2-2 Composition analysis of household waste in the model areas of source separation in Ho Chi Minh City

REPORT 2

COMPOSITION ANALYSIS OF HOUSEHOLD WASTE IN THE MODEL AREAS OF SOURCE SEPARATION IN HO CHI MINH CITY

December, 2013

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ETM CENTER
Director

December, 2013

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DW	:	Dry Weight
HCV	:	High Calorific Value
LCV	:	Low Calorific Value
MSW	:	Municipal Solid Waste
VS	:	Volatile Solid
WW	:	Wet Weight

1. GENERAL INFORMATION

1.1 Project title: "Solid Waste Separation at Sources Pilot Program" - The 2nd composition analysis of household waste in the model areas of source separation in Ho Chi Minh City.

1.2 Objective

To identify the quantity and quality of separated household waste in the model area of pilot study on source separation in district 1, Ho Chi Minh City.

1.3 Implementing Agencies

1.3.1 Physical composition analysis

The Department of Natural Resources and Environment (DONRE), Ho Chi Minh City implements the pilot study on source separation on 86 households in District 1 after training to separate including food waste and other waste for identifying the quality and quantity of household waste before starting the source separation, method as follows:

- To distribute designated plastic bags for sampling wastes to all households in the pilot areas;
- To sample and transport household waste in the pilot areas to Tong Van Tran transfer station in district 11;
- To sort the sampled waste into several categories per each household and weight the sorted waste at Tong Van Tran transfer station in district 11.

1.3.2 Proximate composition analysis

Center for Environmental Technology and Management – ETM Center conducts proximate composition (moisture, volatile, ash content and gross calorific value of sampled household waste in the model areas which aim to make clear the current waste quality and quantity), method as follows:

- To sample the waste after physical composition analysis;
- To analyze proximate composition (moisture, volatile, ash content and gross calorific value).

1.4 Schedule of the 2nd composition analysis

The schedule of the 2nd composition analysis is shown in Table 1.

Table 1 The schedule of the 2nd composition analysis

Day	DONRE	ETM
17 December (Tue)	15:00 Preparation by students at DONRE	
18 December (Wed)	17:00 Distributing plastic bags	
19 December (Thu)	16:00 Sampling waste 17:30 Physical composition analysis	
20 December (Fri)	16:00 Sampling waste 17:30 Physical composition analysis	19:00 Sampling waste- Sample 1
21 December (Sat)	16:00 Sampling waste 17:30 Physical composition analysis	
22 December (Sun)	16:00 Sampling waste 17:30 Physical composition analysis	19:00 Sampling waste – Sample 2
23 December (Mon)	16:00 Sampling waste 17:30 Physical composition analysis	
24 December (Tue)	16:00 Sampling waste 17:30 Physical composition analysis	19:00 Sampling waste – Sample 3
25 December (Wed)	16:00 Sampling waste 17:30 Physical composition analysis	
26 December (Thu)	16:00 Sampling waste 17:30 Physical composition analysis	19:00 Sampling waste – Sample 4

2. ANALYTICAL PLAN AND METHOD

2.1 Analytical plan

Household waste has been classified from 14 categories and the parameter analysis of each category is shown in Table 2.

Table 2 Analytical plan of 14 categories of District 1 household waste in December 2013

No.	Categories	Moisture	Volatile	Gross calorific value
1	Food	○	○	○
2	Shell – bone (also including durian skin, coconut shell, corn cores, egg shells, mango seed, etc.)	○	○	○
3	Paper	○	○	○
4	Plastic	○	○	○
5	Diaper	○	○	○
6	Textiles	○	○	○
7	Garden waste (green leaves, flower, etc.)	○	○	○

No.	Categories	Moisture	Volatile	Gross calorific value
9	Rubber and leather	○	○	○
10	Glass	○	x	x
11	Metal	○	x	x
12	Ceramics	○	x	x
13	Coal ash	○	x	x
14	Others (soil, sand, hair, cigarette butts, sawdust etc.)	○	○	○

Note: ○ - analyze
X – not analyze

2.2 Analytical method

Household waste has been classified from 14 categories and contained in 80-liter bin. After that, ETM take these sorted categories for proximate composition analysis as following:

2.2.1 Sampling method for proximate composition analysis

a. All of sorted waste after physical composition analysis is mixed manually per each category using a shovel so that it becomes as homogeneous as possible.

b. The volume of waste is reduced with a quartering method until the sample gets about 25 kg.

c. The mixed sample is then cut into pieces using shovels and scissors so that the size of a piece would smaller than 15cm long.

d. The volume of waste is again reduced with a quartering method until the sample gets about 5-10kg for food waste and 5 kg plastic and sorted category is smaller than 2kg, collect all; higher than 2kg, collect about 2-5 kg.

2.2.2 Analytical method

Analysis of moisture content

a. Moisture content of each composition is measured individually according to APHA 2540 G (2012).

b. All of the waste for each composition is cut into pieces of 2 to 3 cm^3 and individually spread out in a metal container (the height of the waste in the container should be less than 10cm if possible).

c. Then the waste in the container is dried by conductive heating. Heating temperature is set to 105 degrees Celsius. Heating will continue for 4 to 5 days or until the sample weight reaches a point where it will no longer change.

d. Moisture content of each component is calculated by the difference between the weight of the wet sample and the weight of the dried sample.

Analysis of VS, Ash content and Gross Calorific value

VS, ash content and gross calorific value analysis are conducted using the dried residue from moisture analysis.

10 combustible samples (food, shell-bone, paper, plastic, diaper, textile, wood, flower and garden, rubber and leather, others) are cut into pieces less than 1cm for analysis of Volatile and Ash content. The sample will be combusted at 550 degrees Celsius based on reference APHA 2540 G (2012).

10 combustible samples (food, other food, paper, plastic, diaper, textiles, wood, flower and garden, rubber and leather, others) are cut into pieces less than 1cm. Then, the obtained samples are crushed into pieces so that the size of a piece would smaller than 2mm for analysis of gross calorific value based on reference TCVN 200-2011 (ISO 1928:2009).

The analytical method for all parameters of household waste is presented in Table 3.

Table 3 Analytical method of district 1 household waste in December 2013

No.	Parameter	Analytical method	Analytical Instrument
1	Moisture	APHA 2540 G	WTB Binder, Germany, Mettler Toledo MS204 balance, Switzerland
2	Volatile and Ash	APHA 2540 G	Nabertherm oven, Mettler Toledo MS204 balance, Switzerland
3	Gross calorific value	TCVN 200 -2011 (ISO 1928:2009)	IKA calorimeter C 4000

3. ANALYTICAL RESULTS

3.1 Information of household waste

District 1 household waste is sorted into 14 types, then separately stored in 80-liter bins. After that, each type is weighed by ETM. The information of District 1 household waste in December 2013 is presented in Table 4.

Table 4 Information of District 1 household waste in December 2013

Composition	Weight (g)					
	20 December			22 December		
	Initial sample (g)	% wet weight of initial sample (%)	Analyzing sample (g)	Initial sample (g)	% wet weight of initial sample (%)	Analyzing sample (g)
Food waste	107,500	**51.0**	12,000	72,000	**54.2**	12,000
Shell – Bone	41,600	**19.7**	8,400	9,000	**6.8**	3,600
Paper	11,000	**5.2**	2,000	12,000	**9.0**	2,100
Plastic	20,400	**9.7**	4,000	14,700	**11.1**	3,900
Diaper	5,400	**2.6**	1,600	4,500	**3.4**	1,000
Textile	2,500	**1.2**	2,500	1,000	**0.8**	1,000
Flower and garden	5,500	**2.6**	2,650	8,000	**6.0**	3,500
Wood	400	**0.2**	400	700	**0.5**	700
Rubber and leather	750	**0.4**	750	600	**0.5**	600
Glass	8,400	**4.0**	1,500	2,200	**1.7**	2,200
Metal	700	**0.3**	700	800	**0.6**	800
Ceramic	1,000	**0.5**	1,000	-	**-**	-
Coal ash	300	**0.1**	300	400	**0.3**	400
Others	5,300	**2.5**	5,300	7,000	**5.3**	7,000
Total	**210,750**	**100.0**	43,100	**132,900**	**100.0**	38,800

Composition	Weight (g)					
	24 December			26 December		
	Initial sample (g)	% wet weight of initial sample (%)	Analyzing sample (g)	Initial sample (g)	% wet weight of initial sample (%)	Analyzing sample (g)
Food waste	90,000	**48.7**	7,500	87,000	**48.7**	8,500
Shell – Bone	35,400	**19.2**	4,300	39,000	**21.8**	5,000
Paper	9,600	**5.2**	2,500	10,800	**6.0**	2,300
Plastic	20,000	**10.8**	5,000	16,200	**9.1**	3,300
Diaper	7,000	**3.8**	1,400	6,200	**3.5**	2,000
Textile	4,100	**2.2**	4,100	1,800	**1.0**	1,800
Flower and garden	9,500	**5.1**	2,500	5,000	**2.8**	2,200
Wood	600	**0.3**	600	400	**0.2**	400
Rubber and leather	50	**0.0**	50	1,500	**0.8**	1,500
Glass	3,200	**1.7**	3,200	1,500	**0.8**	1,500
Metal	1,000	**0.5**	1,000	900	**0.5**	900
Ceramic	200	**0.1**	200	700	**0.4**	700
Coal ash	100	**0.1**	100	5,000	**2.8**	5,000
Others	3,900	**2.1**	3,900	2,600	**1.5**	2,600
Total	**184,650**	**100.0**	36,350	**178,600**	**100.0**	37,700

3.2 Physical composition

The results of average percentage (by wet weight and dry weight) of each composition of household waste are shown in Figure 1a and 1b.

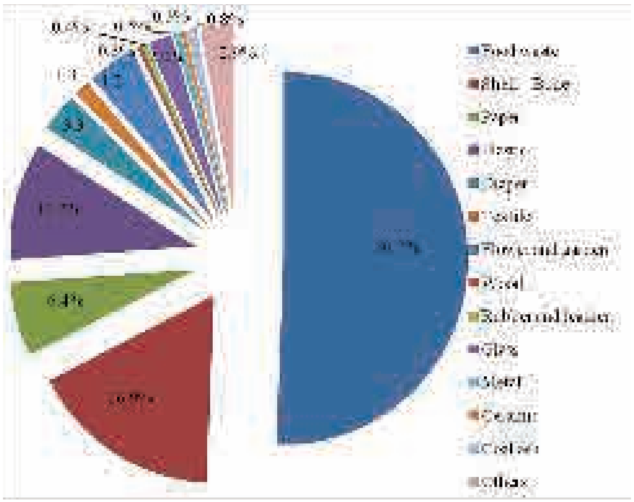

Figure 1a Average percentage of physical compositions (% wet weight) in four samples in December, 2013

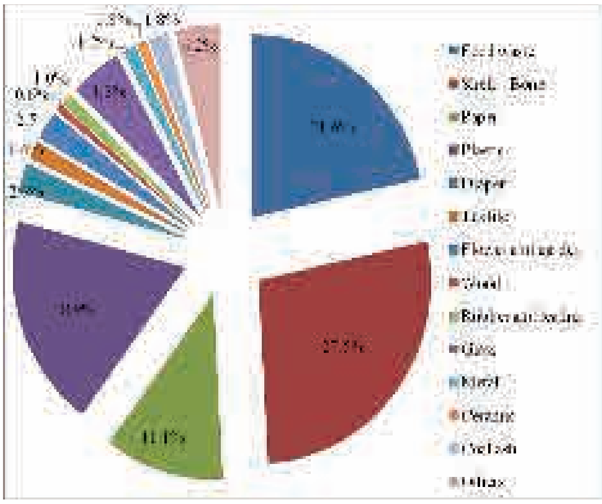

Figure 1b Average percentage of physical compositions (% dry weight) in four samples in December, 2013

As above figures, food waste in district 1 household waste has the highest percentage of 50.7% (% ww) that is higher than Binh Thanh district household waste but lower than Phuoc Hiep landfill. According to Binh Thanh district household waste report (July, 2013) and Phuoc Hiep MSW report (December, 2013), the average percentage of food waste in these two places was 45.3% and 61.3%, respectively.

The shell-bone like shell, bone, eggshell, coconut shell, fruit seed, etc. has the second high percentage of about 16.9% (% ww) that is higher than Binh Thanh district household waste (11.8%). Otherwise, flower and garden; and other compositions in district 1 household waste have their percentages that are lower than Binh Thanh district. Particularly, there are 4.2% and 2.9% for district 1 household waste; 10.8% and 5.0% for Binh Thanh district household waste.

Plastic, glass, metal, coal ash, etc. in district 1 and Binh Thanh district household wastes have insignificantly percentage fluctuation. Particularly, the average percentage (by wet weight) of these compositions is 10.2% for plastic, 6.4% for paper, 3.3% for diaper and 2% for glass. The average percentage (by wet weight) of textile, coal ash and metal is 1.3%, 0.8% and 0.5%, respectively. The average percentage (by wet weight) of ceramic and wood is equivalent, occupied about 0.3%.

The percentage by dry weight showed that among separated waste compositions, shell-bone and food waste occupied mostly with their high percentages namely 27.5% and 21.6%, respectively.

- In addition, there are 18.9% for plastic and 11.1% for paper by dry weight. The average percentage of glass and others is 4.8% and 4.2%, respectively. Another compositions have the average percentage in range of 0.6% - 2.6% by dry weight.

The result of the average percentage of each physical composition (% wet weight) of each sample is presented in Table 5.

Table 5 Average percentage of each physical composition by wet weight in four samples (December, 2013)

No.	Composition	sample 1	sample 2	sample 3	sample 4
1	Food waste	51.0	54.2	48.7	48.7
2	Shell – Bone	19.7	6.8	19.2	21.8
3	Paper	5.2	9.0	5.2	6.1
4	Plastic	9.7	11.1	10.8	9.1
5	Diaper	2.6	3.4	3.8	3.5
6	Textile	1.2	0.7	2.2	1.0
7	Flower and garden	2.6	6.0	5.2	2.8
8	Wood	0.2	0.5	0.3	0.2
9	Rubber and leather	0.4	0.4	0.0	0.8
10	Glass	4.0	1.7	1.7	0.8
11	Metal	0.3	0.6	0.6	0.5
12	Ceramic	0.5	-	0.1	0.4
13	Coal ash	0.1	0.3	0.1	2.8
14	Others	2.5	5.3	2.1	1.5

"-" No sample

3.3 Moisture, VS and ash

3.3.1 Moisture

According to moisture content of each physical composition in each sample presented in Table 6, the fluctuation of moisture content of each composition is shown in Figure 2a, 2b.

Table 6 Moisture content of each composition in four samples

No.	Composition	Moisture content (%)						
		Sample 1	Sample 2	Sample 3	Sample 4	Average	Min	Max
1	Food waste	79.8	81.8	87.4	82.8	83.0	79.8	87.4
2	Shell – Bone	29.3	28.3	27.9	46.0	32.9	27.9	46.0
3	Paper	29.0	34.2	27.7	26.4	29.3	26.4	34.2
4	Plastic	25.5	24.9	24.8	28.4	25.9	24.8	28.4
5	Diaper	67.8	62.8	67.4	79.2	69.3	62.8	79.2
6	Textile	49.0	52.7	56.3	46.5	51.1	46.5	56.3
7	Flower and garden	74.8	78.7	77.2	72.6	75.8	72.6	78.7
8	Wood	26.4	14	26.6	22.7	22.4	14.0	26.6

9	Rubber and leather	8.3	8.9	4.1	7.5	7.2	4.1	8.9
10	Glass	3.1	2.6	9.3	2.4	4.4	2.4	9.3
11	Metal	5.0	4.1	3.1	3.7	4.0	3.1	5.0
12	Ceramic	2.9	-	2.3	2.2	2.5	2.2	2.9
13	Coal ash	38.9	32.2	30.7	9.4	26.3	9.4	38.9
14	Others	43.4	41.7	43.3	38.3	41.7	38.3	43.4

As data presented in Table 6, some compositions have high moisture content as follows:

Food waste: the moisture content of food waste is observed about 79.8% (sample 1), 87.4% (sample 3) and so its average value is 83.0%. The moisture content depends on composition difference of food waste. The food waste has high moisture content due to organic compositions contained such as leftovers, vegetable, and fruit with high moisture content.

Garden waste such as green leaves, flower is also considered as high-moisture-content compositions, in range of 72.6%-78.7%.

Diaper: the moisture content of diaper in household waste ranges from 62.8% to 79.2% and 69.3% as average value. It is lightly higher than moisture content values of Binh Thanh district household waste (63.2%).

Textile: the moisture content of textile in household waste ranges from 46.5% to 56.3% and 51.1% as average value.

The moisture content of shell-bone (other food) fluctuates from 27.9% (sample 3) to 46.0% (sample 4) and 32.9% as average value. The snail shell has the highest moisture percentage and it is resulted from snail restaurants in sampling area.

The moisture content of coal ash is rather high in range of 30.7% - 38.9% in sample 1, 2 and 3 but is very low in sample 4 (9.4%). In sample 4, coal ash composition is husk firewood and the others are charcoal and coal slag.

The moisture content of some other compositions is very low. Particularly, there is 3.1% – 5.0% for metal, 2.4% – 9.3% for glass, and 2.2 – 2.9% for ceramic because they are non-absorbing materials.

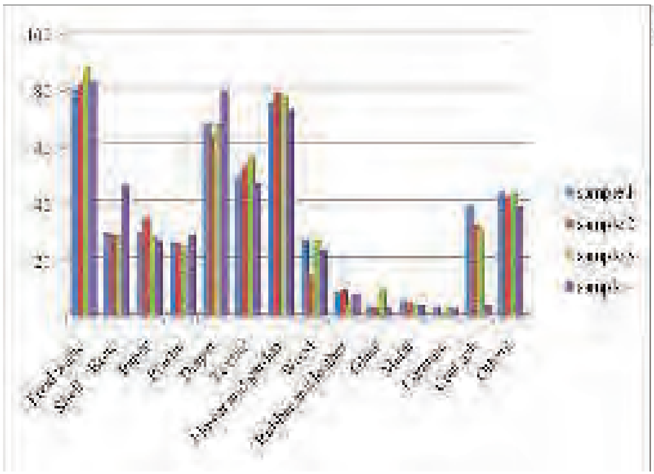

Figure 2a Moisture content (%) of district 1 household waste compositions in four samples

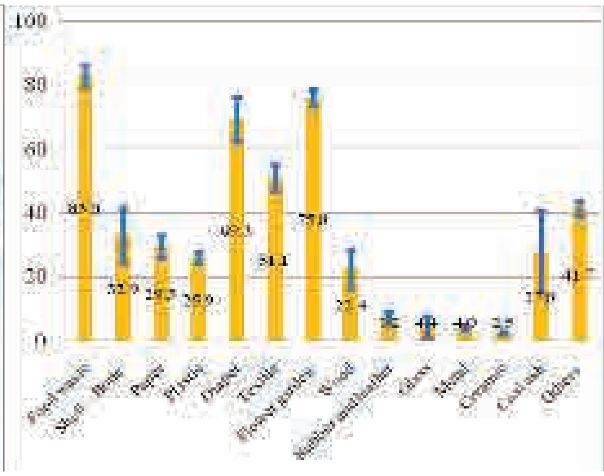

Figure 2b Average moisture content of district 1 household waste compositions

3.2 VS and ash

The results of VS and ash content of each sample are shown in Figure 3a, b, c and d. In which, the ash content of some compositions namely metal, glass, ceramic and coal ash is not analyzed and estimated 100% by dry weight.

VS (by dry weight) of wood, plastic, textile, diaper and paper and food waste is observed with high percentage. In which, VS of wood, plastic and textile is over 90% by dry weight; and diaper, paper and food waste is over 80% by dry weight.

VS of shell-bone (other food) and others is lower. Average VS value of shell-bone and other compositions is approximately 21.5% and 19.6% by dry weight, respectively.

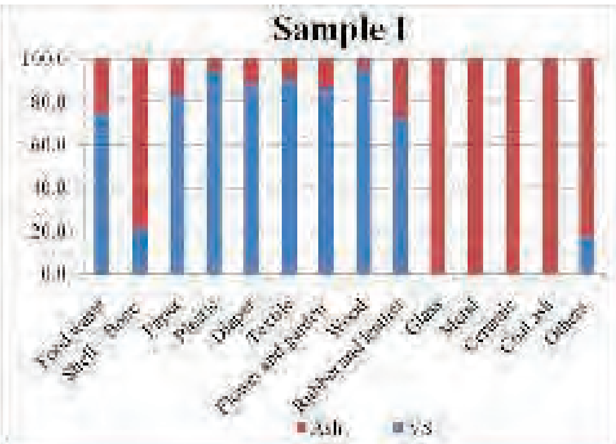

Figure 3a Ash and VS (% dry weight) of sample 1, 20 December, 2013

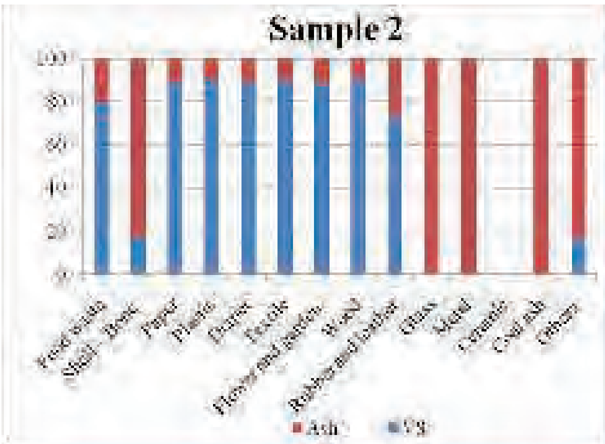

Figure 3b Ash and VS (% dry weight) of sample 2, 22 December, 2013

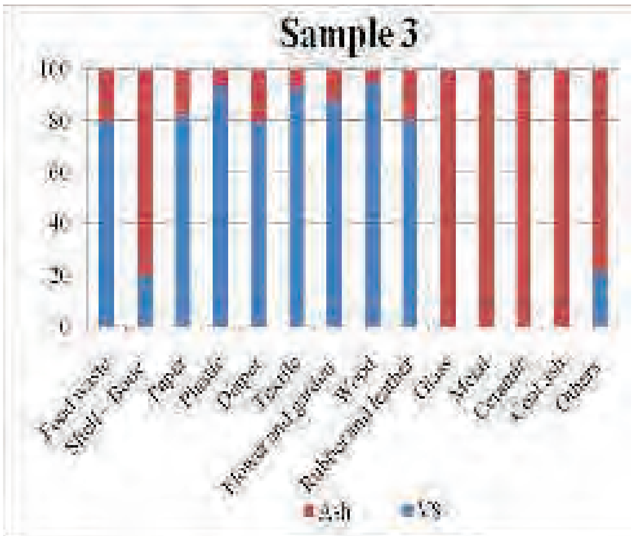

Figure 3c Ash and VS (% dry weight) of sample 3, 24 December, 2013

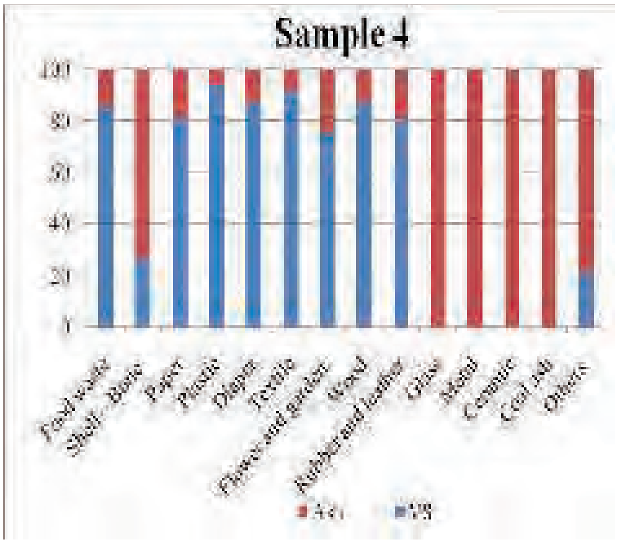

Figure 3d Ash and VS (% dry weight) of sample 4, 26 December, 2013

3.4 Correlation of moisture content, VS and ash

3.4.1 Correlation of moisture content, VS and ash of each composition by wet weight.

Correlation of moisture content, VS and ash (% wet weight) in household waste samples is shown in Figure 4a, b, c, d.

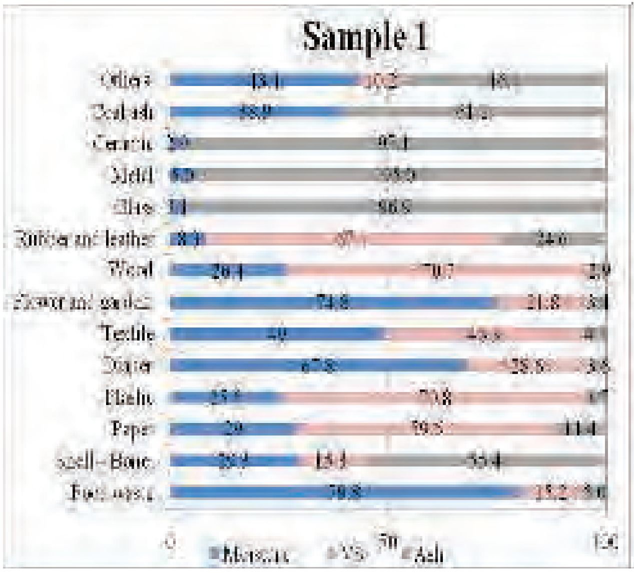

Figure 4a Correlation of moisture content, VS and ash (% wet weight) of each composition in sample 1

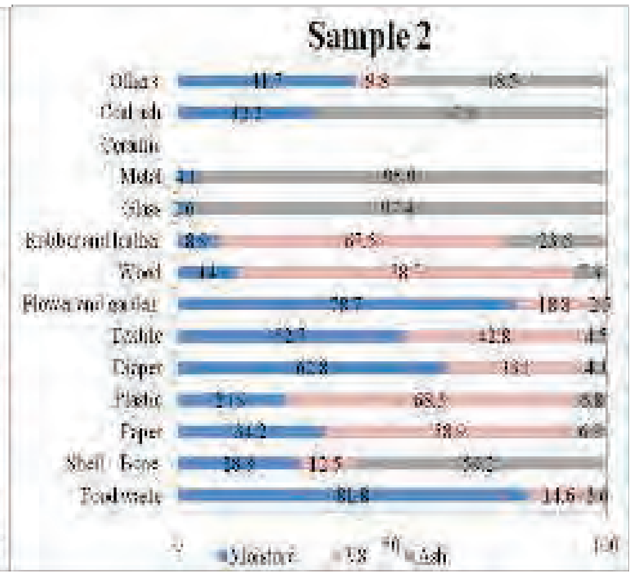

Figure 4b Correlation of moisture content, VS and ash (% wet weight) of each composition in sample 2

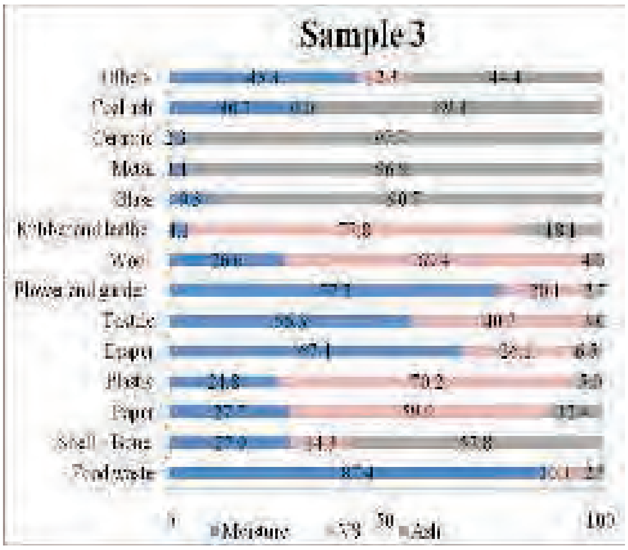

Figure 4c Correlation of moisture content, VS and ash (% wet weight) of each composition in sample 3

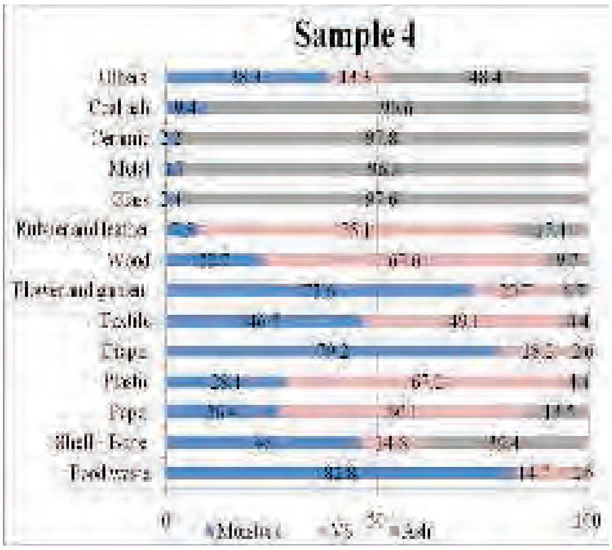

Figure 4d Correlation of moisture content, VS and ash (% wet weight) of each composition in sample 4

According to these figures, the correlation of moisture content, ash and VS in each composition is based on natural characteristics by itself.

The physical compositions of food waste have the highest percentage namely moisture content of 79.8% -87.4%, VS of 10.1% - 15.2% and ash content of 2.5% - 5.0% by wet weight.

The second high percentage is flower and garden namely moisture content of 72.6% - 78.7%, VS of 18.8% - 21.7% and ash content of 2.5% - 6.7% by wet weight.

Moisture content, VS and ash content of diaper is 62.8 % - 79.2%, 18.2% - 33.1% and 2.6% - 6.5% by wet weight, respectively. One of textile is 49.0 % - 56.3%, 40.7% - 49.1% and 3.0% - 4.7%, respectively.

Ash content of ceramic, coal ash and metal is very high in range of 90.7% - 97.8% by wet weight.

3.4.2 Correlation of moisture content, VS and ash of each sample by wet weight

The correlation of moisture content, VS and ash content of each composition is shown Figure 5a, b, c and d. The percentage of moisture content, VS and ash content by wet weight in original sample is shown under horizontal bar chart.

The result of four samples are observed with 56.1% - 61.8% for moisture content, 21.7% - 25.4% for VS and 12.8% - 20.6% for ash content (by wet weight).

The results of moisture, ash content and VS of District 1 household waste samples in December 2013 are presented in Table 7.

Table 7 Moisture, ash content and VS values of District 1 household waste sample in December, 2013

Parameter	Average value	Min	Max
Moisture (%)	59.9	56.1	61.8
Ash (%)	16.8	12.8	20.6
Volatile (%)	23.3	21.7	25.4

The average moisture content of District 1 household waste sample in December 2013 (59.9%) is lower than one of MSW of Binh Thanh district household waste sample in July, 2013 (62.0%). However, the average ash content of District 1 household waste samples (16.8%) is higher than one of Binh Thanh district household waste sample (13.8%).

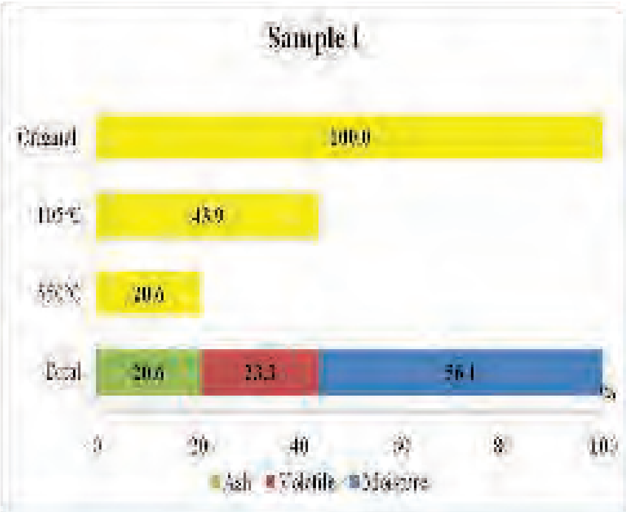

Figure 5a Correlation of moisture content, VS and ash by wet weight in sample 1

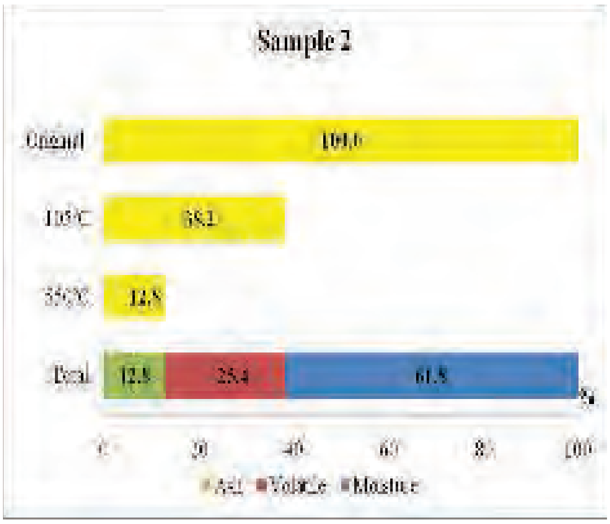

Figure 5b Correlation of moisture content, VS and ash by wet weight in sample 2

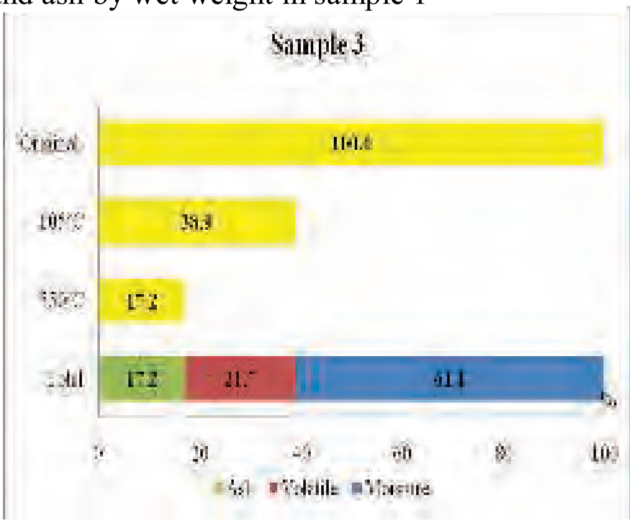

Figure 5c Correlation of moisture, VS and ash by wet weight in sample 3

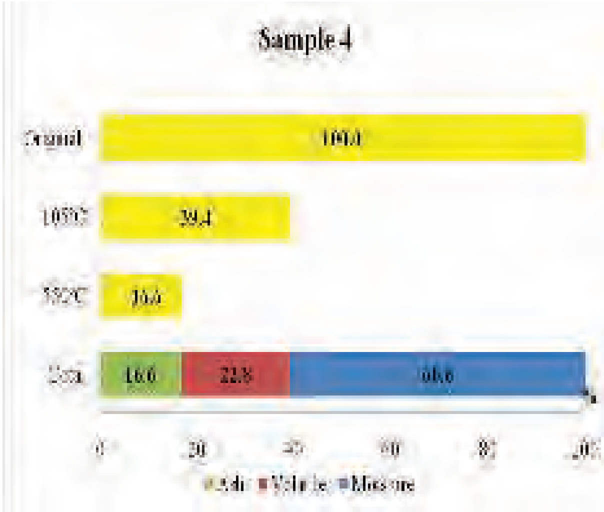

Figure 5d Correlation of moisture, VS and ash by wet weight in sample 4

3.5 Gross calorific value

The gross calorific values of household waste in four samples taken on 20th, 22nd, 24th and 26th December, 2013 are shown in Table 8, Figure 6a and 6b.

Table 8 Gross calorific values by dry weight of four samples (December, 2013)

No.	Composition	Gross calorific value (Cal/g)						
		Sample 1	Sample 2	Sample 3	Sample 4	Average	Min	Max
1	Food waste	3,958	4,643	3,654	4,680	4,234	3,654	4,680
2	Shell – Bone	1,280	1,199	579	588	912	579	1,280
3	Paper	3,767	3,428	3,499	3,645	3,585	3,428	3,767
4	Plastic	9,473	9,019	8,273	8,309	8,769	8,273	9,473
5	Diaper	5,546	5,233	5,111	5,860	5,675	5,111	5,860
6	Textile	4,262	4,717	5,139	4,809	5,352	4,262	5,139
7	Flower and garden	4,275	3,501	4,444	4,307	4,132	3,501	4,444
8	Wood	3,953	4,262	4,293	4,313	4,205	3,953	4,313
9	Rubber and leather	6,678	5,401	-	6,752	6,277	5,401	6,752
10	Glass	-	-	-	-	-	-	-
11	Metal	-	-	-	-	-	-	-
12	Ceramic	-	-	-	-	-	-	-
13	Coal ash	-	-	-	-	-	-	-
14	Others	596	376	318	1601	723	318	1,601

Among these compositions of household waste, plastic has the highest gross calorific value of 8,769 Cal/g.

Rubber & leather, diaper and textile has average gross calorific value in range of 5,352 – 6,277 cal/g.

Some compositions with lower gross calorific values from 3,500 to over 4,200cal/g include food waste (4,234 Cal/g), wood (4,205 Cal/g), flower and garden (4,132 Cal/g) and paper (3,585Cal/g).

Others (soil, sand, rock, etc.) and shell-bone (shell, snail shell, egg shell, etc.) have the lowest gross calorific value. The average gross calorific value of shell-bone and others is 912 and 723 Cal/g, respectively.

The estimated high gross calorific and low calorific values of four samples fluctuate from 1,287 Cal/g to 1,648 Cal/g and from 958 Cal/g to 1,315 Cal/g, respectively.

Therefore, if the low calorific value H_L > 800 Kcal/kg, can be applied range of incineration and if H_L > 1,500 Kcal/Kg, can be applied range of incineration with energy recovery; these household waste can be applied incineration treatment.

Therefore, if the sample has low gross calorific value of H_L > 800 Kcal/Kg, it can be applied for incineration. If the sample has gross calorific value of H_L > 1,500 Kcal/Kg, it can be applied for incineration with energy recovery. Therefore, these household wastes can be applied for incineration treatment.

