATER QUALITY MONITORING PROGRAM

for

**DONREs of Hai Duong, Bac Ninh, Can Tho,
Soc Trang & Tra Vinh Provinces**

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Ministry of Construction – Hanoi

in cooperation with

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ABBREVIATIONS

DONRE	Department of Natural Resources and Environment
MONRE	Ministry of Natural Resources and Environment
WWM	Capacity Development in Wastewater Management (TC Component 2)
TC	Technical Cooperation
FC	Financial Cooperation
TCVN	Vietnamese Standard
CRM	Certified Reference Materials
QA/QC	Quality Assurance/Quality Control
WWTP	Waste Water Treatment Plant
VCEP	Vietnam Canada Environmental Project
GPS	Global Positioning System
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
ISO	International Organization for Standardization

1. INTRODUCTION

“Wastewater and Solid Waste Management in Provincial Centers” is a program funded by the German government and jointly implemented by different institutions of the Government of Vietnam and several German Development Cooperation (GDC) agencies. The program consists of two complementary modules: financial cooperation (FC) and technical cooperation (TC). Whereas the FC module focuses on the funding of new technical infrastructure facilities for wastewater and solid waste management in currently six provincial cities in Vietnam, the TC module provides capacity development on national and local level. The TC consists of three components, ‘Capacity Development for the Ministry of Construction (MOC)’ (Component 1), ‘Capacity Development in Wastewater Management’ (Component 2 also referred to as WWM) and ‘Capacity Development in Solid Waste Management’ (Component 3).

The overall objective of the cooperation program reads:

“Conditions for sustainable wastewater disposal and solid waste management are improved.”

At this point, WWM is providing technical support to local governments, public wastewater companies (WWC) and **Departments of Natural Resources and Environment (DONRE) in six provincial urban centers in Vietnam**, including the cities of Bac Ninh, Hai Duong, Vinh, Can Tho, Soc Trang and Tra Vinh. Depending on the outcome of ongoing investment studies and the availability of sufficient funds, an extension of WWM to additional cities is foreseen within the current phase. WWM focuses on creating favorable conditions for improved public wastewater services and raising awareness on wastewater related issues among the communities and beneficiaries. Accordingly, the objective of TC Component 2 (Phase II) is that:

“Wastewater disposal in supported provincial centers is improved”

In order to achieve this objective, five indicators were formulated, including “The Departments of Natural Resources and Environment (DONRE) in the participating provinces monitor surface water and effluent discharge into receiving water bodies in accordance to prevailing regulations.”¹

To achieve this indicator, the WWM project management commissioned two experts from the Chemistry Institute to support the DONREs in 6 participating provinces to establish a program of water quality monitoring for surface water bodies that receive communal effluent from the treatment plants, which will be constructed through KfW co-financing.

The site visits to DONRES were conducted in order to evaluate the current situation of environment monitoring and analysis center at each province. The results of evaluation are presented in details in this report.

2. OBJECTIVES

Our mission is to support DONRES in participating provinces to improve their capacity for setting up and conducting water environment monitoring programs, including a monitoring program to evaluate impacts of effluent from newly invested wastewater treatment plants on water bodies in the future.

Based on the existing water quality monitoring program conducted by local DONRES and the need of a monitoring program for environmental impact assessment of the future wastewater treatment plants, our activities in this phase consist of:

- Design a monitoring program for domestic wastewater in participating DONREs: Bac Ninh, Hai Duong, Can Tho, Soc Trang and Tra Vinh.

¹ Note: This indicator is not part of the GTZ offer to BMZ.

- To chose additional monitoring points (besides the existing sampling points of present monitoring program), which will be used as indicators for impact assessment of wastewater treatment plant in those provinces;
- To determine water quality parameters which will be analyzed in accordance with TCVN 6772 – 2000;
- To check existing equipments, make a list of small equipments and necessary chemicals which will be used for training courses on water quality monitoring. Based on this, WWM Project will prepare plan to support local DONREs in purchasing necessary equipments and chemical.
- To sample and analyze water quality in project areas before newly invested wastewater treatment plants come into operation.
- To prepare training plan for water quality monitoring before and after operation of wastewater treatment plant.

To reach the above mentioned objectives, we conducted working visits to study about current situation of Environmental Monitoring and Analysis Centers (under the management of DONREs) in participating provinces. The results of working visits are presented in the following sections.

3. WORKING VISIT WITH HAI DUONG AND BAC NINH DONRE

3.1 Environmental Monitoring and Analysis Center – Hai Duong DONRE

In Hai Duong, we worked with officials from DONRE and Hai Duong One member Urban Works Management Company. The involved officials are listed in the below table:

No	Name	Position	Organization
1.	Nguyen Hoai Khanh	Head of environment management department	Hai Duong DONRE
2.	Ta Hong Minh	Director of environmental monitoring and analysis center	Hai Duong DONRE
3.	Phan Thi Uyen	Vice Director of environmental monitoring and analysis center	Hai Duong DONRE
4.	Le Phu Dong	Lab staff	Hai Duong DONRE
5.	Mr. Thien	Head of Sewerage Team	Hai Duong One member Urban Works Management Company
6.	Rene Heinrich	Institutional Advisor	DED

Currently, there are 15 main discharging points. These main discharging points are connected to pumping station:

- Thai Binh river
- Sat river (through Hao Thanh Lake)

Sampling campaign was conducted on 15 and 16 of May, 2008. Currently, there are 9 existing sampling points, which belong to annual provincial environmental monitoring program. For the objective of WWM project, 3 other additional monitoring points as indicated on the map in Fig. 1 were chosen. So far, the water quality monitoring is conducted four times every year at the

existing monitoring points.. The reason to choose 3 additional monitoring points is presented as follows:

- Monitoring point on Hao Thanh sluice and on Bach Dang River: this is the recipient point of urban wastewater; the measured data can be used for environment pollution warning when necessary.
- Monitoring point on Thai Binh river: water at this point can be used for domestic water supply in Hai Duong city
- Monitoring point at Cau Cuong dam and on Sat River (close to Cau sluice): water at this point is used for agricultural irrigation and also this water body is currently affected by wastewater from Hai Duong City.

In addition, these monitoring points also belong to water quality monitoring program of Hai Duong Province.



Figure 3-1 Map of sampling points in Hai Duong City

Some images taken during sampling time



Figure 3-2 Checking probe of WQC – 22A (TOA-Japan), DO sensor was broken



Figure 3-3 Thai Binh River (close to Cam Thuong Water Supply Plant, 500 m to



Figure 3-4 Sampling point at Hao Thanh sluice



Figure 3-5 Sampling at Hao Thanh sluice (close to Hospital No.7)



Figure 3-6 Sampling at bridge, 500 m from Ngoc pumping station upstream



Figure 3-7 Sampling on Sat River (Prof. Hung on the boat to guide on how to take sample)



Figure 3-8 Sampling at bridge on Sat River



Figure 3-9 Sample Analysis in the Lab of Hai Duong DONRE

Names of sampling locations and physical-chemical parameters are listed in the table.