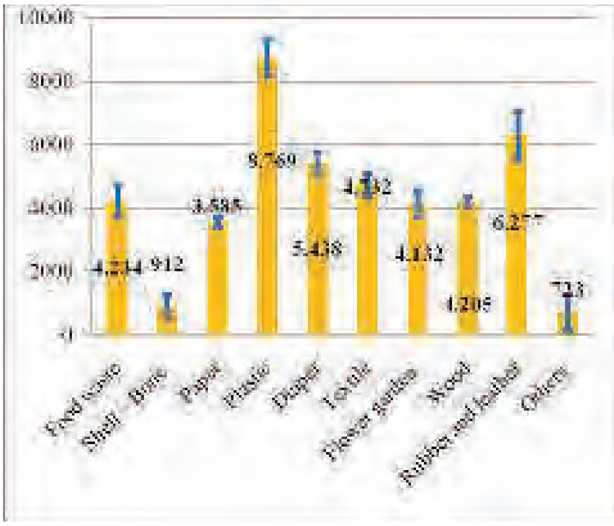

Figure 6a Average gross calorific value of each composition

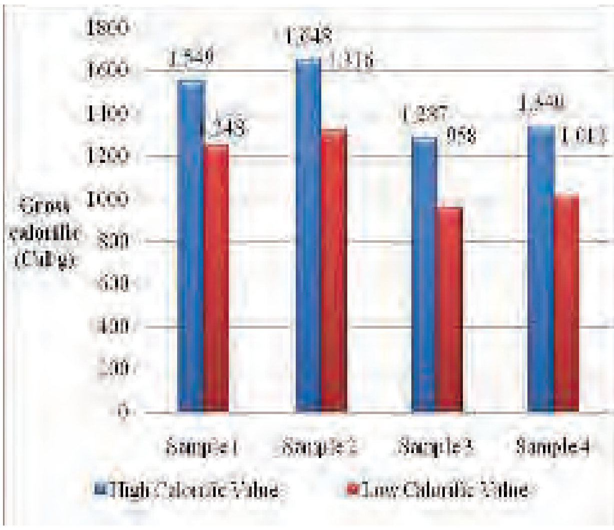

Figure 6b Average gross calorific value of four samples

Appendix

APPENDIX 1

Analytical result

Sample 1 (20.12.2013)

The raw results

No	Composition	Moisture content, at 105°C (%)	Ash, at 550°C (%)	VS (%)	Gross Calorific (Cal/g)
1	Food waste	79.8	24.6	75.4	3958
2	Shell – Bone (snail shells, bones, corn cores, coconut shells, egg shells…)	29.3	78.3	21.7	1280
3	Paper	29.0	16.1	83.9	3767
4	Plastic	25.5	5.0	95.0	9473
5	Diaper	67.8	11.2	88.8	5546
6	Textile	49.0	9.2	90.8	4262
7	Flower and garden	74.8	13.6	86.4	4275
8	Wood	26.4	4.0	96.0	3953
9	Rubber and leather	8.3	26.8	73.2	6678
10	Glass	3.1	-	-	-
11	Metal	5.0	-	-	-
12	Ceramic	2.9	-	-	-
13	Coal ash	38.9	-	-	-
14	Others (soil, sawdust, cigarette butts, hair)	43.4	81.9	18.1	596
Measuring/analyzing method		**SMEWW 2540 G (2012)**	**SMEWW 2540 G (2012)**	**SMEWW 2540 G (2012)**	**TCVN 200:2011**

The other calculated results

No	Category	Physical composition		Proximate composition				
		Wet (%)	Dry (%)	Moisture (%ww)	Volatile (%ww)	Ash (%ww)	HHV (Cal/g)	LHV (Cal/g)
1	Food waste	51.0	23.5	79.8	15.2	5.0	408	188
2	Shell – Bone	19.7	31.8	29.3	15.3	55.4	178	147
3	Paper	5.2	8.4	29.0	59.6	11.4	139	131
4	Plastic	9.7	16.4	25.5	70.8	3.7	685	671
5	Diaper	2.6	1.9	67.8	28.6	3.6	46	37
6	Textile	1.2	1.4	49.0	46.3	4.7	26	23
7	Flower and garden	2.6	1.5	74.8	21.8	3.4	28	18
8	Wood	0.2	0.3	26.4	70.7	2.9	6	6
9	Rubber and leather	0.4	0.8	8.3	67.1	24.6	25	24
10	Glass	4.0	8.8	3.1	0.0	96.9	-	-
11	Metal	0.3	0.7	5.0	0.0	95.0	-	-
12	Ceramic	0.5	1.1	2.9	0.0	97.1	-	-
13	Coal ash	0.1	0.2	38.9	0.0	61.1	-	-
14	Others	2.5	3.2	43.4	10.2	46.4	8	3
	Total	**100.0**	**100.0**				**1549**	**1248**

Sample 2 (22.12.2013)

The raw results

No	Composition	Moisture content, at 105^{o}C (%)	Ash, at 550^{o}C (%)	VS (%)	Gross Calorific (Cal/g)
1	Food waste	81.8	20	80.0	4643
2	Shell – Bone (snail shells, bones, corn cores, coconut shells, egg shells…)	28.3	82.5	17.5	1199
3	Paper	34.2	10.5	89.5	3428
4	Plastic	24.9	9	91.0	9019
5	Diaper	62.8	11.1	88.9	5233
6	Textile	52.7	9.6	90.4	4717
7	Flower garden	78.7	11.7	88.3	3501
8	Wood	14	8.5	91.5	4262
9	Rubber and leather	8.9	25.9	74.1	5401
10	Glass	2.6	-	-	-
11	Metal	4.1	-	-	-
12	Ceramic	-	-	-	-
13	Coal ash	32.2	-	-	-
14	Others (sawdust, cigarette butts, hair)	41.7	83.2	16.8	376
Measuring/analyzing method		**SMEWW 2540 G (2012)**	**SMEWW 2540 G (2012)**	**SMEWW 2540 G (2012)**	**TCVN 200:2011**

The other calculated results

No	Category	Physical composition		Proximate composition				
		Wet (%)	Dry (%)	Moisture (%ww)	Volatile (%ww)	Ash (%ww)	HHV (Cal/g)	LHV (Cal/g)
1	Food waste	54.2	25.8	81.8	14.6	3.6	458	219
2	Shell – Bone	6.8	12.7	28.3	12.5	59.2	59	48
3	Paper	9	15.6	34.2	58.9	6.9	203	186
4	Plastic	11.1	21.8	24.9	68.3	6.8	752	737
5	Diaper	3.4	3.3	62.8	33.1	4.1	66	55
6	Textile	0.7	0.9	52.7	42.8	4.5	16	14
7	Flower and garden	6	3.4	78.7	18.8	2.5	45	19
8	Wood	0.5	1.2	14	78.7	7.3	18	18
9	Rubber and leather	0.4	1.1	8.9	67.5	23.6	20	20
10	Glass	1.7	4.2	2.6	0.0	97.4	-	-
11	Metal	0.6	1.5	4.1	0.0	95.9	-	-
12	Ceramic	-	-	-	-	-	-	-
13	Coal ash	0.3	0.5	32.2	0.0	67.8	-	-
14	Others	5.3	8	41.7	9.8	48.5	12	0
	Total	**100.0**	**100.0**				**1649**	**1316**

Sample 3 (24.12.2013)

The raw results

No	Composition	Moisture content, at 105 °C (%)	Ash, at 550°C (%)	VS (%)	Gross Calorific (Cal/g)
1	Food waste	87.4	19.9	80.1	3654
2	Shell – Bone (snail shells, bones, corn cores, coconut shells, egg shells…)	27.9	80.2	19.8	579
3	Paper	27.7	17.2	82.8	3499
4	Plastic	24.8	6.7	93.3	8273
5	Diaper	67.4	19.9	80.1	5111
6	Textile	56.3	6.9	93.1	5139
7	Flower and garden	77.2	12	88.0	4444
8	Wood	26.6	5.4	94.6	4293
9	Rubber and leather	4.1	18.9	81.1	-
10	Glass	9.3	-	-	-
11	Metal	3.1	-	-	-
12	Ceramic	2.3	-	-	-
13	Coal ash	30.7	-	-	-3
14	Others (soil, sawdust, hair)	43.3	78.3	21.7	318
Measuring/analyzing method		**SMEWW 2540 G (2012)**	**SMEWW 2540 G (2012)**	**SMEWW 2540 G (2012)**	**TCVN 200:2011**

The other calculated results

No	Category	Physical composition		Proximate composition				
		Wet (%)	Dry (%)	Moisture (%ww)	Volatile (%ww)	Ash (%ww)	HCV (Cal/g)	LCV (Cal/g)
1	Food waste	48.7	15.7	87.4	10.1	2.5	224	-6
2	Shell – Bone	19.2	35.5	27.9	14.3	57.8	80	51.2
3	Paper	5.2	9.7	27.7	59.9	12.4	132	124
4	Plastic	10.8	20.9	24.8	70.2	5.0	672	657
5	Diaper	3.8	3.2	67.4	26.1	6.5	63	50
6	Textile	2.2	2.5	56.3	40.7	3.0	49	43
7	Flower and garden	5.2	3	77.2	20.1	2.7	53	31
8	Wood	0.3	0.6	26.6	69.4	4.0	10	9
9	Rubber and leather	0	0.1	4.1	77.8	18.1	-	-
10	Glass	1.7	4	9.3	0.0	90.7	-	-
11	Metal	0.6	1.3	3.1	0.0	96.9	-	-
12	Ceramic	0.1	0.3	2.3	0.0	97.7	-	-
13	Coal ash	0.1	0.1	30.7	0.0	69.3	-	-
14	Others	2.1	3.1	43.3	12.3	44.4	4	-1
	Total	**100.0**	**100.0**				**1287**	**958**

Sample 4 (26.12.2013)

The raw results

No	Composition	Moisture content, at 105 ^{o}C (%)	Ash, at 550^{o}C (%)	VS (%)	Gross Calorific (Cal/g)
1	Food waste	82.8	14.5	85.5	4680
2	Shell – Bone (snail shells, bones, corn cores, coconut shells, egg shells…)	46	72.9	27.1	588
3	Paper	26.4	18.4	81.6	3645
4	Plastic	28.4	6.1	93.9	8309
5	Diaper	79.2	12.6	87.4	5860
6	Textile	46.5	8.3	91.7	4809
7	Flower and garden	72.6	24.6	75.4	4307
8	Wood	22.7	12.6	87.4	4313
9	Rubber and leather	7.5	18.8	81.2	6752
10	Glass	2.4	-	-	-
11	Metal	3.7	-	-	-
12	Ceramic	2.2	-	-	-
13	Coal ash	9.4	-	-	-
14	Others (soil, cigarette butts, foot incenses)	38.3	78.4	21.6	1601
Measuring/analyzing method		**SMEWW 2540 G (2012)**	**SMEWW 2540 G (2012)**	**SMEWW 2540 G (2012)**	**TCVN 200:2011**

The other calculated results

No	Category	Physical composition		Proximate composition				
		Wet (%)	Dry (%)	Moisture (%ww)	Volatile (%ww)	Ash (%ww)	HCV (Cal/g)	LCV (Cal/g)
1	Food waste	48.7	21.3	82.8	14.7	2.5	392	174
2	Shell – Bone	21.8	30.1	46	14.6	39.4	69	15
3	Paper	6.1	11.3	26.4	60.1	13.5	164	155
4	Plastic	9.1	16.6	28.4	67.2	4.4	541	527
5	Diaper	3.5	1.8	79.2	18.2	2.6	43	28
6	Textile	1	1.4	46.5	49.1	4.4	26	23
7	Flower and garden	2.8	2	72.6	20.7	6.7	33	22
8	Wood	0.2	0.4	22.7	67.6	9.7	7	6
9	Rubber and leather	0.8	2	7.5	75.1	17.4	50	50
10	Glass	0.8	2.1	2.4	0.0	97.6	-	-
11	Metal	0.5	1.2	3.7	0.0	96.3	-	-
12	Ceramic	0.4	1	2.2	0.0	97.8	-	-
13	Coal ash	2.8	6.5	9.4	0.0	90.6	-	-
14	Others	1.5	2.3	38.3	13.3	48.4	15	12
	Total	**100.0**	**100.0**				**1340**	1012

APPENDIX 2

Formula

1. Correlation of moisture, VS and ash by wet weight of each composition:

Moisture content of each composition (%) + Ash (% ww) + Volatile (% ww) = 100

Ash (% ww) $= \frac{(100 - \text{MCEC } (\%)) \times \text{ash } (\% \text{ dw})}{100}$

Volatile (% ww)$= \frac{(100 - \text{MCEC } (\%)) \times \text{volatile } (\% \text{ dw})}{100}$

2. Correlation of moisture, VS and ash by wet weight of each sample:

Moisture content (%) + Ash (% ww) + Volatile (% ww) = 100

Moisture content (%) $= \Sigma \frac{\text{PCEC } (\% \text{ ww basis}) \times \text{MCEC } (\%)}{100}$

Ash(% ww) $= \Sigma \frac{\text{SFEC } (\%) \times \text{ash } (\% \text{ dw})}{100}$

Volatile(% ww) $= \Sigma \frac{\text{SFEC } (\%) \times \text{volatile } (\% \text{ dw})}{100}$

3. High calorific value – HCV and Low calorific value – LCV of each sample:

HCV (cal/g) $= \Sigma \frac{\text{Gross Calorific of composition} \times \text{SFEC } (\%)}{100}$

LCV (cal/g) = HCV (cal/g) $- \frac{540 \times \text{Moisture content } (\%)}{100}$

Conversion formula: 1 cal/g = 4.187 J/g

Solid fraction of each composition (%) $= \Sigma \frac{\text{PCEC } (\% \text{ ww basis}) \times (100 - \text{MCEC } (\%))}{100}$

❖ ***Note:***

- *MCEC: Moisture content of each composition*
- *PCEC: Physical composition of each composition*
- *SFEC: Solid fraction of each composition*

APPENDIX 3

Sampling and Analyzing Photograph

Separating and sampling household waste activities at Tong Van Tran transfer station

Pretreatment household waste sample for analysis at ETM Center


SAMPLE 1
SHELL-BONE

Household waste sample after analysis moisture (dried at 105°C)

Sample 1: 20.12.13

Sample 2: 22.12.13

Sample 3: 24.12.13

Sample 4 : 26.12.13

Sample 1: 20.12.2013

Sample 2: 22.12.2013

Sample 3: 24.12.2013

Sample 4: 26.12.2013

REPORT OF

MOISTURE CONTENT ANALYSIS OF HOUSEHOLD WASTE IN HO CHI MINH CITY

February, 2014

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CONTENTS

LIST OF TABLE

LIST OF FIGURE

1. GENERAL INFORMATION

1.1 Project title: "Moisture content analysis of household waste in Ho Chi Minh City".

1.2 Objective:

To identify the moisture content of each category of household waste originally contained (before all categories are mixed together, or before the moisture of wet wastes such as food waste moves into other categories of household waste such as paper, plastic, etc.)

1.3 Implementing Agencies

Physical composition and moisture analysis

ETM implements the pilot study on source separation on 10 ETM staff's households in Ho Chi Minh City after training to separate including food waste and other waste for identifying the moisture of household waste, method as follows:

- To distribute designated plastic bags including food waste and others waste bags for sampling wastes to all households during 2 weeks of the pilot study.
- To sample and transport household waste in the pilot areas to ETM center in district 9.
- To separate to 14 categories and analyze moisture of each categories.

1.4 Schedule of the moisture content analysis

The schedule of the moisture content analysis is shown in table 1.

Table 1 The schedule of the moisture of content analysis

No	Date		Activities
1	17 February 2014	Mon	09:00 Sort waste into 14 categories 10:00 Sample 1 set of 100 g per category 11:00 Measure weights of each sample 13:00 Start drying samples
2	20 February 2014	Thu	09:00 Sort waste into 14 categories 10:00 Sample 2 set of 100 g per category 11:00 Measure weights of each sample 13:00 Start drying samples
3	24 February 2014	Mon	09:00 Sort waste into 14 categories 10:00 Sample 3 set of 100 g per category 11:00 Measure weights of each sample

No	Date		Activities
			13:00 Start drying samples
4	27 February 2014	Thu	09:00 Sort waste into 14 categories 10:00 Sample 4 set of 100 g per category 11:00 Measure weights of each sample 13:00 Start drying samples

1.5 Sampling wastes

The sampling wastes is carried out as following:

- To select 10 staffs of ETM who live together with more than 3 members in their houses.
- To ask 10 staffs of ETM to separate food waste and other waste in their houses or NOT to mix all wastes.
- Attach ID labels on plastic bags, black plastic bags with wastes separated as other waste, other colors plastic bags with wastes separated as food waste.
- Distribute designated plastic bags to 10 ETM staff's households for making separated waste habit during two weeks of the pilot study.
- To transport food waste and other waste separately to ETM in the morning on 17, 20, 24 and 27 February 2014.

2. ANALYTICAL RESULTS:

2.1 Physical composition:

The result of total physical composition of ETM staff's household waste is presented in table 2:

Table 2 Physical composition of ETM staff's household waste

Composition	17 February		20 February		24 February		27 February	
	Initial sample (g)	**% wet weight of initial sample (%)**	**Initial sample (g)**	**% wet weight of initial sample (%)**	**Initial sample (g)**	**% wet weight of initial sample (%)**	**Initial sample (g)**	**% wet weight of initial sample (%)**
Biodegradable food (remaining food, fruit peels, vegetables)	14,299	66.6	13,330	56.3	13,734	66.5	13,242	72.2
Non-biodegradable food (bone, fruit seeds, corn pulp, egg shells, seeds, coconut shell, mango seed)	656	3.1	2,082	8.8	988	4.8	1,538	8.4

Paper	958	4.5	598	2.5	954	4.6	418	2.3
Plastic	2,308	10.8	2,291	9.7	2,722	13.2	1,689	9.2
Diaper	1,652	7.7	2,193	9.3	1,612	7.8	1,167	6.4
Textile	817	3.8	31	0.1	204	1.0	45	0.2
Flower and garden	211	1.0	1,272	5.4	237	1.1	2	0.0
Wood	33	0.2	849	3.6	101	0.5	21	0.1
Rubber and leather	194	0.9	4	0.01	36	0.2	4	0.0
Glass	29	0.1	613	2.6	-	-	-	-
Metal	109	0.5	162	0.7	39	0.2	-	-
Ceramic	-	-	-	-	-	-	183	1.0
Coal ash	-	-	-	-	-	-	-	-
Others (solid, sawdust, incense, hair, etc)	193	0.9	258	1.1	25	0.1	29	0.2
Total	21,458	100.0	23,681	100.0	20,651	100.0	18,337	100.0

The results of average physical composition (%wet weight) of ETM staff's household waste for separated food waste and other waste are presented in figure 1a and 1b

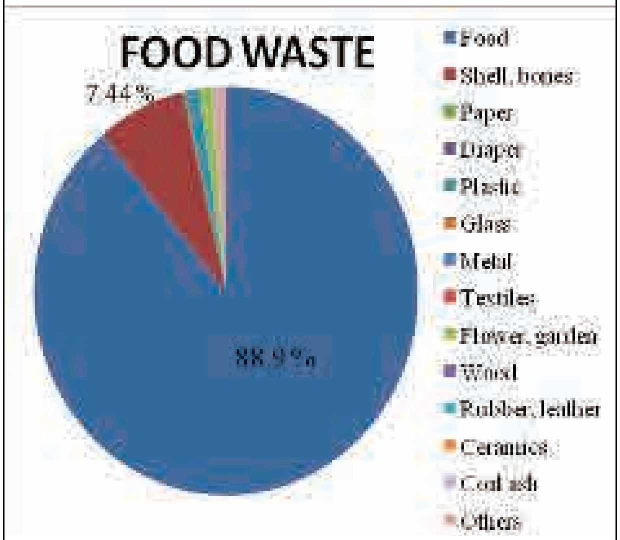


Figure 1: Average physical composition

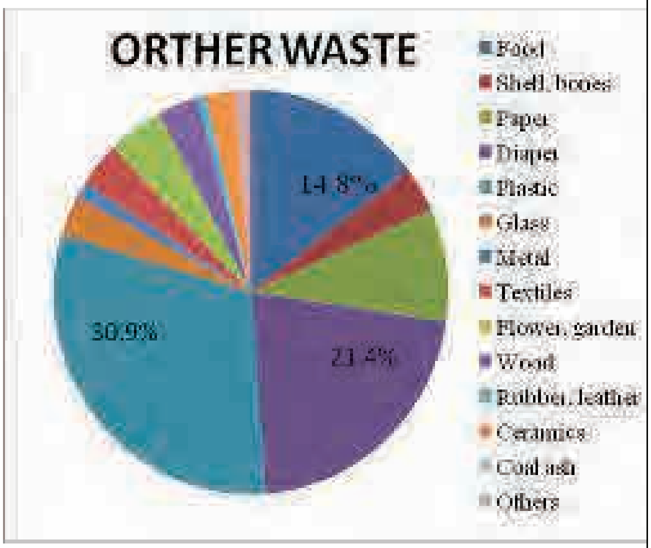


Figure 2: Average physical composition (%

(% wet weight) of 4 sample in food waste	wet weight) of 4 sample in other waste

The waste classification in the following ETM staff's households:

- Food waste: food waste dominates 88.9%, others waste is 11.1%.
- Others waste: others waste dominates 85.2%, food waste is 14.8%.

The physical composition results showed that the separation food waste and other waste is carried out strictly. However, some difficulties encountered during the pilot study:

- Mostly, households of ETM staffs don't locate at waste separation area in Ho Chi Minh City.
- These households have not had habit of waste separation yet.
- ETM staffs' usually guide and supervise their relatives to separate wastes. However, waste separation has not been implemented entirely, especially when ETM staffs' go for working.

2.2 Moisture

The moisture content's data of each sample were presented in table 3, and the fluctuation of moisture of each composition was shown in Figure 2a, 2b.

Table 3 Statistic moisture of each composition of 4 samples

No.	Composition	Moisture content (%)						
		Sample 1	Sample 2	Sample 3	Sample 4	Average	Min	Max
1	Biodegradable food (remaining food, fruit peels, vegetables)	77.9	80.6	80.5	81.0	80.0	77.9	81.0
2	Non-biodegradable food (bone, fruit seeds, corn pulp, egg shells, seeds, coconut shell, mango seed)	48.5	40.4	50.9	38.0	44.4	38.0	50.9
3	Paper	12.8	12.5	17.7	19.7	15.7	12.5	19.7
4	Diaper	67.2	63.4	69.7	74.4	68.7	63.4	74.4
5	Plastic	22.1	21.3	21.6	25.1	22.5	21.3	25.1
6	Glass	0.3	0.3	-	0.2	0.3	0.2	0.3
7	Metal	4.5	2.5	2.2	3.4	3.2	2.2	4.5
8	Textiles	23.9	41.4	43.8	41.5	37.7	23.9	43.8
9	Flower garden (green leaves, flower, etc.)	60.2	65.6	69.9	-	65.2	60.2	69.9
10	Wood	3.5	4.3	3.5	5.8	4.3	3.5	5.8

11	Rubber, leather	39.6	2.6	7.2	7.7	14.3	2.6	39.6
12	Ceramics	-	-	-	0.2	0.2	0.2	0.2
13	Coal ash	-	-	-	-	-	-	-
14	Others (soil, hair, cigarette butts, incense, sawdust, etc.)	36.0	11.5	1.8	11.4	15.2	1.8	36.0

"-" no sample

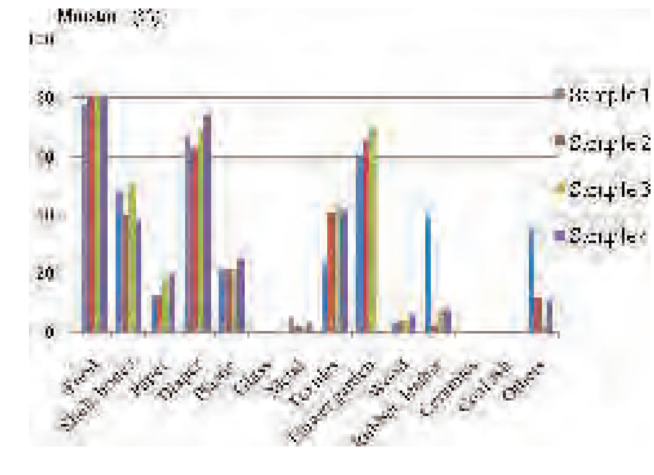


Figure 3 Moisture content (%) of ETM staffs' household waste composition

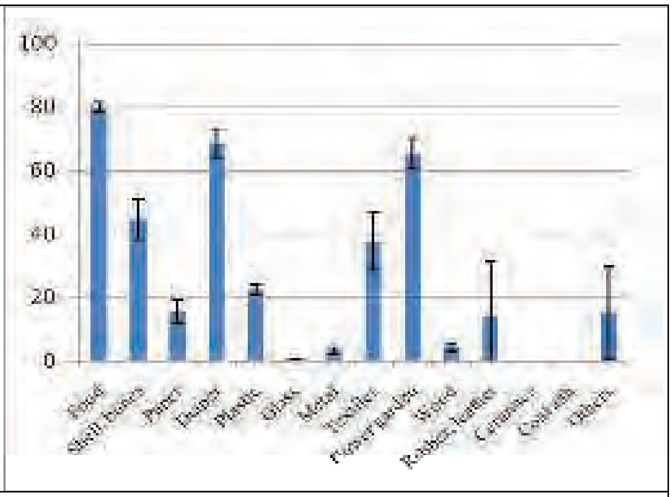


Figure 4 Average moisture value of ETM staffs' household waste composition

The results of moisture clearly showed that:

Biodegradable food: moisture of biodegradable food is highest ranging from 77.9% (sample 1) to 81.4% (sample 4) and average value is 80.0%. It depends on difference of food waste components. It could be the food waste mainly contains organic components such as leftovers, vegetable, fruit with high moisture.

Diaper: moisture content of diaper from household waste in the range of 63.4% to 74.4% and 68.7% is average value. It's also as moisture data of district 1 household waste (69.3%).

Garden waste such as green leaves, flower also considers as the components with high moisture, average value is 65.2%.

Moisture data of non-biodegradable fluctuate within from 38.0% of sample 4 to 50.9% of sample 3 (44.4% average value). In this composition, the snail shell is the highest proportion.

Textile: moisture content of textile from household waste in the range of 23.9% to 43.8% and 37.7% in average value. Moisture of textile in sample 1 is lower than the others because the textile of sample 1 includes just only fabric, face mask; does not include wet handkerchief.

Moisture data of plastic fluctuate within from 21.3% of sample 2 to 25.1% of sample 4 (22.5% in average value). This data isn't different compared to its in Binh Thanh household waste 23.4%, as well as district 1 household waste 25.9%.

Paper: moisture content of paper from ETM staff's household waste is in the range of 12.5% to 19.7% and 15.7% in average value. The moisture of paper significantly depends on whether the household waste is separated before or not. The result of paper moisture of ETM and district 1 household waste which is separated food waste and others waste before has low moisture are 15.7%, 29.3% respectively. In contract, the paper moisture of Binh Thanh households waste not classified is higher, ranging from 46.2% to 53.0%.

Rubber and leather: moisture content of rubber and leather from household waste is in range of 2.6% to 39.6% and 14.3% is in average value. The rubber and leather in sample 1 has a special sponge absorbed water that make it high moisture than the others.

Moisture results in metal (2.2% – 4.5%), glass (0.0% – 0.3%), and ceramic (0.0 – 0.2%) are considered as low values because of non-absorbing materials.

Others: the moisture of others in sample 1 is high 36%, whereas the moisture of it in sample 2,3,4 is low ranging from 1.8% to 11.5%. That the others of sample 1 contains a lot of wet soil and wet sawdust makes it high moisture.

APPENDIX 1

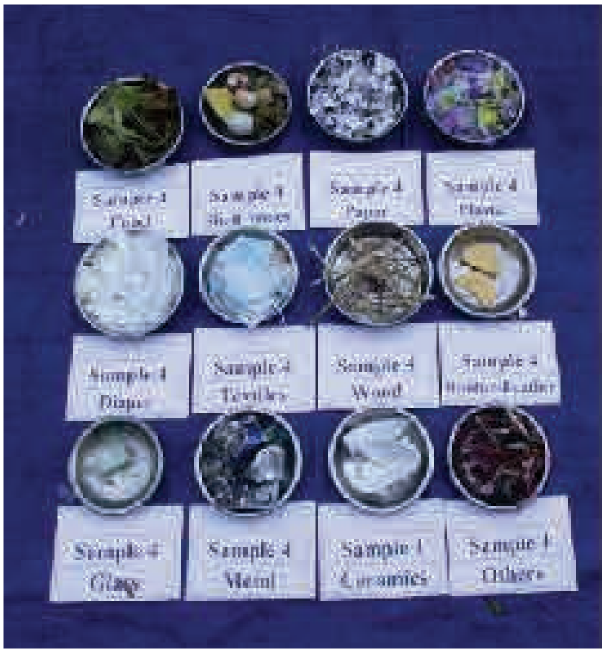
Separating and Analyzing ETM staff's household waste photograph

Separating household waste activities at ETM center

Household waste sample after analysis moisture (dried 105^{o}C)

Sample 1: 17th February 2014

Sample 2: 20th February 2014



Sample 3: 24th February 2014

Sample 4: 27th February 2014

APPENDIX 2
Information of household sample

Table 1 Information data of ETM staff's household sample in February 2014

ID	Number of family members	Number children (< 3 years old)	Address	Note: Type of household/ accommodation	Note: Go to market / supermarket	Note: Frequently go to market/ supermarket	Number of sampling date	Food waste: m Food (g)/ %Food per Food waste	Food waste: m Other(g)/ %Other per Food waste	Other waste: m Food(g)/ %Food per Other waste	Other waste: m Other(g)/% Other per Other waste	Go to market/ Supermarket on sampling dates?
1	4	1	637/28A Quang Trung street, ward 11, Go Vap District, Ho Chi Minh City	Household	Market + supermarket	3-4 times/week	1st day	1,335.8/99.4	8/0.6	13/3.2	395/96.8	Yes
							2nd day	654/99.5	3/0.5	-	612.4/100.0	No
							3rd day	1,404/91.3	134/8.7	-	483/100.0	Yes
							4th day	1,476/100.0	-	-	575/100.0	Yes
2	4	1	219/18A NguyenVan Tang street, Long Thanh My ward , District 9, Ho Chi Minh City	Household	Market + supermarket	6 times/week	1st day	-	-	-	-	-
							2nd day	1,398/99.4	8/0.6	326.7/40.5	479.7/59.5	Yes
							3rd day	507/60.6	329/39.4	-	359/100.0	No
							4th day	191/94.1	12/5.9	99/17.6	462/82.4	Yes
3	4	1	104 K, Binh Trung Đong , District 2, Ho Chi	Household	Market + supermarket	3-4 times/week	1st day	547.7/100.0	0/0.0	-	814/100.0	Yes
							2nd day	667/98.1	13/1.9	25.0/4.6	515.6 /95.4	No

ID	Number of family members	Number children (< 3 years old)	Address	Note			Number of sampling date	Food waste		Other waste		Go to market/ Supermarket on sampling dates?
				Type of household/ accommodation	Go to market / supermarket	Frequently go to market/ supermarket		m Food (g)/ %Food per Food waste	m Other(g)/ %Other per Food waste	m Food(g)/ %Food per Other waste	m Other(g)/% Other per Other waste	
			Minh City				3rd day	2,048/98.3	36/1.7	45/8.3	494/91.7	Yes
							4th day	225/100.0	-	-	203/100.0	No
4	4	0	102 Nguyen Anh Thu street , Hiep Thanh ward, District 12, Ho Chi Minh City	Household	Market	4-6 times/week	1st day	1,131.0/83.9	217.2/16.1	104/39.4	160/60.6	Yes
							2nd day	723/88.3	96/11.7	627.0/32.2	1,320.9/67.8	Yes
							3rd day	332/99.7	1/0.3	-	241/100.0	No
							4th day	1,316/100.0	-	53/38.1	86/61.9	Yes
5	4	0	2/2/63 Le Thuc Hoach street, Phu Tho Hoa ward, Tan Phu District, Ho Chi Minh City	Household	Market	4 times/week	1st day	810.7/98.4	13.2/1.6	15/14.4	89/85.6	Yes
							2nd day	606/100.0	-	115.7/27.5	305.4/72.5	Yes
							3rd day	404/87.4	58/12.6	304/48.1	328/51.9	No
							4th day	263/100.0	-	-	1,051/100.0	Yes
6	6	0	3185C, Pham The Hien, district 8, Ho Chi Minh City	Household	Market	3 times/week	1st day	654.0/89.9	73.7/10.1	29/7.0	386/93.0	Yes
							2nd day	-	-	-	-	-
							3rd day	-	-	-	-	-
							4th day	-	-	-	-	-

ID	Number of family members	Number children (< 3 years old)	Address	Note			Number of sampling date	Food waste		Other waste		Go to market/ Supermarket on sampling dates?
				Type of household/ accommodation	Go to market / supermarket	Frequently go to market/ supermarket		m Food (g)/ %Food per Food waste	m Other(g)/ %Other per Food waste	m Food(g)/ %Food per Other waste	m Other(g)/% Other per Other waste	
7	3	0	606/162 3/2 street, District 10, Ho Chi Minh City	Accommodation	Market + supermarket	2-3 times/week	1st day	1,116.6/74.4	385/25.6	5/0.4	1,141/99.6	Yes
							2nd day	251/92.6	20/7.4	-	125/100.0	No
							3rd day	287/68.2	134/31.8	-	276/100.0	No
							4th day	326/100.0	-	-	375/100.0	Yes
8	7	1	11 street 52, ward 15 District 11, Ho Chi Minh City	Household	Market	5 times/week	1st day	2,675.6/96.7	91.1/3.3	39/4.4	843/95.6	Yes
							2nd day	1,419/83.0	291/17.0	-	393/100.0	No
							3rd day	1,443/100.0	-	-	603/100.0	Yes
							4th day	2,594/89.9	290/10.1	63/32.1	133/67.9	Yes
9	3	0	12/4 Truong Van Thanh street, Hiep Phu ward, District 9, Ho Chi Minh City	Accommodation	Market	4 - 5 times/week	1st day	723.7/98.6	10/1.4	714/44.9	877/55.1	No
							2nd day	1,422/51.0	1,365/49.0	-	215.2 /100.0	Yes
							3rd day	1,095/77.8	312/22.2	-	482 /100.0	Yes
							4th day	477/75.0	159/25.0	-	154/100.0	No

ID	Number of family members	Number children (< 3 years old)	Address	Note			Number of sampling date	Food waste		Other waste		Go to market/ Supermarket on sampling dates?
				Type of household/ accommodation	Go to market / supermarket	Frequently go to market/ supermarket		m Food (g)/ %Food per Food waste	m Other(g)/ %Other per Food waste	m Food(g)/ %Food per Other waste	m Other(g)/% Other per Other waste	
10	7	0	109/47/11 street 8, Linh Xuan ward, Thu Duc District , Ho Chi Minh City	Household	Market + supermarket	4 - 5 times/week	1st day	1303.0/95.7	58.9 / 4.3	20 / 3.1	632/96.9	Yes
							2nd day	783/91.9	69/8.1	-	667.6 /100.0	No
							3rd day	848/83.8	164/16.2	127/12.2	917/87.8	Yes
							4th day	413/52.8	369/47.2	-	414/100.0	No
11	3	0	39/3/9 street 3, Truong Tho street, Thu Đuc District, Ho Chi Minh City	Household	Market	3 times/week	1st day	749.0/96.9	23.6/3.1	163/38.6	259/61.4	Yes
							2nd day	758 / 98.8	9/1.2	187.9/63.7	107.3/36.3	No
							3rd day	420/100.0	-	47/56.6	36/43.4	No
							4th day	-	-	-	-	-
12	4	0	808 E, Binh Khanh, district 2, Ho Chi Minh City	Household	Market + supermarket	2-3 times/week	1st day	671.5/95.8	29.2/4.2	5/5.8	81/94.2	No
							2nd day	-	-	-	-	-
							3rd day	-	-	-	-	-
							4th day	1,796/97.0	56/3.0	- /0.0	101/100.0	Yes

ID	Number of family members	Number children (< 3 years old)	Address	Note			Number of sampling date	Food waste		Other waste		Go to market/ Supermarket on sampling dates?
				Type of household/ accommodation	Go to market / supermarket	Frequently go to market/ supermarket		m Food (g)/ %Food per Food waste	m Other(g)/ %Other per Food waste	m Food(g)/ %Food per Other waste	m Other(g)/% Other per Other waste	
13	Canteen of ETM	0	Lot T2-6, D1 street, district 9, Ho Chi Minh City	Household	Supermarket	5-6 times/week	1st day	505.3/80.0	126.6/20.0	968/70.2	410/29.8	Yes
							2nd day	322/100.0	-/0.0	284.3/9.5	2713.4/90.5	Yes
							3rd day	4,314/95.2	219/4.8	108/7.5	1324/92.5	Yes
							4th day	1,251/93.8	83/6.2	- /0.0	473/100.0	Yes
14	7	1	151 Đinh Bo Linh street ward 26, Binh Thanh District, Ho Chi Minh City	Household	Market	3 times/week	1st day	-	-	-	-	-
							2nd day	2,489/98.3	43/1.7	271.9/24.1	854.4/75.9	Yes
							3rd day	-	-	-	-	-
							4th day	2,700/100.0	-	-	214/100.0	Yes

m food: mass of food waste (g)

m others: mass of others waste (g)

“-“ : no sample

Table 2 General information of ETM staff's household

ID	Name of family member	Sex	Age	Number of family member	Address
1	Nguyen Thi Thuy Nhu	Female	32	04	637/28A Quang Trung street, ward 11, Go Vap District, Ho Chi Minh City
	Nguyen Van Thach	Male	29		
	Nguyen Vinh	Boy	1.5		
	Nguyen Thi Hao	Female	59		

ID	Name of family member	Sex	Age	Number of family member	Address
2	Le Chuc Nhanh	Male	31	04	219/18A NguyenVan Tang street, Long Thanh My ward , District 9, Ho Chi Minh City
	Nguyen Thi Lan	Female	29		
	Le Nguyen Duy Anh	Boy	9 month		
	The babysitter	Female	45		

ID	Name of family member	Sex	Age	Number of family member	Address
3	Nguyen VanTruc	Male	31	04	104 K, Binh Trung Đong , District 2, Ho Chi Minh City
	Vo Thi Dieu Hien	Female	31		
	Vo Thi Ngoc Huynh	Female	19		
	Nguyen Vo Khanh An	Female	1		

ID	Name of family member	Sex	Age	Number of family member	Address
4	Nguyen Thi Kim Dung	Female	52	04	102 Nguyen Anh Thu street , Hiep Thanh ward, District 12, Ho Chi Minh City
	Pham Thi Hien	Female	46		
	Nguyen Nha Truc	Female	23		
	Nguyen Khanh Linh	Female	17		

ID	Name of family member	Sex	Age	Number of family member	Address
5	Tran Thi Tuyet	Female	38	04	2/2/63 Le Thuc Hoach street, Phu Tho Hoa ward, Tan Phu District, Ho Chi Minh City
	Nguyen Thi Kim Tuyet	Female	24		
	Bui Thi Hoai Thuong	Female	14		
	Bui Thi Hoai An	Female	5		

ID	Name of family member	Sex	Age	Number of family member	Address
6	Phan Anh Hau	Male	23	04	3185C, Pham The Hien, district 8, Ho Chi Minh City
	Le Minh Thuan	Male	22		
	Ha Thanh Hang	Female	29		
	Nguyen Thuy Tramg	Female	24		

ID	Name of family member	Sex	Age	Number of family member	Address
7	Dang Le Hoang Yen	Female	23	03	606/162 3/2 street, District 10, Ho Chi Minh City
	Tran Dang Hoang Nhu	Female	20		
	Phan Thuy Quyen	Female	23		

ID	Name of family member	Sex	Age	Number of family member	Address
8	Do Lam Nhu Y	Female	31	07	11 street 52, ward 15 District 11, Ho Chi Minh City
	Do Truong Quang	Male	76		
	Lam Thi Cam	Female	66		
	Do Lam Nhu Thuy	Female	33		
	Do Quang Liem	Male	31		
	Nguyen Thi Thao	Female	32		
	Do Phuc Buu Khang	Boy	14 month		

ID	Name of family member	Sex	Age	Number of family member	Address
9	Nguyen Van Lam	Male	57	03	12/4 Truong Van Thanh street, Hiep Phu ward, District 9, Ho Chi Minh City
	Ho Thi Ha	Female	50		
	Nguyen Ho Phuong Lan	Female	23		

ID	Name of family member	Sex	Age	Number of family member	Address
10	Nong Mai Hoang	Male	34	05	109/47/11 street 8, Linh Xuan ward, Thu Duc District , Ho Chi Minh City
	Thai Van Danh	Male	28		
	Huynh Thi Kim Nu	Female	30		
	Huynh Thi Tuyet Trinh	Female	27		
	Tran Thi Diem	Female	58		

ID	Name of family member	Sex	Age	Number of family member	Address
11	Doan Thi Hong Chau	Female	32	03	39/3/9 street 3, Truong Tho street, Thu Đuc District, Ho Chi Minh City
	Le Hoang Chi Thanh	Male	32		
	Le Thien Phu	Male	5		

ID	Name of family member	Sex	Age	Number of family member	Address
12	Nguyen Thi Bich Thuy	Female	34	04	808 E, Binh Khanh, district 2, Ho Chi Minh City
	Bui Thi Xuan Ha	Female	35		
	Nguyen Hoang Hat	Male	34		
	Huynh Thi Thanh Tam	Female	20		

ID	Name of family member	Sex	Age	Number of family member	Address
13	Canteen of ETM			Cook for 30 persons/day	Lot T2-6, D1 street, district 9, Ho Chi Minh City

ID	Name of family member	Sex	Age	Number of family member	Address

14	Nguyen Thi Tuong Hoanh	Female	33	07	151 Đinh Bo Linh street ward 26, Binh Thanh District, Ho Chi Minh City
	Nguyen Duc Dung	Male	64		
	Tran Thi Tuong Vi	Female	60		
	Phan Thi Tinh	Female	65		
	Nguyen Quoc Quy	Male	28		
	Nguyen Quoc Bao	Male	36		
	Ngo Tuong Mai	Girl	3		

2-3 IDENTIFICATION OF SOURCES OF SOLID WASTE SUITABLE FOR INCINERATION AND VIABLE AMOUNTS OF MUNICIPAL SOLID WASTE FOR PHUOC HIEP LANDFILL, GO CAT LANDFILL AND DONG THANH LANDFILL

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Report 1

IDENTIFICATION OF SOURCES OF SOLID WASTE SUITABLE FOR INCINERATION AND VIABLE AMOUNTS OF MUNICIPAL SOLID WASTE FOR PHUOC HIEP LANDFILL, GO CAT LANDFILL AND DONG THANH LANDFILL

October 2014

Contents

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LIST OF ACRONYM

APHA	American Public Health Association
B.O.D	Board of directors
BTNMT	Department of natural Resources and Environment
DONRE	Department of natural Resources and Environment
DPIWMF	Da Phuoc Integrated Waste Management Facility
DW	Dry weight
EM	Effective Microganisms
EPA	Environmental Protect Agency
ETM	Center for Environmental Technology and Management
GHV	Gross heating value
HCMC	Ho Chi Minh City
HDPE	High Density Polyethylene
HHV	Higher heating value
HW	hazardous waste
ISWTZ	Integrated Solid Waste Treatment Zone
LFG	Landfill gas
LHV	Lower heating value
MSW	Municipal solid waste
SW	Solid waste
TCVN	Vietnam Standards
VS	Volatile solid
WW	Wet weight

1. GENERAL INTRODUCTION

1.1 Phuoc Hiep Landfill

1.1.1 Location

The Phuoc Hiep Landfill that is located in the Integrated Solid Waste Treatment Zone (hereinafter called as ISWTZ) in Northwest of HCMC in Tam Tan Hamlet, Phuoc Hiep Commune, Cu Chi District is about 50km far from the central City in the Northwest and about 5km far from the central Cu Chi District in the Southwest. This area that has relatively flat terrain in the low-lying area of Cu Chi district, has many artificial and natural canals. The Phuoc Hiep Landfill has the landmarks as follows:

- In the East and North: border on the planned areas in the ISWTZ in Northwest of HCMC and existing melaleuca forest;
- In the Northwest: border on canal No. 16;
- In the Southwest: border on Thay Cai canal;
- In the Southeast: border on canal No. 15.

The area around the landfill has a thin population density that is mainly concentrated along the asphalt road run parallel with Thay Cai canal (towards the Provincial Road No. 8).

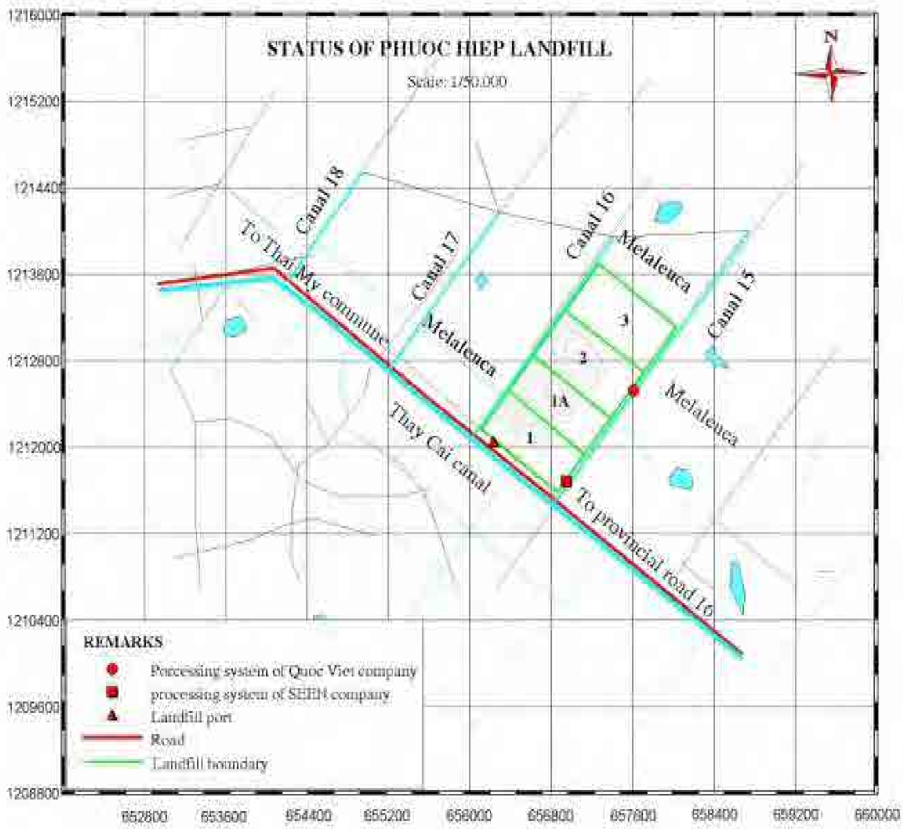

Figure 1. Current master layout of Phuoc Hiep Landfill. (**Source**: ETM, 2012)

1.1.2 Scale

The Phuoc Hiep Landfill consists of the landfills as follows:

- Phuoc Hiep Landfill No. 1, No. 1A and Landfill No. 2: they are currently stopped their operation;
- Phuoc Hiep Landfill No. 3 has just been both constructing and receiving the MSW and is going to be closured.

The Phuoc Hiep Landfill No. 1 had been officially operated from January 2003 to at the end of 2007 with a total area of landfill cells of about 18.993ha and an average receiving capacity of about 3,000 tons/day.

The Phuoc Hiep Landfill No. 1A had been operated from February 2007 to February 2008 with a total area of landfill cells of about 9.75ha and a design capacity of about 3,000 tons/day.

The Phuoc Hiep Landfill No. 2 had been operated since February 2008 with a total area of landfill cells of about 19.5ha and a receiving capacity of about 3,500 tons/day. The Phuoc Hiep Landfill No. 2 is connected with the Phuoc Hiep Landfill No. 1A to utilize the enclosure wall of the Phuoc Hiep Landfill No. 1A. A part of the Phuoc Hiep Landfill No. 2 that borders on the Phuoc Hiep Landfill No. 1A will be utilized to bury the MSW in order to increase the receiving capacity. The Phuoc Hiep Landfill No. 2 had been operated until at the end of 2013, then it has stopped to receive the MSW. At this time, the MSW had so been buried in the landfill No. 3. The leachate that is generated from the Phuoc Hiep Landfill is now partly stored in reservoirs and partly treated by the Quoc Viet Environmental Protection and Technological Science Company (with a treatment capacity of 1,000 m^3/day) and the SEEN Technologies Corporation (with a treatment capacity of 800 m^3/day).

The Phuoc Hiep Landfill No. 3 is designed in a total area of 15ha with a design capacity of 2,000 – 2,500 tons/day. At present, the HCMC’s PC gave a notice in writing No. 475/TB-VP dated 17/6/2014 about the closure of the Phuoc Hiep Landfill No. 3. Accordingly, the CITENCO is responsible for making the plan of closuring the Phuoc Hiep No. 3. After the Landfill No. 3 is stopped its operation, the total amount of MSW received by the Landfill No. 3 will be transferred to the Da Phuoc Integrated Waste Management Facility (DPIWMF).

The general information of the scale and current master layout of the Phuoc Hiep Landfill is presented in **Table 1** and **Figure 1** respectively.

Table 1. Summary of the Phuoc Hiep Landfill scale

No.	Information	Phuoc Hiep Landfill No. 1	Phuoc Hiep Landfill No. 1A	Phuoc Hiep Landfill No. 2	Phuoc Hiep Landfill No. 3
1	Operation time	1/2003 – 5/2006	2/2007 – 2/2008	2/2008 – at the end of 2013	10/2003 - now
2	Area of each landfill (ha)	18.993	9.75	19.5	15
3	Design capacity (tons/day)	3,000	3,000	1,500 – 2,500	2,000 – 2,500
4	Practically average receiving capacity (tons/day)	3,000	3,000	2,500 – 3,000	-
5	Landfill method	Sanitary	Sanitary	Sanitary	Sanitary
6	Height of landfill cell (m)	25	15 - 17	36	-
7	Depth of landfill bottom (m)	-7	-7	-7	-10

Source: HCMC's DONRE, 2010, 2013.

1.1.3 Operation procedure

The MSW landfill technology in the Phuoc Hiep Landfill is the sanitary landfill technology with full environmental protection works, HDPE (High Density Polyethylene) liner, LFG collection system, leachate collection and treatment system, storm-water collection system. In addition, there are the auxiliary works namely weighing station, vehicle washing floor, dike, other works catering for the management task, etc. The Phuoc Hiep Landfill is operated by the procedure as shown in Figure 2.

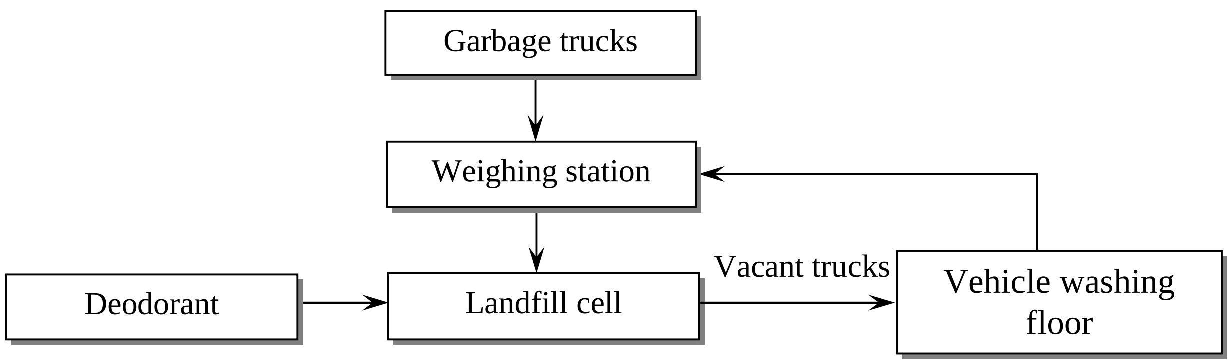

Figure 2. Operation procedure of Phuoc Hiep Landfill. (**Souce**: ETM, 2012)

Phuoc Hiep Landfill No. 1

The Phuoc Hiep Landfill No. 1 has a total landfill area of about 18.996ha that is divided into four cells with 4.74ha/each cell. The maximum height of each cell is 25m. The MSW that is buried into ten layers in each cell with 2.2m/layer (the MSW is smoothly bulldozed by bulldozers and carefully compacted). Each layer is separated by intermediate layer with a thickness of 20cm. The topcoat is a bentonite geotextile waterproofing membrane and a soil layer with a thickness of 30cm below.

The depth of MSW landfill is -7 m below the ground. The liners from the top to the bottom include as follows:

- MSW layer: 10;
- HDPE: 2.2 mm;
- Sand layer: 0.2 m;
- Macadam layer: 2x3 (a thickness of 0.3 m).

The Phuoc Hiep Landfill No. 1A and No. 2 is built with the same liner and topcoat compared to the Phuoc Hiep Landfill No. 1.

Phuoc Hiep Landfill No. 1A

The sanitary landfill technology that is applied in the Phuoc Hiep Landfill No. 1A is similar to the Phuoc Hiep Landfill No. 1. However, the most different point between the Phuoc Hiep Lanfill No. 1A and the other landfills is the design of pile wall. Specifically, the Phuoc Hiep Landfill No. 1A is built with the prestressed piles surrounding the landfill to prevent the subsidence and landslide incidents. The basic parameters of the Phuoc Hiep Landfill No. 1A include as follows:

- Total area of landfill: 9.75ha;
- Number of landfill cells: 2 cells;
- Number of layers in each cell: 7 layers;
- Thickness of daily coat: 0.15 – 0.20m;
- Thickness of coat at the end of day: 0.5 – 0.6m (it could be replaced by canvas);
- Heigh of MSW layer: 2.0 – 2.2 m (or 2.4 – 3.6 m);
- Total height of 7 layers: 15.0 – 17.0m.

Phuoc Hiep Landfill No. 2

When the Phuoc Hiep Landfill No. 2 reaches the intended height, it wiil be connected with the Phuoc Hiep Landfill No. 1A to utilize the enclosure wall of the Phuoc Hiep Landfill No. 1A. A part of the Phuoc Hiep Landfill No. 2 that borders on the Phuoc Hiep

Landfill No. 1A will be utilized to bury the MSW in order to increase the receiving capacity. The basic parameters of the Phuoc Hiep Landfill No. 2 include as follows:

- Total area of landfill: 19.5ha;
- Number of landfill cells: 4 cells;
- Number of layers in each cell: 15 layers;
- Thickness of daily coat: 0.15 – 0.20m;
- Thickness of coat at the end of day: 0.5 – 0.6m (it could be replaced by canvas);
- Heigh of MSW layer: 2.0 – 2.2 m;
- Total height of 15 layers: 36.0 m.

Phuoc Hiep Landfill No. 3

As discussed information and site monitoring, it showed that the Lanfill No. 3 has been operated since October 2013 and has been constructing more some works by the Korean Contractor.

1.2 Go Cat Landfill

1.2.1 Location

The Go Cat Landfill that is built in the land located in Binh Hung Hoa A Commune, Binh Tan District that borders on Hoc Mon District and Binh Tan District. It is about 15km far from the central City in the Northeast. The Go Cat Landfill is located in the highly topographical area to the Northeast of Binh Tan District.

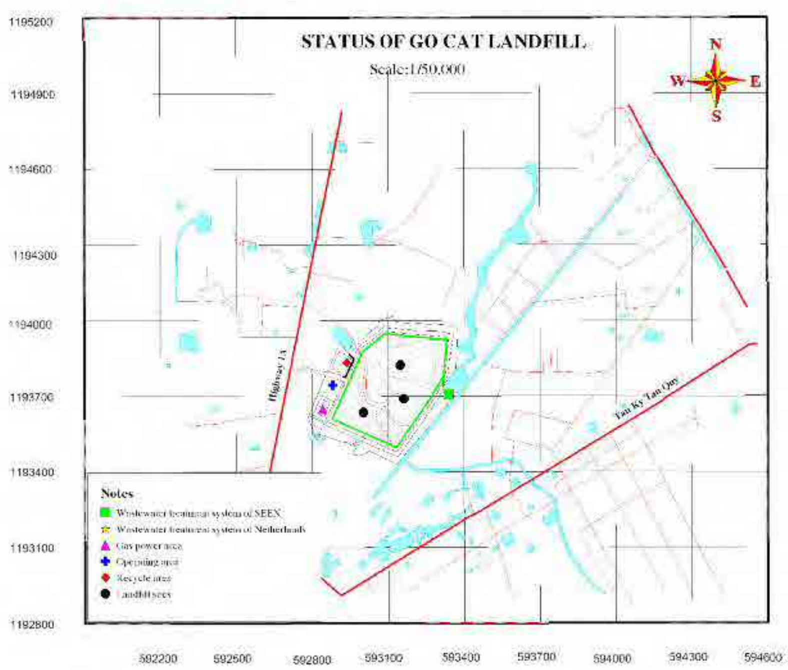

Figure 3. Current master layout of Go Cat Landfill. **(Source:** ETM, 2012)

1.2.2 Scale

The Go Cat Landfill is designed and completely built by the Netherlands modern technique and technology with the waterproofing liner, soil coat and canvas, LFG and leachate collection and treatment system that is firstly installed in this landfill in Vietnam. Total surface area of the Go Cat landfill is 25ha (17.5ha for landfill). As initial design, the Go Cat Landfill had been operated in 2001 and closured in 2005 with a toal treatment capacity of about 2,000 tons/day and design capacity of about 3.65 tons from the beginning to the end of operation (HCMC's DONRE, 2010).

In fact, the Go Cat Landfill had been officially operated on 19/01/2002 and officially closured on 01/08/2007 with a total receiving capacity of 3,000 tons/day and total amount of MSW buried of about 5,000,000 tons (HCMC's DONRE, 2010 and ETM, 2012). The amount of leachate that is generated from the Go Cat Landfill is currently collected and treated by the SEEN Technologies Corporation with a total treatment capacity of 200 m^3/day (a design capacity of 400 m^3/day).

Table 2. Summary of Go Cat Landfill scale

No.	Information	Scale
1	Operation time	19/01/2002 – 01/08/2007
2	Total surface area of Go Cat Landfill	25 ha
3	Total area of landfill	17.5ha
4	Practically receiving capacity	3,000 tons/day
5	Total amount of MSW received in practical	5,000,000 tons
6	Number of landfill cells	5 landfill cells (total area of 17.5ha)
	- Area of landfill cell 1	3.58ha
	- Area of landfill cell 2	3.43ha
	- Area of landfill cell 3	3.58ha
	- Area of landfill cell 4	3.54ha
	- Area of landfill cell 5	3.37ha
7	Height of landfill surface now (above the ground)	In range of +16m - +18.9m(*)
8	Depth of landfill bottom	-7m
9	Leachate reservoir	L x B x H = 20 x 7 x 3.3 (m)
10	Leachate treatment capacity (SEEN)	200 m^3/day

Source: HCMC's DONRE (2010) and ETM (2012).

(*) Practical monitoring result dated 01/10/2014, see **Annex**.

1.2.3 Operation procedure

The Go Cat Landfill is issued with the Invesment Policy that is sponsored in terms of the finance and technology by the Netherlands Government. The Go Cat Landfill is the first landfill in Vietnam that applied the sanitary landfill technology. The main works that are invested include HDPE liner, wastewater collection and treatment system, biogas collection system to produce the power energy, transfer floor for dedicated equipment, weighing bridge and washing station, a boundary walls in a height of 6m and other works.

The MSW is buried in landfill cell at a depth of -7m below the ground and filled into 9 layers (each layer with a thickness of 2.2m). The intermediate soil layers (8 layers) with a thickness of 0.15m for each layer are filled between the MSW layers. The topcoat with a thickness of 1.3m and the bottom liner with a thickness of 0.5m are also installed. The total height of final landfill cell is about 23m (from 16m to 18.9m higher than the ground, excluding the subsidence in the decomposition process of SW). The topcoat and bottom liner of one landfill cell are structured as follows:

The topcoat has a thickness of 1.3 m including:

- Sand protective layer: 0.25m
- Waterproofing layer: 1.5mm
- Sand layer for water adsorption: 0.25m
- Soil layer: 0.8m.

The bottom liner has a thickness of 0.5m including:

- HDPE waterproofing geomembrane: 2.2mm
- Sand layer: 0.2m
- Leachate collection system
- Macadam layer 2x3, a thickness of 0.3m.

The Go Cat Landfill is operated by the following procedure as shown in **Figure 4**.

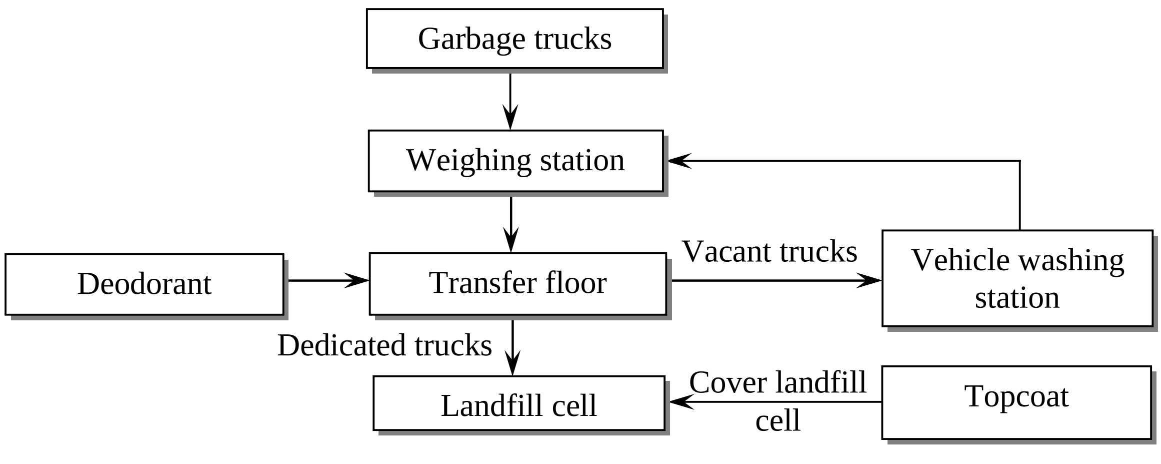

Figure 4 Operation procedure of Go Cat Landfill. **(Source:** ETM, 2012)

The MSW landfill technology in Go Cat Landfill is the sanitary landfill technology with HDPE liner, leachate collection and treatment systeme. Since 2007, Go Cat Landfill has stopped receving SW, only remaining the activities of SW recycling system, leachate collection and treatment system, biogas collection system to produce the power energy.

1.3 Dong Thanh Lanfill

1.3.1 Location

The Dong Thanh Landfill that is located Hamlet 3, Dong Thanh Commune, Hoc Mon District, HCMC is about 9km far from the central City as the crow flies to the South of Dong Thanh Commune, Hoc Mon District.

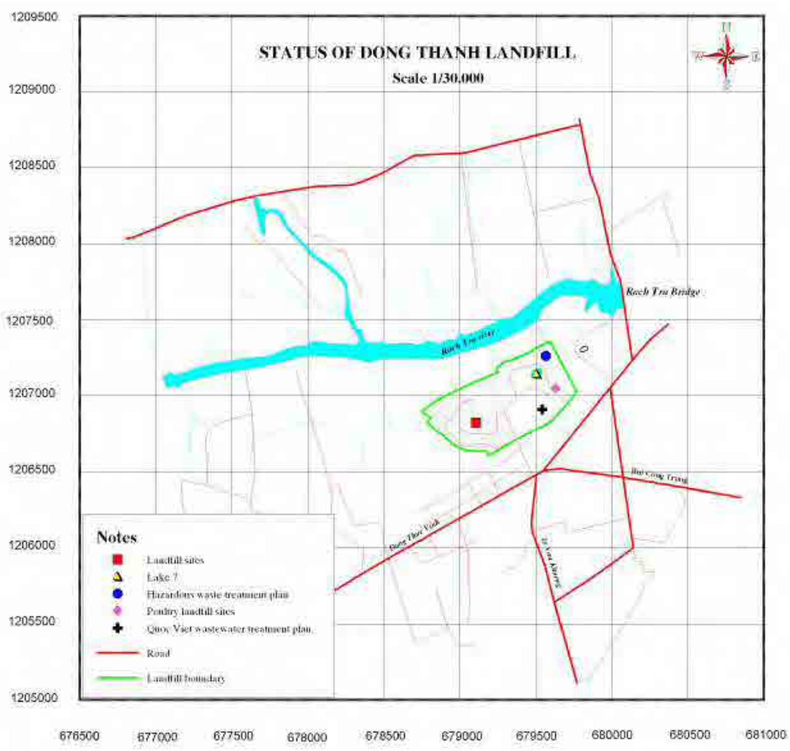

Figure 5. Current master layout of Dong Thanh Landfill. **(Source:** ETM, 2012)

1.3.2 Scale

The Dong Thanh Landfill had started to spontaneously bury the MSW in 1989 (the former area is soil pits exploited). In 1991, the Dong Thanh Lanfill had officially becomed the Dong Thanh waste disposal site with a total initial area of 10 ha. At present, the total area of the Dong Thanh waste disposal site is 43 ha. The MSW receiving capacity of the Dong Thanh Landfill is 3,000 tons/day in average. From 31/12/2002 onwards, the Landfill has stopped receiving the MSW. From 1991 to 2002, the total amount of the MSW that is received in the Dong Thanh Landfill is 10,800,000 tons in practical.

From 2002 to 2006, the Dong Thanh Landfill received the construction SW (debris) with a capacity of 1,000 tons/day. Until 2014, the Dong Thanh Landfill has stopped receving this waste.

In addition, from 2003 to 2004, the Dong Thanh also received the flu poultry delivered by the City Animal Health Department with a capacity of about 100 - 800 tons/day (about 4 days/week).

On the other hand, during the period of the Hoa Binh Septic Tank Treatment Company temporarily stopped its operation to move to the DPIWMF (12/2006 – 03/2008), the Dong Thanh landfill also received the amount of septic tank from the districts with a capacity of about 1,000 – 4,000 tons/day. As site monitoring and discussed with the B.O.D of the Landfill, until 2014, the Dong Thanh Landfill receives no longer the septic tank.

Beside receiving the debris and animal organs, the hazardous waste (HW) treatment plant in HCMC with a total area of 2.7ha that was built in the Dong Thanh Landfill came into the operation with a design capacity of 21 tons/day.

Because the Dong Thanh Landfill is a former spontaneous landfill, it was not installed with a bottom liner, LFG collection and treatment system and leachate collection and treatment system either. Until 2003, the leachate that is generated from the Dong Thanh Landfill was concerned and collected and treated. At the monitoring time (October 2014), the leachate in the Dong Thanh Landfill is collected by the Quoc Viet Environmental Protection and Technological Science Company (hereinafter briefly called as Quoc Viet Company) for treatment (a total area of treatment zone is about 7ha) with a treatment capacity of about 500 - 600 m^3/day (a design capacity of 900 m^3/day).

The scale of the Dong Thanh Landfill is briefly presented in **Table 3**.

Table 3. Summary of Dong Thanh Landfill scale

No.	Information	Scale
1	Operation time	1991-2002
2	Total area of Dong Thanh Landfill	43 ha
3	Receiving capacity of MSW (1991-2002)	3,000 tons/day
4	Total amount of SW received	10,800,000 tons
5	Receiving capacity of debris (2002-2006)	1,000 tons/day
6	Receiving capacity of debris (2006 - now)	100-500 tons/day
7	Receiving capacity of flu poultry (2003-2004)	100-800 tons/day
8	Receiving capacity of animal organs (2004-now)	100 tons/day
9	Receiving capacity of septic tank (received no longer)	1,000 – 4,000 tons/day

No.	Information	Scale
10	Design capacity of HW treatment plant in HCMC	21 tons/day
11	Leachate reservoir	
	Area (ha)	2.4
	Depth of reservoir (m)	25
	Depth of water level (m)	15
12	Treatment capacity of leachate	500 – 600 m^3/day

Source: HCMC's DONRE, 2010 and monitoring result in Dong Thanh Landfill, 2010, 2014.

1.3.3 Operation procedure

The Dong Thanh Landfill that is operated by a traditional method is semi-submersible landfill. It is continously operated and lasted in many years (1991 – 2002) and is mostly used for MSW landfill. The previously spontaneous landfill process made a high slope and very different altitudes in the Dong Thanh Landfill. The MSW landfill cells in the Dong Thanh Landfill are presented in **Table 4**.

Table 4. Summary of landfill cells in Dong Thanh Landfill

Article	Landfill cell 1	Landfill cell 2	Landfill cell 3
Total area (ha)	21.4	9.7	3.78
Receiving capacity (tons /day)	3.000		
Height of landfill cell (m)(above the ground)	+ 32	+ 17.5	+ 11
Depth of landfill cell bottom (m)(below the ground)	- 23	-	-
Bottom liner	No	No	No

Note: *- No information.*
Source: CENTEMA, 2003 and ETM, 2012.

✓ ***MSW landfill procedure***

The MSW is filled and smoothly bulldozed into each layer with a width of 0.6m and compacted by bulldozers before disposing other MSW layer. Each MSW layer with a width of 4m is covered by a clay layer with a width of 0.3m. During the landfill operation process, the deodorant EM (Effective Microganisms) is spayed over the surface of the covering layer at the end of the day to reduce the offensive odors diffused into the ambient air. The leachate is collected by open ditches installed around the landfill cells, then stored in the reservoir at the end of landfill.

✓ ***Debris landfill procedure***

The debris in HCMC is daily collected and transferred to the Dong Thanh Landfill by dedicated trucks. After weighing bridge, the debris is disposed and smoothly bulldozed under the guidance of the site instructor. As site monitoring dated 05/03/2010, the Dong Thanh Landfill received daily about 100 – 500 tons/day and the debris is diposed above the old MSW layer in the Dong Thanh Landfill.

The debris bulldozing process is based on the status of the area that is selected for debris disposal as follows:

- If the debris is disposed in the subsidence pits due to MSW decomposition, the debris will be filled into each layer in the landfill cells by bulldozer;
- If the debris is disposed in the mud area, the excavator will be used for excavating a little amount of debris pushed away to support the bulldozer;
- If the debris is pile up, the high-capacity bulldozer and excavator will be made the debris piled up.

✓ ***Diseased livestock, poultry landfill procedure***

The Dong Thanh Landfill have two landfill areas for diseased livestock and poultry (ETM, 2012). The landfill procedure of diseased livestock, poultry in the Dong Thanh Landfill is presented in **Figure 8**.

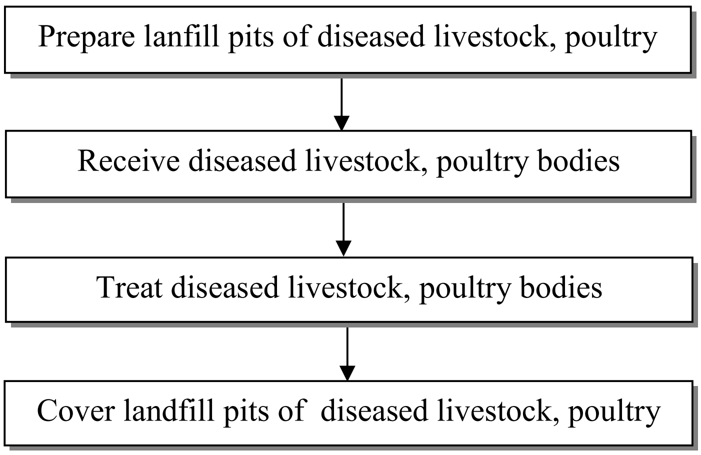

Figure 6. Landfill procedure of livestock and poultry bodies in Dong Thanh Landfill. **(Source:** ETM, 2012)

The preparation of the landfill cells of diseased livestock and poultry bodies in the Dong Thanh Landfill is implemented by the following steps:

- Landfill cells are excavated at a depth of 2.5m, a width of cell bottom of 2m, a width of cell mouth of 3.5 – 4m and a length unlimited (based on the length of HDPE bottom liner);
- Cover powder lime layer at the bottom of the cell with a thickness of at least 5cm and spread around the edge of the cell;
- Cover PE waterproofing sheet around the edge and the bottom of the cell;

- Spread lime above the bottom liner.

The treatment and landfill procedure for diseased livestock and poultry bodies in the Dong Thanh Landfill is implement by the major steps as follows:

- Shred the carcase sacks with a length of at least 0.2 m before discharging into the landfill cells. The operator must wear the protective gloves and clothing;
- Spread lime into each layer between carcase sacks;
- After completely treating the diseased carcase sacks, cover more lime layer above with a thickness of at least 5cm;
- Install vertically the venting pipe with its holes into the landfill cells (each pipe is installed at a distance of about 0.3cm along the length of the landfill cell). The specifications of venting pipe are as follows:
  + Diameter of venting pipe: 42 – 60 mm;
  + Diameter of hole around the venting pipe: 10 – 15 mm;
  + Total area of holes: 15 - 20% (of total pipe surface area);
  + Minimum length of the venting pipe: 1m.

The covering task in the landfill cells of diseased carcases in the Dong Thanh Landfill is implemented by the following steps:

- Cover the soil layer with a width of at least 0.6. The soil layer could be decomposed compost mixed with husk ash or wood ash, rice husk, straw. EM-Bokashi is mixed with husk ash or wood ash, rice husk, straw. The amount of EM Bokashi is used about 10% of the amount of soil layer;
- Cover the soil layer with straw of dried coconut leaves above with a thickness of at least 0.2m. When it starts to rain, the canvas is covered to prevent the storm-water runoff into the cells. The subsidence in the landfill cells is daily controlled. If the subsidence of the topsoil layer is over 0.2 m, the soil must be added with a thickness as same as the initial thickness.
- Cover the edge of the cells with a thickness of at least 0.2m to prevent the storm-water runoff. The soil is added with a ratio of horizontal slope and vertical slope = 3 : 1.

✓ **Septic tank treatment procedure**

The septic tank is treated in the area of 0.096 ha that includes 24 cells with an area of 96 m^3 for each cell (length x width x depth = 10m x 4m x 2.4m). The septic tank landfill cell is structured by the layers from the bottom to the top namely stone layer 4 x 6 and leachate collection pipe with a diameter of Φ60 installed, stone layer 1 x 2, sand layer and geomembrane.

2. IDENTIFICATION OF COMBUSTIBLE SOLID WASTE

2.1 Overview of SW treatment technology by incineration method

The SW is treated by thermal method where the SW is transformed from solid state to gaseous, liquid and ash state by using the heat as well as the energy is released as heat.

The incineration technology is the treatment process where the solid or liquid organic wastes will be transformed into gaseous state. The gaseous wastes will be heated through combustion net to reach a certain temperature so that the organic compounds are decomposed into the elements. The elements will combine with the oxygen into the persistent gases that will be released into the ambient air after emission treatment system.

By the incineration technology, the volume of SW is significantly reduced about 80 – 90%. The incineration process could produce the energy by heat exchange of gases produced at high temperature.

The incineration process is operated by the following principle:

- Temperature: it is necessary to ensure that the temperature is enough high for the reaction happend more quickly and completely without dioxin produced and maximum treatment efficiency reached (expected temperature for MSW > 900 °C). If the temperature is too high, the gas flow-rate is generated too much affecting the gas retention time in the secondary chamber. It means that the contact between the gases and the air is reduced and a large amount of of black smoke and the high concentration pollutants such as CO, THC are also observed in the emissions. If the temperature is not high enough, the reaction will not be completely occurred, so the black smoke is also observed in the emissions.
- Mixture: in orde to strengthen the efficiency of contacting between the burned SW and oxidants, the shield is installed the chamber with a suitable slope between the air flow and spray nozzle to enhance the mixing. The mixture could be assessed by the mixed factors.
- Time: the combustion retention time is long enough for the reaction to be thoroughly happened. The time must be made sure so that the SW could be thoroughly burned depending on the burned SW and combustion temperature.

The products after combustion are slag and ash containing the hazardous wastes in the SW components. The percentage of the SW residue after combustion is based on each SW type (including incombustible and combustible components) and a design of the incinerator (a heating capacity of each incinerator). In addition, the emissions generated from the incinerator that are the above-mentioned emissions could cause harm to the environment and public health (EPA, 2004).

Status of applying the incineration technology for SW treatment

For SW treatment, the landfill technology has mainly been applied. The technology has some advantages such as simple operation, not high low investment and operation cost, etc. but there are many potential risks to the surrounding environment. In addition, the shortcomings of the landfill management task is also a reason causing the environmental pollution (soil, surface water, groundwater, air), the landfill technology also wastes the natural soil resource, etc. Some other treatment technologies that were researched and applied are SW incineration, SW compression, building material production, microbiological fertilizer production, SW reuse and recycling.

In foreign countries

The MSW treatment methods are mainly landfill, microbiological fertilizer production, energy recycling, reuse and recovery. In comparison with other treatment methods, the incineration method is applied with high recovery of the energy as well as a little amount of soil resources wasted, so this method is applied to many foreign countries, especially the soil and energy resources are more and more reduced. In the Europe and Japan, the MSW is basically treated by incineration method that is currently becoming a new trend of MSW treatment in China.

In 2010, there were up to 77% of MSW in China that were treated by landfill method, 20% by incineration method and only 3% by composting method. As “The National Plan for the Construction of facilities for Treatment of Urban Household Waste in a Non-hazardous Way under the 12th Five-Year Plan of China”, it showed that China will increase up to 35% the amount of SW treated by incineration method, up to 6% the amount of SW treated by composting method. It means that the amount of SW that is treated by landfill method is reduced to 59%[1].

As S.Kusch et al. 2011, in the European countries, the application of incineration method for SW treatment is tending to be increased together with the method of reuse, recycling and compost production while the landfill method is gradually reduced. In particular, the total amount of MSW treated by the incineration method that occupied about 15 – 17% and tended to be increased from 1997 to 2009, treated by the landfill method that was reduced from 65% in 1997 to about 40% in 2009 and kept reducing in the following years. The countries namely Denmark, France, Germany, Sweden and Switzerland have

[1] The National Plan for the Construction of facilities for Treatment of Urban Household Waste in a Non-hazardous Way under the 12th Five-Year Plan of China

applied the incineration method for SW treatment in combination with the energy recovery that will be also the forthcoming trend of SW treatment in these countries. Specifically, in Germany, from 2007 to 2009, the MSW landfill method had been absolutely removed, the incineration method in combination with the energy recovery for the SW treatment had been increased from 20% in 1997 to over 30% in the period of 2006 – 2009. Until 2009, there were totally 449 factories of SW treatment by the incineration method that has been operated in over 20 western and central European countries (excluding the HW treatment factories) (Department for Environment Food & Rural Affairs, 2013).

The trend of SW treatment by incineration method was also applied in the United Kingdom with about 15.1% of total amount of MSW treated by incineration method in 2011, or 3.98 million tons/year. Especially in the UK, until March 2010, there were totally 73 factories that were licensed for the SW incineration (Department for Environment Food & Rural Affairs, 2013)

Japan is the country that has the limited soil resource, so from the 1990s, the country had selected the incineration method that is a main method for the SW treatment. The amount of SW that were burned from 1994 to 2003 in Japan were about 350 million tons/year, occupied over 70% of total amount of SW generated. Until 2003, there were totally 995 factories applying the incineration method for SW treatment and 401 factories applying other methods for SW treatment (Katsuya Kawamoto, 2006).

In Vietnam

In Vietnam, the MSW treatment technology that is mainly applied at present is a landfill technology. The incineration method has not been popularly applied to treat the MSW, but is popularly applied to treat the industrial waste, especially hazardous waste (HW). The SW in Vietnam is burned by two methods namely combined incineration in available incinerators (industrial boiler; brick, ceramic furnace; clinker furnace, etc.) or one-level or two-level industrial incinerators with a low capacity, static furnace, manual electric furnace.

However, the initial results show that the domestic technologies have not been completed and reached the comprehensive efficiency while the foreign technologies and equipment have not been suitable for the SW properties in Vietnam (unseparated at source, high moisture content, high percentage of food compared to other components). In practical, the incineration technology had been applied in some local areas for SW treatment in small scale, has not been much applied in large scale. Some applications are presented as follows:

First, there was "MSW incinerator BD-ANPHA" of the Polytechnic University (Hanoi) and Duc Minh One Member Co., Ltd. This technology that consisted of automatic separation equipment, rotary drying machine, hydraulic loading machine is the versatile incineration machine for SW with a capacity of 250 – 750 kg/h. The incinerator was designed to burn both MSW and industrial SW, the heat from the incinerator will be reused for some purposes namely heat the boiler, dry agricultural products, provide hot water, provide hot wind, drying, etc. As site monitoring result, it showed that the concentration of the wastes that were generated from the incinerator were all lower than QCVN 30:2012/BTNMT[2]. This technology were applied in some cities and provinces namely Khanh Hoa, Hai Phong, Thanh Hoa, Nam Dinh, Binh Duong, Soc Trang, Quang Ninh, Bac Can, Da Nang, etc.