Hai Duong sampling locations with physical-chemical parameters (measured at sites)

No	Sampling point	Position	pH	T°C	Conductivity (mS/m)	DO(mg/l)	Turbidity (NTU)	Salinity (%)	Time of sampling
1.	Cat bridge on Sat River	20°55'43" 106°19'24"	6.41	28.0	43.3	DO Probe broken	50	0.021	9h30, May,15,08
2.	Binh Minh Lake	20°56'03" 106°19'29"	8.61	28.7	69.3	"	47	0.035	10h10 May,15,08
3.	Bach Dang Lake	20°56'22" 106°20'25"	8.86	29.5	73.2	"	22	0.037	10h50 May,15,08
4.	Bach Dang lake – river junction	20°55'44" 106°20'31ss	7.89	29.3	73.1	"	9	0.037	11h05 May,15,08
5.	500m from Ngoc Chau pumping station upstream	20°55'36" 106°20'31"	8.36	28.8	45.8	"	15	0.023	11h15 May,15,08
6.	Cong Cau port	20°54'55" 106°20'36"	7.76	27.5	23.9	"	31	0.012	11h35 May,15,08
7.	Channel near Cuong bridge	20°54'39" 106°20'03"	7.38	30.2	55.6	"	22	0.028	12h05 May,15,08
8.	Sluice near ceramic factory (additional monitoring point)	20°56'15.5" 106°19'13.8	7.23	28.6	80.7	"	72	0.040	15h May,15,08

No	Sampling point	Position	pH	T°C	Conductivity (mS/m)	DO(mg/l)	Turbidity (NTU)	Salinity (%)	Time of sampling
9.	Moat (close to No.7 hospital)	20°56'28.8" 106°19'29.8"	7.12	26.8	102.4	"	9	0.051	15h20 May,15,08
10.	Sluice on An Ninh road (additional monitoring point)	20°56'42.2" 106°19'56.4"	6.97	27.7	117.3	"	16	0.085	15h45 May,15,08
11.	Thai Binh river (close to Cam Thuong water supply plant, 500m to upstream)	20°55'24.9" 106°18'08.5"	7.12	27.9	19.6	"	38	0.010	16h15 May,15,08

(Note: DO probe of water quality checker (TOA 22 – Japan) was broken. No DO values were recorded.)

Water quality of sampling locations (analyzed in the lab) in Hai Duong

No	Sampling point		NO ₃ ⁻ (mg/l)	NO ₂ ⁻ (mg/l)	NH ₄ ⁺ (mg/l)	PO ₄ ³⁻ (mg/l)	BOD ₅ (mg/l)	COD (mg/l)	F ⁻ (mg/l)	SO ₄ ²⁻ (mg/l)
1.	Cat bridge on Sat River		5.31	0.151	0.125	0.32	4.5	10.9	0.27	21
2.	Binh Minh Lake		3.98	0.696	13.357	11.5	17.6	37.0	0.37	45
3.	Bach Dang Lake		7.53	1.577	1.518	10.0	26.3	50.0	0.64	39
4.	Bach Dang lake – river junction		2.28	0.923	10.92	28.7	21.0	39.0	0.57	39
5.	500m from Ngoc Chau pumping station upstream		5.31	0.233	0.133	0.05	9.6	20.0	0.52	49
6.	Cong Cau port		5.76	0.042	0.342	0.09	2.9	7.3	0.16	21
7.	Channel near Cuong bridge		0.44	0.009	0.255	0.38	8.6	24.0	0.82	75
8.	sluice near ceramic factory (additional point)		5.31	0.039	38.85	30.8	36.7	78.0	0.74	45
9.	Moat (close to No.7 hospital)		23.03	0.013	24.28	11.2	44.3	80.0	0.79	31
10.	Sluice on An Ninh road (additional monitoring point)		7.52	0.006	21.85	0.29	24.3	43.2	0.49	9
11.	Thai Binh river (close to Cam Thuong water supply plant, 500m to upstream)		3.54	0.033	0.133	0.20	0.9	2.3	0.21	15
12.	CRM	Standard	10.00	0.200				100.0	1.00	
			10.20	0.193				103.0	0.96	

No	Sampling point		NO ₃ ⁻ (mg/l)	NO ₂ ⁻ (mg/l)	NH ₄ ⁺ (mg/l)	PO ₄ ³⁻ (mg/l)	BOD ₅ (mg/l)	COD (mg/l)	F ⁻ (mg/l)	SO ₄ ²⁻ (mg/l)
13.	QA/QC		9		6	7		9		
			23.91		0.364	0.42		77.0		

List of equipments and chemicals proposed by Hai Duong DONRE

No.	Name of water quality parameter (TCVN 6772-2000)	Chemicals, Equipment	Made in	Units	Qty
I	Coliform				
1		Lauyryl trypto mannit broth	Germany	Kg	02
2		Oxidaza reagent	Germany	litre	0,5
3		Kovac Reagent	Germany	litre	0,5
4		Petri disk	Germany	piece	200
5		Culture loop (Que cấy)	Germany	piece	20
6		Test tube	Germany	tube	200
7		Culture loops	Germany	piece	20
8		NaCl	Germany	kg	01
II	BOD₅				
1		DO meter	USA (YSI)	piece	01
2		Na ₂ HPO ₄ . 7.H ₂ O	Germany	gram	500
3		CaCl ₂	Germany	gram	500
4		FeCl ₃	Germany	gram	500
		MgSO ₄	Germany	gram	500
III	S²⁻				
1		Sulfide 1	USA (HACH)	ml	300
2		Sulfide 2	USA (HACH)	ml	300
IV	pH				
1		pH meter	USA (HACH)	piece	01
V	Turbidity				
1		Turbidity meter	USA (HACH)	piece	01
VI	Mineral Oil				
1		Extract and analysis of mineral oil Ser 148	Italy (Velp)	Piece	01
VII	Settable solids				
1		Vacuum pumping	USA	piece	01
2		Glass funnels	Germany	piece	05
3		Filters	Germany	box	05
VIII	Dissolved solids				
1		TDS meter	USA (HACH)	piece	01
IX	Suspended solids				
1		Filters (φ 47)	Germany	box	05
X	For field				
1		Water quality Checker TOA-22 and probe	Japan	piece	01

3.2 Environmental Monitoring and Analysis Center – Bac Ninh DONRE

In Bac Ninh, we have worked with office from DONRE and Bac Ninh Water Supply and Sewerage One Member Limited Liability Company. The list of involved officials is presented in the below table:

No	Name	Position	Organization
1.	Nguyen Dai Dong	Director of Center of environmental monitoring and analysis	Bac Ninh DONRE
2.	Nguy Thi Diem Huong	Lab staff – Chemist	Bac Ninh DONRE
3.	Phan Khac Hue	Lab staff – Chemist	Bac Ninh DONRE
4.	Tran Trung	Field group – Chemist	Bac Ninh DONRE
5.	Nguyen Thanh Son	Lab staff – Environmentalist	Bac Ninh DONRE
6.	Pham Thi Tuyen Mai	Lab staff – Chemist	Bac Ninh DONRE
7.	Vu Thi Huyen	Lab staff – Environmentalist	Bac Ninh DONRE
8.	Nguyen Trong Kien	Lab staff – Chemist	Bac Ninh DONRE
9.	Nguyen Van Hao	Lab staff – Chemist	Bac Ninh DONRE
10.	Mr. Bien	Head of Sewage department	Bac Ninh Water Supply and Sewerage One member Limited Liability Company
11.	Rene Heinrich	Institutional Advisor	DED

Currently Bac Ninh has one provincial monitoring program, in which 15 sampling locations are monitored with frequency of 4 times/year. They are:

1. Dai Xa Bridge - Phong Khe
2. Nga Bridge
3. Bo son Bridge
4. Kim Chan pumping station
5. City combined drainage system
6. Phong Khe bridge
7. Van An Canal
8. Sewer system from Vo Cuong industrial zone
9. City combined drainage system close to School of technical works
10. Dong Tram Lake
11. Thanh Lake

Some pictures taken during Bac Ninh sampling campaign on May, 21, 2008



Figure 3-11 Sampling at Kim Chan Sluice on Cau River



Figure 3-12 Tao Khe Canal 2 (500 m from WWTP to downstream)