Since January 2004, the pilot incinerator with Model NFI – 120, a capacity of 150 - 500 kg/h has been applied in Lim Town, Tien Du District, Bac Ninh Province. As trial operation, the amount of MSW were treated approximately 6 – 8 tons/day, the incinerator was stably operated and the amount of smoke and slag was insignificantly generated without offensive odors[3]. One another town in Bac Can Province has also applied the pilot incinerator for SW treatment in Ba Be Town, Ba Be District that was made by Vietnam Mineral Resources, Power and Environment Corporation (VMPEC) since July 2014[4].

In addition, some other incineration technologies for MSW treatment were applied such as small-scale incinerator Model ĐM-LSH-500 with a capacity of 500 kg/h (made by Duc Minh One Member Co., Ltd.); incinerator Model NFi-05 with a capacity of 450 kg/day; plasma incinerator with a high capacity (about 50 – 3,000 tons/day) Model Plasma JMI, ENSERCO incineration technology with a capacity of 450 tons/day (made by Thang Long Environmental Services J.S. Company), etc.

In general, the application of the incineration technology for MSW treatment in Vietnam is not popular, so this technology is currenty applied with small capacity and scale. The practical applications show that the emission treatment efficiency of this technology is rather high and the emissions after treatment meet the National Technical Regulations and have not caused the negative impacts on the surrounding environment. In the future, the application of the incineration technology for SW treatment in combination with energy recovery in Vietnam is widely deployed together with the recycling technology and compost processing technology to access to gradually reduce the application of landfill technology and to contribute to the environmental protection. Although the

[2] http://www.ducminhmtv.com.vn/tin-tuc/cong-nghe/bao-cao-cong-nghe-lo-dot-chat-thai-ran-sinh-hoat-bdnanpha
[3] http://baobacninh.com.vn/news_detail/81040/tien-du-thi-diem-lo-dot-chat-thai-ran-sinh-hoat.html
[4] http://vmpec.com.vn/20449-vmpec-trien-khai-du-an-lo-dot-rac-thai-sinh-hoat-tai-huyen-ba-be-tinh-bac-can-07-2014.html

incineration technology requires rather high investment and operation cost (the total investment capital for one SW incineration factory with a capacity of 300 tons/day is estimated approximately 20 - 30 million USD[5]) together with rather high cost of relevant equipment maintenance, it will significantly contribute to solve the energy problem and the environment hygiene in the urban area.

Overview of the heating value of SW

The heating value includes higher heating value (HHV) and lower heating value (LHV). In which, the HHV or GHV is a heating value of SW mixture and the LHV is a net heating value.

The MSW consists of many components including many combustible components that could significantly create the energy (the heating value) for the power generation. As Tchobanoglous, 1993, the heating value of the MSW components is presented in **Table 5** below.

Table 5. Heating value of MSW components

No.	Component	Heating value (KJ/kg)		Heating value (Cal/g)	
		Range	Specific value	Range	Specific value
1	Food	3,489 – 6,978	4,652	837 – 1,675	1,116
2	Paper	11,630 – 18,608	16,747	2,791 – 4,466	4,019
3	Carton	13,956 – 17,445	16,282	3,349 – 4,187	3,908
4	Plastic	27,912 – 37,216	32,564	6,699 – 8,932	7,815
5	Textile	15,119 – 18,608	17,445	3,629 – 4,466	4,187
6	Rubber	20,934 – 27,912	23,260	5,024 – 6,699	5,582
7	Leather	15,119 – 19,771	17,445	3,629 – 4,745	4,187
8	Garden waste	2,326 – 18,608	6,513	558 – 4,466	1,563
9	Wood	17,445 – 19,771	18,608	4,187 – 4,745	4,466
10	Glass	116 – 223	140	28 – 54	34
11	Tin can	233 – 1163	689	56 – 279	165
12	Other metals	233 – 1163	689	56 - 279	165
13	Dust, ash, etc.	2,326 – 11,630	6978	558 – 2,791	1,675
14	MSW (mixture)	9,304 – 13,956	11,630	2,233 – 3,349	2,791

Source: Tchobanoglous et al., 1993.

As mentioned in Table 1, the plastic has the highest heating value with a specific value of 7,815 Cal/g. The components that have the HHV include paper (4,019 Cal/g), carton (3,908 Cal/g), textile (4,187 Cal/g), rubber (5,582 Cal/g), leather (4,187 Cal/g) and wood

[5] Tuan Luong, MSW: which treatment technology do you apply?, http://www.epe.edu.vn/?nid=478, 2014

(4,466 Cal/g). The other components namely food, metal, glass, garden waste, dust, ash, etc. have the LHV of below 1,500 Cal/g. The heating values of the components namely glass, tin can or metal as mentioned in Table 1 are not their own heating values, but are the heating values of their external coats, labels and materials attached. Therefore, these components could be considered as incombustible components that could not form the heat if they burned.

As M.F.Seelig et al. (2012), the HHV of MSW is approximately 9.98 MJ/kg (≈ 2,395 Cal/g) and the LHV of MSW is approximately 4.77 MJ/kg (≈ 1,145 Cal/g). In similar, as Amrehn (2014), the GHV of MSW in Vietnam is about 10 MJ/kg (or 2,400 Cal/g). In which, the components that have the HHV of over > 20 MJ/Kg (or > 4,800 Cal/g) are paper and plastic. In addition, the analytical result of the SW components in the Phuoc Hiep Landfill, HCMC made by ETM, 2014, the HHV and LHV of the MSW fluctuate about 1,600 – 2,300 Cal/g and 980 – 2,000 Cal/g respectively.

The MSW in Vietnam in general and in HCMC in particular could be separated into 11 major components such as (1) food (meat, fish, vegetables, rice, bread, fruits, etc.); (2) paper; (3) diaper; (4) plastic; (5) textile; (6) wood; (7) Rubber-leather; (8) metal; (9) inorganic components (coal ash, brick, glass, etc.); (10) shell-bone and (11) others (the components that have too small sizes or could not be visually separated are soil, stone, hair, cigarette butts, etc.). Among these components, the plastic has the high combustible possibility and the most energy generation with the HHV of about 7,000 – 9,000 Cal/g; the HHV of paper, diaper, textile, wood, rubber-leather fluctuates about 3,000 – 6,000 Cal/g. Otherwise, the food that has the lowest heating value fluctuates about 3,000 – 4,000 Cal/g (ETM, 2014).

In conclusion, the SW components namely plastic, rubber-leather, diaper, textile, garden waste, wood, paper or food that have all the HHV of over 1,500 Cal/g have high combustible possibility to produce the energy for the power generation (as Ph.D Kosuke Kawai, 2012).

2.2 Combustible possibility of the SW components in Phuoc Hiep Landfill, Dong Thanh Landfill and Go Cat Landfill

ETM has implemented the sampling programs at Phuoc Hiep, Go Cat and Dong Thanh Landfills to assessing the combustible possibility of waste, along with full chemical and physical analyses of MSW, through which, to assessing the possibility of using the incineration technology for MSW treatment. For Phuoc Hiep Landfill has received MSW, ETM has analysed the new MSW, not buried. For Go Cat and Dong Thanh Landfills had been stopped receiving and landfilling the SW, the SW samples are taken in the landfill cells by the drilling method or cranes according to the depth of the sample taken.

The Go Cat Landfill and Dong Thanh Landfill had been stopped operating for a long time. The Dong Thanh Landfill had been stopped operating since 2002 and the Go Cat Landfill had been stopped operating since 2007. In these landfills, the SW had been buried seven years ago for new SW and over 23 years for old SW (the SW had been buried in the Dong Thanh Landfill since 1991). Thus, the current properties of SW are changed compared to the initial properties due to the organic matters decomposed by time together with leachate generation, storm-water infiltration into the surface water and groundwater sources in local areas for a long time. Meanwhile, the Phuoc Hiep Landfill has received the SW before official closure, so the SW components are new and many organic components has not been decomposed.

In order to assess the combustible possibility of SW, ETM took the SW samples in the landfill cells in the Dong Thanh Landfill, Go Cat Landfill and the SW from the MSW collection vehicles at Phuoc Hiep Landfill. As the analytical result of the GHVs of the SW components in these landfills, the combustible components that could be burned to highly produce the energy could be determined. The analytical result of the GHV of the SW components is mentioned hereinafter.

2.2.1 Combustible possibility of the SW components in Phuoc Hiep Landfill

For Phuoc Hiep Landfill, ETM has analysed the new MSW, not buried. In comparison with the Dong Thanh Landfill and Go Cat Landfill, the SW components in the Phuoc Hiep Landfill is rather new and many other components have not been decomposed. In the Phuoc Hiep Landfill, the food that has a rather high percentage compared to other components is about 66.2%. Additionally, the percentage of the other components are about 17.0% for plastic mainly nylon; about 5.8% for textile, about 3.5% for diaper, 3.1% for paper, 1.6% for inorganic components and about 1.0% for shell-bone. The rest components namely rubber-leather, metal and others that are insignificantly fluctuate about 0.2 – 0.7%. The SW components in the Phuoc Hiep Landfill are showned in **Figure 7**.

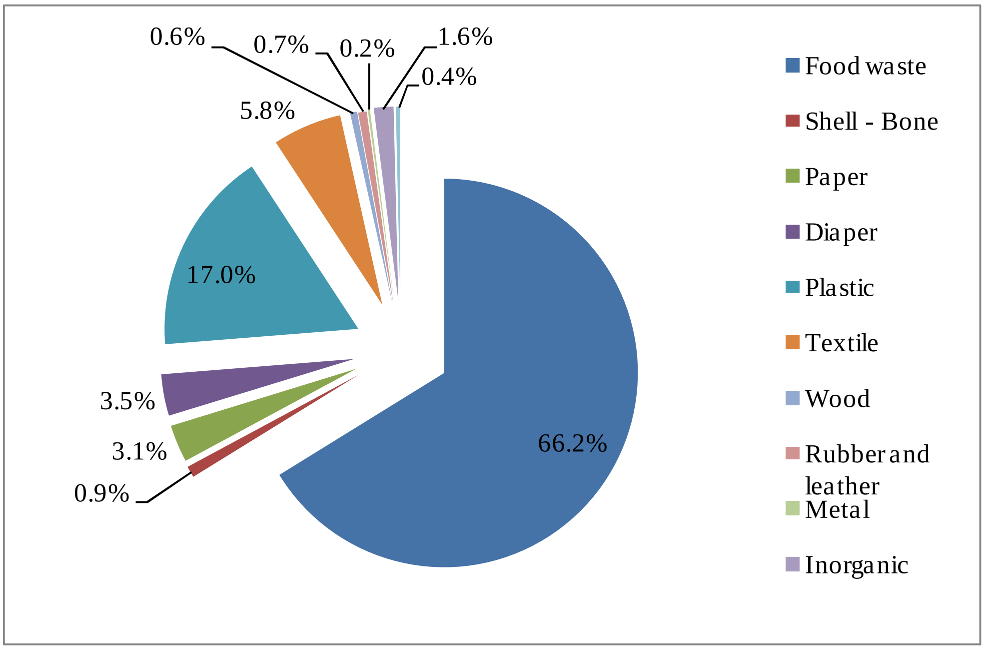

Figure 7. SW components in Phuoc Hiep Landfill.

Because the SW is newly buried in the Phuoc Hiep Landfill, there are many combustible components namely food, paper, diaper, plastic, textile, wood and rubber-leather that could be burned to highly produce the energy. The GHV of these components fluctuate in wide range of 3,700 – 8,400 Cal/g in which the plastic has the highest heating value and the food has the lowest heating value. The analytical result of the GHV of the SW components in the Phuoc Hiep Landfill is shown in **Figure 8** below.

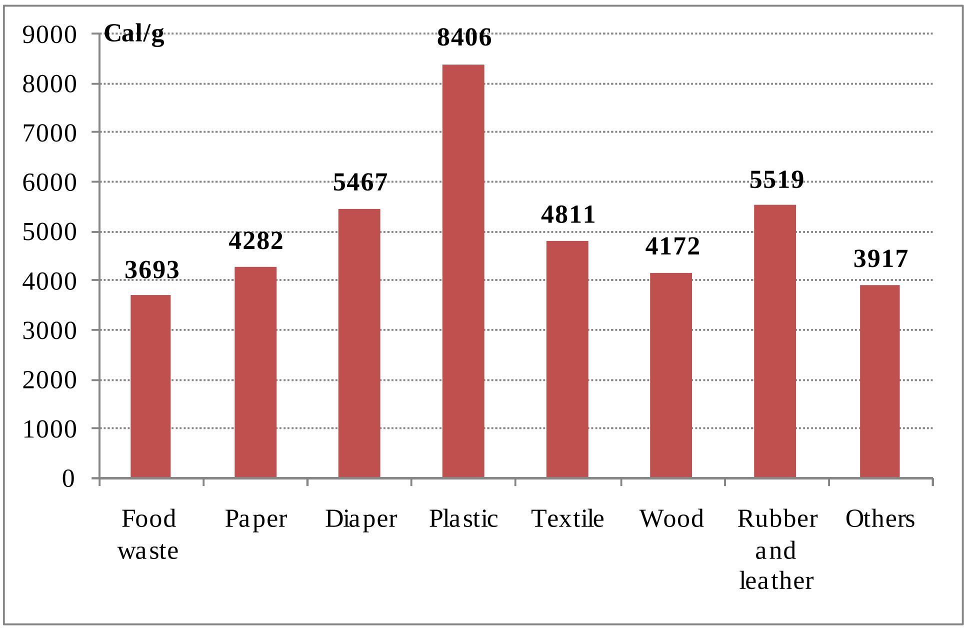

Figure 8. GHV of the SW components in Phuoc Hiep Landfill**.**

The plastic has the highest heating value of about 8,406 Cal/g compared to the other components in the SW in the Phuoc Hiep Landfill that were analyzed. This is the component that has the highest percentage in SW in the Phuoc Hiep in general and in MSW in Vietnam in particular.

The components namely paper, diaper, textile, wood, rubber-leather have all the average heating value in range of about 4,000 – 5,000 Cal/g.

Others and food have the lowest heating values that are 3,917 Cal/g and 3,693 Cal/g.

In conclusion, the SW components in the Phuoc Hiep Landfill have all the HHVs and could be burned to produce the energy for the power generation, even the components that have high moisture content (about 70%) and diaper (approximately 80%). The other components namely shell-bone, metal and inorganic components (ceramic, glass) could not be burned.

2.2.2 Combustible possibility of the SW components in Dong Thanh Landfill

The SW in the landfill cells in the Dong Thanh Landfill is taken at different depth of about 3 - 22m and then analyzed with its components, the SW samples in the landfill cells in the Dong Thanh Landfill, Go Cat Landfill were landfilling over a period of 5 – 7 years. The samling and analyzing procedure of the SW components in the Dong Thanh Landfill are shown in **Figure 9**.

a. Crane used for excavating and taking SW in landfill cell

b. SW in landfill cell

c. SW excavated and piled up


d. SW separation


e. SW before and after separation

f. Some components separated


g. Nylon, plastic

h. Shell-bone


i. Textile

j. Rubber

Figure 9. Sampling and analyzing procedure of the SW components in Dong Thanh Landfill (**Source**: HCMc 's DONRE, 2007).

As analytical result, the SW components left in the landfill cells in the Dong Thanh Landfill include mud (0 – 50%), plastic (including mainly nylon) (20.7 – 62.7%), bamboo-straw-leaves (11.4 – 20.7%), papers (including carton, plastic coated paper) (0 – 2.1%), wood (0 – 5.3%), leather (0 – 1.1%), color metal (0 – 2.4%), iron (0 – 0.5%) and other components namely stone, ceramic, shell-bone, textile, rubber and sacks, hair, etc. The average percentage of the SW components in the Dong Thanh Landfill is shown in **Figure 10**.

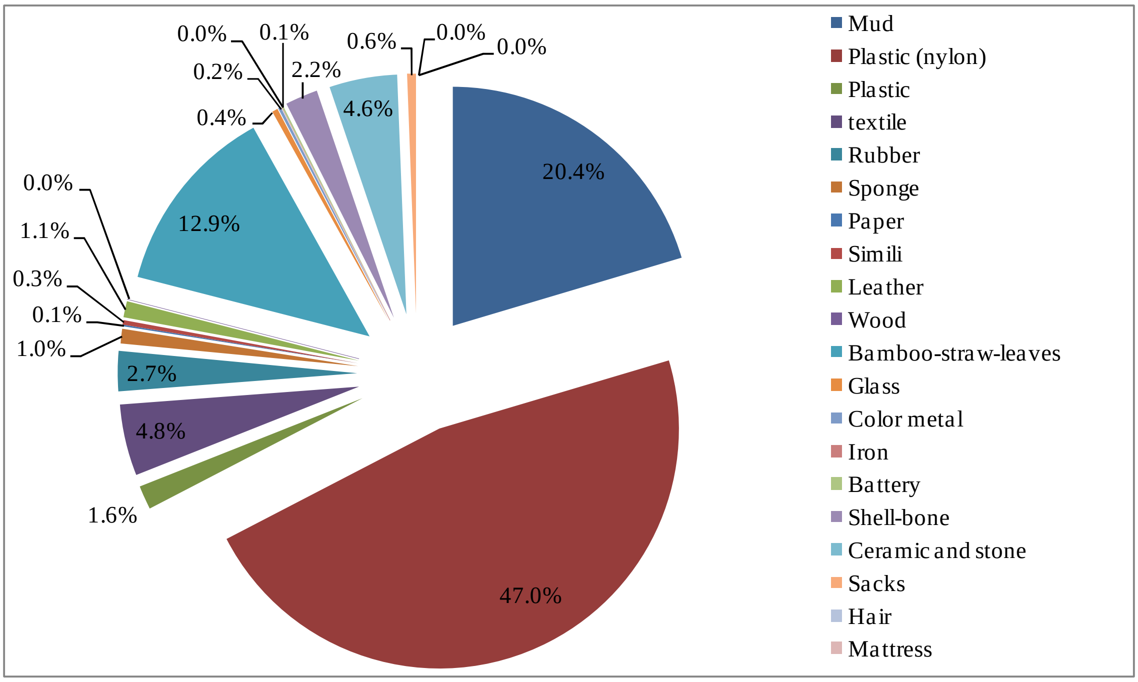

Figure 10. SW components in Dong Thanh Landfill (**Source**: HCMc 's DONRE, 2007).

In conclusion, beside mud (not or completely decomposed), there are paper, wood and some organic components with a low combustible possibility that could be degradable to produce the gas or be burned for the power generation.

As analytical result, the combustible components in MSW that could be burned to highly produce the energy include plastic, rubber, leather, diaper, textile, garden waste, wood, papers (carton, plastic coated paper) and food; these components are mostly observed in the SW buried in the Dong Thanh Landfill except food (decomposed) and diaper (is not observed in the SW components at the sampling time due to the low demand of using this component).

The GHV of the SW components is estimated depending on the analytical result of the SW elements namely C, H, O, N, S (as specifically presented in the ***Report 2:*** *Analysis of the physical and chemical properties of the SW in Phuoc Hiep Landfill, Dong Thanh Landfill and Go Cat Landfill*). The GHV is presented in **Table 6** and shown in **Figure 11** below.

Table 6. GHV of the SW components is estimated depending on the analytical result of the SW elements namely C, H, O, N, S in Dong Thanh Landfill (under Tchobanoglous et al. 1993)

No.	Component	GHV (Btu/lb)	GHV (Cal/g)
1	Paper	6,616	3,693
2	Textile	9,668	5,397
3	Rubber	17,430	9,730
4	Leather	12,796	7,143
5	Wood	7,584	4,233

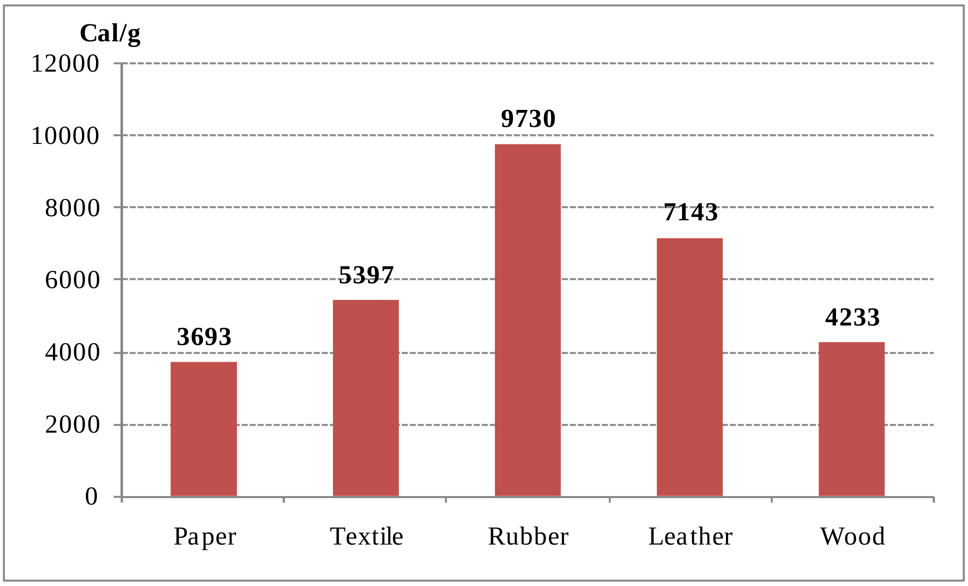

Figure 11. GHV of the SW components in Dong Thanh Landfill.

The GHV of the SW components in the Dong Thanh Landfill is rather high and equivalent to the GHV of the SW components in the Phuoc Hiep Landfill. In which, the rubber and leather component in the Dong Thanh Landfill is separately analyzed with its GHV, so the GHV in the Dong Thanh landfill is higher than one in case of general analysis of two components in the Phuoc Hiep Landfill. Particularly, the GHVs of rubber and leather are 9,730 Cal/g and 7,143 Cal/g respectively while the general GHV of rubber and leather is about 5, 519 Cal/g in average. As some analytical results under the programs on SW separation at source in Binh Thanh District and District 1, HCMC in 2013, the general GHV of rubber and leather is not as high as the separate GHVs of rubber and leather. The general GHVs of rubber and leather in Binh Thanh District and District 1 are 4,673 Cal/g and 6,277 Cal/g.

The GHVs of paper and wood that are similar to the specific GHVs recorded from the different researches is approximately 4,000 Cal/g. Similarly, the textile is approximately 5,000 Cal/g.

The analysis of the elements namely C, H, O, N, S is not applied to the plastic, so the GHV of this component could not be estimated. However, as the percentage of plastic and nylon in the SW components in the Dong Thanh Landfill and the GHV of the plastic in range of 7,000 – 9,000 Cal/g recorded from other researches, it showed that the plastic is one of combustible components to highly produce the energy in the Dong Thanh Landfill.

The above-mentioned components that have all the HHV of over 1,500 Cal/g could be burned to highly produce the energy. Beside these components, some other components in the SW buried that could be also burned to highly produce the energy include simili, porous foam, bamboo, leaves, sacks, mattresses.

2.2.3 Combustible possibility of the components of the SW in Go Cat Landfill

The SW samples are taken in the Go Cat Landfill at a depth of 1 – 5.5m by the cranes. The SW sampling process in the Go Cat Landfill is shown in Figure 12 below.

a. Crane to excavate and take SW

b. SW piled up

c. Excavated pit for taking SW

d. Sampling activity

e. SW before separation

f. Some SW components after separation

g. Wood

h. Paper

i. Plastic

j. Rubber

Figure 12. Sampling process in Go Cat Landfill.

Similar to the SW components in the Dong Thanh Landfill, the SW components are manily mud, soil and stone, hair (other components could be visually separated), inorganic components and low biodegradable components. In which, there about 35.8% – 54.0% for others; 24.6 – 51.9% for plastic, mainly nylon; 1.8 – 13.4% for textile; 0.6 – 2.3% for paper; 0 – 1.9% for shell-bone, wood, glass, metal and rubber.

The components such as plastic, textile, wood, rubber that have HHV are observed in the SW components in the Go Cat Landfill. As analytical results, the GHV of these components are high, so they could be treated by incineration method with the energy produced. The average HV of the components of the SW in the Go Cat Landfill is presented in **Table 7** and shown in **Figure 13**.

Table 7. Average heating value of the SW components in Go Cat Landfill

No.	Component	Average heating value (Cal/g)
1	Plastic	8,852
2	Textile	4,139
3	Wood	3,484
4	Shell-bone	1,112
5	Paper	3,591
6	Rubber	5,555
7	Persistent biodegradable components	2,441
8	Others	1,597

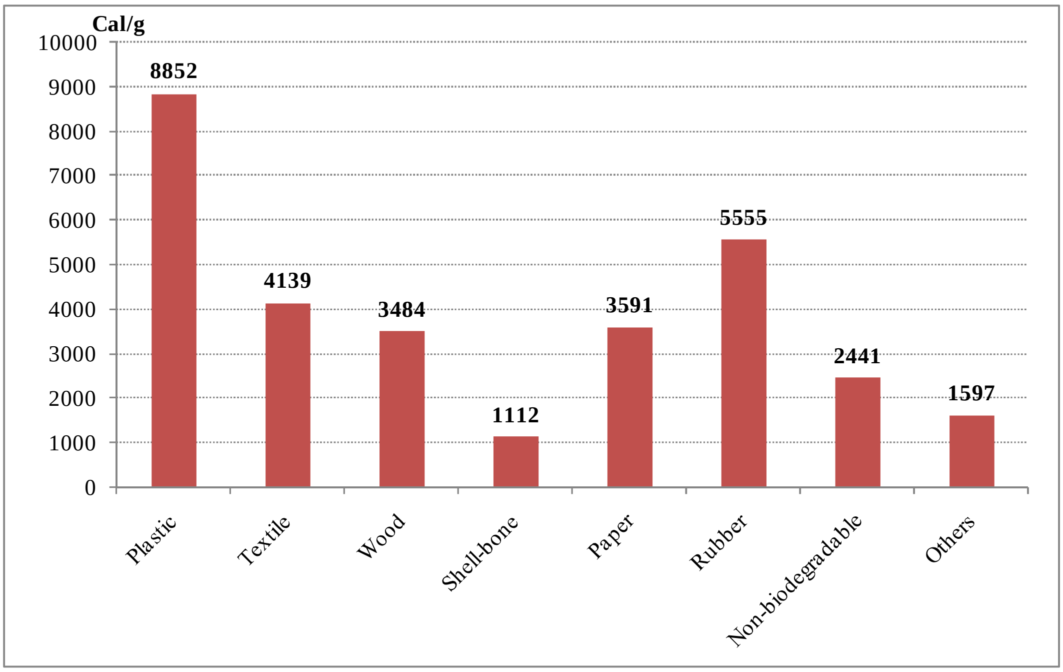

Figure 13. Average heating value of the SW components in Go Cat Landfill.

The plastic has the highest heating value compared to the other components. The average heating value of the SW in the Go Cat Landfill is about 8,852 Cal/g that is equivalent to the average heating value of the SW before landfill in the Phuoc Hiep Landfill (about 8,400 Cal/g) and one of the SW in Binh Thanh District and District 1 under the programs on SW separation at source (approximately 9,000 Cal/g) (ETM, 2014).

The GHV of rubber is equivalent to the GHVs in the Phuoc Hiep Landfill, District 1 and Binh Thanh District that were analyzed. The GHV of SW in the Go Cat Landfill is 5,555 Cal/g while the GHVs of the SW types in the other places fluctuate about 4,600 – 6,200 Cal/g. However, these values are rather different to ones in the Dong Thanh Landfill that are approximately 4,000 Cal/g lower than the others.

The GHV of textile of the SW in the Go Cat landfill is about 4,139 Cal/g that is lower than one in the Phuoc Hiep Landfill (4,811 Cal/g), in the Dong Thanh Landfill (5,397 Cal/g), in Binh Thanh District and District 1 (5,201 and 5,352 Cal/g respectively) but a insignificant difference.

The GHVs of wood, paper are similar, approximately 3,500 Cal/g. The components could generate the HHV in the Go Cat Landfill. The GHVs are lower than ones in the other places (in rang of 3,500 – 4,500 Cal/g).

The persistent biodegradable components (the wastes containing cellulose such as coconut fibers, mango seeds, etc.) as well as the LHV components compared to the above-mentioned components that could be burned to produce the energy for the power generation have the average heating values of 2,441 Cal/g và 1,597 Cal/g respectively.

The shell-bones that are the low combustible components could be treated by incinceration method (HHV > 800 Cal/g) but they could not be burned to produce the energy (HHV > 800 Cal/g). The average heating value is low, only 1,112 Cal/g.

Excep the inorganic components namely metal, glass and hazardous components (e.g. batteries, syringes) are incombustible to produce the energy, most of the other components that are highly combustible could be burned to produce the energy for the power generation (except shell-bones).

3. CONCLUSION

Both Dong Thanh Landfill and Go Cat Landfill stopped receiving and landfilling the SW. At present, the landfills collect and treat the leachate and biogas for generator. The SW in the Dong Thanh Landfill is deeply buried in the landfill cells and covered by debris layer with a width of 3-5m at the top of landfill cells. There are not many environmental problems namely offensive odors, leachate or LFG arised within the Dong Thanh Landfill. The Go Cat Landfill has the time of stopped operation that is less than the Dong Thanh Landfill, so there are many environmental problems left in the Go Cat Landfill such as leachate or LFG, topcoat in the landfill cells with small height of about 20 – 50cm (as site monitoring catering for taking the SW samples). The Phuoc Hiep Landfill among three above-mentioned landfills is the only one landfill that had still received the SW until 2003[6] as planned. The environmental problems in this landfill are mainly offensive odors and leachate generated.

The SW components in both Dong Thanh Landfill and Go Cat Landfill that are similar include mud, soil, stone, nylon, textile, paper, rubber, leather, wood and other components namely metal, ceramics, glass, etc. In which, the components that have high combustible possibility with HHV of over 1,500 Cal/g (in range of 1,500 – 9,000 Cal/g) are plastic, textile, paper, rubber, leather, wood, coconut fiber, mango seeds. So, these components could be burned to produce the energy for the power generation.

The Phuoc Hiep Landfill has still been operated, so the SW components in this landfill are different from the components of the old SW in the Go Cat Landfill and Dong Thanh Landfill. The SW in the Phuoc Hiep Landfill has the HHV components namely plastic, textile, paper, rubber-leather, wood that are similar to the SW components in two other landfills, except that some components namely food unburied and new diaper are additionally generated in recent years due to the demand of customers. The components have all the HHV of over 1,500 Cal/g (in range of 3,500 – 8,500 Cal/g) that could be burned to produce the energy for the power generation.

[6]Official Letter No. 475/TB-VP issued by the HCMC's PC dated 17/6/2014 regarding the closure of the Phuoc Hiep Landfill No. 3.

2-4 ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF THE SOLID WASTE BURIED IN DONG THANH LANDFILL GO CAT LANDFILL

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REPORT 2

ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF THE SOLID WASTE BURIED IN DONG THANH LANDFILL GO CAT LANDFILL AND PHUOC HIEP LANDFILL

October 2014

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APHA	American Public Health Association
B.O.D	Board of directors
BTNMT	Department of natural Resources and Environment
DONRE	Department of natural Resources and Environment
DPIWMF	Da Phuoc Integrated Waste Management Facility
DW	Dry weight
EM	Effective Microganisms
EPA	Environmental Protect Agency
ETM	Center for Environmental Technology and Management
GHV	Gross heating value
HCMC	Ho Chi Minh City
HDPE	High Density Polyethylene
HHV	Higher heating value
HW	hazardous waste
ISWTZ	Integrated Solid Waste Treatment Zone
LFG	Landfill gas
LHV	Lower heating value
MSW	Municipal solid waste
SW	Solid waste
TCVN	Vietnam Standards
VS	Volatile solid
WW	Wet weight

1. OVERVIEW OF MUNICIPAL SOLID WASTE IN HO CHI MINH CITY (HCMC)

In the recent 5-10 years, the situation of MSW generation in Vietnam in general and in HCMC in particular has had a rapid increase of volume and the changes of the SW composition and properties. This is the inevitable changes together with the population growth and the process of urbanization, industrialization in recent years. The process of rapid population growth has resulted in the gradually increased demand of housing, domestic activities, education, training, health care, transportation, etc. that has directly affected the natural environment and social environment. The amount of waste, especially SW from the domestic activities in urban area has constantly increased and has still tended to be more and more increased in the future. Besides, the quality of people's lives is also better, so the demand of the consumers is also increased. Accordingly, the amount of wastes will be generated more with more many different components such as diapers, electrical and electronic utensils, etc.

As *the National Environment Report 2011 – Solid Waste* of the MONRE, the input MSW components in the landfills in some local Cities/Provinces namely Hanoi, Hai Phong, Hue, Da Nang, HCMC and Bac Ninh in the period of 2009 – 2010 showed that the amount of food wastes is significant in range of 53.81 – 77.1%, followed by the plastic in range of 8.35 – 15.96%, the paper in range of 1.92 – 8.17% and the other components such as textile , wood, rubber-leather, metal, glass, ceramics, soil and sand, coal slag, hazardous wastes (HW), sludge and others in range of 0 – 6% as mentioned in **Table 1** below.

Table 1 Percentage of input MSW in landfills in some Cities/Provinces in the period of 2009 – 2010

No.	Component	Hanoi (Nam Son)	Hanoi (Xuan Son)	Hai Phong (Trang Cat)	Hai Phong (Dinh Vu)	Hue (Thuy Phuong)	Da Nang (Hoa Khanh)	HCMC (Da Phuoc)	HCMC (Phuoc Hiep)	Bac Ninh (Ho Town)
1	Organic SW	53.81	60.79	55.18	57.56	77.10	68.47	64.50	62.83	56,90
2	Paper	6.53	5.38	4.54	5.42	1.92	5.07	8.17	6.05	3,73
3	Textile	5.82	1.76	4.57	5.12	2.89	1.55	3.88	2.09	1,07
4	Wood	2.51	6.63	4.93	3.70	0.59	2.79	4.59	4.18	-
5	Plastic	13.57	8.35	14.34	11.28	12.47	11.36	12.42	15.96	9,65
6	Rubber-leather	0.15	0.22	1.05	1.90	0.28	0.23	0.44	0.93	0,20
7	Metal	0.87	0.25	0.47	0.25	0.40	1.45	0.36	0.59	-
8	Glass	1.87	5.07	1.69	1.35	0.39	0.14	0.40	0.86	0,58
9	Ceramic	0.39	1.26	1.27	0.44	0.79	0.79	0.24	1.27	-
10	Soil and sand	6.29	5.44	3.08	2.96	1.70	6.75	1.39	2.28	27,85
11	Coal slag	3.10	2.34	5.70	6.06	-	0.00	0.44	0.39	-
12	Hazardous coomponents	0.17	0.82	0.05	0.05	-	0.02	0.12	0.05	0,07

No.	Component	Hanoi (Nam Son)	Hanoi (Xuan Son)	Hai Phong (Trang Cat)	Hai Phong (Dinh Vu)	Hue (Thuy Phuong)	Da Nang (Hoa Khanh)	HCMC (Da Phuoc)	HCMC (Phuoc Hiep)	Bac Ninh (Ho Town)
13	Sludge	4.34	1.63	2.29	2.75	1.46	1.35	2.92	1.89	-
14	Others	0.58	0.05	1.46	1.14	-	0.03	0.14	0.04	-
Total		**100**	**100**	**100**		**100**	**100**	**100**	**100**	

Source: The National Environment Report 2011, MONRE.

In HCMC, the MSW is mainly generated from households, officies, commercial centers, trading enterprises and street wastes. The MSW components are rather various with two major components namely food and plastic, the other components are little namely paper, diaper, textile , wood, rubber-leather, metal, garden waste, inorganic components and others. The SW components in HCMC (Dong Thanh, Go Cat, Phuoc Hiep Landfill) has been changed in the period of 1996 – 2013 as shown in **Figure 1**.

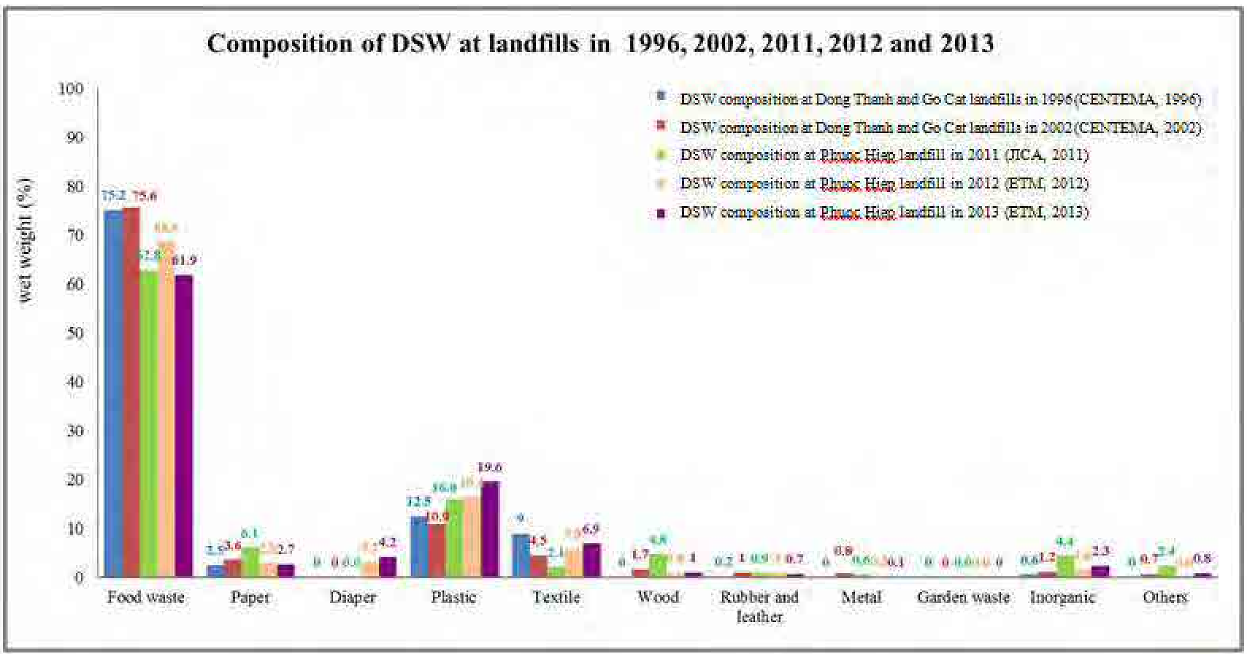


Figure 1 Fluctuation of MSW components in the landfills in HCMC in 1996, 2002, 2011, 2012 và 2013.

As shown in **Figure 1**, from 1996 to 2013, the percentage of the food tends to be reduced but is rather high, in range of 61.9 – 75.6%. Otherwise, the components that tend to be increased include plastic (10.9 – 19.6%) and diaper (0 – 4.2%) due to the demand of consuming these components increased. The other components are not much and could be insignificantly changed by time.

The MSW in Vietnam contains mainly the food with high moisture content, so the MSW moisture content is also rather high. For the SW in the Phuoc Hiep, Dong Thanh and Go Cat Landfill in HCMC, it contains the food of 60 – 70% that has rather high moisture content in range of 60 – 75%) leading to the SW moisture content increased (in range of 50 – 70%). In addition, the high moisture content of MSW is also resulted from many various factors such as storm-water infiltration from the process of SW storage at source to the process of SW collection and transportation to the landfill. Because the components namely paper, textile , especially diaper have moisture content absorption, the storm-water will be retained inside these components leading to the SW moisture content increased.