Figure 3-13 Sampling point on the lake near Hoang Quoc Viet street. Water sample is darkly greened. This is a serious eutrophication lake



Figure 3-14 Lake near Hoang Quoc Viet Street



Figure 3-15 Tao Khe Canal 2 (500 m from WWTP to downstream)

No	Sampling point	Position	pH	T°C	Conductivity (mS/m)	Turbidity (NTU)	Salinity (%)	DO (mg/L)	Time of sampling
1.	Lake N0.1, Thi Cau Commune	21.19686 106.09455	5.2	27.9	75	65	0.037	9.7 Eutrofication	10 am May, 21,08
2.	Dong Tram Lake (in monitoring network)	21.20494 106.08852	6.9	26.9	81.2	52	0.04	4.9	11h May, 21,08
3.	Hoang Quoc Viet street, Zone No 1	21.19525 106.08574	7.6	27.5	99.7	51	0.052	12.9 Eutrofication	11h45 May, 21,08
4.	Thanh Lake	21.18108 106.05943	8.9	30.7	75.6	31	0.038	18.8 Eutrofication	14h30 May, 21,08
5.	Kha Le Lake	21.16220 106.04958	8.6	31.4	56.6	24	0.028	14.8 Eutrofication	14h45 May, 21,08
6.	A lake close to BN railway station	21.17804 106.05576	8.6	30.2	69.9	82	0.035	15.7 Eutrofication	15h May, 21,08
7.	A lake close to the old hospital (Thuong Lake)	21.18929 106.08018	8.3	29.3	70.6	117	0.035	13.01 Eutrofication	15h35 May, 21,08
8.	Thi Chung Lake	21.18860 106.06348	7.8	29.5	88	66	0.044	12.59 Eutrofication	15h45 May, 21,08
9.	Lake in opposite to PCP	21.18417	8.4	30.3	32.7	10	0.016	9.84	15h50

No	Sampling point	Position	pH	T°C	Conductivity (mS/m)	Turbidity (NTU)	Salinity (%)	DO (mg/L)	Time of sampling
		106.07738						Eutrofication	May, 21,08
10.	Technical Technology School (In monitoring network)	21.18147 106.07.791	6.9	21.6	120	48	0.060	0.16	16h May, 21,08
11.	Cau River 1(surface water) (Sandy Port)	21° 12.519 106° 05.021	6.4	27.3	21.2	51	0.011	3.89	9h30 May, 22,08
12.	Cau River 2(surface water) (Stone Port)	21° 11.933 106°07.060	6.9	27.3	20.5	48	0.01	3.99	10h25 May, 22,08
13.	Cau River 3 (surface water) (500m from Doi Canal 2 – at Viet Thong Commune))	21° 12.403 106° 07.411	6.9	27.5	20.2	39	0.01	4.13	10h55 May, 22,08
14.	Tao Khe Canal 2 (500m from WWTP downstream)	21° 11.053 106° 06.023	6.9	28.3	45.7	44	0.023	2.87	11h30 May, 22,08
15.	Tao Khe Canal 2 (500m from WWTP upstream)	21° 11.714 106° 06.134	7.1	29.3	46.2	42	0.023	5.02	11h55 May, 22,08

Water quality of sampling locations (analyzed in the lab) in Bac Ninh

No.	Sampling point	pH	BOD (mg/l)	TSS (mg/l)	PO ₄ ³⁻ (mg/l)	COD (mg/l)
1.	Lake N0.1, Thi Cau Commune	5,2	45,5	74	1,501	119
2.	Dong Tram Lake (in monitoring network)	6,9	39,6	46,4	0,418	110
3.	Hoang Quoc Viet street, Zone No 1	7,6	57,5	107,2	1,339	193
4.	Thanh Lake	8,9	28,2	44,4	0,011	74
5.	Kha Le Lake	8,6	23,6	22,8	1,140	57
6.	A lake close to BN railway station	-	54,3	89	0,034	149
7.	A lake close to the old hospital (Thuong Lake)	-	46,4	114	0,805	115
8.	Thi Chung Lake	-	49,2	64,4	0,030	119
9.	Lake in opposite to PCP	-	32	39	0,003	94
10.	Technical Technology School (In existing monitoring network)	-	58,6	52,4	2,876	145
11.	Cau River (surface water) (Sandy Port)	6,4	8,6	27,0	0,021	25
12.	Cau River (surface water) (Stone Port)	6,9	7,6	24,8	0,018	19
13.	Cau River (surface water) (200m from Kim Doi 2 pumping station – at Viet	-	25,4	18,8	0,170	56

No.	Sampling point	pH	BOD (mg/l)	TSS (mg/l)	PO ₄ ³⁻ (mg/l)	COD (mg/l)
	Thong Commune)					
14.	Tao Khe Channel (500m from WWTP upstream)	6,9	9,1	12,8	0,048	24
15.	Tao Khe Channel (500m from WWTP downstream)	-	28,3	24,4	0,250	61
16.	TCVN 5942:1995 (B)	5,5-9	<25	80	-	<35
17.	TCVN 6772:2000 (Level II)	5-9	30	50	6	-

According to TCVN 6772-2000, for domestic wastewater monitoring, it is necessary to analyze 10 water quality parameters. Some water quality parameters are analyzed through training supported by VCEP. However, there are still some parameters missing in this training. Parameters that need to be included in training course on water quality parameter analysis, which will be done by WWM Project, are listed in the below table:

No	Parameters	Remarks
1.	Settable solids	Training as well as related chemicals, glassware, and necessary equipment required
2.	Sulfur	Training as well as related chemicals, glassware and necessary equipment required
3.	Nitrate (NO_3^-)	Training as well as related chemicals, glassware and necessary equipment required
4.	Mineral Oil	Training as well as related chemicals, glassware and necessary equipment required
5.	Total coliform	Chemical and equipment have been purchased by DONRE. However, they have never been used. Training is necessary

List of necessary equipments and chemicals for training proposed by Bac Ninh DONRE

No.	Name of water quality parameter (TCVN 6772-2000)	Chemicals, Equipment	Made in	Units	Qty
I	BOD₅				
1		Internal solution and replacement membrane for DO meter	USA	Kit	02
2		$\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$	Germany	gram	500
3		CaCl_2	Germany	gram	500
4		FeCl_3	Germany	gram	500
		MgSO_4	Germany	gram	500
		H_2SO_4	Germany	gram	
		NaOH	Germany	gram	
		KH_2PO_4	Germany	gram	
		K_2HPO_4	Germany	gram	
		CRM for BOD ₅	Germany		
II	S²⁻				
1		HCl , KI , I_2 , $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$			
2		Ho Tinh Bot, salycilic acid, CRM			
III	NO₃⁻				
1		KNO_3 , Cloropore, HCl			
IV	PO₄³⁻				
1		Con. H_2SO_4 , $\text{K}(\text{SbO})\text{C}_4\text{H}_4\text{O}_6 \cdot 1/2\text{H}_2\text{O}$, $(\text{NH}_4)_6\text{MoO}_{24} \cdot 4\text{H}_2\text{O}$, ascorbic acid, KH_2PO_4 , CRM			
V	Mineral oil				

No.	Name of water quality parameter (TCVN 6772-2000)	Chemicals, Equipment	Made in	Units	Qty
1		HCl, n-hexan, methyl-tert-bityl ether, Na ₂ SO ₄ , extract funnel, distilled pot, glass funnel, filter, CRM, (centrifugal machine, centrifugal tube, desiccators) „ desiccators	Italy (Velp)	piece	01
VI	Suspended solids				
1		Filters (φ 47)	Germany	box	05
VII	Turbidity				
		Turbidity meter		piece	01
VIII	pH				
		pH meter and pH electrode		piece	01
IX	Heavy metals				
1		Standard solutions for Zn, Cd, Pb, Cu, Hg, As, acetate buffer, KCl		litre	0.5 for each
2		Gold electrode for As analysis		piece	01
X	For field				
1		Horizontal sampling		piece	01
2		Sampling stick		piece	01

3.3 Main Remarks on Bac Ninh & Hai Duong DONRE

Both Bac Ninh and Hai Duong Centers for Environmental Monitoring and Analysis have standard laboratories, which were equipped with equipments and tools by Vietnam Canada Environmental Project (VCEP). VCEP also carefully trained their staffs (managers, field and laboratory staffs) for Environment Monitoring activities. After VCEP finished, both Centers have significantly improved their capacity by building new working room and purchasing some additional lab equipments. They have also implemented several local and government monitoring programs. In addition to acknowledgeable progress in laboratory improvement, field measurement has shown some shortcomings as follows:

Equipments: TOA Multi-parameter meter of Hai Duong DONRE has not worked well (probe was not firmly connected). Many spare parts of sampling equipments in both DONREs have broken down that need to be repaired and replaced by new ones.

Field measurement staffs: all field measurement staffs who were trained by VCEP have gone out, new comers are young and hard working. However they were not trained well, therefore they were not familiar with field measurement of parameters such DO, pH, Cond, ORP as well as equipment calibration. They need to be re-trained in regular basis.

Due to limited time, this field trip mainly focused on water sampling before construction of newly invested wastewater treatment plants, therefore training on water quality monitoring for new staffs will be conducted in next trips.

4. WORKING VISIT WITH THREE SOUTHERN PARTICIPATING DONRES

4.1 Training Activities in Can Tho, Soc Trang and Tra Vinh DONRES

Following the trips to Bac Ninh and Hai Duong DONREs, we visited three southern participating DONREs including Tra Vinh (TV), Can Tho (CT) and Soc Trang (ST) on 6-12th October 2008. The objective of this working visit is to help these in establishing and implementing water environment monitoring programs, including a monitoring program to evaluate impacts of effluent from newly invested wastewater treatment plants on water bodies.

Unlikely Hai Duong and Bac Ninh DONREs, staffs of ST, CT and TV DONREs were not trained by VCEP training courses. Therefore, we had to spend more time in training about equipment calibration, Quality Assurance/Quality Control (QA/QC).

Training activities for those DONREs in this phase consist of:

- Training on Designing a Water Quality Monitoring Program and Application in Domestic Wastewater Quality Monitoring in Local City as a Case Study
- General introduction on designing a water quality monitoring program:
 - Objective of a water quality monitoring program (why to monitor water quality?)
 - Monitoring Parameters (What parameters need to be monitored?)
 - Location of monitoring points (where?)
 - Time and frequency of monitoring (when?)
 - How to conduct a field trip
 - Prepare a checklist if necessary (calibration of equipments, meters, sampler (horizontal, vertical, bottle samplers), bottles, labels, data sheet, GPS, maps, chemicals for sample preservation, cooling box, ice box for sample preservation.
 - Sampling: recording longitude and latitude of sampling location, physico-chemical parameters: pH, DO, Temperature, conductivity, salinity, TDS, turbidity; weather, hydrological parameters.
 - How to take samples: Composite, double, spike samples, field and laboratory blank samples....
 - Preservation and transport of samples
 - Laboratory Analysis
 - Reporting
 - Budgeting

Application of Water Quality Monitoring Program in Assessing Impact of KfW newly invested wastewater treatment plants on water bodies in project areas

- Objective of a water quality monitoring program: is to assess the impact of wastewater treatment plant on water bodies in project areas, determine the improved water quality, efficiency of wastewater collection system and wastewater treatment plant
- Monitoring Parameters in accordance with TCVN 6772: pH, BOD₅, COD, TDS, TSS, Settle able solids, Sulfur (in H₂S), Nitrate (NO₃⁻), Mineral Oil (food), Phosphate (PO₄³⁻, Total coli forms). Depending on local laboratory facilities and local budget, for monitoring, monitoring parameters can be reduced.
- Existing sampling locations (where?):
 - Centers for Environmental Monitoring and Analysis present their existing water quality monitoring programs;

- Inspect the existing sewerage system and review operation plan of wastewater treatment plan, position existing discharging points on local map in coordination and cooperation with WWM companies;
- Determine additional monitoring points (beside the existing monitoring points of present monitoring program), which will be used as indicators for assessing impact of wastewater treatment plants on water bodies in project participating provinces;
- Time and frequency of sampling (when?): use data from local monitoring program (TV 2 times/year, CT 4 times/year, ST 1 time/year), it is advised that sampling should be done at least twice every year (one in dry season and one in rainy season). Each time of sampling should be done at least in two periods (one in spring tide period and one in neap tide period) as water quality is strongly affected by tide regime in these provinces.

To help staffs of Center for Environmental Monitoring and Analysis understand measured parameters as well as how to use equipment better, we gave some theoretical lectures to all participants as follows:

pH measurement:

- Role of pH in water quality
- Reactions taking place on glass membrane
- Working principle of pH electrode
- Glass membrane
- Structure of pH electrode
- Explained about slope of standard curve
- Explained about one and two points calibration
- How to maintenance electrode.

DO measurement:

- Role of DO in water quality
- Reactions take place on working electrode
- Working principle of DO electrode
- Oxygen membrane
- Structure of DO electrode
- Explained about the calibration on saturated air and oxygen saturated solution
- How to add internal solution
- How to clean working electrode
- How to calibrate a DO sensor
- How to maintenance DO sensor

Conductivity measurement:

- Role of Conductivity in water quality
- Working principle of *Conductivity 4* electrode
- Structure of *Conductivity* electrode
- How to clean working electrode
- How to maintenance *Conductivity* sensor

Red ox potential (ORP) measurement:

- Role of ORP in water quality
- Working principle of *ORP measurement*
- Structure of *ORP* electrode
- How to clean working electrode

- How to maintenance *ORP* sensor

Turbidity measurement:

- Role of turbidity in water quality
- Working principle of *turbidity measurement*
- Structure of *turbidity* sensor
- How to clean *turbidity* sensor
- How to maintenance *turbidity* sensor

At the same time, we also introduced about theory of conductivity, salinity, turbidity measurements, presented how to convert data from salinity to conductivity, the relationship between water quality parameters.

As TV and ST Centers for Environmental Monitoring and Analysis do not have water quality multi-parameter meters (TOA), therefore the lectures were only explained in theory. As soon as they are provided water quality multi meters (TOA), we will retrain them to use that equipment. CT Center for Environmental Monitoring and Analysis has water quality multi-parameter meters (Horiba), their staffs are skilled in using such equipment; however the equipment is rather expensive to buy for other DONREs (approximate 7,000 USD).

Training on Calibration and Maintenance of HACH pH, DO Meters (in TV and ST), Turbidity meter (in ST)

QA/QC in Sample Analysis

WWM experts introduced about field blank, equipment blank, lab blank, duplicate samples, CRM...Field QA/QC requirement (Control samples, acceptance criteria, deviation, corrective action, data handling....) and operation procedures (sample management, reagent/standard preparation, general laboratory techniques, test method, equipment calibration and maintenance, corrective action and reporting). For 3 southern DONREs, the QA/QC procedure probably has not been implemented frequently.