The VS of MSW in the landfills in HCMC occupies about 30% while the ash content occupies approximately 10%. Almost SW components have good combustible possibility at 550^{o}C such as food, paper, plastic, diaper, textile , wood, rubber-leather, etc. while the other components namely inorganic components, shell-bone or metal, etc. are mostly unchanged after combustion.

As Amrehn (2014), the HHV of the MSW in Vietnam is about 10 MJ/kg (≈ 2,400 Cal/g). In which, the components that have the HHVs of over 20 MJ/Kg (≈ > 4,800 Cal/g) include paper and plastic. For the MSW in HCMC, as the analytical results of the SW components in the Phuoc Hiep, Go Cat and Dong Thanh Landfill carried out by ETM, the plastic have the most combustible possibility for the energy generation with the HHV in range of 7,000 – 9,000 Cal/g; the components namely paper, diaper, textile , wood, rubber-leather have the HHV in range of 3,000 – 6,000 Cal/g. Otherwise, the food has the lowest heating value in range of 3,000 – 4,000 Cal/g. The HHV and LHV of the MSW is about 2,000 Cal/g and 1,500 Cal/g respectively (ETM, 2014).

In summary, due to the SW unseparated at source, the SW that is transported to the landfills in HCMC is mixed wastes including the components possibly separated namely food (the highest percentage), plastic, paper, textile , wood, rubber-leather, shell-bone, metal, inorganic components and some components that could not be visually sorted are called as others. The SW has rather high moisture content and almost SW components have good combustible possibility at 550^{o}C, the ash content after combustion is rather little, occupied only 10%ww. The heating value of the SW is rather high, so the SW could be burned for the energy recovery (LHV > 1,500 Cal/g).

The analyis, assessment of the input SW properties known as the SW unburied in the landfills in HCMC are mentioned hereinbefore. The SW after landfill will be decomposed and reduced with its volume, especially after 5 – 10 years, the biodegradable components namely food, paper or garden waste were mostly decomposed. The SW components were left mainly wood, textile , plastic, glass and metal. The organic components after decomposition will generate the leachate together with the amount of storm-water and surface-water infiltrated into the landfill cells, so the buried SW layer has high moisture content, the deeper SW layers will have higher moisture content due to the vertical infiltration of leachate inside the landfill cells.

The SW properties after landfill will be changed by year, the fluctuation of the SW components is mainly based on the biological decomposition of the SW components inside the landfill cells. The longer landfill time will result in the more decreased amount of the SW leading to the subsidence, landslide occurred in the landfill cells due to the volume of the SW reduced in the landfill cells by time. The analytical result of the physical and chemical properties of the SW buried 5 – 10 years ago in the Go Cat and Dong Thanh Landfill are presented hereinafter in this report.

2. METHOD OF SAMPLING AND ANALYZING THE SW COMPONENTS

ETM has implemented the sampling programs at Phuoc Hiep, Go Cat and Dong Thanh Landfills to analyzing the chemical and physical components of MSW. For Phuoc Hiep Landfill has received MSW, ETM has analysed the unburied MSW. For Go Cat and Dong Thanh Landfills had been stopped receiving and landfilling the SW, the SW samples are taken in the landfill cells by the drilling method or cranes according to the depth of the sample taken. The sampling and analytical methods is presented as follow.

2.1 Sampling method

2.1.1 Sampling

The sampling location is mainly based on the safety and the specific property of the SW samples. The SW samples are taken by excavating or drilling the landfill cells in each layer or from the MSW collection vehicles. The sampling method in each landfill is presented as follows:

In Phuoc Hiep Landfill

The SW sampling that is catering for analyzing the components and properties of the MSW in the Phuoc Hiep Landfill is from the collection trucks to the landfill as follows:

- Sampling locations are based on the safety and the specific property of the SW samples taken;
- The SW is taken from the collection trucks with a frequency of every ten trucks;
- The SW is taken in the transfer station where the trucks will deliver the SW to the landfill cells. In each pile of SW, the SW samples are taken at four random points with 20kg/each point. Thus, the total amount of the SW from each truck fluctuates 75 – 80kg.
- The sampling process will be carried out four times, so the total amount of the SW is taken about 300 – 320 kg.

In Dong Thanh Landfill

The Dong Thanh Landfill that began to spontaneously bury the MSW in 1989 without bottom liner was designed under the technical standard for hygienic landfill. Until 2002, the Dong Thanh Landfill had stopped receiving the MSW. The program on drilling to take the SW samples in the Dong Thanh Landfill is carried out to cater for analyzing the SW components in this landfill after being buried for a long time.

In order to monitor the SW components, the researching team took the SW samples at three different locations. Because the SW is dumped around from the bottom to the top, the SW components and properties in different locations are almost similar. The researching team selected three highest locations with the least amount of debris dumped that are drilled to take the SW samples to determine the composition and properties of the SW left in the landfill cells. The sampling locations are shown in **Figure 2**.

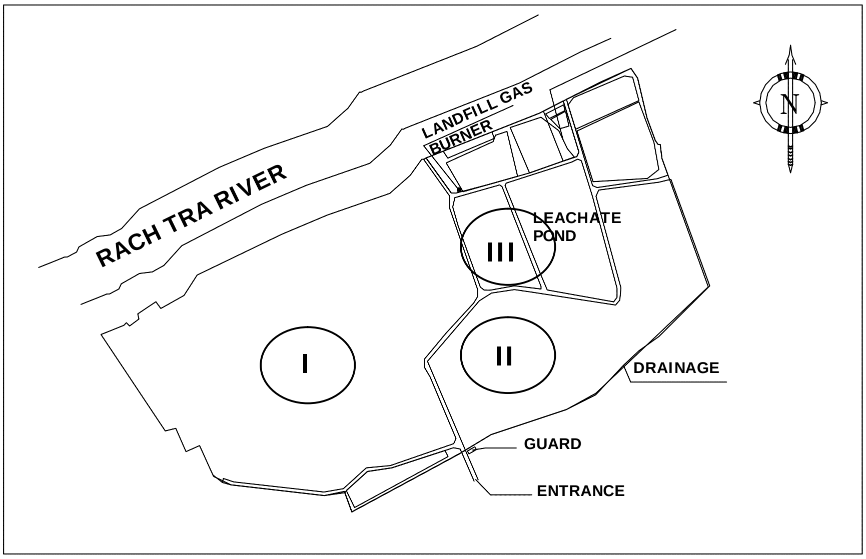


Figure 2. Sampling locations in Dong Thanh Landfill.

In case, the samples that are taken at a depth of 3 – 17 m will be taken by cranes. The samples that are taken at a depth of 17m and above will be taken by crane together with the driller. In theory, in order to precisely determine the analytical result, the amount of each SW sample is taken about 200 lb, or 98kg. However, the sampling devices must be improved in conformity with the property of the SW decomposed in the landfill, so the amount of the SW samples that are different fluctuates about 70-95 kg/sample. The symbols of the SW samples and sampling locations are presented in **Table 2** below.

Table 2. Symbol of the SW samples and sampling locations in Dong Thanh Landfill

Symbol	Depth (m)	Sampling device	Quantity (kg)
I3	3	Crane	87.5
I6	6	Crane	88.2

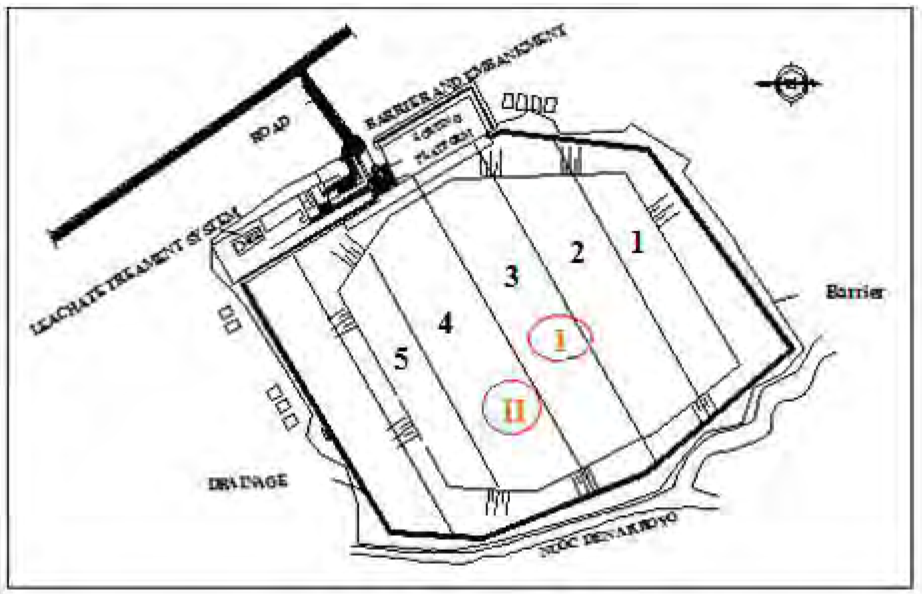
Symbol	Depth (m)	Sampling device	Quantity (kg)
I9	9	Crane	83.8
I12	12	Crane	75.7
I18	18	Driller	85.1
II3	3	Crane	86.5
II6	6	Crane	87.1
II9	9	Crane	90.5
II12	12	Crane	91.7
II17	17	Crane	64.3
II20	20	Driller	70.5
II22	22	Driller	81.4
III3	3	Driller	95.7
III6	6	Driller	83.2
III9	9	Driller	91.4
III16	16	Driller	92.7
III19	19	Driller	84.8

Note: I, II, III are symbols corresponding to the drilling hole 1, 2 and 3

Source: DONRE, 2007

In Go Cat Landfill

The Go Cat Landfill had been operated from 2002 to 2007, the SW sample was taken on 01/10/2014 after the landfill had stopped its operation 7 years ago. The sampling method is similar to the Dong Thanh Landfill. Unlike the sampling program in the Dong Thanh Landfill, the sampling program in the Go Cat Landfill was made only at a depth of 1 - 5 m by only crane. The sampling locations are shown in **Figure 3**.



Note: I: Location 1, landfill cell 3, near landfill cell 2

II: Location 2, landfill cell 4

Figure 3. Sampling locations in Go Cat Landfill.

The SW sampling procedure is carried out by the folowing steps:

- The crane is used for excavating and shovelling the SW from the landfill cells into a pile according to each layer with a depth of 1 – 5m. The SW samples are taken at depth of 1m and 5m.
- At each depth, the SW sample is separately piled up and then taken by plastic buckets with a volume of 80L. The amount of the SW sample that is equivalent to a filled 80-liter bucket fluctuates 50 – 60 kg.
- The total amount of the SW sample that is equivalent to four filled 80-liter buckets fluctuates 200 – 240 kg.

2.1.2 Sample treatment

The sample treatment procedure is conformed to the following steps:

- After sampling, the SW sample is spread into a canvas on the ground, then cut into smaller pieces with a size of about 15cm by knives and scissors. The large-size components such as carton, tree branches, etc. will be cut into smaller pieces with a size of less 15cm. Each SW sample will be thoroughly mixed by manual method via portable shovels to reach the thorough mixing of the SW sample.
- After that, the mixed sample is divided into four equal parts that will take two parts to reach the smaller amount of the sample. This sampling process is done 2 times. Finally, the amount of the SW sample that is analyzed is one-quarter of the initial amount. The sample treatment process is shown in **Figure 4** below.

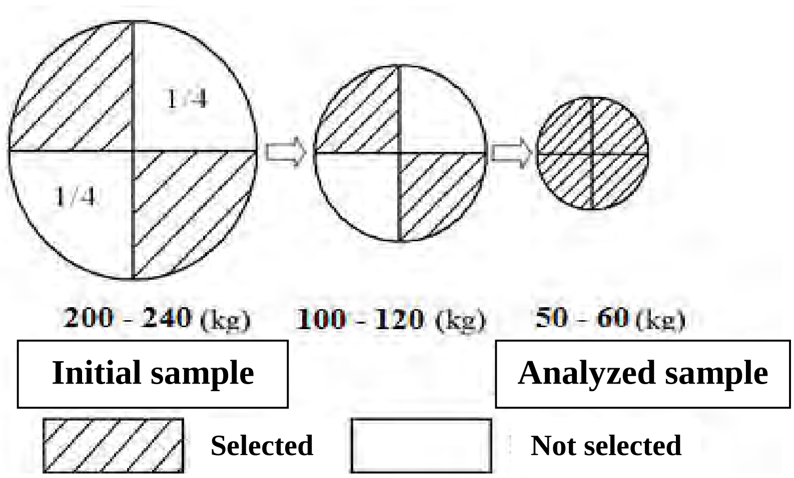


Figure 4. Sampling method.

2.2 Analytical method

2.2.1 Density

a. Use 80-liter plastic barrels with full information such as volume (V_0) and weight (W_0) of empty barrel written down.
b. The SW sample is stored in these barrels, prevent too filled barrels.
c. Lift vertically the barrels to a height of about 30 cm from the ground to reduce the SW porosity. When the porosity is decreased, the volume of SW in the barrels is also reduced. Accordingly, the SW could be added more into the barrels like step b until the barrels are suitably filled.
d. Perform the step c three times, then determine the quantity of the SW barrels (including the amount of both SW and barrel) (W_1).
e. Density of the SW sample is determined by the following formula:

$$\textbf{Density} \quad (\mathrm{kg/L} = \mathrm{T/m^3}) = \frac{W_1(\mathrm{kg}) - W_0(\mathrm{kg})}{V_0} \quad (1)$$

2.2.2 Physical components

a. The SW sample is spread into a canvas on the ground to be separated into each component.
b. The initial sample is separated into 11 components namely 1-Food (meat, fish, vegetables, rice, bread, fruits, etc.); 2-Paper; 3-Diaper, 4-Plastic; 5-Textile ; 6-Wood; 7-Rubber, leather; 8-Metal, 9-Inorganic components (coal ash, brick, glass, etc.); 10-Shell-bone; 11-others (including too small components so that they could not be visually separated).
c. Weigh each SW component (X_i), total amount of SW sample estimated by total amount of all SW components. Each physical component of the SW sample is estimated by the following formula:

$$\textbf{Physical component } (X_i)\ (\%\ \mathrm{WW}) = \frac{X_i\ (\mathrm{kg\ WW})}{X\ (\mathrm{kg\ WW})} \times 100$$

$$\textbf{Physical component } (X'_i)\ (\%\ \mathrm{DW}) = \frac{X'_i\ (\mathrm{kg\ DW})}{X'\ (\mathrm{kg\ DW})} \times 100$$

2.2.3 Analysis of moisture content, ash content, VS and HHV

Moisture content

a. The moisture content of each SW component is separately determined under APHA 2540G (2012).
b. Each SW component is cut into smaller pieces with a size of 2 – 3 cm, then put into a metal dish with a diameter of 20 cm. The height of SW sample in the dish should be less 10cm if any.
c. After that, the SW sample is dried at 105^{o}C in 4 – 5 days until the amount of this sample could not be changed.
d. Finally, the moisture content of each SW component is estimated by the difference between the DW and WW of the sample.

VS, ash content and HHV

The SW components are cut into small pieces with a size of less 1cm before being analyzed to determine the VS and ash content. After that, the SW samples will be burned at 550^{o}C under APHA 2540 G (2012).

Similar to the analysis of the VS and ash content, the SW samples are cut into small pieces with a size of less 1cm, then ground into the pieces with a size of 2mm, finally analyzed to determine the HHV under TCVN 200-2007 (ISO 1928:2009).

The method of analyzing the SW samples is presented in **Table 3** below.

Table 3. Analytical method of the SW samples

No.	Parameter	Analytical method	Analytical device
1	Moisture content	APHA 2540 G	WTB Binder, Germany, Metter Toledo MS204 balance, Switzerland
2	VS and ash content	APHA 2540 G	Nabertherm oven, Metter Toledo MS204 balance, Switzerland
3	HHV	TCVN 200-2011 (ISO 1928:2009)	IKA calorimeter C 4000

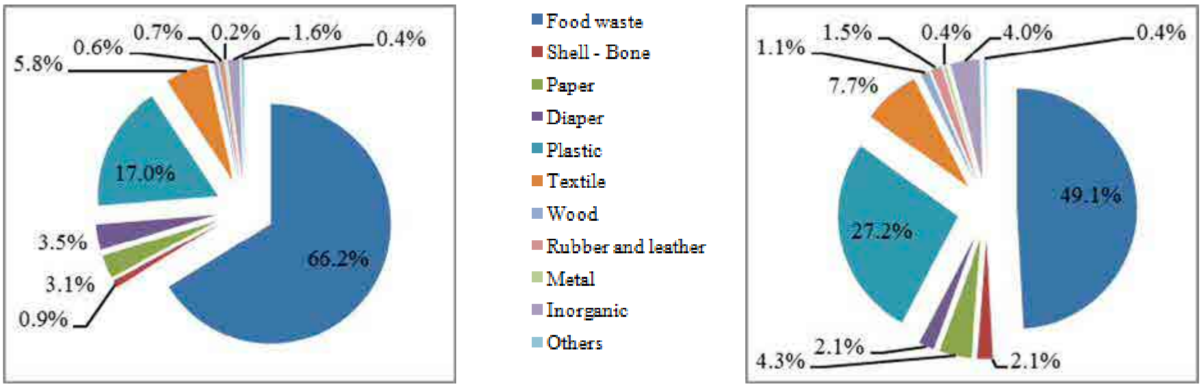
3 ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF THE SW IN PHUOC HIEP, GO CAT, DONG THANH LANDFILL

3.1 SW properties in Phuoc Hiep Landfill

Phuoc Hiep Landfill has received the SW before closure, ETM has analysed the unburied MSW. So the SW components are new and many organic components has not been decomposed. Besides, in 2012 – 2014, ETM has carried out many programs of sampling and analysis the MSW at Phuoc Hiep Landfill. The results of chemical and physical analyses are presented as follows:

3.1.1 SW components in Phuoc Hiep Landfill

The SW components that are mainly observed in the SW samples in the Phuoc Hiep Landfill consist of firstly food, secondly plastic including mainly nylon. The components that have the average and stable proportion compared to the other components are paper, textile, diaper and shell-bone. The components that have low proportion are wood, rubber-leather, metal, inorganic components and others. The SW components (by DW and WW) are shown in **Figure 5** below.



Physical composition (%ww) of MSW **Physical composition (%dw) of MSW**

Figure 5. SW components in Phuoc Hiep Landfill.

The MSW in the Phuoc Hiep Landfill in the sampling periods (from 2012 to 2014) is separated into 11 components namely (1) Food, (2) Shell-bone, (3) Paper, (4) Diaper, (5) Plastic, (6) Textile, (7) Wood, (8) Rubber-leather, (9) Metal, (10) Inorganic components, (11) Others. The analytical result of the SW components in the Phuoc Hiep Landfill is presented as follows:

- The food has the percentage that is much higher than the other components. The total amount of the other components is always lower than the amount of the food by WW, or equivalent to the amount of the food by DW. The percentage of the food fluctuates 61.3 – 70.1%ww and 40.5 – 55.2%dw.

- After the food, the plastic have the second percentage, occupied 16.1 – 19.6%ww and 23.7 – 33.3%dw.

- The components such as textile , diaper, paper, inorganic components and shell-bone have the average proportion of 61.3 – 70.1%ww and 40.5 – 55.2%dw.

- The components namely rubber-leather, wood, others and metal have the average proportion of 0 – 1.4%ww and 0 – 3.2%dw.

3.1.2 Physical, chemical properties in Phuoc Hiep Landfill

Density

The analysis results of Phuoc Hiep MSW from 2012 to 2014 shows that, the density of the SW in the Phuoc Hiep Landfill fluctuates 0.30 – 0.40 kg/l, reached 0.36 kg/l in average.

Moisture content

The average moisture content of the SW components in the Phuoc Hiep Landfill is shown in **Figure 6** below.

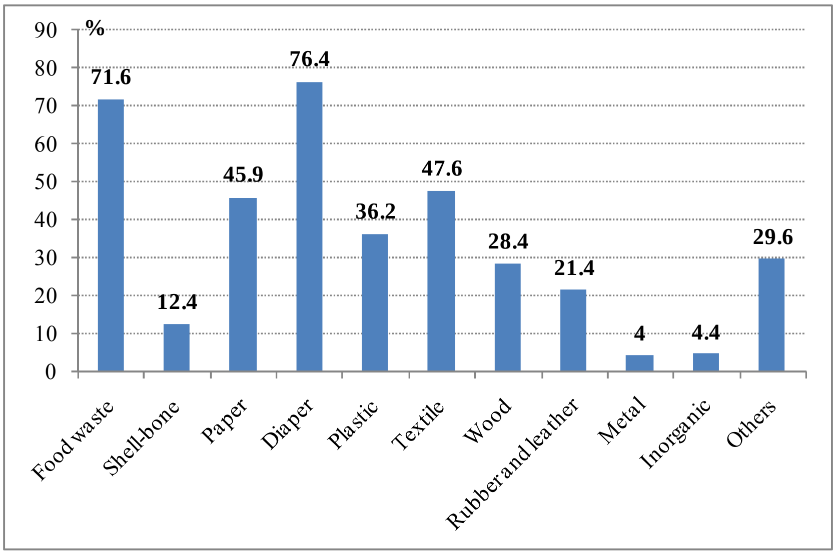


Figure 6. Average moisture content of the SW components in Phuoc Hiep Landfill.

- The food that are mainly vegetables, meat, fish, residual food, etc. and additionally little of sand, mud, soil unseparated has rather high moisture content, about 71.6% in average. The average moisture content values of the SW components in the sampling periods fluctuate 67.6 – 74.3%.

- The paper has the average moisture content of 45.9% in range of 38.7 – 53.8%.

- Together with the social development, the demand of using the diapers is also more and more increased due to their usefulness and diversity. The diaper has the highest moisture content, approximately 82,7% that is about 10% higher than the lowest moisture content of 71.2%, the anverage moisture content of diaper is about 76.4%. The diaper is a type of good water absorbent, but is easily affected by the moisture content of the SW mixture and leachate. This is a main cause to make the moisture content of this component in the highest concentration compared to the other components, even the food.

- Similar to the paper, the textile is a good water absorbent, thus this component has also rather high moisture content in range of 38.7 – 53.8%, about 47.6% in average.

- With respect to the property, the plastic could not absorbed the moisture content, howeverm the moisture content of the plastic fluctates 29.9 – 44.0% and about 36.2% in average. The leachate from the SW mixture could be absorbed on the surface of the packings causing rather high moisture content.

- The moisture content of the rubber fluctuates in widely range of 6.0 – 38.6% and about 21.4% in average.

- The moisture content of the components namely wood, metal and inorganic components fluctuates in range of 17.4 – 34.4%, 1.5 – 7.6% and 3.5 – 6.7% respectively.
- The other components have the moisture content in range of 8.9 - 29.1%. The moisture content is not similar between the SW components in different analysis periods due to the different components of the SW samples taken. The SW sample that has mainly others namely garden waste, soil, etc. has higher moisture content compared to the SW samples containing a lot of hair, batteries, etc.

- The shell-bone has a difference of the moisture content between the analysis periods due to the different components of the SW samples taken. The SW samples containing a lot of mango seeds, corn cores, etc. will has higher moisture content compared to the SW samples containing a lot of shell-bone, etc. The shell-bone has the moisture content in range of 7.4 – 18.6%.

VS and ash content

The combustible possibility of the SW components in the Phuoc Hiep Landfill is shown by ash content and VS in **Figure 7**.

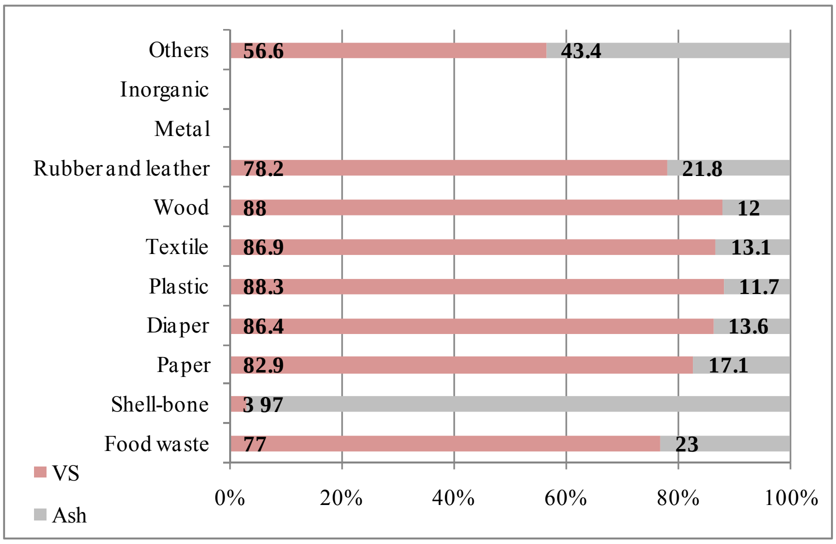


Figure 7. VS and ash content of the SW components in Phuoc Hiep Landfill.

- **For ash content:**

+ The average ash content of the shell-bone is rather high, approximately 97.0%.

+ The components that have the average ash content of over 20% include about 43.4% for others, about 23% for food and about 21.8% for rubber-leather. The ash content of the food and rubber-leather is similar, insignificantly different between the analysis periods. The ash content values of the other components between the analysis periods are similar to the assessment of the moisture content values. Specifically, the ash content and VS of the other components are different due to the different components of the SW samples taken. The SW samples containing garden waste, hair, etc. have the higher combustible possibility and lower ash content compared to the SW samples containing soil, etc.

+ The rest components that have the ash content of less 20% include 17.1% for paper, 13.6% for diaper, 11.7% for plastic, 13.1% for textile , 12.0% for wood.

- **For VS:**

+ The components that have the average ash content of less 20% will have the highest average VS, over 80% including 82.9% for paper, 86.4% for diaper, 88.3% for plastic, 86.9% for textile , 88.0% for wood.

+ The components that have the average ash content in range of 50 – 80% include 56.6% for others, 77.0% for food and 78.2% for rubber-leather.

+ The shell-bone has high ash but the lowest VS of only 3.0%.

Relation between moisture content, ash content and VS

The relation between the moisture content, ash content and VS of each SW component in the Phuoc Hiep Landfill is shown in **Figure 8**.

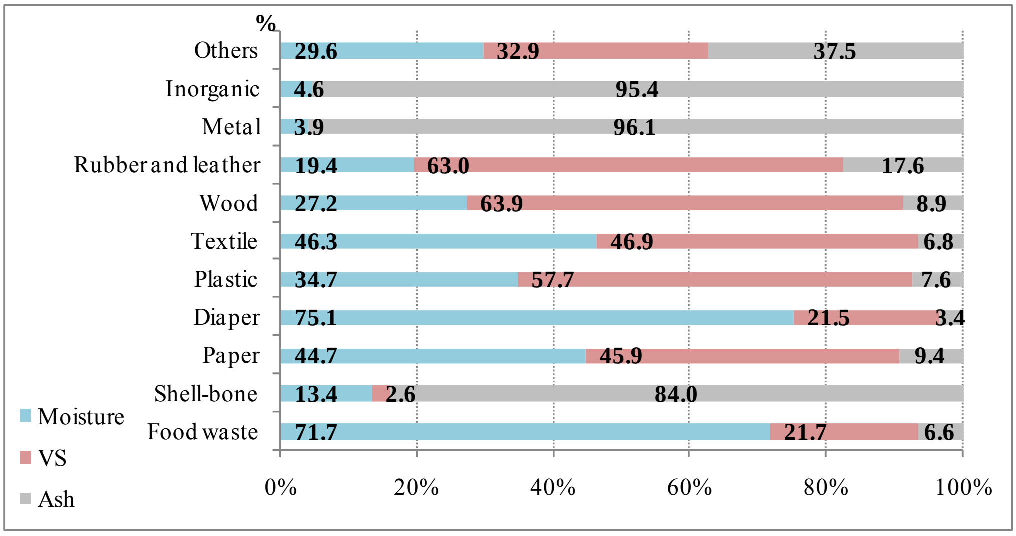


Figure 8. Relation between moisture content, ash content and VS of each SW components in Phuoc Hiep Landfill.

- The food has the highest proporation by weight compared to the other components and also rather high moisture content (67.6 – 74.3%). The food contains mainly organic matters, so it has good combustible possibility at 550°C. As a result, the VS and ash content of this component is about 20.1 - 24.1% and 4.4 – 9.1% respectively.

- As above-mentioned, the diaper has the highest moisture content compared to the other components (in range of 71.2 – 80.8%). This component is made by organic, flammable matters such as cotton, paper, etc., so its VS and ash content are about 16.0 – 25.8% and 2.7 – 5.0% respectively.

- The paper has the moisture content in range of 38.7 – 53.8%; rather high VS in range of 37.5 – 50.0% that is approximately the moisture content; ash content of only 7.4 – 11.3%.

- The other components such as plastic, textile , wood, rubber – leather have the average moisture content (6.0 – 54.0%), high VS (40.9 – 75.9%) and low ash content (5.9 – 22.2%).

Moisture content, ash content and VS of mixed sample

The mixed sample in the Phuoc Hiep Lanfill that is new SW has rather high moisture content in range of 55.4 – 70.9%. Almost combustible components at 550°C are oberved in the SW in the Phuoc Hiep Landfill, so the VS of this mixed sample is rather high, occupied 23.7 – 32.2% while the incombustible inert components is rather low, approximately 10%, in range of 5.4 – 12.4%.

HHV

Almost SW components in the Phuoc Hiep Landfill have all the HHV in range of 3,700 – 8,400 Cal/g. The analytical result of the HHV of the SW components in the Phuoc Hiep Landfill is shown in **Figure 9**.

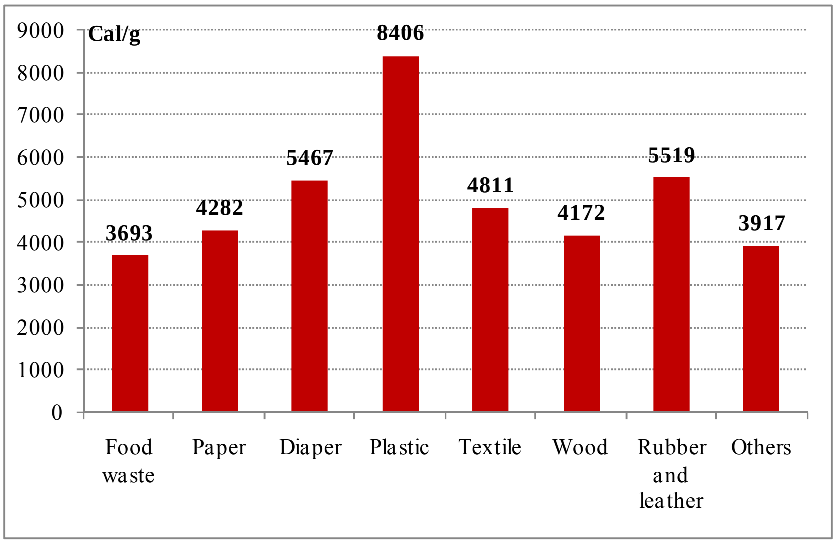


Figure 9. HHV of the SW components in Phuoc Hiep Landfill.

The plastic has the highest heating value compared to the other components, reached 8,406 Cal/g in average. This component occupies significantly in the SW components in the Phuoc Hiep Landfill in particular and in the MSW in Vietnam in general.

The components such as paper, diaper, textile , wood, rubber-leather have all the average heating value in range of 4,000 – 5,000 Cal/g.

Others and food that have the LHVs are 3,917 Cal/g and 3,693 Cal/g respectively.

In conclusion, the heating values of the separate components of the SW in the Phuoc Hiep Landfill are rather high, so these components could be burned to produce the energy (> 1,500 Cal/g). The heating values of the mixed sample in the Phuoc Hiep landfill fluctutates 1,370 – 2,297 Cal/g (HHV) and 987 – 2,001 Cal/g (LHV). These values are suitable for being burned to produce the energy. However, these components could be treated by the incineration method (> 800 Cal/g).

3.2 SW properties in Dong Thanh Landfill

3.2.1 SW components in Dong Thanh Landfill

The analytical result of the SW components left in the Dong Thanh Landfill is presented in **Table 4** and shown in **Figure 10**.

As analytical result of the SW components, the mud that is left in the SW samples fluctuates 0.0 - 50.2%. The SW samples that are taken in the drilled hole No. 1 have the mud with the highest concentration (among three drilled locations) in range of 26.7% - 50.2%. The SW samples that are taken at deeper locations have the lower concentration of mud. The SW samples that are taken in the drilled hole No. 2 have the lower concentration of mud compared to the SW samples taken in the drilled hole No. 1. Except two samples at a depth of 17m and 20m, they have a little of mud while the other samples (at a depth of 3m, 6m, 9m, 12m) have the mud concentration in range of 23.3 - 27.7%. the SW samples that are taken in the drilled hole No. 3 have the lowest concentration of mud in range of 9.1% - 14.7%.

Among 18 components of the SW samples taken in the Dong Thanh Landfill, plastic (mainly nylon) has the highest percentage (20.7% - 62.7%). The SW samples that have low concentration of mud often contain a lot of nylon. Five SW samples that are taken in the drilled hole No. 3 have the concentration of nylon in range of 43.4% - 54.3%. The SW samples that are taken in the drilled hole No. 1 have the lower concentration of nylon in range of 20.7% -41.8%. The high concentration of nylon left in the SW components in the Dong Thanh Landfill is one of causes affecting the decomposition rate of organic matters, LFG recovering possibility as well as leachate removal.

After plastic and mud, the bamboo-straw-leaves that are also observed with a large amount in the SW samples analyzed occupy 11.4% - 20.7%. Although the components namely stone-ceramic; shell-bone; textile ; rubber have the lower proportion, they are all observed in the SW samples analyzed. Especially, some samples could contain sacks with the percentage of up to 11.6%.

The components that have very low proportion include paper (0-2.1%), wood (0-5.3%), leather (0-1.1%), color metal (0-2.4%), iron (0-0.5%). Some samples are observed with hair, occupied 0,6%.

Therefore, beside mud (completely decomposed and not decomposed), there are paper, wood and some low degradable organic components in the Dong Thanh Landfill that could be decomposed to produre the gases or be burned to produce the energy.

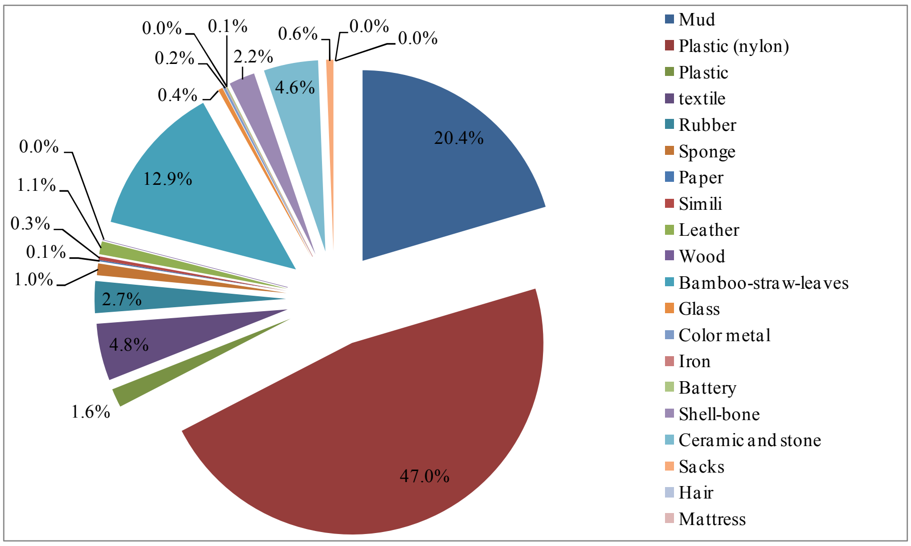


Figure 10.SW components in Dong Thanh Landfill (%ww).

3.2.2 Physical, chemical properties in Dong Thanh Landfill

The analytical result of moisture content, ash content, VS, Total organic carbon (TOC) of the SW sample taken in the Dong Thanh Landfill is briefly presented in **Table 5** and shown in **Figure 11**, **Figure 12** as follows:

Moisture content

The moisture content of the SW samples taken in the Dong Thanh Landfill fluctuates about 50.0 - 68.0%. In which, almost SW samples have the moisture content in range of 50 - 60% that is lower than the moisture content of the SW buried (normally in range of 75.0 – 85.0%). The moisture content of the SW samples taken in same drilling hole, at various depth is different about 0.8 - 14%. The SW samples that are taken at deeper points have normally the higher moisture content. It shows that the leachate is flowed towards the bottom of the landfill cell. However, the SW samples that are taken in different points at same depth have significantly different moisture content. For example, the SW samples taken at a depth of 6m have the moisture content such as about 50.8% for I6, 56.9% for II6 and 61.0% for III6. The moisture content distribution is different inside the landfill that is resulted from many causes namely the different moisture content of the SW components buried, level of different compression in various landfill locations, different landfill time and movement of leachate inside the landfill. In which, the last one is a main cause for the different distribution of the SW moisture content inside the landfill.

Ash content and VS

The ash content and VS of the SW samples in the Dong Thanh Landfilln fluctuate about 12.0 – 40.0%ww and 10 – 28%ww respectively.

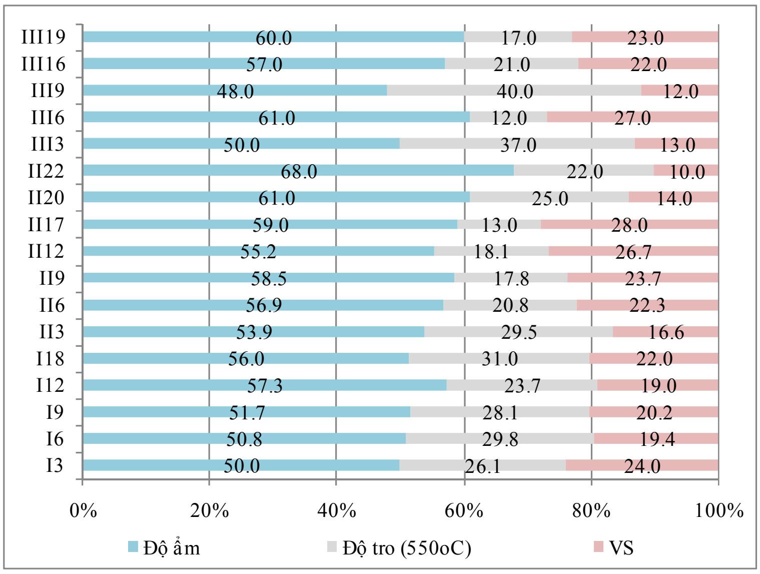


Figure 11. Relation between moisture content, ash content and VS of the SW samples in Dong Thanh Landfill.

TOC

As the analytical result of the chemical properties of the SW samples taken in the Dong Thanh Landfill, it shows that the TOC significantly fluctuates depending on the locations and depth of the SW samples taken (3.3 – 23.8%), in which:

- Up to 35% of SW samples have TOC < 10%, mostly of samples from drill hole No.I and No.II at shallow depth from 3 to 12m.
- 47% of samples have TOC ranging from 10% to 20%, mostly of samples from drill hole No.III.
- Yet only 18% of samples have TOC > 20%.

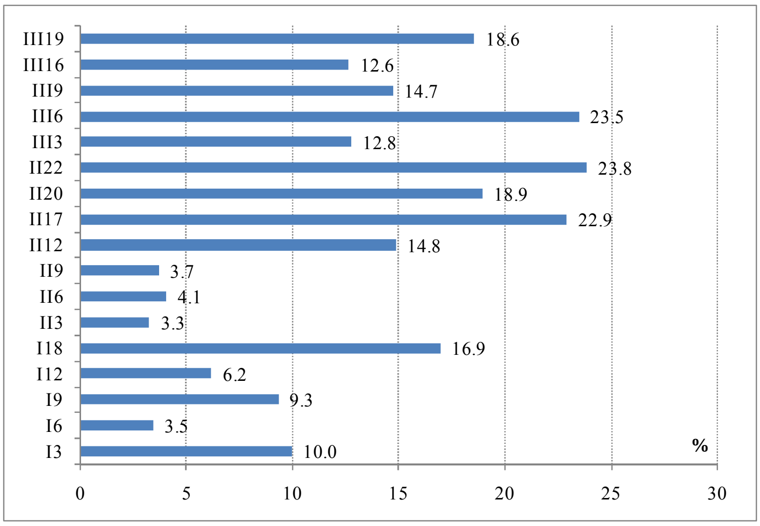


Figure 12.TOC of the SW samples in Dong Thanh Landfill.