- Sampling: we presented on how to record coordinate of sampling location including longitude and latitude, physico-chemical parameters: pH, DO, temperature, conductivity, salinity, TDS, turbidity ...; whether, hydrological parameters. We introduced on how to take samples, including composite, double, spike samples, field and laboratory blank samples.... As TV and ST do not have water quality multi-parameter meter and all TV, CT, ST do not have sampler therefore we could not train them to use that equipment. However we introduced on how to choose sampling location on the field, and how to make a composite sample, blank samples....
- Preservation and transport of samples: All three Centers for Environmental Monitoring and Analysis (CT, ST, TV) don't have specialized vehicle to go to the field to take sample. Tra Vinh and Soc Trang Centers use motorbikes to go to the field to take, and samples are preserved in simple sample box. Therefore, it is very difficult to meet the requirement of TCVN standard for sample preservation and transport. CT rent specialized car and boat to go to the field to take sample, so CT certainly meet requirement of TCVN standard for sample preservation and transport.
- Laboratory Analysis: We evaluated data to determine if the DQOs are met. Staffs of Can Tho Center for Environmental Monitoring and Analysis have enough skills to determine defined water quality parameters in accordance with TCVN 6772 – 2000. While, staffs of Soc Trang Center for Environmental Monitoring and Analysis are not good at these skills. Hence, they were trained to analysis total phosphorus, NO₃—N and COD with QA/QC samples. Data analysis was also introduced. For TV, they have some difficulties in determination of BOD₅ because they use Winkler technique to titrate DO in the sample. Some errors occur during titrating DO in sample, the mitigation measurement will be given by Ha in the next phase.

Reporting: Due to time limitation, this training was only focused on analyzing some parameters, therefore reporting will be trained in next training course.

Budgeting: Preliminary introduction on budgeting for a water quality monitoring program was given by WWM expert

Future Plan: Preparation for the future training activities for water quality monitoring before and after operation of wastewater treatment plant

4.1 Environmental Monitoring and Analysis Center – Tra Vinh DONRE

In Tra Vinh, we worked with officials from DONRE and Mr. Thang from Urban Works Management Company. The list of involved people is presented in the below table.

No	Name	Position	Organization
7.	Nguyen Thi My Hoa	Director	Center for Natural Resources and Techniques
8.	Doan Thi Thu Thao	Vice Director	Center for Natural Resources and Techniques
9.	Dang Van Dien	?Director	Tra Vinh, Environmental Protection Agency
10.	Nguyen Quoc Tuan	Head of environmental department	Tra Vinh, Environmental Protection Agency
11.	Nguy Duong Mai Thy	Head of laboratory	Center for Natural Resources and Techniques
12.	Nguyen Quang Thang		Urban Public Works Management One Member Limited Company

Some images taken during our working time



Figure 4-1 Meeting with Directors of Environment Monitoring Center and Environment Management Department and their staffs



Figure 4-2 Lectures on equipments: operation principles, calibration, measurement and maintenance

In the existing monitoring program of Tra Vinh DONRE, there are only 4 sampling locations. Three of them are used for wastewater quality monitoring as follows:

1. Tran Phu Street: it is considered as a typical location where water quality is directly affected by domestic wastewater discharged from households and establishments in the area.
2. General hospital: water quality is directly affected by hospital wastewater
3. Frozen food processing factory: water quality is affected by industrial wastewater

There is only one location for surface water quality monitoring:

1. Long Binh Bridge 1: water quality is affected by surface water.

On Oct, 7, 2008, EMD selected wastewater samples from 4 above locations (3, 4, 5 and 6 on the map in figure 4-3)

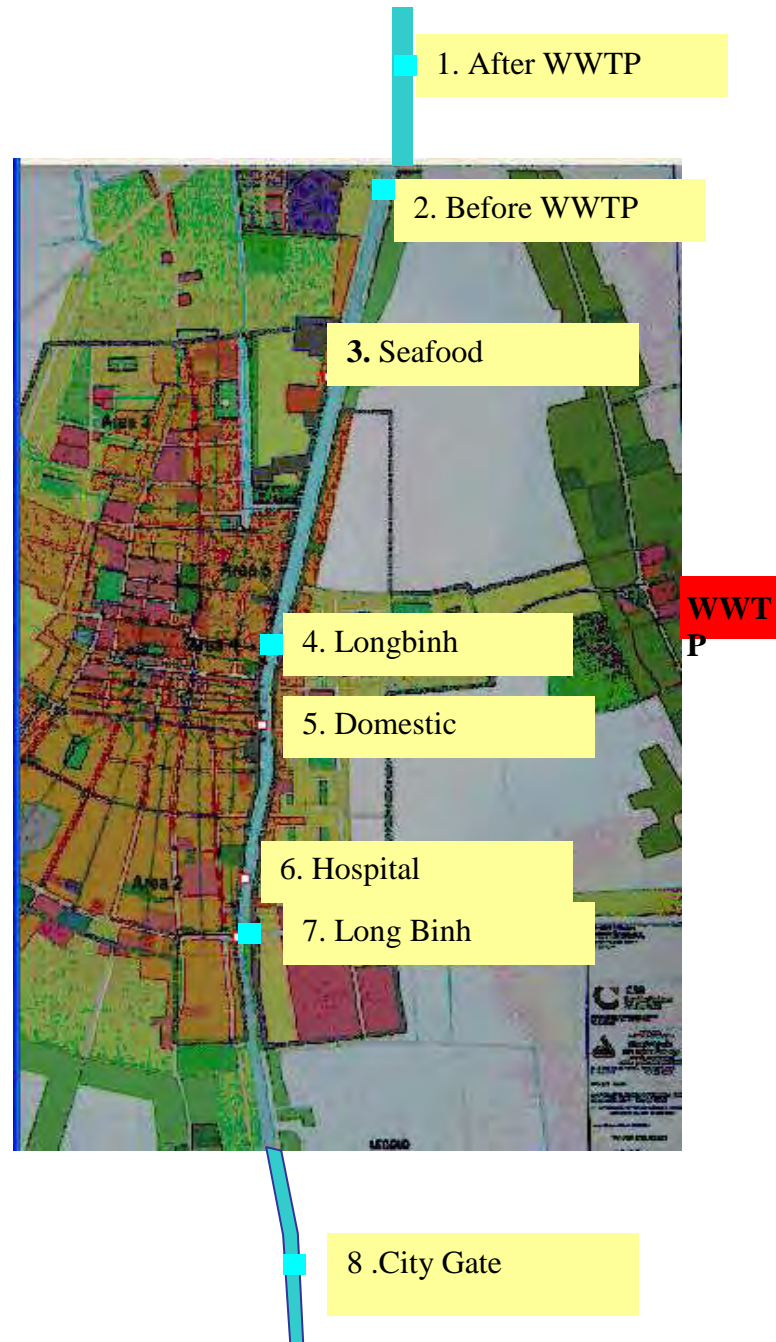


Figure 4-3 Map of sampling points in Tra Vinh City

As mentioned above, currently TV Center for Environmental Monitoring and Analysis is responsible for monitoring quality of wastewater discharged at 3 discharging points (Bach Dang market – domestic wastewater - discharging point No. 3, City Hospital – hospital wastewater - discharging point No. 6, and seafood processing factory-industrial wastewater-discharging point No. 3) and quality of surface water at one location (No.4). It is suggested to monitor 4 additional locations along Long Binh River (No. 1, 2, 7 and 8 on the Fig 4-3).

Treated wastewater from WWTP will be discharged directly into Co Chien River. This is a big river with high flow rate. On the other hand, the budget allocated for water quality monitoring program is limited, therefore it is not necessary to monitor water quality on Co Chien River.

Some images taken during sampling time are shown in the following figures



Figure 4-4 Wastewater from frozen food processing: as industrial wastewater



Figure 4-5 Polyclinic hospital: wastewater from hospital

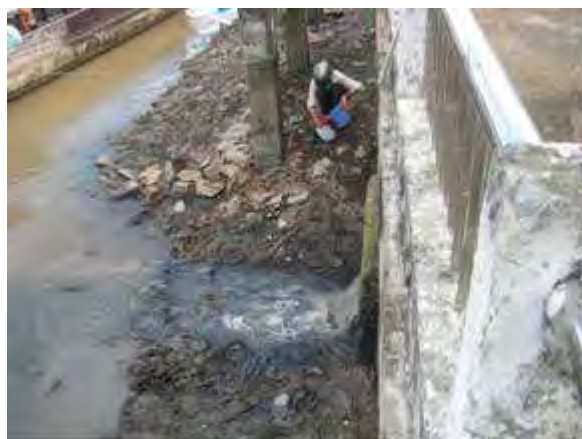


Figure 4-6 Tran Phu street: its is considered as a typical local case to be impacted by municipal domestic activities



Figure 4-5 Long Binh 1st Bridge :as surface water

At the moment, Tra Vinh Center for Environmental Monitoring and Analysis has no field equipment. Instead of field equipment, lab staffs use multi-parameter meter (HACH) to measure DO, pH and temperature on the field. It causes a risk to the damage of this equipment since it was not designed for waterproof as well as for mechanical shock resistance.

Sampling locations and measured physical parameters are listed in the below table.

Tra Vinh sampling locations with physical parameters (measured at sites)

No.	Location	Longitude	Latitude	Remarks
1	500m Upstream from a Bridge	9.963758	106.351558	Suggested Additional point
2	Outlet from seafood processing factory	9.948911	106.347970	Existing point
3	Long Binh Bridge 1	9.936732	106.345249	Existing point
4	Main outlet from TV city (Tran Phu street)	9.933136	106.345001	Existing point
5	Outlet from the City Hospital	9.926177	106.344259	Existing point
6	Long Binh Bridge 2	9.923509	106.343888	Suggested Additional point
7	Upstream of Long Binh river (gateway to Tra Vinh city)	9.894395	106.348341	Suggested Additional point

4.2 Environmental Monitoring and Analysis Center – Can Tho DONRE

In Can Tho, we worked with persons from DONRE and Can Tho Water Supply and Sewerage One member Limited Liability Company. Name list is below:

No	Name	Position	Major
12.	Ky Quang Vinh	Director of Center of environmental monitoring and analysis	CT DONRE Master of Environmental management
13.	Đoan Thanh Tam	Lab/field staff	Environmental engineering
14.	Lưu Tân Tài	Lab/field staff	Environmental management
15.	Nguyễn Xuân Cường	Lab/field staff	Environmental engineering
16.	Thai Phương Vũ	Lab/field staff	Chemist. Master of Environmental management
17.	Trần Phương Đông	Lab/field staff	Environmental management

18.	Nguyen Khanh Luan	Lab/field staff	Chemist
19.	Nguyen Thi Ngoc Tran		Local Professional in CT
20.	Frank Schweizer		Institutional Expert (South)

Currently Can Tho has provincial monitoring programs with frequency of 4 times per year. In dense population region, sample taking is conducted at 8 locations in monthly basis.

The Bassac River (called as Hau River) is about 200km long, located in Mekong Delta. The water depth ranges from 3 to 30m from upstream part, Chau Doc city to Long Xuyen City, and gradually reduces. The deepest area of Bassac River is near Can Tho City, about 100 km far from the sea. Can Tho River flows through Can Tho City forms natural boundary between Ninh Kieu and Cai Rang districts. Can Tho River plays an important role in environment, tourism and economic development of the city.

Names of sampling locations are shown in the below map, and physical parameters are listed in the below table.



Figure 4-6 Meeting with CT DONRES staffs



Figure 4-7 Giving lectures on designing a monitoring program and equipment



Figure 4-8 Giving lectures on lab analysis

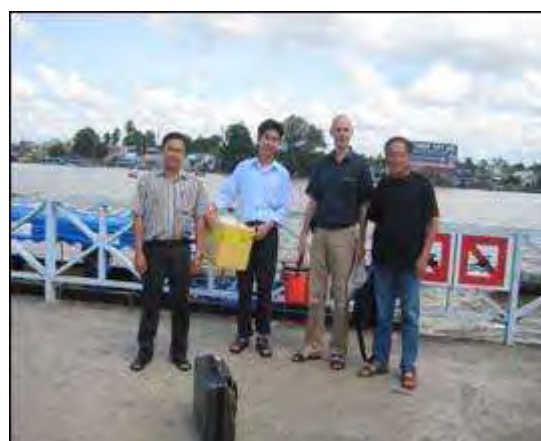


Figure 4-9 Just before boating



Figure 4-10 Mr. Vu, a DONRE staff taking sample from Hau River



Figure 4-11 Mr. Frank on boat in the field trip



Figure 4-12 A boat used for field trip



Figure 4-13 Mr. Dong, a CT DONRE staff is recording water parameters from the Horiba multi-meter



Figure 4-14 Part of Can Tho Bridge, under which is location for a composite sample (up stream of WWTP)



Figure 4-15 Transect for a composite sample (down stream of WWTP)

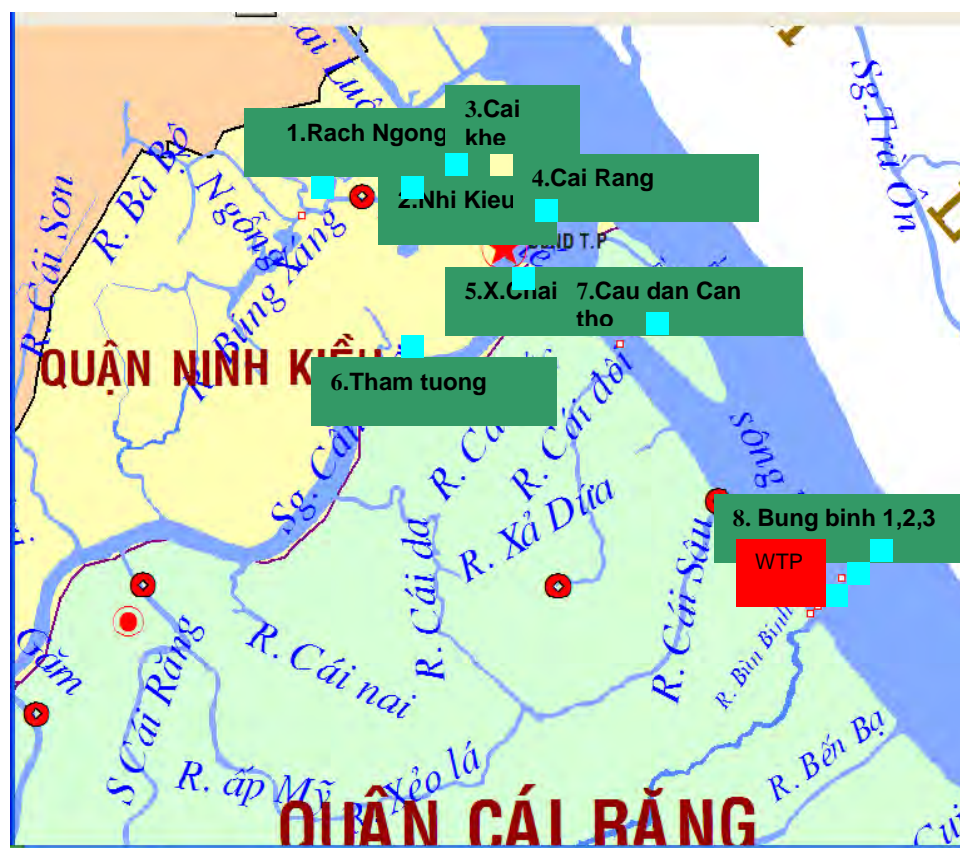


Figure 4-16 Some pictures taken during CT sampling campaign on 13 October, 2008

Around Can Tho City, there are 6 selected sampling locations.