Table 4.SW components in Dong Thanh Landfill

Component	Percentage (%)																	
	Mixed sample	I3	I6	I9	I12	I18	II3	II6	II9	II12	II17	II20	II22	III3	III6	III9	III16	III19
Mud	20.4	36.6	39.7	43.2	50.2	26.7	27.7	24.1	24.9	23.3	0	0	14.7	13.0	9.1	12.7	12.2	12.4
Nylon	47.0	24.0	27.4	22.0	20.7	41.8	25.9	34.4	26.7	47.2	58.2	62.7	51.1	43.6	54.3	43.4	48.3	53.3
Plastic	1.6	1.3	0.7	0.7	1.2	3.1	1.6	1.7	1.7	2.7	2.5	2.0	1.8	2.6	2.0	1.8	3.5	1.9
Textile	4.8	14.9	6.1	1.9	2.8	2.9	6.5	0.6	3.9	1.2	1.6	6.4	4.4	5.5	1.9	2.3	2.7	2.0
Rubber	2.7	3.1	2.7	1.3	2.4	0.6	4.0	1.8	0.6	0.4	2.3	0.7	1.4	2.2	2.2	1.6	1.3	2.1
Sponge	1.0	0.7	0.1	1.1	0	0	0.8	0.6	2.8	0.5	0	0.6	0.6	0.6	0.8	0	1.5	1.3
Paper	0.1	0	0.6	2.0	0	0	2.1	1.4	1.5	0.4	0	0.1	0	0	0	0	0	0
Simili	0.3	1.1	0.5	3.7	0.5	0.7	1.8	0	0	1.9	3.1	1.8	1.6	1.5	0.6	0.8	1.6	1.7
Leather	1.1	0.3	0.3	0	0	0	0.5	0	0	0	0.6	0.3	0.6	0.3	0	0.7	0	0
Wood	0	5.3	3.3	1.6	0.4	0	0	1.1	0.3	0	0	0	0	0.8	0	0.5	0	1.4
Bamboo, straw, leaves	12.9	8.2	11.7	19.3	18.5	13.5	17.3	20.7	13.0	16.6	17.9	17.0	16.5	14.8	12.5	15.8	15.7	11.4
Glass	0.4	1.0	0.2	0	0.3	0.5	0	0.3	0.6	0.5	0.8	0.1	0.2	0.2	0.6	1.3	0.2	0.4
Color metal	0.2	0.1	0.2	0	0	0.1	0	0	0	0	0.9	0.7	0.7	0.9	1.9	1.5	1.0	2.4
Iron	0	0	0	0	0	0.2	0.1	0	0.1	0.5	0	0	0	0	0	0	0	0
Battery	0.1	0.1	0	0.1	0.1	0.1	0.1	0	0.2	0.1	0	0	0.1	0	0	0	0	0.1
Shell-bone	2.2	1.6	0.8	0.8	0.4	0.8	4.7	0.6	1.6	0.8	1.1	2.0	1.8	0.6	1.4	0.9	1.5	0.9
Stone and ceramic	4.6	1.1	5.8	2.4	2.5	6.0	3.7	1.7	10.6	1.6	10.1	5.1	3.2	9.5	9.5	15.3	8.7	5.8
Sack	0.6	0	0	0	0	3.1	2.0	5.2	11.6	2.1	0.9	0.4	1.1	3.8	3.0	1.4	1.7	2.9
Hair	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mattress	0	0	0	0	0	0	1.0	5.7	0	0	0	0	0	0	0	0	0	0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: DONRE, 2007

Table 5. Physical, chemical properties of the SW samples in Dong Thanh landfill

Property	Value																	
	Đơn vị	I3	I6	I9	I12	I18	II3	II6	II9	II12	II17	II20	II22	III3	III6	III9	III16	III19
Moisture content	%	50.0	50.8	51.7	57.3	56.0	53.9	56.9	58.5	55.2	59.0	61.0	68.0	50.0	61.0	48.0	57.0	60.0
Ash content (550^{o}C)	%ww	26.1	29.8	28.1	23.7	31.0	29.5	20.8	17.8	18.1	13.0	25.0	22.0	37.0	12.0	40.0	21.0	17.0
VS	%ww	24.0	19.4	20.2	19.0	22.0	16.6	22.3	23.7	26.7	28.0	14.0	10.0	13.0	27.0	12.0	22.0	23.0
TOC	% (DW)	9.95	3.46	9.34	6.20	16.94	3.29	4.07	3.72	14.84	22.90	18.92	23.84	12.75	23.47	14.70	12.64	18.55

Source: DONRE, 2007

HHV

The SW sampling in the Dong Thanh Landfill is not catered for analyzing the HHV of the SW. However, the HHV of each SW component could be estimated depending on the analytical result of the elements namely C, H, O, N, S and the following formula (Tchobanoglous et al. 1993):

$$HHV = 145 \times C + 610 \times \left(H_2 - \frac{1}{8}O_2\right) + 40 \times S + 10 \times N \text{ (Btu/lb)} \quad (2)$$

Where:

C: percentage of C (Carbon) by dry weight (DW)
H_2: percentage of H (Hydrogen) by DW
S: percentage of S (Sulfur) by DW
O_2: percentage of O (Oxygen) by DW
N: percentage of N (Nitrogen) by DW

The analytical result of C, H, O, N, S of each SW component and the estimated HHV of the SW components in the Dong Thanh Landfill are presented in **Table 6** and shown in **Figure 7** below.

Table 6. Analytical result of C, H, O, N, S of the SW components in the Dong Thanh Landfill

Component	DW (kg)	Weight of elements											
		C		H		O		N		H		Ash	
		%	Kg	%	Kg	%	Kg	%	Kg	%	Kg	%	Kg
Paper	0.44	43.50	0.19	6.00	0.03	44.00	0.19	0.30	0.00	0.20	0.00	6.00	0.03
Textile	3.25	55.00	1.79	6.60	0.21	31.20	1.01	4.60	0.15	0.15	0.00	2.50	0.08
Rubber	1.19	78.00	0.93	10.00	0.12		0.00	2.00	0.02		0.00	10.00	0.12
Leather	0.73	60.00	0.44	8.00	0.06	11.60	0.08	10.00	0.07	0.40	0.00	10.00	0.07
Wood	1.61	49.50	0.80	6.00	0.10	42.70	0.69	0.20	0.00	0.10	0.00	1.50	0.02

Source: DONRE, 2007

Table 7.HHV of the SW components in Dong Thanh Landfill under Tchobanoglous et al. 1993

No.	Component	**HHV** (Btu/lb)	**HHV** (Cal/g)
1	Paper	6,616	3,693
2	Textile	9,668	5,397
3	Rubber	17,430	9,730
4	Leather	12,796	7,143
5	Wood	7,584	4,233
6	Mixed sample	-	-

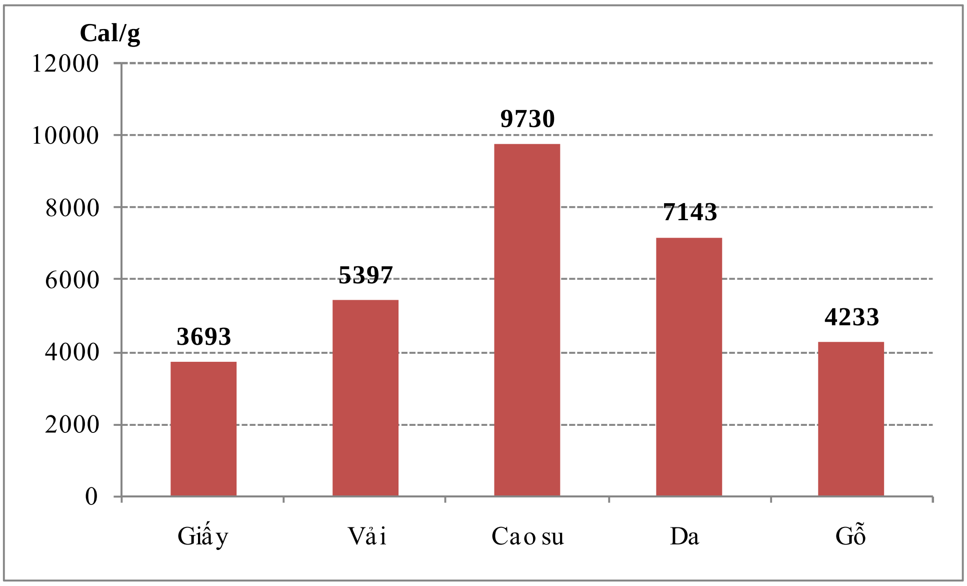


Figure 13. HHV of the SW components in Dong Thanh Landfill.

As mentioned in Table 7, the HHV of the separate components in the Dong Thanh Landfill is rather high. Thus, these components could be burned for the energy recovery. However, the heating value of mixed sample that is estimated depending on the HHV of each separate component (paper, textile , rubber – leather and wood) in the Dong Thanh Landfill is rather low, about 427 Cal/g (HHV).

3.3 SW properties in Go Cat Landfill

The SW that is taken at two points with a depth of 1m and 5 – 5.5m in the Dong Thanh Landfill caters for analyzing its components. The SW samples at different depth have some different properties namely density, components, moisture content, etc. but have a general property of SW buried by time. The analytical result of the SW components taken in the Go Cat Landfill dated October 2012 is presented hereinafter.

3.3.1 SW components in Go Cat Landfill

Similar to the SW samples in the Dong Thanh Landfill, the SW components after being buried in over 7 years in the Go Cat Landfill are mainly the persistent biodegradable components and inorganic components together with mud, soil and stone mixed in the SW. In addition, there are the components that could be separated consist of plastic, textile , wood, shell-bone, glass, metal, paper, leather and some hazardous components (battery, syringe), persistent biodegradable components (coconut fiber, mango seeds, etc.) and some components (e.g. hair, soil, stone; scrap textile , plastic, etc.) that could not be visually separated are called as “others”.

SW components by wet weight (%ww)

The SW components by WW that are taken in the Go Cat Landfill are presented in **Figure 14** below.

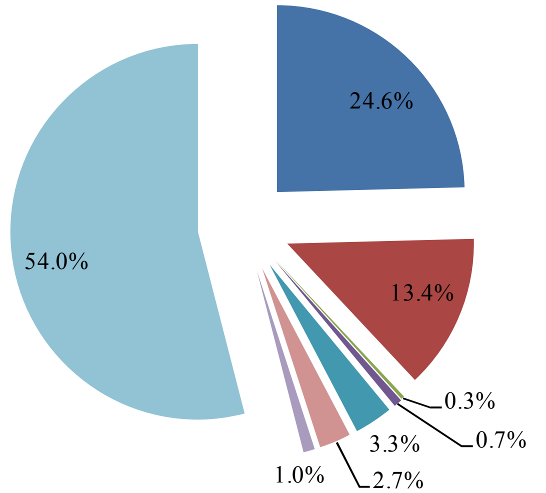
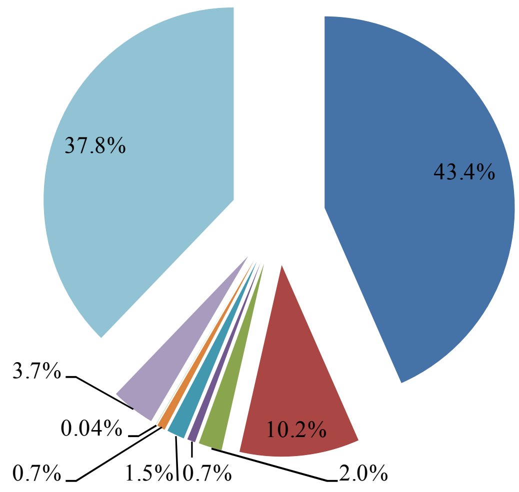
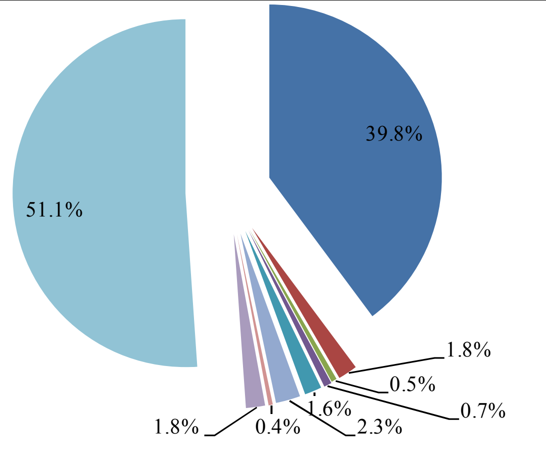
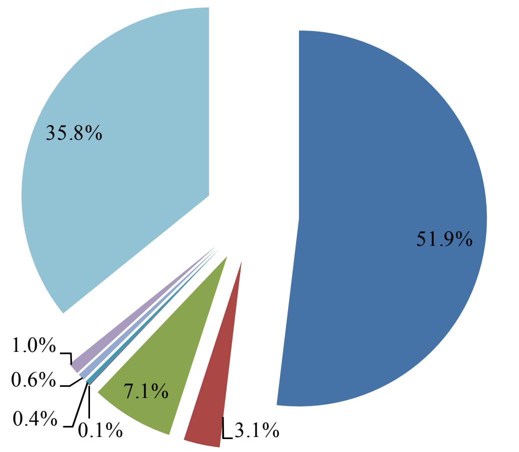
SW sample in landfill cell 3	SW sample in landfill cell 4	Note
 ***a. Sample 1- at a depth of 1m***	 ***c. Sample 3- at a depth of 1m***	Plastic Textile Wood Shell-Bone Glass Metal Paper Rubber Hazardous waste Non-biodegradable Others
 ***b. Sample 2 – at a depth of 5.5m***	 ***d. Sample 4 – at a depth of 5m***	Plastic Textile Wood Shell-Bone Glass Metal Paper Rubber Hazardous waste Non-biodegradable Others

Figure 14. SW components in Go Cat Landfill by wet weight (%ww).

The plastic mainy nylon is a main component of the SW in the Go Cat Landfill, occupied about 24.6%ww – 51.9%ww according to the buried depth and location. This component has the high percentage in the SW due to its usefulness in daily life. Moreover, the component could be decomposed for a long time (40 – 100 years), thus it could not be decomposed in the period of 7 – 10 years, it has stayed mostly the same and not been decomposed. For that reason why it has the high percenatged in the SW.

In SW layers at a depth of about 1m, the textile has also the high percentage (10.2%ww and 13.4%ww while this component is not much at a depth of about 5 – 5m (3.1%ww and 1.8%ww).

As analytical result, the percentage of wood is not similar between the SW samples. Specifically, the wood is about 0,3 – 0,7%ww in the SW samples taken in the landfill cell 3 while the wood is up to 2,0 – 7,1%ww in the SW samples taken in the landfill cell 4.

The percentage of the other components is lower namely about 0.1 – 0.7%ww for shell-bone, 0.4 – 1.9%ww for glass. The metal has is rather low percentage and is only observed in the sample taken in the landfill cell 4 (about 0.7%ww).

The paper is a degradable component and easily rotted in flooded leachate condition in the landfill cells, the rest paper is mainly carton or plastic coated paper. There are only two among four samples that are observed with this component. Specifically, the paper is observed in the sample at a depth of 5.5m in the landfill cell 3 (2.3% ww) and in the sample at a depth of 5m in the landfill cell 4 (0.6% ww).

Similarly, the rubber has low percentage and is not similar between the samples. It is observed in the sample taken in the landfill cell 3, occupied about 1.6%ww (Sample 1, at a depth of 1m) and about 0.4%ww (Sample 2, at a depth of 5.5m).

The hazardous components such as battery, syringe are only observed in the Sample 3 at a depth of 1m in the landfill cell 4, occupied about 0.04%ww.

The persistent biodegradable components (e.g. coconut fiber, mango seeds, etc.) are rather uniformly distributed in the samples in the Go Cat Landfill, occupied about 1.0 – 3.7%ww.

Because the SW was buried for a long time with many components decomposed into scraps that could not be visually separated, “others” have the highest percentage, about 35.8 – 54.0%ww.

SW components by dry weight (%DW)

The SW components by DW that are taken in the Go Cat Landfill is presented in **Figure 15** below.

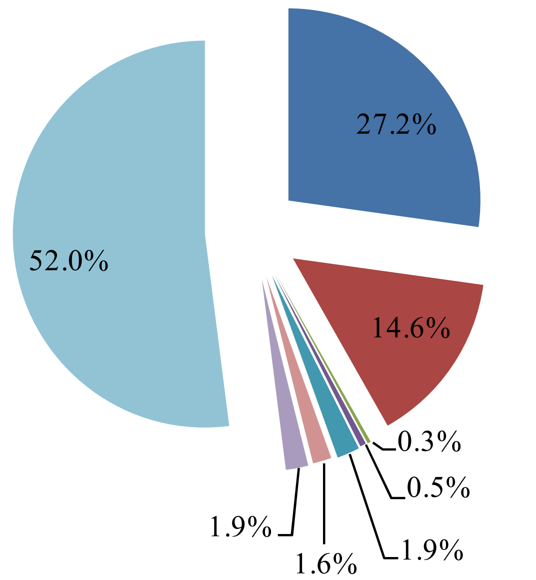
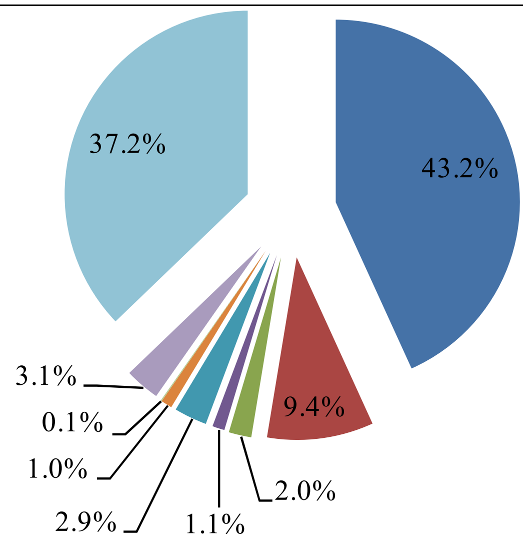
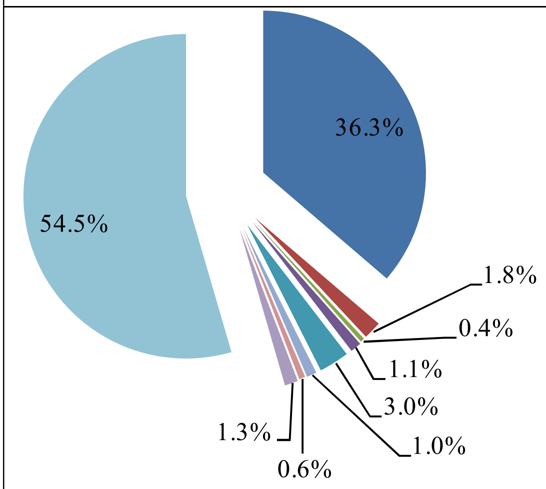
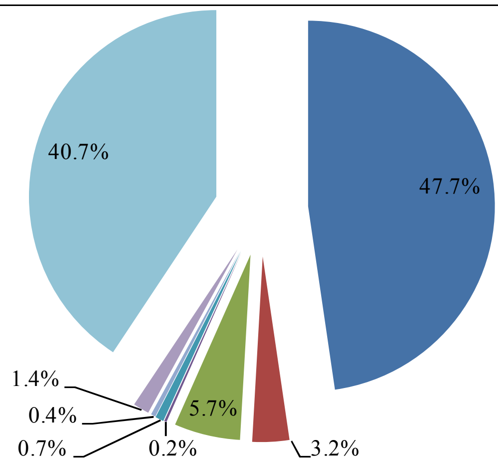
SW sample in landfill cell 3	SW sample in landfill cell 4	Note
		Plastic Textile Wood Shell-Bone Glass Metal Paper Rubber Hazardous waste Non-biodegradable Others
Sample 1- at a depth of 1m	***Sample 3- at a depth of 1m***	
		Plastic Textile Wood Shell-Bone Glass Metal Paper Rubber Hazardous waste Non-biodegradable Others
Sample 2 – at a depth of 5.5m	***Sample 4 – at a depth of 5m***	

Figure 15.SW components in Go Cat Landfill by DW (%dw).

As above-shown in Figure 15, the percentage of the SW components by DW is similar to one by WW. In which, the plastic (mainly nylon) are about 27.2 – 47.7%dw; the textile has a higher percentage in the samples at a depth of 1m in the landfill cell 3 and landfill cell 4 that is about 14.6%dw and 9.4%dw respectively and only 1.8%dw and 3.2%dw at a depth of 5 – 5.5m.

The other components such as wood, shell-bone, glass, metal, paper, rubber, hazardous components and persistent biodegradable components have rather low percentage, less 5%dw, occupied about 0.2 – 3.1%dw.

Similar to estimation by WW, others that are estimated by DW have rather high percentage, occupied about 37.2 – 52.0%dw.

3.3.2 Physical, chemical properties in Go Cat Landfill

Density

Because the SW were buried in the landfill cells and affected by leachate, so the SW density could be varied on the increase of the depth of the SW buried. As analytical result, it shows that the SW density in lower layers (5 – 5.5m) is higher than one in upper layers (1m) as presented in **Table 8**.

Table 8. SW density in Go Cat Landfill

No.	Sample	Density (kg/l)
1	Sample 1- landfill cell 3 – 1m	0.65
2	Sample 2 – landfill cell 3 – 5.5m	0.70
3	Sample 3 – landfill cell 4 – 1m	0.61
4	Sample 4 – landfill 4 – 5m	0.72

As mentioned in **Table 8**, the SW density at a depth of 1m that ranges 0.61 – 0.65 kg/l is lower than one at a depth of 5.0 – 5.5m, occupied about 0.70 - 0.72 kg/l.

Moisture content

The SW components in landfill cells has high moisture content due to the affect of leachate inside the landfill cells as follows:

The paper has the highest moisture content compared to the other components analyzed. It is resulted from the water absorption and retention, especially in flooded leachate condition like the landfill cells at a depth of 5 – 5.5m. The moisture content of the paper in the Sample 2 and Sample 4 is 79.8% and 74.3% respectively.

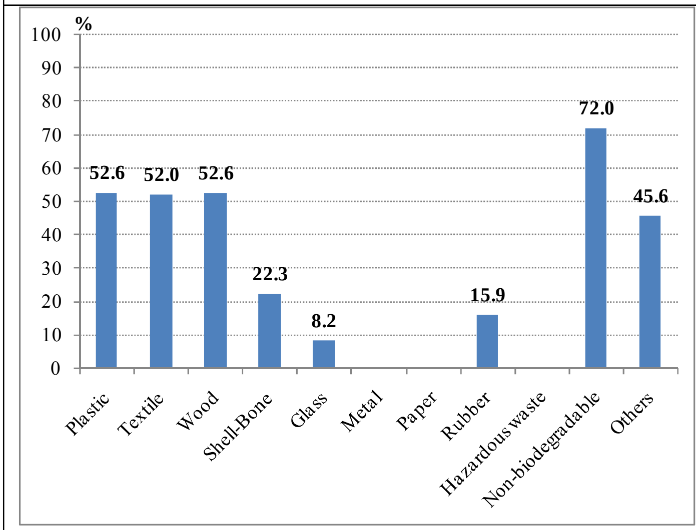
The components such as plastic, textile , wood and others have the moisture content of about 50%, specifically plastic (52.3 – 58.6%); textile (52.0 – 55.6%); wood (51.8 – 63.7%); others (45.6 – 52.8%).

The persistent biodegradable components namely coconut fiber, mango seeds have the moisture content in range of 60.4 – 72.0%. Especially, the Sample 4 is mainly mango seeds (low moisture content), so the moisture content of this sample that is about 36.4% is lower than one of the samples containing a lot of coconut fibers.
The rubber has the moisture content in range of 15.9 – 39.7%. The samples at a depth 5.5m has higher moisture content.

The shell-bone has stable and rather low moisture content, approximately 20% (in range of 21.1 – 24.9%). The moisture content of the glass fluctuates 8.2 – 22.8%. The moisture content of the metal is about 22.4% (Sample 3). The Sample 3 contains the hazardous components namely battery and syringe, so it has the lowest moisture content, occupied only 4.2%.

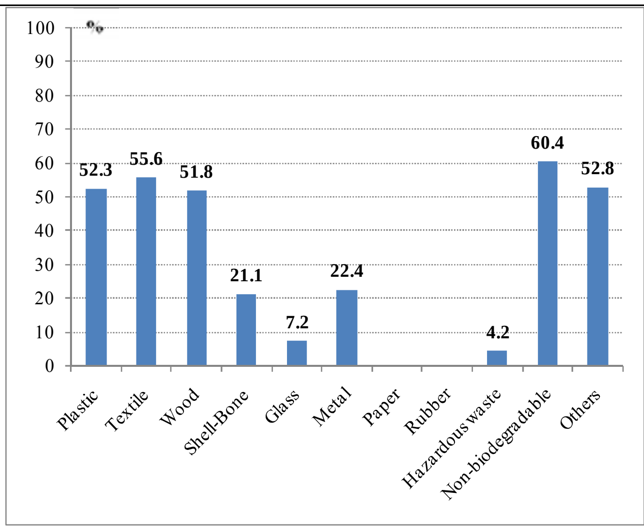
The moisture content of the SW components in the landfill cells is shown in **Figure 16**.

SW sample in landfill cell 3

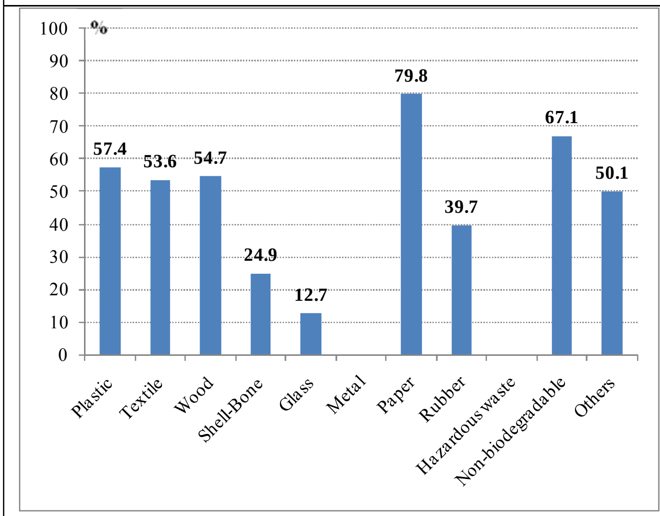


Sample 1- at a depth of 1m

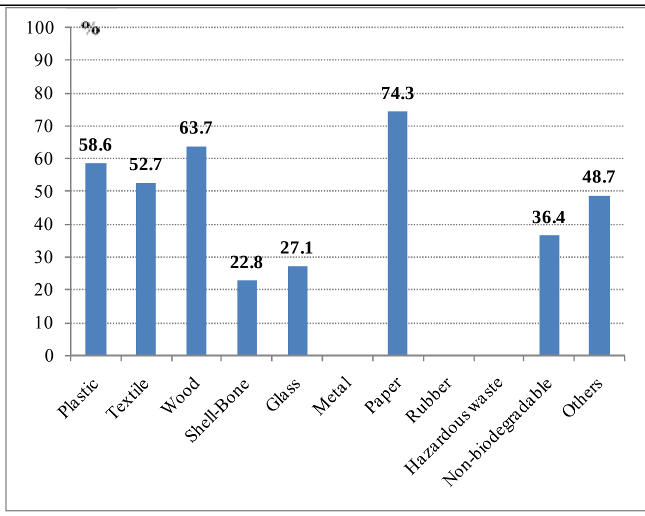
SW sample in landfill cell 4



Sample 3- at a depth of 1m



Sample 2 – at a depth of 5.5m



Sample 4 – at a depth of 5m

Figure 16. Moisture content of the SW components in Go Cat Landfill.

VS/ash content

The analytical result of VS/ash content by DW is shown in **Figure 17**.

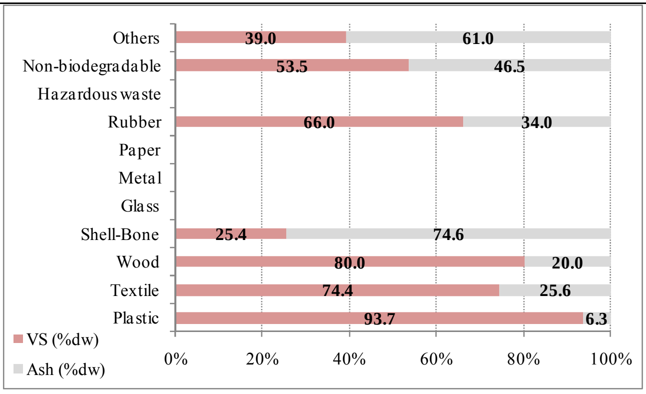
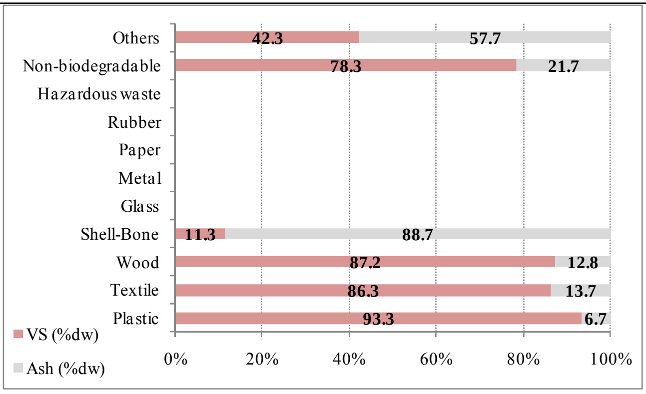
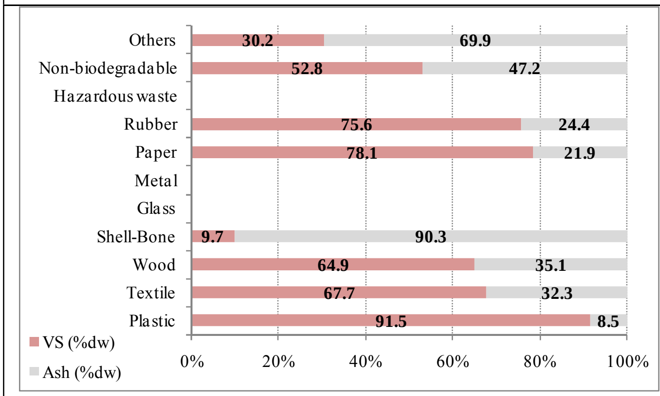
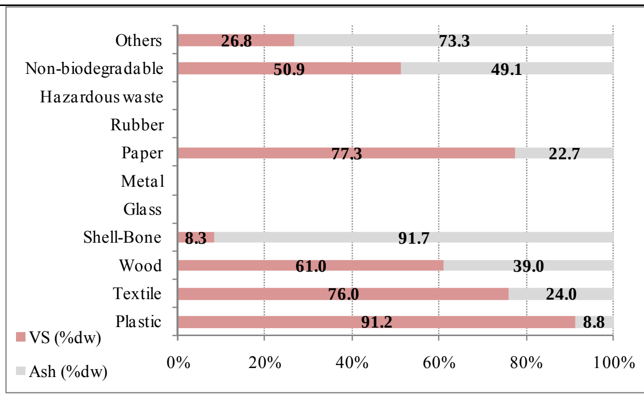
Sample in landfill cell 3	Sample in landfill cell 4
	
Sample 1- at a depth of 1m	***Sample 3- at a depth of 1m***
	
Sample 2 – at a depth of 5.5m	***Sample 4 – at a depth of 5m***

Figure 17.VS/ash content by DW of the SW samples in Go Cat Landfill.

The components that could be highly combustible at 550^{o}C include plastic (VS of about 91.2 -93.7%dw); textile (VS of about 67.7 – 86.3%dw); wood (VS of about 61.0 – 87.2%dw), rubber (VS of about 66.0 – 75.6%dw); paper (VS of about 78.1 and 77.3%); persistent biodegradable components (VS of about 50.9 – 78.3%dw).

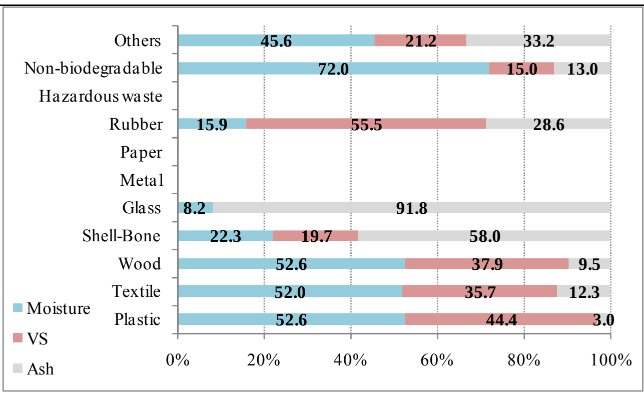
Otherwise, "others" and shell-bone are two components that could not be highly combustible at 550^{o}C and the incombustible inert matters are left rather much. The ash content of two components is 57.7 – 73.3%dw and 74.6 – 91.7%dw respectively.

The components such as metal, glass and hazardous components are incombustible inorganic components, so the VS of these components is zero.

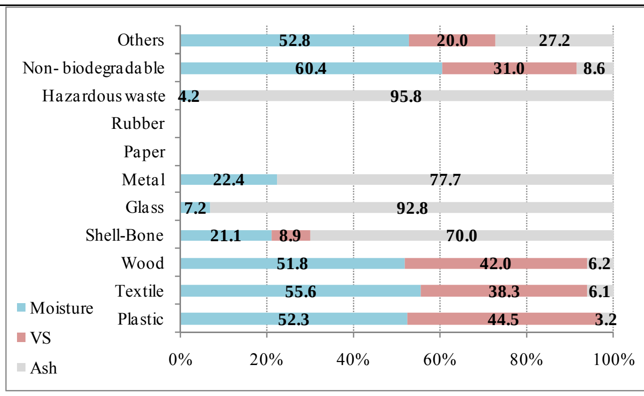
Relation between moisture content, ash content and VS

The relation between the moisture content, ash content and VS of each SW component in the Go Cat Landfill is shown in **Figure 18**.

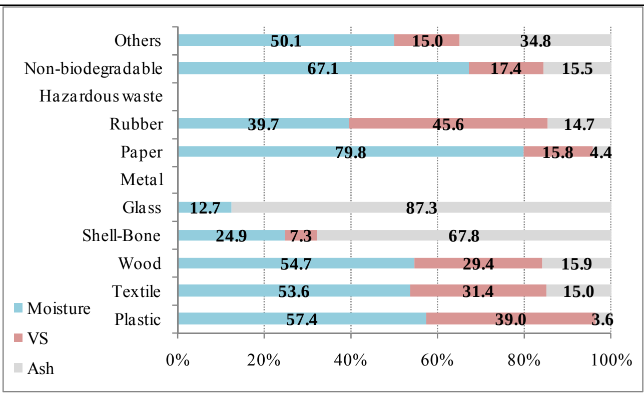
Sample in landfill cell 3	Sample in landfill cell 4



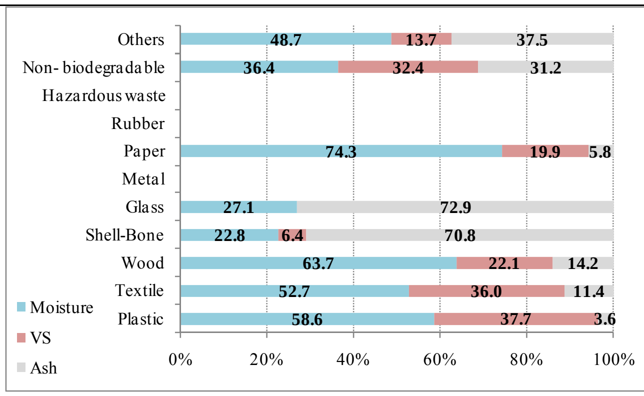
Sample 1- at a depth of 1m



Sample 3- at a depth of 1m



Sample 2 – at a depth of 5.5m



Sample 4 – at a depth of 5m

Figure 18. Relation between the moisture content, ash content and VS of each SW component in Go Cat Landfill.

According to the relation between the moisture content, ash content and VS of the SW components in the Go Cat Landfill, it shows that the moisture content is a high propotion in almost SW components, especially combustible components including:

- The plastic that has the moisture content in range of 50 – 60% is highly combustible component (VS: 35 – 45%ww) with rather low ash content of only 3%;
- Similarly, the textile and wood that has the moisture content in range of 50 – 60% is highly combustible component (VS: 35 – 45%ww) with ash content of approximately 10%.

- The persistent biodegradable components namely coconut fiber and mango seeds have also high moisture content (mainly coconut fiber) in range of 60 – 72%; average combustible possibility with similar VS and ash content.

In addition, some other components that have low moisture content and low combustible possibility include as follows:

- The shell-bone has low moisture content of about 20%, VS in range of 6.4 – 19.7%ww, ash content of about 58.0 – 70.8%ww.
- The glass, metal and hazardous components have low moisture content of approximately 10%, no VS and, high ash content of up to 90%.

Moisture content, ash content and VS of mixed sample

The moisture content, ash content and VS of mixed sample are presented in **Table 9** below.

Table 9. Moisture content, ash content and VS of mixed sample in Go Cat Landfill

No.	Sample	Moisture content (%ww)	Ash content (%ww)	VS (%ww)
1	Sample 1- Landfill cell 3 – 1m	47.7	22.6	29.7
2	Sample 2 – Landfill cell 3 – 5,5m	53.3	21.9	24.8
3	Sample 3 – Landfill cell 4 – 1m	52.0	15.2	32.8
4	Sample 4 – Landfill cell 4 – 5m	55.0	17.4	27.6

As mentioned in **Table 9**, the moisture content of the SW samples buried in the landfill cells in the Go Cat Landfill that is about 50% (in range of 47.7 – 55.3%) is similar to one in the Dong Thanh Landfill but lower than one unburied in the Phuoc Hiep Landfill (in range of 55.4 – 71% (ETM, 2014)).

The ash content and VS are similar and insignificantly different from the ash content and VS of the SW unburied. In which, the combustible components at 550^{o}C (VS in range of 24.8 – 32.8%) have always VS that is higher than VS of the incombustible components (ash content in range of 15.2 – 22.6%). The difference between two parameters in the Go Cat Landfill is about 1.0 – 2.0 times that is lower than one in the Phuoc Hiep Landfill (2.5 – 4.5 times). The VS of the SW buried is reduced in comparison with new SW that could be clarified depending on the degradable possibility of the combustible components (e.g. organic wastes, paper, newspaper, leaves, etc.) buried under the ground in many years.

HHV

The HHV of each component of the SW samples in the Go Cat Landfill is shown in **Figure 19** below.