At the present, there are 6 sampling locations on Can Tho River and Cai Khe canal which are receiving waters for surrounding areas (Locations No.1 – No.6 on the map). All of these sampling locations are suitable for our future monitoring program. Because newly invested wastewater treatment plant will be built in the downstream part of Cai Sau river, it is proposed to select two additional sampling locations (No. 7 and No.8) on Hau river (upstream and downstream of wastewater treatment plant) in order to assess the impact of effluent from wastewater treatment plant. For these two additional sampling locations, sampling should be done by composite sample technique, in that samples should be taken from three separate locations at intersection of the river at same volume and mixed. It is required to analyze only one composite sample. By this way, budget for sample analysis can be saved up to 70%.

Names of sampling locations in the below figure and physical parameters are listed in the below table.



Hình 4-17 Map of sampling points in Can Tho – Hau river

Data collected in Can Tho (Oct. 2008)

No	Sampling point	Position	BOD5 (mg/l)	COD (mg/l)	Turb. NTU	SS (mg/l)	NH ₃ -N (mg/l)	NO ₃ -N (mg/l)	pH	Cond (S/m)	DO (mg/l)	t°C	TDS (mg/l)
16.	Xóm Chài ferry station	10.030733 105.7883	8	9.7	62	114	0.2	1.7	7.15	0.300	5.80	30.46	0.16
17.	Tham Tuong canal	10.025083 105.77767	24	29.7	42	121	4.51	2.0	7.05	0.258	4.61	30.36	0.16
18.	Nhị Kieu Bridge	10.039033 105.77792	6	7.1	50	216	0.551	0.7	7.14	0.237	4.82	30.49	0.19
19.	Cai Khe	10.042533 105.7831	5	6.5	55	59	0.61	0.7	7.26	0.243	4.96	30.45	0.15
20.	Ngong canal	10.03895 105.76983	7	8.3	44	39	0.72	0.60	7.06	0.398	3.25	29.33	0.12
21.	Can Tho Bridge (approaching road)	10.026683 105.80192	-	-	-	-	-	-	7.07	0.213	6.22	30.60	0.14
22.	Cai Sau canal	10.012083 105.81212	12	14.9	99	85	0.069	1.3	7.03	0.276	6.44	30.77	0.16
23.	Roundabout No. 1	10.001067 105.82103	-	-	-	-	-	-	7.18	0.264	6.65	31.12	0.16
24.	Roundabout No. 2	10.001817	-	-	-	-	-	-	7.10	0.224	6.58	31.29	0.14

REPORT ON DONRES VISITS
BN, HD, CT, ST AND TV

No	Sampling point	Position	BOD5 (mg/l)	COD (mg/l)	Turb. NTU	SS (mg/l)	NH ₃ -N (mg/l)	NO ₃ -N (mg/l)	pH	Cond (S/m)	DO (mg/l)	t°C	TDS (mg/l)
		105.82172											
25.	Roundabout No. 3	10.004433 105.82415	-	-	-	-	-	-	7.61	0.213	7.03	30.69	0.14

4.3 Environmental Monitoring and Analysis Center – Soc Trang DONRE

Soc Trang Environmental Monitoring Center (EMC) has just been established. There are 6 officials in this center: 1 director, 2 lab staffs, 1 accountant, 1 field staff and 1 cashier. In near future, they are going to have 2 more field staffs. The list of involved participants in training course conducted by Hung and Ha from 17, 18 and 21 of October, 2008 is presented in the below table:

No	Name	Position	Major
21.	Tran Van Thanh	Vice director of DONRE	Chemist
22.	Dong Thong Nhat	Director of EMC	Chemist
23.	Nguyen Dinh Khoa	EMC staff. Field team	Mechanics engineer
24.	Tran Mai Kieu	Lab staff	Food processing
25.	Bui Thi Viet Ha	Lab staff	-
26.	Danh Thanh Ha	EMD staff	-
27.	Lam Huynh Minh Tri	EMD staff	-
28.	Nguyen Thi Thanh Tuyen	EMD staff	Environmental engineering
29.	Phan Thanh Tri	EMD staff	-



Figure 4-18 Mr. Dong Thong Nhat Director of Soc Trang Environment Monitoring Center



Figure 4-19 Simple box for sample transport (which is too small for preservation in cooling condition)



Figure 4-20 Meeting with Soc Trang DONRE staff

At this moment, ST has one water quality monitoring program. They conduct sampling only once every year at 3 locations (No. 2, 3 and 5 indicated on the map, see Fig 4-21), regardless in tide regime. Current and additional sampling locations are mainly located along Maspero River. In future, it is suggested to select 4 additional sampling locations (No. 1, 4, 6 and 7). However, sampling location No. 3 can be skipped due to its limited representative. At the same time, this river is being silted, it is better to take sample at location No.4.

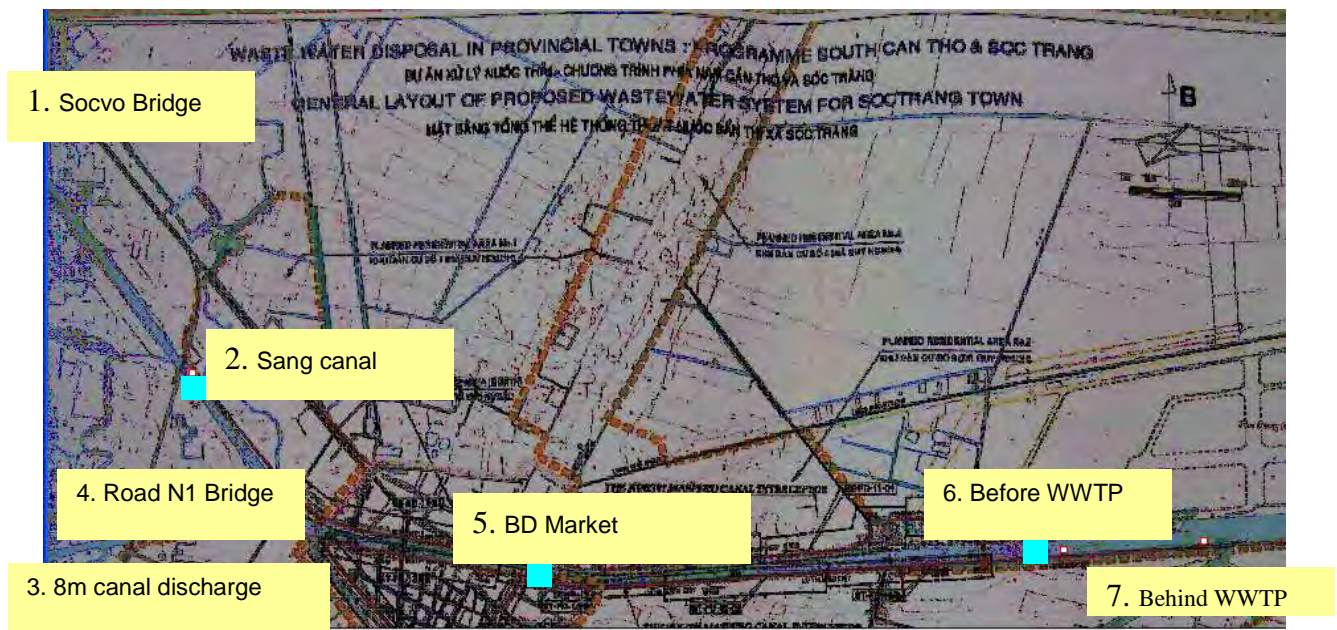


Figure 4-21 Sampling locations for water quality monitoring in Soc Trang City



Figure 4-22 Training using of water quality meter on site (Kenh Sang location)



Figure 4-23 Training using of water quality meter on site (Socvo location)



Figure 4-24 "8 m canal" from a sea processing factory



Figure 4-25 3rd April at market location



Figure 4-26 Measurement of turbidity in laboratory



Figure 4-27 Giving lectures on designing a monitoring program and equipment

Like Tra Vinh, Soc Trang Center for Environmental Monitoring has no field equipment to measure water quality on the field. At the present, they use lab equipment (multi-parameter

meter HATCH) to measure 4 parameter on the field. pH probe was damaged and it needs to be replaced by a new one. Measured data are presented in the below table.

No.	Sampling location	Position	DO (mg/l)	Temp. (°C)	Cond. (µS/cm)
1	Sang canal	09°36.837 105°57.852	0.46	30.6	294
2	Canal 8m- 2	09°37.902 105°57.134	1.04	30.9	261
3	Giap gianh	09°36.401 105°57.641	0.57	29.3	537
4	Market 3 th April	09°36.345 105°58.662	0.85	29.8	317
6	500m behind WWTP	09°36.412 106°06.012	0.30	30.2	289
7	500m before WWTP	09°36.369 105°59.429	0.56	30.1	288

4.4 Main Remarks on Three Southern DONRES

Tra Vinh is a small town with main economic structure of agriculture, animal husbandry and food processing. The existing equipments of Tra Vinh Environment Monitoring Center were mainly provided by national and international projects. Although there are some expensive equipments such as AAS, it has never been used. Tra Vinh Environmental Monitoring and Analysis Center has just been granted ISO 17025 for standard lab. This international standard specifies the general requirements for the competence to carry out tests and/or calibrations, including sampling. It covers testing and calibration performed using standard method, non-standard method and laboratory-development methods. However, it is only applicable for several water quality parameters. During our working visit with Tra Vinh Environmental Monitoring and Analysis Center, we recognized that the staffs of the center were young, willing to learn and desired to have further training in lab analysis and field sampling in order to use effectively their existing equipments.

Can Tho is the largest city in Mekong Delta and it is facing rapid urbanization and industrialization. There are a lot of rivers and canals in this region. Can Tho Environmental Monitoring and Analysis Center has been supported by national and international projects. Especially, with the strong support from Can Tho Department of Science and Technology, their lab was well equipped and staffs were well trained. The field team works actively. The existing equipments have been used effectively. DONRE can themselves design and conduct a monitoring program generally as well as monitoring programs for WWM project. However, QA/QC procedures have not been applied so far. Knowledge and application of QA/QC should be improved in order to meet the requirement of the Circular No. 10/2007/TT-BTNMT issued by MONRE on Oct. 22, 2007.

Soc Trang is a small city with main economic sector of agriculture. The lab of Soc Trang Environmental Monitoring and Analysis Center is not designed professionally. Equipments were provided through some national and international projects. Although there are some very expensive equipments such as HPLC, Lab staffs probably were not trained adequately to use those equipments. Therefore such equipments seem to be used very rarely. Because of budget limitation and local demand, water quality monitoring is conducted only once every year. However, after a special training course in lab analysis as well as in field sampling, the

center's staffs can themselves analyze some simple parameters in accordance with requirement of WWM project and correspondent QA/QC procedure.

Equipments:

TV and ST Centers for Environmental Monitoring and Analysis do not have field water quality multi-parameter meters; they are using lab DO meter and pH meter (HATCH) for field measurement. Those equipments are not suitable for field measurement and may be easily degraded in the fields. CT is using Horiba U20, which is very good equipment. However this multi-parameter meter is very expensive and requires highly skilled users. Water quality checker TOA 22A (Made in Japan) is an useful and well working equipment for field activities. Three southern DONREs have not this equipment. It would be effective for them to have this kind of equipment through support of WWM project as it will be an effective equipment to measure parameters in the field (Estimated cost is 2.900,00 USD/item).

In all three southern DONREs TV, CT, ST, there is no field sampler: no horizontal neither horizontal sampler. They are using simple and non-standard tools for field sampling, so that sampling can not meet standard requirements. Therefore we could not train them how to use those equipments for field sampling. We did train them how to take a composite sample as well as some QA/QC sample: blank, repeatable, duplicate, spike samples....We recommended DONREs to buy horizontal and/or vertical sampler and/or at least a bottle stick sampler (the simplest and cheapest one).

As soon as they have those equipments, we will come back to retrain them to use, calibrate and maintain multi-parameter meter and how to use sampler to take samples as required by standard procedure.

TV, CT, ST DONREs do not have special car for field trip: CT rent a private car, while TV and ST use motorbikes, which is not safe for carrying sample in particular with chemicals for preservation by cooling box with ice. We recommend that they had better buy a car or rent a car for field trip.

In those DONREs, they determine BOD5 using respiration technique. This technique is simple and easy for user; however, it has low accuracy. Basically, people from three above DONREs still determine BOD5 as simply as they can, they do not understand clearly each step in implementation, and therefore they can not control the quality of data they got. BOD5 analysis using DO probe is more applicable and skill training are also required.

In principle, the current capacity of those DONREs in compliance with TCVN 6772-2000 for domestic wastewater discharge standards can be summarized in the below table:

1. pH: Tra Vinh and Can Tho can analysis this parameter fluently. And pH probe in ST was broken
2. BOD: Soc Trang, Can Tho and Tra Vinh are using respiration techniques. Tra Vinh is using Winkler titration technique. It is recommended to use DO measurement for all three DONREs
3. Suspended solids: all of them can analyze this parameter well
4. Settleable solids: all three DONREs have never analyzed this parameter. However it is easy to do the analysis by using simple technique, and they can do by themselves
5. Total dissolved solids: all of them can analyze this parameter well
6. Sulfur (H ₂ S): No DONRE analyzes this parameter
7. Nitrate (NO ₃): this parameter is well analyzed by HATCH reagents using spectrophotometer (DR model) in all three DONREs
8. Mineral oil (Food): No equipment and no chemicals to analyze
9. Phosphate (PO ₄ ³⁻): this parameter is well analyzed by HACH reagents using spectrophotometer (DR model) in three DONREs
10. Total coliforms: No chemicals and no equipments to analyze

5. CONCLUSION

Three and haft day period is a quite short time to do the training for technical staffs of each DONRE. While, most of technical staffs in DONREs are lacking of experience in field measurement, at the same time there is a short of multi-parameter meters as well as samplers. In labs, they use mainly ready-to-use chemicals produced by HATCH. It is easy for them to conduct an analysis; however, they do not clearly understand steps of analysis. Therefore as mentioned above, they could not control the quality of received data. Moreover, those chemicals are much expensive compared with original one. We suggested using original chemicals to prepare necessary reagents and conduct the analysis. By this way, the budget can be saved for other activities. Therefore, this trip can be a beginning of training activities and give DONREs necessary ideas for next training after they have new equipment as mentioned above. They also need to have more staff specialized in chemistry. According to our experience from VCEP training courses, training for DONREs' staffs is very necessary and it can be repeated in long-term basis.