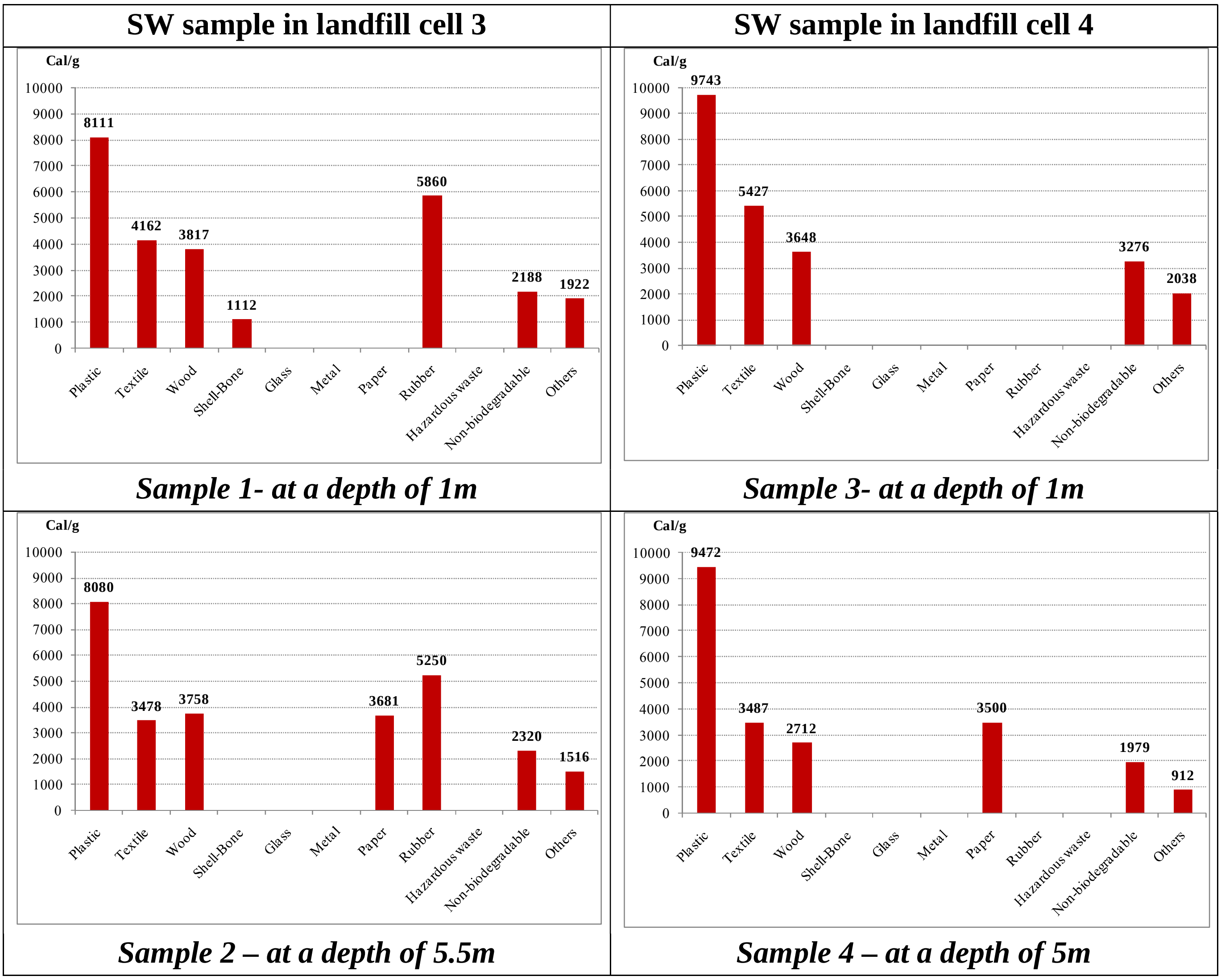


Figure 19. HHV of the SW components in Go Cat Landfill.

As shown in Figure 19, the persistent biodegradable components and others have the HHV in range of 2,000 – 10,000 Cal/g. These are the highly combustible components (high VS, low ash content) as follows:

- The plastic has HHV. The analytical result shows that the HHV of the plastic in the SW components in the Go Cat Landfill is similar to the HHVs that were recorded from the national and international researches performed. The HHV of the plastic fluctuates 8,080 – 9,743 Cal/g.

- Next is the HHV of the rubber that are 5,860 Cal/g (Sample 1) and 5,250 Cal/g (Sample 2).

- The HHV of the paper fluctuates 3,487 – 5,427 Cal/g.

- The HHV of the wood that is similar to the one of the paper fluctuates 2,712 – 3,817 cal/g.

- The HHVs of the persistent biodegradable components and others that are lower than the HHVs of the rest components fluctuate 912 – 2,320 Cal/g.

HHV of mixed sample

The HHV of mixed sample in the Go Cat Landfill is rather high, in range of 1,980 – 2,709 Cal/g (HHV) and 1,724 – 2,429 Cal/g (LHV). The analytical result of the heating values of the SW samples in the Go Cat Landfill is shown in **Figure 20**.

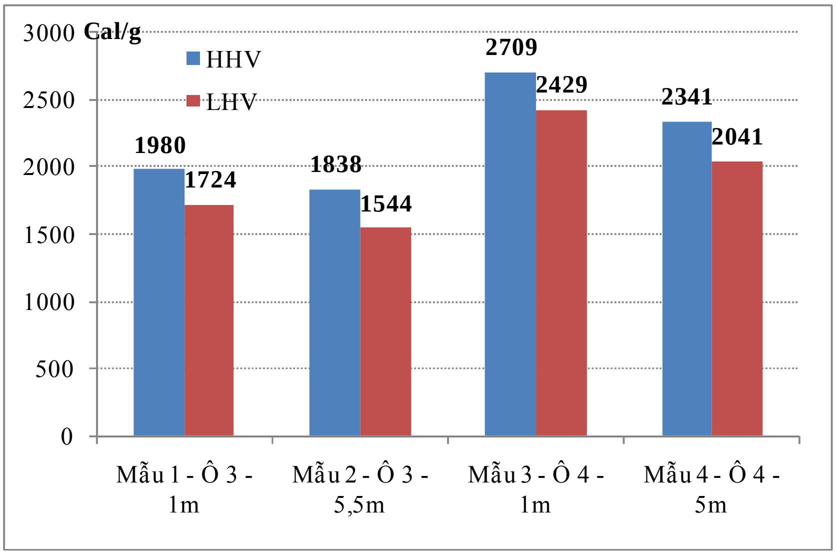


Figure 20. HHV and LHV of the SW samples in Go Cat Landfill.

4 CONCLUSION

The SW after being buried for a long time will be decomposed and rotten as well as affected by leachate in the landfill cells, so this SW will be significantly changed compared to the SW unburied. It could be applied to explain the difference between the SW in the Phuoc Hiep Landfill with the SW in the Dong Thanh Landfill and Go Cat Landfill. The SW components and properties in these landfills are summarized as follows:

SW in Phuoc Hiep Landfill:

- ***Composition***: The food occupies up to 66.2%ww and 49.1%dw that are many times higher than the other components. Next, the plastic has also high proportion with 17.0%ww and 27.2%dw. The other components namely textile , diaper, paper, inorganic components, shell-bone, rubber-leather, wood, metal and others have low proportion, in range of 0.2 – 5.8%ww and 0.4 – 7.7%dw.

- ***Moisture content***: The moisture content of the food, paper, diaper and textile is rather high, in range of 45.9 – 76.4%. In which, the diaper has the highest moisture content (76.4%), followed by food (71.6%), textile (47.6%) and paper (45.9%). The components that have average moisture content includes plastic (36.2%), wood (28.4%), rubber-leather (21.4%), and others (29.6%). The other components that have rather low moisture content, approximately 10% include shell-bone, metal and others.

- ***Relation between moisture content, ash content and VS:*** The relation between the moisture content, ash content and VS of the SW samples in the Phuoc Hiep Landfill shows that the moisture content, VS and ash content of the SW samples are 55.4 – 70.9%, 23.7 – 32.2% and 5.4 – 12.4% respectively.

- ***HHV:*** The plastic has the highest heating value, approximately 8,400 Cal/g in average while the food has the lowest heating value, approximately 3,700 Cal/g. The other components have the average heating value in range of 4,100 – 5,500 Cal/g. The mixed sample has about 1,300 – 2,300 Cal/g (HHV) and 980 – 1,800 Cal/g (LHV).

SW in Dong Thanh Landfill and Go Cat Landfill:

- ***Composition***: The SW components in these landfill are mainly mud created by the decomposition of organic matters and inorganic or persistent biodegradable components such as nylon, paper (carton, plastic coated paper), wood, metal, rubber, textile , coconut fiber, mango seeds, shell-bone. In which, the plastic mainly nylon occupies about 20 – 65% and others (mud, soil, stone, hair, scrap paper, scrapnylon, etc.) occupies about 50% of total amount of SW.

- ***Moisture content***: The moisture content of the buried SW components that is rather high is mainly affected by leachate inside the landfill cells. The components that have high moisture content include paper with the highest moisture content (70 – 80%); coconut fiber, mango seeds (60 – 75%); plastic, textile , wood (45 – 60%); mud, soil, stone (approximately 50%), rubber (15 – 40%). The other components that have low water absorption leading to low moisture content, in range of 5 – 20% include metal, glass, inorganic components, shell-bone, etc.

- ***Relation between moisture content, ash content and VS:*** The moisture content of SW buried in landfill cells (50 – 60%) is lower than one of SW unburied (before being buried) (about 60 - 80%). The VS of the SW buried is also lower than one of the SW unburied. As a result, the ash content and the incombustible components have higher proportion.

- ***HHV:*** In buried SW components, some combustible components that could be burned to produce the HHV include plastic, wood, paper, rubber, textile (HHV in range of 3,600 – 9,800 Cal/g); the other components that are persistent biodegradable components (e.g. coconut fiber, mango seeds) or others (mud, soil, stone; scrap textile , scrap nylon, hair, etc.) and shell-bone have lower heating values in range of 900 – 3,300 Cal/g.

2-5 DETERMINATION OF THE HEATING VALUE OF SOLID WASTE FROM THE SOLID WASTE SEPARATION PROGRAM AT SOURCE IN ISTRICT 1 AND BINH THANH DISTRICT

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Report 3

DETERMINATION OF THE HEATING VALUE OF SOLID WASTE FROM THE SOLID WASTE SEPARATION PROGRAM AT SOURCE IN DISTRICT 1 AND BINH THANH DISTRICT

October 2014

Contents

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LIST OF FIGURE

LIST OF ACRONYM

APHA	American Public Health Association
DONRE	Department of natural Resources and Environment
DW	Dry weight
EM	Effective Microganisms
ETM	Center for Environmental Technology and Management
GHV	Gross heating value
HCMC	Ho Chi Minh City
HDPE	High Density Polyethylene
HHV	Higher heating value
LHV	Lower heating value
MSW	Municipal solid waste
SW	Solid waste
TCVN	Vietnam Standards
VS	Volatile solid
WW	Wet weight

1. OVERVIEW OF SW COMPONENTS WITH HIGHER HEATING VALUE (HHV)

The heating value includes higher heating value (HHV) and lower heating value (LHV), in which the HHV or gross heating value (GHV) is the heating value of SW mixture and the LHV is net heating value. As M.F.Seelig et al., the HHV and LHV of MSW is about 9.98 MJ/kg (≈ 2,395 Cal/g) and 4.77 MJ/kg (≈ 1,145 Cal/g) respectively. For MSW in Vietnam, the heating value is about 10 MJ/kg (≈ 2,400 Cal/g). In which, the components that have the HHV of over 20 MJ/Kg (≈ > 4,800 Cal/g) include paper and plastic (Amrehn, 2014).

The MSW consists of many components including many combustible components that could significantly create the energy (the heating value) for the power generation. As Tchobanoglous, 1993, the heating value of the MSW components is presented in **Table 1** below.

Table 1 Heating value of MSW components

No.	Component	Heating value (KJ/kg)		Heating value (Cal/g)	
		Range	Specific value	Range	Specific value
1	Food	3,489 – 6,978	4,652	837 – 1,675	1,116
2	Paper	11,630 – 18,608	16,747	2,791 – 4,466	4,019
3	Carton	13,956 – 17,445	16,282	3,349 – 4,187	3,908
4	Plastic	27,912 – 37,216	32,564	6,699 – 8,932	7,815
5	Textile	15,119 – 18,608	17,445	3,629 – 4,466	4,187
6	Rubber	20,934 – 27,912	23,260	5,024 – 6,699	5,582
7	Leather	15,119 – 19,771	17,445	3,629 – 4,745	4,187
8	Garden waste	2,326 – 18,608	6,513	558 – 4,466	1,563
9	Wood	17,445 – 19,771	18,608	4,187 – 4,745	4,466
10	Glass	116 – 223	140	28 – 54	34
11	Tin can	233 – 1163	689	56 – 279	165
12	Other metals	233 – 1163	689	56 - 279	165
13	Dust, ash, etc.	2,326 – 11,630	6978	558 – 2,791	1,675
14	MSW (mixture)	9,304 – 13,956	11,630	2,233 – 3,349	2,791

Source: Tchobanoglous et al., 1993.

As mentioned in Table 1, the plastic has the highest heating value with a specific value of 7,815 Cal/g. The components that have the HHV include paper (4,019 Cal/g), carton (3,908 Cal/g), textile (4,187 Cal/g), rubber (5,582 Cal/g), leather (4,187 Cal/g) and wood (4,466 Cal/g). The other components namely food, metal, glass, garden waste, dust, ash, etc. have the LHV of below 1,500 Cal/g. The heating values of the components namely glass, tin can or metal as mentioned in Table 1 are not their own heating values, but are the heating values of their external coats, labels and materials attached. Therefore, these components could be considered as incombustible components that could not form the heat if they burned.

The SW components in Vietnam in general and in HCMC in particular could be separated into some main types namely food (meat, fish, vegetables, rice, bread, fruits, etc.), paper; diaper, plastic, textile, wood, rubber and leather, metal, inorganic components (ash, brick, glass, etc.), shell, bone and other components (that have too small sizes or could not visually separated namely soil, stone, hair, cigarette butt, etc.). In which, as Kosuke Kawai (2012), the components that could be burned (combustible components) include paper, plastic, fresh and raw food, grass, rubber and leather, fiber, tree, diaper and other components. These are the components that have the HHV in range of 40 – 90%, ash occupies 1 – 13%, especially other components have volatile solid (VS) and ash content that are similar with the percentage of approximately 30%. The heating values of these components are rather high, so they could be burned for the power generation.

As the analytical result of the heating value of the MSW taken in the Phuoc Hiep Landfill, HCMc, it showed that the HHV and LHV of MSW fluctuated about 1,600 – 2,300 Cal/g and 980 – 2,000 Cal/g respectively. In which, the plastic is the most combustible component with the heating value of about 7,000 – 9,000 Cal/g; paper, diaper, textile, wood, rubber and leather have the heating value in range of 3,000 – 6,000 Cal/g. Otherwise, the food is the component that has the LHV in range of 3,000 – 4,000 Cal/g (see **Table 2**).

Table 2 Heating value of MSW in the Phuoc Hiep Landfill, HCMC

No.	Component	Heating value (Cal/g)		
		Average	Minimum	Maximum
1	Food	3,693	3,187	4,246
2	Paper	4,282	3,578	4,893
3	Diaper	5,467	4,582	6,280
4	Plastic	8,406	7,372	9,204
5	Textile	4,811	4,500	5,067
6	Wood	4,172	3,945	4,428
7	Rubber, leather	5,519	4,455	6,736
8	Others	3,917	3,917	3,917

Source: Joint Venture of KOBELCO and HITACHI ZOSEN, 2012, 2013 and 2014.

In comparison with the landfill technology, the application of incineration technology for the SW treatment brings more advantages, significantly reduces the volume of SW buried and could recover the energy by the heat exchange of high-temperature gases formed for the power generation. The trend of SW incineration for the energy recovery to operate the generator is being currently applied in many countries all over the world to tend to limit and thoroughly remove the SW treatment by the landfill method. As the research of Ph.D Kosuke Kawai, 2012 on the MSW management in the Southeast Asian countries, especially in Vietnam, it showed that the optimum heat value for the MSW treatment by incineration method is HHV > 800 Cal/g, and the suitable heat value threshold for the MSW treatment by incineration method together with the energy recovery for the power generation is HHV > 1,500 Cal/g. Therefore, as above-mentioned analytical result of the heating value of the SW in the Phuoc Hiep Landfill, the SW in HCMC could be absolutely treated by the incineration method together with the energy recovery for the power generation.

2. PROGRAM ON SW SEPARATION AT SOURCE

In 2013, Center for Environmental Technology and Management (ETM) combined with the HCMC's DONRE to carry out the program on SW separation at source at two areas namely Ward 14, Binh Thanh District (July, 2013) and Ben Nghe Ward, District 1 (December, 2013), HCMC under the Project on "***Solid Waste Separation at Source Pilot Programme – Composition Analysis of Household Waste in the Model Areas of Source Separation in Ho Chi Minh City***". The program aimed mainly at the determination of the quantity and quality of household SW before implementing the model of SW research and separation at source.

2.1 Implementing organization

ETM will combine with the HCMC's DONRE to carry out the program. In which, DONRE is responsible for collecting and separating the household SW, then ETM is responsible for sampling and analyzing the physical and chemical components of SW. The responsibilities are specifically presented as follows:

DONRE

- Provide nylon bags for all households to store SW within the researched areas;
- Collect SW from households and transport SW to the concentration station for separation;
- Separate SW components and weigh each component sorted.

ETM

- Take SW sample and analyze the physical components;

- Analyze the components such as humidity, ash content, VS and gross heating value (GHV).

2.2 Implementing content

2.2.1 Analytical plan

The SW that is collected from the households is separated into 14 components. The analyzed parameters of each component are presented in **Table 3.**

Table 3 Plan of analyzing 14 components of SW

No.	Component	Moisture content	VS	GHV
1	Food	○	○	○
2	Shell – bone (also including durian skin, coconut shell, corn cores, egg shells, mango seed, etc.)	○	○	○
3	Paper	○	○	○
4	Plastic	○	○	○
5	Diaper	○	○	○
6	Textiles	○	○	○
7	Garden waste (green leaves, flower, etc.)	○	○	○
8	Wood	○	○	○
9	Rubber and leather	○	○	○
10	Glass	○	x	x
11	Metal	○	x	x
12	Ceramics	○	x	x
13	Coal ash	○	x	x
14	Others (soil, sand, hair, cigarette butts, sawdust, etc.)	○	○	○

Note: ○ – Analyzed; x – Not analyzed.
Source: Joint Venture of KOBELCO and HITACHI ZOSEN, 2012, 2013 and 2014.

2.2.2 Analytical method

The household SW is separated into 18 components that are stored in 80-liter buckets. After that, ETM will take the sorted SW sample for analyzing its components. Each component is taken and analyzed by the following steps:

Sampling method

- All SW component after separation will be manually mixed by shovels to become a homogeneous mixture;
- SW samples will be cut into smaller pieces in a size of less 15cm by knives or scissors to be thoroughly mixed;
- The quantity of sample that is analyzed is taken depending on the method of 4 parts (SW sample is divided into 4 parts in which two parts are only taken for analysis and two other parts removed) and the method is carried out two times. For food and plastic, the quantity of analyzed sample that is taken two times is 5 - 10kg and 2 - 5kg in order. For other components, if the quantity of sample is less 2kg, it will be all taken, if it is more 2kg, the quantity of sample is taken in range of 2 – 5kg.

Analytical method

❖ *Moisture content*

- Moisture content of each component will be separately analyzed under APHA 2540 G (2012);
- Each SW component will be cut into smaller pieces in a size of less 2 - 3 cm^3, then stored in a metal plate (a height of SW shout be smaller than 10 cm if any);
- After that, the SW in metal plate will be dried in the drying oven. The temperature is adjusted at 105^oC, the SW will be continuously dried in 4 - 5 days until the weight of SW in the plate is not changed any more.
- Moisture content of the SW is estimated by the difference of the SW sample before and after drying (evaporation released after drying).

❖ *VS, ash content and GHV*

- VS, ash content and GHV are analyzed by SW after being dried for its moisture content determination.
- There are 8 – 10 components (food, bone and shell-bone, paper, diaper, plastic, Textile, garden waste, wood, leather and rubber, others) compared to the plan as mentioned **Table 3** that are analyzed . The SW will be cut into smaller pieces in a size of less 1cm before analyzing its ash content and VS. The SW will be burned at a temperature of 550^oC under APHA 2540 G (2012).
- These components after being cut into smaller pieces in a size of less 1cm will be reduce their sizes of less 2mm to analyze the GHV under TCVN 200-2007 (ISO 1928:1995).
- The analytical methods of the parameters are presented in **Table 4**.

Table 4 Analytical methods

No.	Parameter	Analytical method	Analytical Instrument
1	Moisture content	APHA 2540 G	WTB Binder, Germany, Mettler Toledo MS204 balance, Switzerland
2	VS and ash content	APHA 2540 G	Nabertherm oven, Mettler Toledo MS204 balance, Switzerland
3	Gross calorific value (GHV)	TCVN 200 -2011 (ISO 1928:2009)	IKA calorimeter C 4000

3 ANALYTICAL RESULTS OF GHV OF SW COMPONENTS UNDER THE IMPLEMENTED PROGRAMS ON SW SEPARATION AT SOURCE

3.1 Analysis of GHV of SW components

Among 14 components are separated from household SW in this program, there are 8 – 10 components that are determined their GHV, including food, paper, diaper, plastic, textile, garden waste, wood, rubber and leather, shell-bone and others.

The program on analyzing the taken samples is performed in alternating 4 days of 8 days of taking the sorted samples. The average heating value of household in District 1 is shown in **Figure 1.**

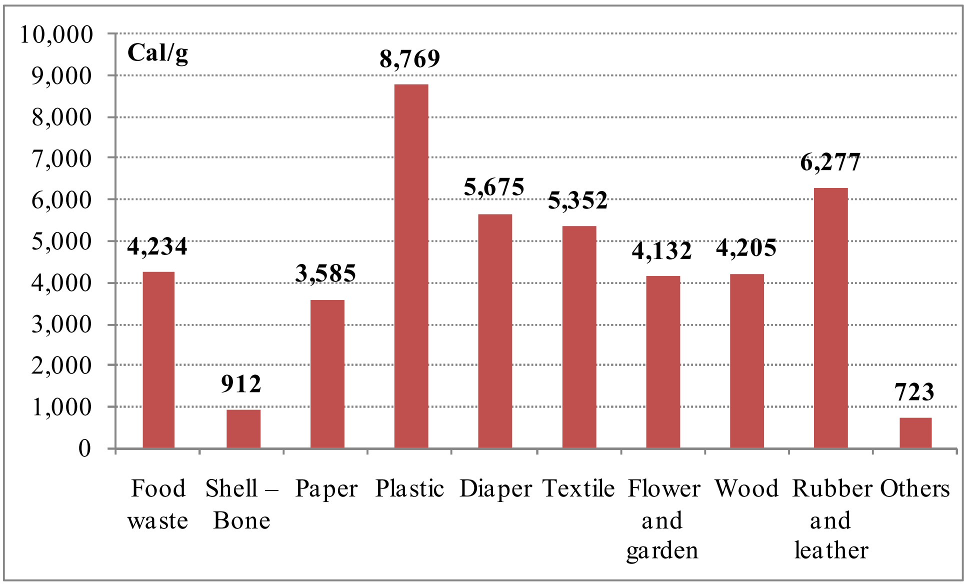

Figure 1 Average heating value of each component of household MSW samples in District 1.

As shown in **Figure 1**, it shows that the average heating value of the plastic is the highest, reached 8,769 Cal/g.

The components that have the average heating value in range of 4,000 – 6,500 Cal/g include rubber and leather (6,277 Cal/g), diaper (5,675 Cal/g), textile (5,352 Cal/g), food (4,234 Cal/g), wood (4,205 Cal/g) and garden waste (4,132 Cal/g).

The average heating value of the paper that ranges 3,000 – 4,000 cal/g is 3,585 Cal/g.

The analytical result showed that the GHV of two components is about 912 Cal/g (bone & shell-bone) and 723 Cal/g (others) that are 4 – 8 times lower than the GHV of the other components.

The analytical result of the average heating values of the components in household in District 1 is presented in **Table 5** below.

Table 5 Average heating value of each component of household SW samples

No.	Composition	Average (Cal/g)	Minimum (Cal/g)	Maximum (Cal/g)
1	Food waste	4,234	3,654	4,680
2	Shell – Bone	912	579	1,280
3	Paper	3,585	3,428	3,767
4	Plastic	8,769	8,273	9,473
5	Diaper	5,675	5,111	5,860
6	Textile	5,352	4,262	5,139
7	Flower and garden	4,132	3,501	4,444
8	Wood	4,205	3,953	4,313
9	Rubber and leather	6,277	5,401	6,752
10	Others	723	318	1,601

3.2 Physical and chemical properties of HHV components

3.2.1 Physical property

The percentage (by wet weight (WW) and dry weight (DW)) of the components of household SW samples is shown in Figure 2, Figure 3 and Figure 4 below.

Percentage of SW components by WW

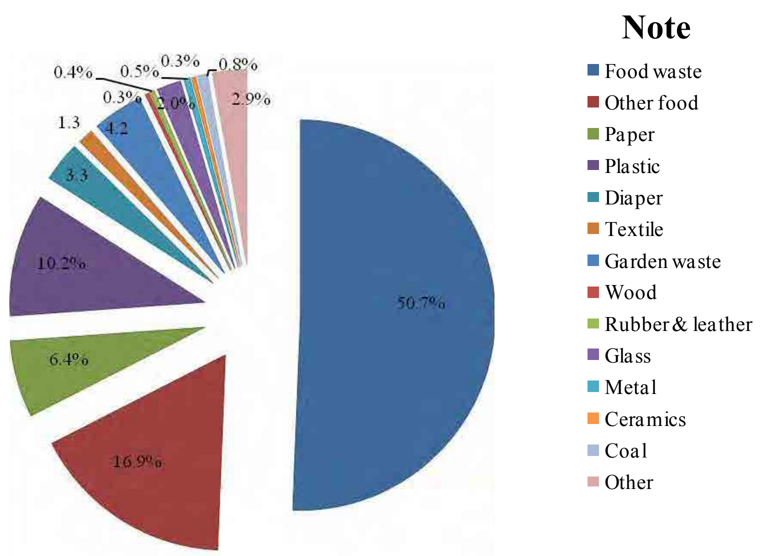

Figure 2 Percentage of household SW components in District 1 by WW.

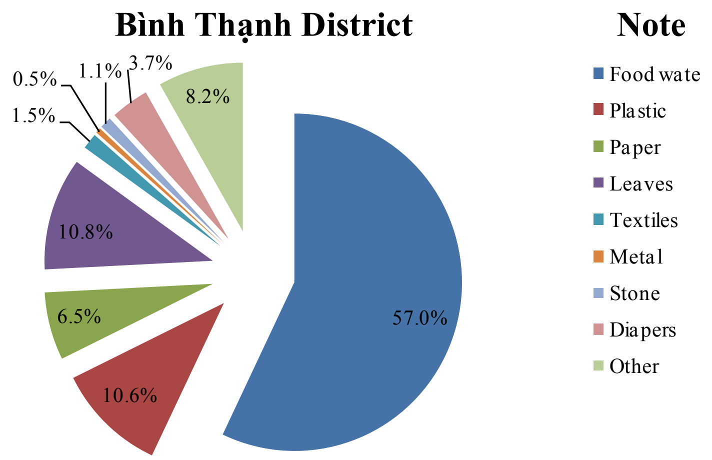

Figure 3 Percentage of household SW components in Binh Thanh District by WW.
(Source: Hayama Kazuyuki, 2014)

As shown in **Figure 2** and **Figure 3**, the food has the highest percentage, occupied 67.6% by WW for SW samples in District 1 and 57.0% by WW for SW samples in Binh Thanh District (including food waste and other food), lower than one in the Phuoc Hiep Landfill (61.3% by WW) (ETM, 2014). The food percentage of SW samples in District 1 is higher than one in Binh Thanh District and Phuoc Hiep Landfill (61.3% by WW) (ETM, 2014).

The plastic is mainly nylon bags, occupied about 10% by WW (10.2% by WW and 10.6% by WW for SW samples in District 1 and Binh Thanh District respectively). This is a persistent bio-degradable component with a high percentage in MSW due to a habit of using nylon bags in Vietnam now.

The garden waste (in District 1) or leaves (in Binh Thanh District) and others are two components that have rather high percentage of 10.8% by WW and 5.0% by WW respectively compared to the other components of household SW samples in Binh Thanh District. However, the values are a half lower than the percentage of these two components of household SW samples in District 1 that is 4.2% by WW and 2.9% by WW respectively.

The paper, diaper, fabric, rubber and leather are the components that have similar percentage between the SW samples in District 1 and Binh Thanh District. In which, there are about 6.5% by WW for paper, 3.5% by WW for diaper, 1.5% by WW for textiles, 0.4% by WW for rubber and leather.

The wood has rather low percentage that is different between the SW samples in District 1 and in Binh Thanh District. Specifically, the percentage of wood in the SW samples in District 1 is about 0.9% by WW while one in Binh Thanh District is only 0.3% by WW. Thus, the percentage of wood of the SW samples in these two districts that is not similar but insignificantly different is still a specific percentage by WW in MSW. Moreover, the wood is also a component that is daily generated with a little amount daily activities from the households in the urban areas like HCMC, so it occupies a little amount of the SW components compared to other components.

In summary, the percentage of the SW components by WW in District 1 and Binh Thanh District is similar, except some components with different percentage but insignificant. The analytical results still obviously show the percentage of the MSW components by WW.

Percentage of SW components by DW

The percentage of the components by DW of household SW samples in District 1 is shown in **Figure 3**).

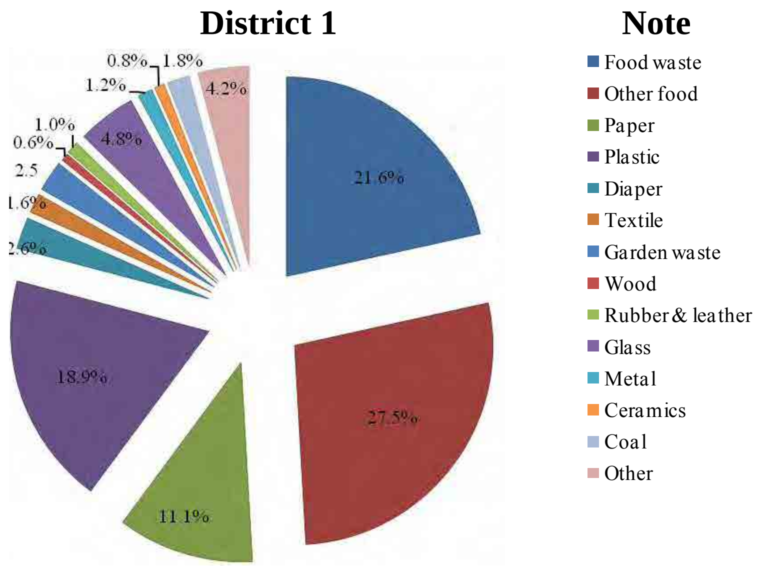

Figure 4 Percentage of SW components in District 1 by DW.

The percentage of food by DW is still the highest, occupied 21.6% by DW respectively.

The percentage of plastic by DW that is similar to the percentage of food is about 18.9% by DW respectively. Additionally, there are about 11.1% by DW for paper; about 2.5% by DW for garden waste; about 2.6% by DW for diaper.

The percentage of other components namely textile, rubber and leather that is rather low ranges 0.6 – 2.2% by DW.

3.2.2 Moisture content, ash content, VS

The analytical results of moisture content, ash content and VS of the household SW components in District 1 that are performed under the SW separation programs are presented in **Table 6** below.

Table 6 Analytical result of moisture content, ash content and VS of household SW components in District 1

No.	Component	Moisture content (%)	VS (%)	Ash content (%)
1	Food	83.0	13.7	3.4
2	Other food	32.9	14.2	53.0
3	Paper	29.3	59.6	11.1
4	Plastic	25.9	69.1	5.0
5	Diaper	69.3	26.5	4.2
6	Textile	51.1	44.7	4.2
7	Garden waste	75.8	20.4	3.8

No.	Component	Moisture content (%)	VS (%)	Ash content (%)
8	Wood	22.4	71.6	6.0
9	Rubber & leather	7.2	71.9	20.9
10	Glass	4.4	-	95.7
11	Metal	4.0	-	96.0
12	Ceramics	2.5	-	97.5
13	Coal	27.8	-	72.2
14	Other	41.9	11.4	46.7

For moisture content, among the components of household SW samples sorted, there are rather many components that have high moisture content. Specifically, there are 5 – 7 components out of 14 components with a moisture content of 40 – 83%, 3 - 5 components out of 14 components with a moisture content of 20 – 30%, other components with very low moisture content of less 5%. The moisture content of the components of household SW samples sorted is presented as follows:

- Food, diaper and garden waste are the components that have the highest moisture content of over 60%. In which, the food includes the wastes from the food processing activities (e.g. vegetables, fruits, meat, fish, rice, etc.) or residual food (bread, rice, noodle, vermicelli, etc.) that are a component with the highest moisture content of about 83.0%.

- Specifically, the moisture content is 63.2% respectively for diaper; 75.8% respectively for garden waste.

- The moisture content of textile of the household SW samples that fluctuates about 40 – 50%.

- The moisture content of paper of the household SW samples is only 29.3%.

- The moisture content of plastic and wood is low in range of 20 – 30%.

- The moisture content of rubber and leather is very low, less 10%.

For **VS and ash content**, the VS and ash content of the components show the combustible possibility of the SW at 550^{o}C, especially for the HHV components as follows:

- The components that have high combustible possibility include plastic, wood, rubber and leather. These are the HHV components. The VS and ash content of plastic is 69.1%; about 4 – 5% respectively. Similarly, the VS and ash content of is 71.6%;

8.8% respectively. The rubber and leather have high combustible possibility with the VS of 71.9. Otherwise, the ash content of this component that is rather higher than one of two other components is 20.9% respectively (the moisture content of this component is very low about 7.2% respectively).

- The paper and textile have rather high combustible possibility while the ash content of these components is rather low, approximately 10%. The VS of paper and textile are 59.6% and 44.7% respectively.

- The VS of diaper and garden waste fluctuates about 20 - 30% and the ash content of these components is about 4%.

- The VS and ash content of food is about 13 – 17% and 3 – 5% respectively.

The relation between the moisture content, ash content and VS of the components of the household SW samples in District 1 is shown in **Figure 6**.

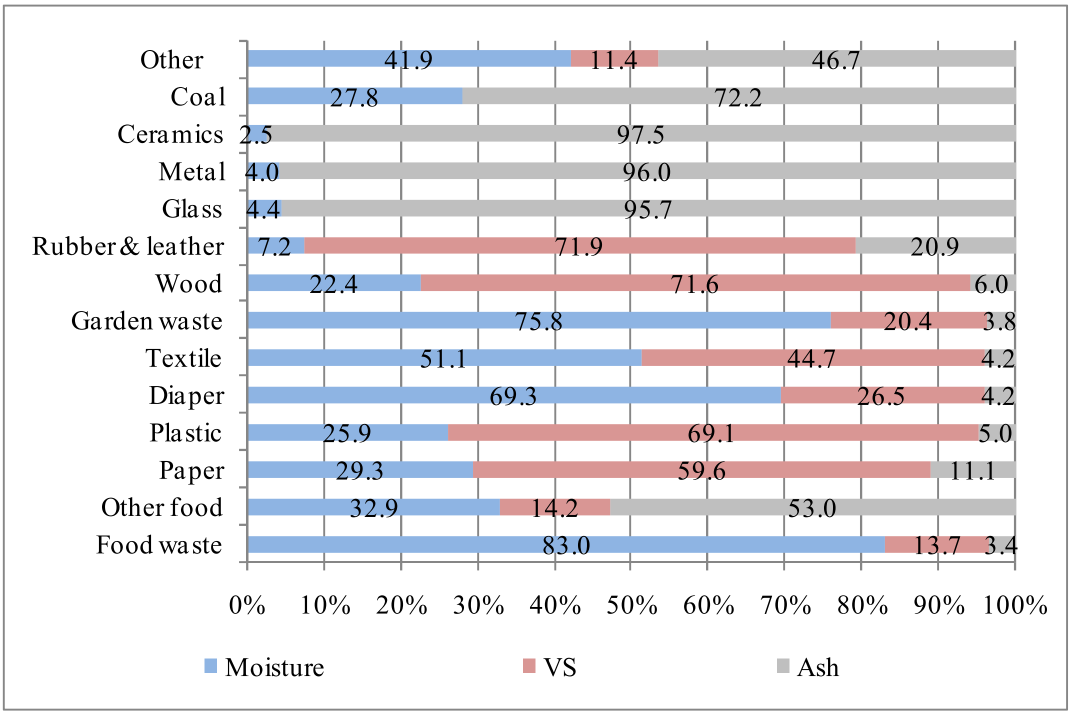

Figure 5 Relation between moisture content, ash content and VS of the components of the household SW samples in District 1.

4 CONCLUSION

The programs on SW separation at source in 2013 were performed to separate and analyze the components of the SW taken from households together with the physical and chemical properties of the SW (e.g. moisture content, ash content, VS, GHV). In which, the components that are identified with high combustible possibility include plastic, paper, wood, rubber & leather, diaper, textile, garden and food. The SW components and their physical properties are presented as follows:

Composition: the food that has the highest percentage among the components of the household SW samples ranges about 45 – 50%. The plastic that has the second percentage is about 10%. The percentage of other components is about 6.5% for paper, 3.5% for diaper, 1.5% for textile, 0.4% for wood and rubber & leather.

Moisture content: the food and diaper have both the highest moisture content, above 60%; the textile has the second moisture content in range of 40 – 50%; the paper has the moisture content in range of 30 – 50%; the plastic and wood has the moisture content in range of 20 – 30%; the rest component namely rubber – leather has the lowest moisture content, less 10%.

Relation between ash content and VS: most of the SW components has high combustible possibility and low ash content. The components including plastic, wood, rubber – leather have the highest combustible possibility with VS of about 65 – 75% and ash content of 4 – 30%. Similarly, the paper and textile have both low ash content, less 10% while they have high VS in range of 40 - 60%. The diaper could be highly combustible at 550^{o}C with ash content of about 4% and VS of about 20 – 30%. The food has high moisture content (over 60%). The rest components that are mostly combustible organic matters occupies about 13 – 17% with ash content of about 3 – 5%.

As above-mentioned analytical result of the average heating value, the components that could be burned to recover the energy for the power generation (HHV > 1,500 Cal/g, as Kosuke Kawai, 2012) include plastic, rubber and leather, diaper, textile, garden waste, wood, paper and food. These components have the HHV in range of 3,000 – 9,000 Cal/g.

Appendix

3-1 REPORT
WATER SURVEY AND ANALYSIS FOR THE PROPOSED SOLID WASTE INCINERATION PROJECT WITH CAPACITY OF 300 TONS/DAY

TSUNEISHI KAMTECS CORPORATION

REPORT

WATER SURVEY AND ANALYSIS FOR THE PROPOSED SOLID WASTE INCINERATION PROJECT WITH CAPACITY OF 300 TONS/DAY

HO CHI MINH, AUGUST, 2014

TSUNEISHI KAMTECS CORPORATION

REPORT

WATER SURVEY AND ANALYSIS FOR THE PROPOSED SOLID WASTE INCINERATION PROJECT WITH CAPACITY OF 300 TONS/DAY

REPRESENTATIVE	**REPRESENTATIVE**
TKC	**ENTEC**

HO CHI MINH, AUGUST, 2014

CONTENTS

ABBREVIATION

BOD	Biochemical Oxygen Demand
BTNMT	Ministry of Natural Resources and Environment
CEMTES	Centre of Environmental Monitoring & Technical services
COD	Chemical Oxygen Demand
DO	Dissolved oxygen
ENTEC	Environmental Technology Center
IPs	Industrial park
LA	Long An
QCVN	Vietnam Technical Regulations
TCVN	Vietnam Standard
TDS	Total Dissolved Solid
TKC	Tsuneishi Kamtecs Corporation
TSS	Total Suspended Solid
VCD	Vam Co Dong river

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1. INTRODUCTION

1.1. Objective of the Survey

At the present, the Representative Office of Tsuneishi Kamtecs Corporation in Vietnam (hereinafter referred to as TKC) is carrying out the pre-feasibility study on the waste-to-energy project with capacity of 300 tons per a day in Ho Chi Minh City and neighboring provinces (including Dong Nai, Binh Duong, Ba Ria - Vung Tau and Long An).

One of the important issues to be investigated is the water survey and analysis in the proposed project's area (hereinafter referred to as the Work).

Tsuneishi has asked the Environmental Technology Centre (ENTEC) to cooperate with Tsuneishi implementing the "Work" above.

Purpose of the Study is to carry out Water Survey and Analysis for the Proposed Solid Waste Incineration Project with Capacity of 300 tons/day.

1.2. Scope of Work

ENTEC shall carry out the Work under the supervision of the TKC . The Work consists of the followings;

– Preparation work

– Collection of existing data on surface and ground waters in the proposed project area (Water flow, capacity in dry and rainy seasons, quality etc.)

– Water sampling and analysis, including ground water and surface water during both rising and shifting tides.

– Reporting

1.3. The Legal and Technical Documents

1.3.1. The Vietnam environmental standards and regulations

– TCVN 7704:2007/BTNMT - National technical regulations on boilers - technical requirements for the design, structural fabrication, installation, use and repair

– Standard for feed water to boiler according to ABMA

– QCVN 02:~~2008~~2009/~~BTNMT~~ BYT – National Technical Regulation on domestic ~~surface~~ water quality;

~~– QCVN 09:2008/BTNMT – National Technical Regulation on groundwater quality;~~

1.3.2. The Technical Documents

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[18]. Environmental impact assessment of the project "Chemical Storage Warehouse with capacity of 1,000 tons" at Nhut Chanh Industrial Park, Ben Luc district, Long An province, 2014.

2. COLLECTION OF EXISTING DATA ON WATER RESOURCES IN PROJECT AREA

2.1. Surface water

2.1.1. Water reserves

On the Ben Luc district, there are 2 main flows, including the Vam Co Dong River (VCD) and Ben Luc River, in addition to a system of small canals.

Network flow diagrams in Ben Luc district is presented in Figure 1.

Figure 1. Network diagram of rivers and canals in Ben Luc district, Long An province

(1). Vam Co Dong River

VCD river have catchment area of 6,000 km^2, derived from Cambodia passing through Vietnam in Xamat and runs through Tay Ninh Province from the Northwest and then in Long An Province through Hue Duc, Duc Hoa, Ben Luc district southeast direction; connected to the Vam Co Tay River at Tan Tru district of Vam Co Lon River estuary Soai Rạp. VCD river stretch passing through Long An 145 km long, 400 m wide average, depth of the river bed in Duc Hue demand is -17 m, in Ben Luc bridge is -21 m. VCD River is a tributary of the Dong Nai river level 1, connect the Vam Co Tay River in the horizontal channel; VCD River connect with Saigon River, Dong Nai river run through Thay Cai channel, Ha An channel, Ben Luc River, ...

Because there are many small tributaries, thus VCD river very convenient for traffic in waterways to transport commodity from other place to Tay Ninh or the opposite from Tay Ninh to other places . VCD River is the source of irrigation water for Duc Hoa, Duc Hue, Ben Luc district with an area of about 84,000 ha of rice cultivation. Every day, VCD River to receive a relatively large amount of waste from factories, industrial parks, residential areas and households scattered along the river.

Section of the VCD river flowing through Ben Luc District approximately 36.5 km long, and the main source of water supply with rainwater. Annual precipitation is large, but unevenly distributed: heavy rainfall coincides with a flood of the Mekong river, it often happens inundation, dry season rainfall was low, accounted for 15% of the total rainfall of year, so the water supply for agricultural production and dosmetic water is difficult.

The average discharge year of VCD river is about 94 m^3/s, the average discharge of dry season is about 10 m^3/s. VCD basin is relatively contained, unless Mekong river flood is large and discharge of Dau Tieng decrease to 10-12 m^3/s (1996) will be strongly influenced basin.

(2). Ben Luc River

Ben Luc river connecte with Saigon River through Kenh Doi , large 20-25 m, deep 2-5 m, influenced hydrological regime of VCD river. This is the draining for regional Ben Luc, Nha Be, Binh Chanh and urban areas of HCMC; is waterway connecting the Western provinces with Ho Chi Minh City, which borders the water at Binh Dien Bridge, the boundary between sour and sweet water in the rainy season. Long section through Ben Luc district is 7.8 km, split Ben Luc district to two region North and South.

Discharge for many years of Ben Luc River is about 46.8 m^3/s, the average dry season flow of about 7.5 m^3/s. Discharge average of flood season is about 78.8 m^3/s.

(3). The system of small canals

– The horizontal channel system, with the main canal as Xang Lon, Xang Nho canal, Rach No, Rach Vong, Nuoc Muc, Thu Thua, Bien Cung, Ba Mot, T4 canal with total length of about 46 km. The horizontal channel system to keep water from the VCD river to inland areas;

– Canal vertical system as Rach Chiec canal of Thanh Loi commune and Thanh Hoa commune, Go Dung canal, Ba Vu canal, Nam Dong canal connecting Xang Lon channel to Ben Luc river , total length of canal vertical system about 41 km, have mission lead water in the dry season and drainage in flood season;

– Natural canal and incision system about 65 km, incision and canal of main beginVCD river to turn west and east of the district. The main of incision as Bac Tan, Ong Huu, Ba Lang, Ba Cua…

– The hydrology of Ben Luc district is influenced by west sea tidal semi-diurnal. The hydrology in the VCD river is higher the receipt of irrigation water upstream, possibility transmission of tide and salty is quick about 0.09 g/l/km.

– Because the average tide changes from 0.66 m - 0.95 m, thus gravity irrigation capabilities are limited, except the riparian zone. October and May of year have flood water, high tide should be dike to protect. Height of dike is (+) 1.9 m - 2.2 m.

Information about network flows in Ben Luc District are summarized in Table 1.

Table 1. The summary of the stream system in Ben Luc district.

No	**Name of river/canal**	**Length (km)**	**Average width (m)**	**Average flow (m^3/s)**	**Location**
1	Vam Co Dong River	145	.400	94	Cambodia→ Tay Ninh province → Long An province (Duc Hue, Duc Hoa, Ben Luc Districts) under the southeast, connecting with Vam Co Tay River at Tan Tru District of Vam Co Lon River pour into Soai Rap estuary.
2	Ben Luc River	7,8	20 - 25	46,8	Connecting VCD River with Saigon River through Kenh Doi canal
3	The horizontal canal system	Total length about 46km	10 - 15	23	There are mission transfer water from VCD river to inland areas such as Xang Lon, Xang Nho canal, Rach No, Rach Vong...
4	Channel system vertical	Total length about 41km	8 - 12	14,2	The mission lead in the dry season and drainage in flood season as canal Rach Chiec of Thanh Loi commune and Thanh Hoa commune ...
5	Natural river and	Total length	5 - 7	9,7	Begin in VCD river to turn west and east of the district

No	Name of river/canal	Length (km)	Average width (m)	Average flow (m^3/s)	Location
	canals	about 65km			as Bac Tan, Ong Huu, Ba Lang, Ba Cua…

(4). General remarks

Through collecting the above results showed that the volume of surface water in the project area is abundant. This surface water source is capable of supplying water for agricultural activities, industrial activities…

2.1.2. Surface water quality

The latest monitoring results (in 2013) by Centre of Environmental Monitoring & Technical services (CEMTES) performed. Specifically as follows:

(1). Frequency of monitoring

Frequency of Vam Co Dong River water quality monitoring was conducted in 4 times/year. Specifically as follows:

– The 1st: in March every year (characteristic of the dry season and low flows in the year);

– The 2nd: in June every year (characterizes of the early rainy season);

– The 3rd: in September every year (characteristic of flood peak periods);

– The 4th: in December everyyear (characterizes of the early dry season, tide).

(2). Time of monitoring

The time of monitoring in each monitoring is determined based on the lowest tidal regime in month (usually from date 9 to 12 or date from 23 to 25 of lunar month).

(3). Position of monitoring

Position of Vam Co Dong River water quality monitoring in Ben Luc District area consists of 04 points with specific locations are presented in Table 2 and Figure 2.

Table 2. Water quality monitoring position of VCD river section running through Ben Luc district

No.	Location	Notation	Longitude	Latitude
1	Confluence of Xang Lon canal and Vam Co Dong river	LA-W01 (National)	574428	1186112
2	Near Tan Nghe Nam Co., Ltd.	VCĐ-10	576525	1179852

No.	Location	Notation	Longitude	Latitude
3	Ben Luc Bridge	LA-W02 (National)	579033	1176517
4	500m downstream from Bourbon port (Confluence of Chanh canal and Vam Co Dong river)	VCĐ-11	580211	1173849

Source: CEMTES, 2013

Note: The coordinate system is used in Table 2 is the VN2000 coordinate system

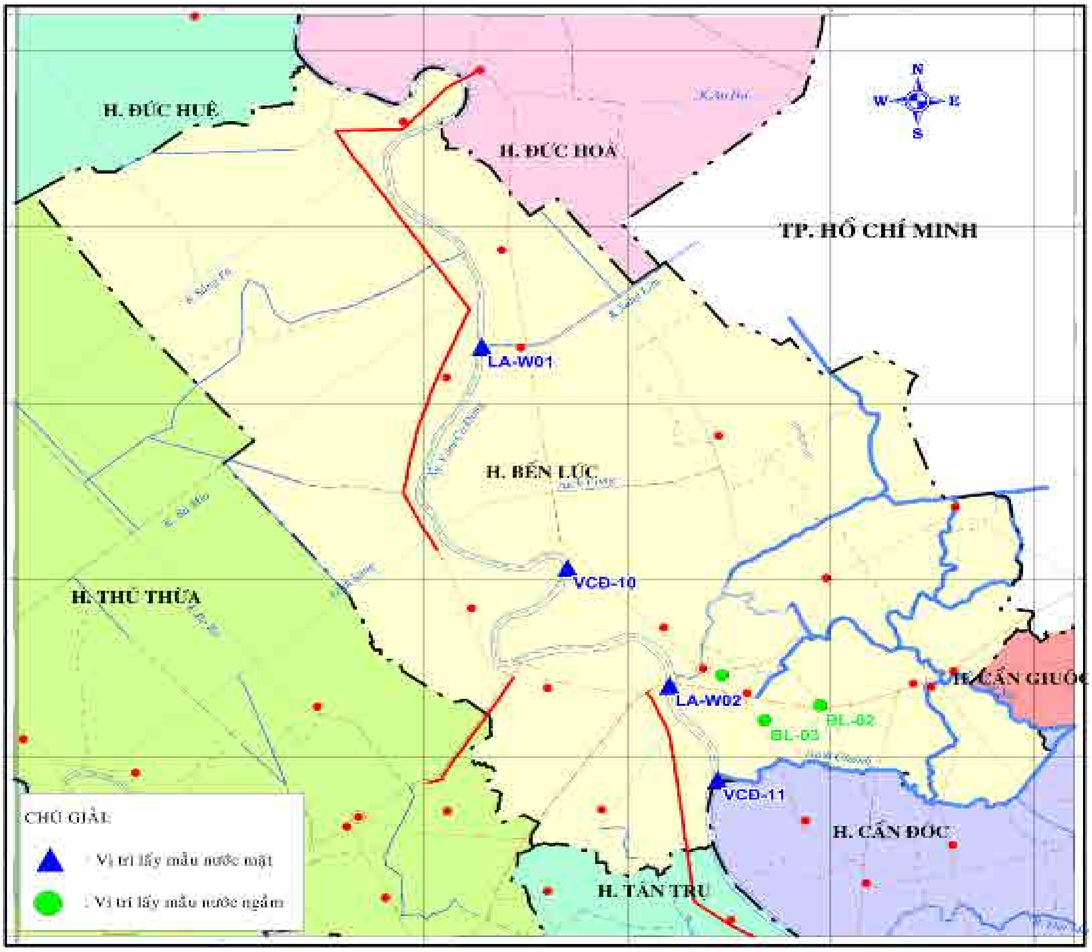

Figure 2. Locations of surface water and groundwater sampling

(4). Monitoring results

Monitoring results are compared with TCVN 7704:2007 - National technical regulations for boilers - technical requirements for the design, structural fabrication, installation, use and repair, (Section 9.6.2: feed water quality criteria is specified for natural circulation boiler pressure up to 4 MPa)

Evolution of the parameters at the monitoring position of the months in the year as follows:

1). pH

Based on monitoring results Monitoring and Technical Environmental Services center of Long An Province, compared pH values with TCVN 7704:2007 are presented in Table 3 and Figure 3 follows.

Table 3. Monitoring results of pH indicator in VCD river section running through Ben Luc District

Monitoring period	**Position**				**TCVN 7704:2007**	
	LA-W01	**VCĐ10**	**LA-W02**	**VCĐ11**	**Feedwater**	**Boiler water**
March 2013	5.97	6.09	6.38	6.53	8.5 – 10.5	10.5 – 11.5
June 2013	6.18	6.06	5.85	5.47	8.5 – 10.5	10.5 – 11.5
September 2013	6.59	6.28	6.09	6.12	8.5 – 10.5	10.5 – 11.5
December 2013	5.78	5.01	5.89	5.79	8.5 – 10.5	10.5 – 11.5

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

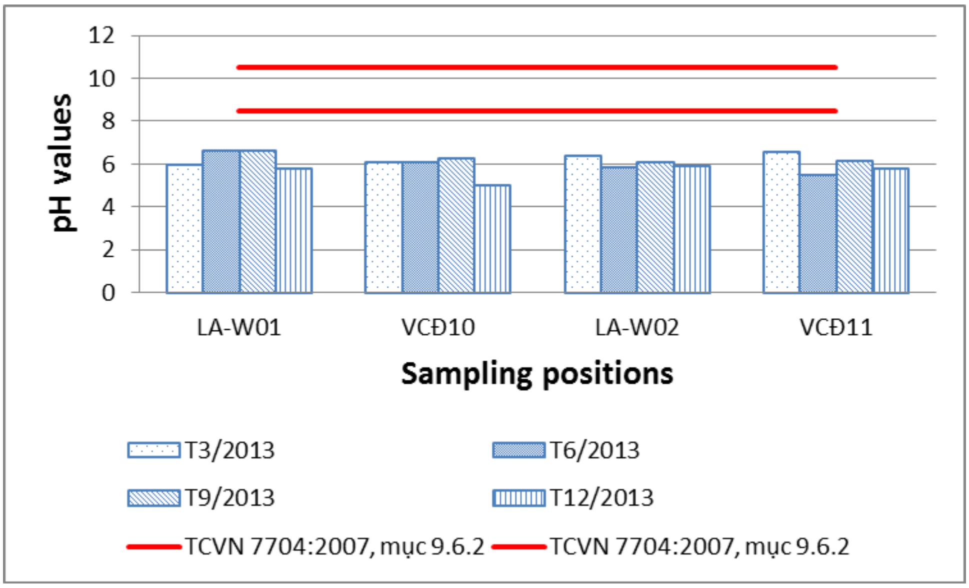

Figure 3. Fluctuation of pH on the Vam Co Dong river (section running through Ben Luc District), 2013

PH values measured on the Vam Co Dong river section running through Ben Luc district ranged from 5.01 to 6.59; highest value at the LA-W01 position in June and September (6.59); lowest value at VCĐ10 position in September (5.01). This suggests that Vam Co Dong River water quality is weak acidity, all of monitoring points are not achieved TCVN 7704: 2007 - National technical regulations for boilers - technical requirements for the design, structural fabrication, installation, use and repair, (Section

9.6.2: feed water quality criteria is specified for natural circulation boiler pressure up to 4 MPa). Acidification problems of Vam Co Dong River will greatly affect the water supply for the operation of the boiler as well as drinking water, irrigation and aquaculture process in the region.

2). Dissolved Oxygen in Water (DO)

DO values in river water is shown in Figure 4 and Table 4

Table 4. Monitoring results of DO concentrations in the Vam Co Dong River water

Monitoring period	**Units**	**Position**				**TCVN 7704:2007**
		LA-W01	VCD 10	**LA-W02**	**VCĐ11**	**Feedwater**
March 2013	mg/kg	**1.63**	**1.39**	**1.82**	**2.54**	≤ 0.4
June 2013	mg/kg	**3.02**	**3.63**	**3.02**	**2.98**	
September 2013	mg/kg	**3.02**	**3.15**	**3.05**	**3.03**	
December 2013	mg/kg	**3.63**	**3.77**	**3.86**	**2.14**	

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

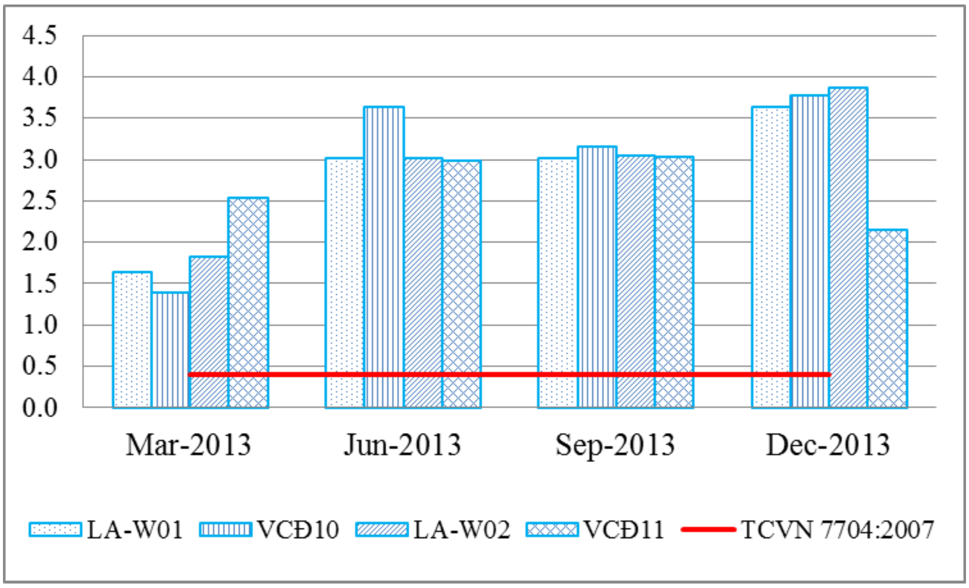

Figure 4. Comparing DO values of in Vam Co Dong river water (section running through Ben Luc District), 2013with TCVN 7704:2007

Through monitoring results so that, DO parameter value is from 1.63 to 3.86, highest in December in position LA-W02 (3.86 mg/kg); lowest value at the VCĐ10 position in March (173.75 µgdl/kg) and most sample do not meet TCVN 7704:2007.

3). The turbidity

Monitoring results of turbidity in Vam Co Dong river section flow through Ben Luc District are shown in Table 5.

Table 5. Monitoring results of turbidity in VCD river section running through Ben Luc District

Monitoring period	**Units**	**Position**				**TCVN 7704:2007**
		LA-W01	VCD 10	**LA-W02**	**VCĐ11**	
March 2013	NTU	18	35	28	34	≤ 23
June 2013	NTU	46	43	36	37	
September 2013	NTU	58	40	43	59	
December 2013	NTU	37	20	45	51	

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

Comparison of changes in turbidity parameter values are shown in Figure 5.

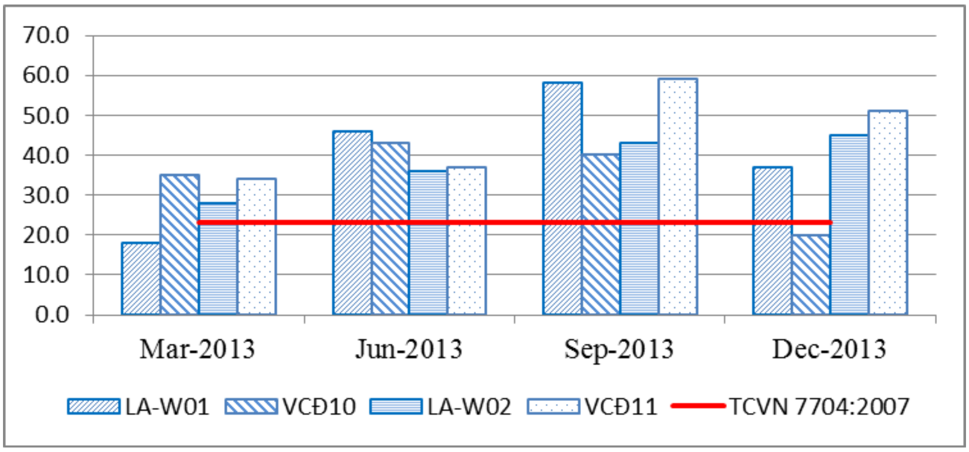

Figure 5. Comparison of changes in turbidity parameter values in VCD river section through Ben Luc District with TCVN 7704:2007

Results of measurement of turbidity on VCD river of section through Ben Luc District in 2013 with considerable differences, ranging from 18 to 59 NTU, average annual value is 38.5 NTU, most sample do not meet TCVN 7704:2004, except samples LA-W01 in March and sample VCD10 in December.

4). TSS

Comparing TSS concentrations in the river water at monitoring locations are presented with TCVN 7704:2007 as show follow in Table 6 and Figure 6.

Table 6. Monitoring results of TSS in Vam Co Dong river section running through Ben Luc District in 2013

Unit: mg/l

Monitoring period	**Position**			
	LA-W01	**VCĐ10**	**LA-W02**	**VCĐ11**
March 2013	15	22	51	21
June 2013	22	17	16	19
September 2013	19	21	21	41
December 2013	26	17	10	14
TCVN 7704: 2007	***≤15***			

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

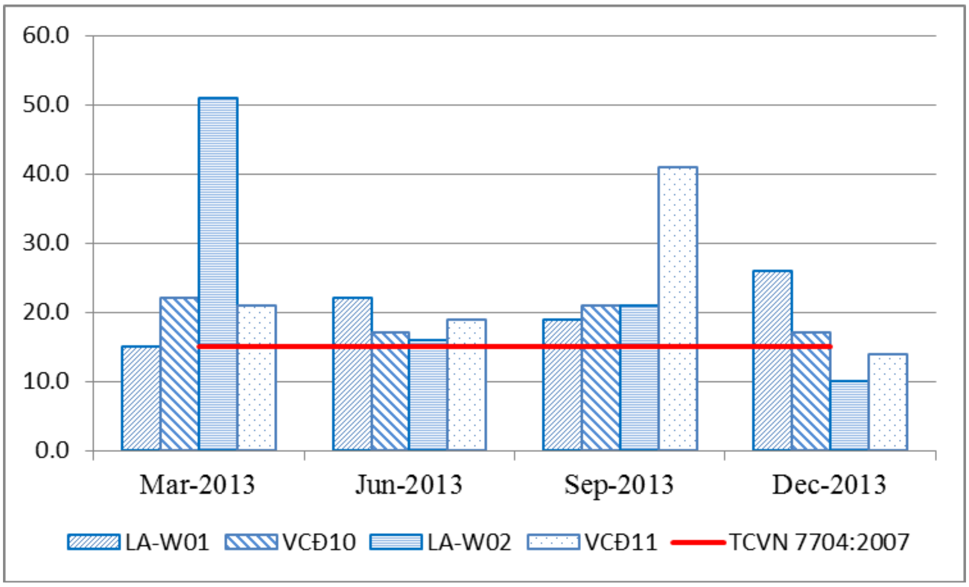

Figure 6. Comparing TSS concentrations in VCD river section through Ben Luc District in 2013 with TCVN 7704:2007

Table 6 and Figure 6 show that TSS concentration values from 10 to 51 mg/l, most of sample exceeded TCVN 7704:2007 Standard, except samples LA-W02 and VCD11 at the time of December.

5). Amonium

Comparing Ammonium concentration at the monitoring location in river water with TCVN 7704: 2007 are presented in Table 7 and Figure 7.

Table 7. Monitoring results of ammonium in Vam Co Dong river section running through Ben Luc District in 2013

Unit: mg/l **Monitoring period**	**Position**			
	LA-W01	**VCĐ10**	**LA-W02**	**VCĐ11**
March 2013	0.049	0.048	0.039	0.057
June 2013	0.607	0.573	0.746	0.769
September 2013	0.208	0.268	0.267	0.293
December 2013	0.576	0.264	0.405	0.331

TCVN 7704:2007	***1***

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

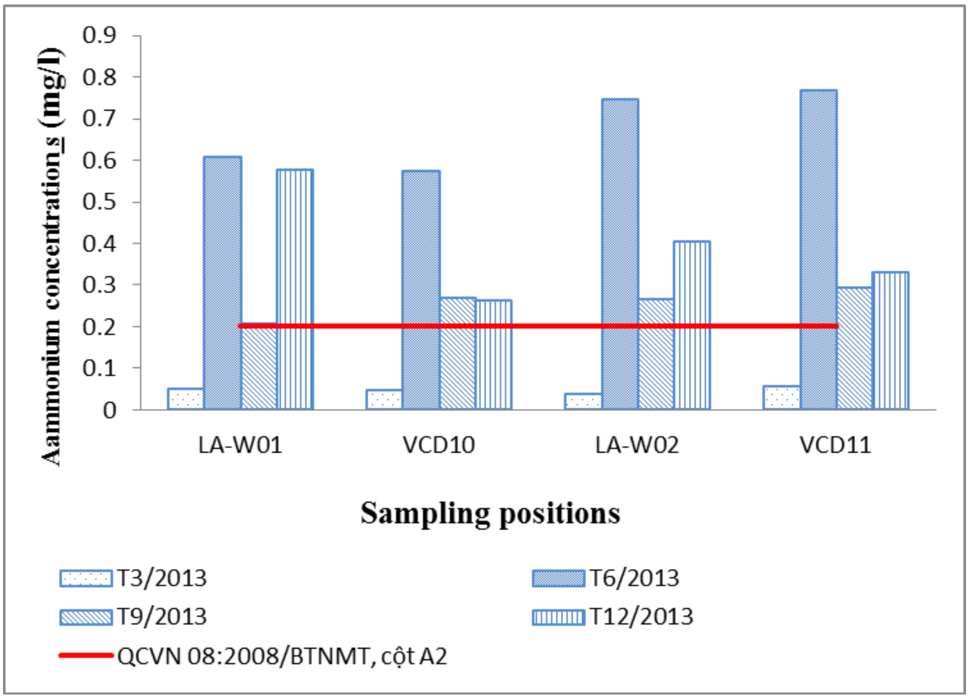

Figure 7. Fluctuation of the ammonium concentration in Vam Co Dong river section running through Ben Luc District in 2013

Figure 7 show that, ammonium concentrations in surface waters of the vam Co Dong river section through Ben Luc District from 0.048 to 0.769 mg/l, the average values is 0.343 mg/l, all the samples meet TCVN 7704:2007 Standard.

6). Iron

Evolutions of iron concentrations in the river water at monitoring locations are presented in Table 8. Values were compared with TCVN 7704:2007 is shown in Figure 8.

Table 8. The value of iron content over the monitoring periods 2013

Unit: mg/l

Monitoring period	**Position**			
	LA-W01	**VCĐ10**	**LA-W02**	**VCĐ11**
March 2013	0.75	0.8	**1.66**	0.67
June 2013	**1.21**	0.98	0.91	0.99
September 2013	**1.71**	**1.38**	**1.36**	**2.47**
December 2013	**1.87**	**1.73**	**1.6**	**175**
TCVN 7704:2007	***≤0,3 mg/l***			

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

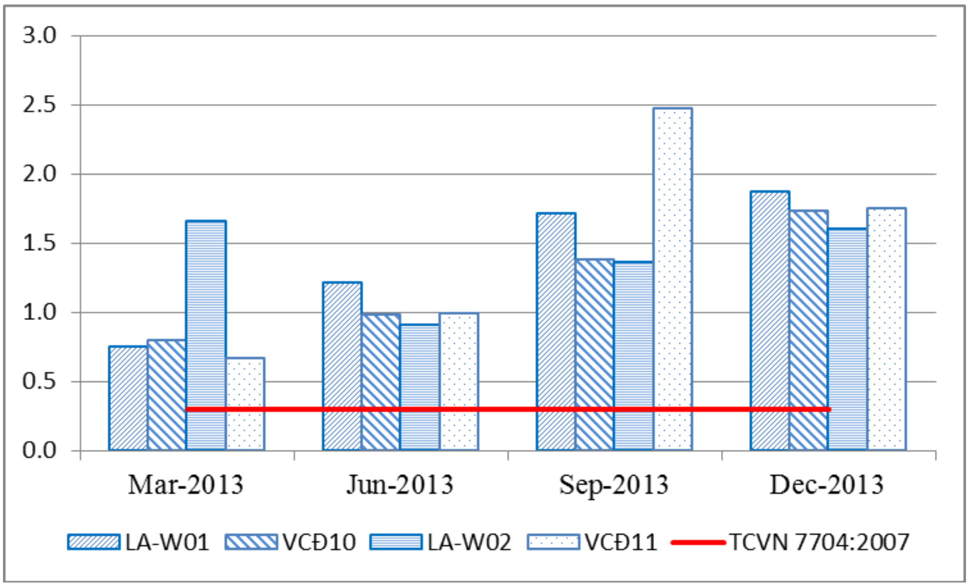

Figure 8. Comparing of iron concentrations in Vam Co Dong river section through Ben Luc District in 2013 with TCVN 7704:2007

Figure 8 show that, iron content in the monitoring of positions in VCĐ in Vam Co Dong river section through Ben Luc District ranged from 0.670 to 2.470 mg/l, the average value is 1.36 mg/l, exceed TCVN 7704:2007 many time with all samples.

7). Total oil and grease

Evolutions of total oil and grease concentrations in the river water at monitoring locations are presented in Table 9. Values were compared with TCVN 7704:2007 is shown in Figure 9.

Table 9. The value of total oil and grease over the monitoring periods 2013

Unit: mg/l

Monitoring period	**VCĐ11**
March 2013	0.68
June 2013	0.47
September 2013	0.17
December 2013	0.85
TCVN 7704:2007	***< 0.3 mg/l***

Source: CEMTES, 2013

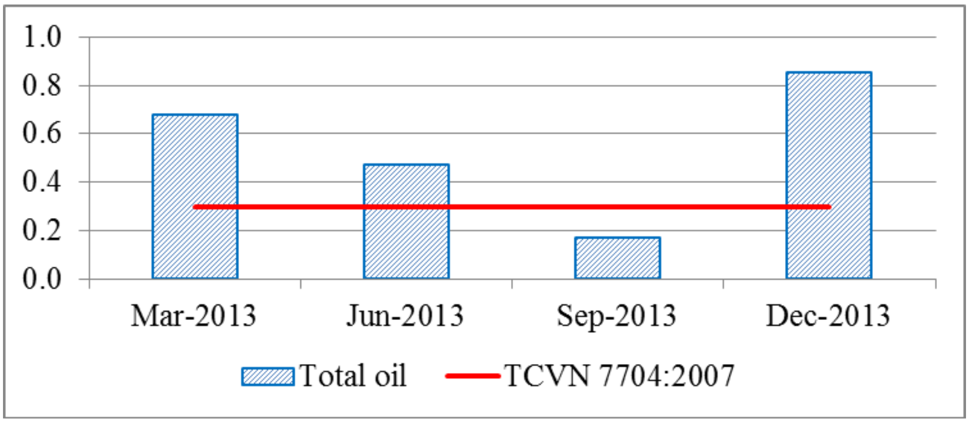

Figure 9. Fluctuation of total oil and grease values in Vam Co Dong river section running through Ben Luc District in 2013

Figure 9 show that total oil and grease values in all positions of the monitoring period ranged from0.17 mg/kg to 0.85 mg/kg, the average value is 0.54, most of sample exceeds TCVN 7704-2007, except sample at September.

2.1.3. Assessment of surface water resources and quality in the project area

(1). Reserves

The obtained results show that the surface waters of the Vam Co Dong river, Ben Luc river, canal systems in the project area are capable of providing enough water demand for the project.

However, the river's flows in Ben Luc District are strongly influenced by the tide, so the water is saline, containing high iron concentration. So now most of the industrial production facilities in Ben Luc district using waters from the groundwater treatment plants as Go Den Water Supply Plant, Thuan Dao Industrial Park water supply plant, Hoang Long Water Supply Plant, Ben Luc Water Supply Plant.

(2). Surface water quality

Comparison of surface water quality in the project area with TCVN 7704: 2007 shows that:

– pH values of the VCD river water running through Ben Luc district ranged from 5.01 to 6.59, did not meet TCVN 7704: 2007;
– The iron content ranged from 0.67 – 2.470 mg/kg higher than the TCVN 7704: 2007;
In addition, the quality of surface water in Ben Luc district is unqualified for boiler's supply due to the following reasons:

– Water flow is unstable, influenced by semi-diurnal tides - twice a day tide and low tide. Besides, the difference in flow between seasons is quite large;
– Due to tidal effects, surface water in Ben Luc district is saline.

– Due to the influence of the acidification land area, surface water in Ben Luc district is affected by acidity;

Therefore, industrial parks and manufacturing plants in this area do not use surface water for the production activities.

2.2. Groundwater

2.2.1. Current status of exploitation and use

According to a survey to assess the status of groundwater in Long An province, characteristics of main aquifers in Long An province is presented in Table 10.

Table 10. Characteristics of main aquifers in Long An province

No	Name of aquifers	Deep (m)	Thickness of aquifers (m)	Characteristics
1	Holocene aquifer (qh)	8	8 - 20	Salinization, aluminous
2	Middle-upper Pleistocene Aquifer (qp2-3)	23.5	23.5 - 55.7	It is possible water supply dosmetic and production
3	Pleistocene Aquifer (qp1)	6	6 - 113	Affected by alum and total higher mineralization
4	Pliocene Aquifer (n_2^2)	19.3	32,4 – 86,7	It is possible water supply dosmetic and production
5	Lower Pliocene Aquifer (n_2^1)	123,0 – 200,5 m	76,3	It is possible water supply dosmetic and production
6	Miocene Aquifer vulnerability (n_3^1)	211 m – 348 m	87,1	It is possible water supply dosmetic and production

The current, Long An province focus mainly exploiting in the 2 floors water Pliocene and Miocene. The total capacity of ground water extraction from deep wells in the Long An province currently around 110,000 m^3/day, mining focus primarily in stories n_2^2 relatively shallow waters in the region. Alone in the floor n_2^2 mining capacity is 63,585 m^3/day, but still smaller than the potential reserves but has exceeded the volume of aquifer (40,430 m^3/d), resulting lever water of aquifer are lowering.

– Ben Luc has 3 projects focused urban water supply (Water Supply Company of Ben Luc, Go Den Water supply, water supply system Ben Luc), extraction capacity is 2,160 m^3/day, water extraction from the aquifer n_2^2, mining depth from 50 m - 210 m;

– There are 122 works of rural piped water supply, mining capacity 7,459 m^3/day, water extraction from the floor n_1^3, n_2^1 and n_2^2. Most floors in depth from 180 m to exploit 220 m;

– There are 381 individual mining projects, mining capacity of 223.5 thousand m3/day of water extraction from the floor n13, n21 and n22, mining depth from 140 m to exploit 220 m;

– Also, Ben Luc District has some plants that use groundwater as large as:

+ Formosa Taffeta Textile Company (4 drilling wells with capacity of 80 m^3/h/well);

+ Chungshing Textile Company (2 drilling wells with capacity 60 m^3/h/well);

+ Luong Hoa Sugar Factory (2 drilling wells with capacity of 30 & 80 m^3/h/well);

+ Ben Luc Dyeing Factory (3 drilling wells with capacity of 80 m^3/h/well);

+ Dong Tam Tiles Company (1 drilling well with capacity of 30 m^3/h);

+ Thang Loi Brick Company (1 drilling well with capacity of 30 m^3/h);

+ CheiJeDang fodder factory (1 drilling well with capacity of 30 m^3/h).

The other industrial wells are concentrated in the area of Long Hiep commune, Ben Luc Town, Phuoc Loi, Nhut Chanh etc. and are focused on exploiting the aquifer n_2^2, installed at depths from 190 m to 240 m has lowered the groundwater in the area.

2.2.2. Ground water quality status

According to the latest monitoring results (2013) by Environmental Monitoring & Technical services Center performed.

(1). Frequency of monitoring

Monitoring and environmental technical services center performed 2 times/year (in March, August).

(2). Position monitoring

The ground water position monitoring in Ben Luc district is decribled in Table 11.

Table 11. The ground water monitoring positions in Ben Luc district

No.	Monitoring Positions	Symbol	Coordinates	Number of wells	Well capacity	Deep (m)/layer
01	Mining well of Ben Luc town water plant (Ben Luc District), Ben Luc	BL-01	580320; 1176813	2	50 m^3/h	190-210/ N_2^2

No.	Monitoring Positions	Symbol	Coordinates	Number of wells	Well capacity	Deep (m)/layer
	water Supply and Urban service Corporation company					
02	Mining well of Go Den water plan (Ben Luc district) – well No.6	BL-02	582732; 1175963	9 (7 active wells)	50 m^3/h/well	250/ N_2^2
03	Mining well of Thuan Dao IP water plan (Ben Luc district) – well No.6	BL-03	581377; 1175540	2	900 m^3/day/well	200/ N_2^2

Source: Monitoring and environmental technical services center, 2013

Notes: The coordinate system is used in above table is VN-2000 coordinate system

(3). Monitoring result

Groundwater monitoring results in 2013 in the project area compared to the ISO 7704: 2007 is presented in Table 12:

Table 12. Monitoring result of ground waster at phase 1 in Ben Luc district (March, 2013)

No.	Position sampling	Code	pH	Hardness	TSS	COD	Amonia	Clorua	Florua	Nitrate	Sulfate	Xianua	Phenol	Asen	Mangan	iron	E.Coli	Coli form
				mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 mL	MPN/100 mL
1	NN03: Mining well of Cai Cat water plant (Moc Hoa district)	MH-01	7,49	121	KPH	23,9	0,165	376	0,051	0,5	5	1,53	0,064	-	0,008	-	KPH	KPH
2	NN04: Mining well of Go Den water plant (Ben Luc district)	BL-02	6,06	216	8	253	0,339	1026	0,205	0,03	18	21,3	0,614	-	0,008	-	KPH	KPH
3	NN05: Mining well of Thuan Dao IP water plant – Ben Luc district (Hoang Long water supply company)	BL-03	6,36	223	5	332	0,277	1108	0,226	0,03	43	20,6	0,024	0,021	0,009	KPH	KPH	KPH
4	NN06: Mining well of Ben Luc town water plant (Ben Luc district)	BL-01	6,1	145	6	234	0,278	776	0,124	0,05	46	18,8	0,767	-	0,005	-	KPH	KPH
TCVN 7704:2007		Feed water	8,5 - 10,5	1	15	-	1	-	-	≤ 0.02	-	-	-	-	-	0,3	-	-

Notes:

TCVN 7704:2007 - National technical regulations on boilers - technical requirements for the design, structural fabrication, installation, use and repair.
“-“: Not regulation

Results of monitoring of groundwater quality in Ben Luc District phase 2 (August 2013) is presented in Table 13.

Table 13. Monitoring result of ground waster at phase 2 in Ben Luc district (August, 2013)

No.	Position sampling	Code	pH	Hardness	TS	COD	Amonia	Clorua	Florua	Nitrate	Sulfate	Xianua	Phenol	Asen	Mangan	Iron	E.Coli	Coliform
				mg/L	mg/L	mg/L	mg/L	mg/L	(mg/L)	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	MPN/100mL	MPN/100mL
1	NN04: Mining well of Go Den water plant (Ben Luc district)	BL-02	6,11	350	1,187	5	0,259	406	1,106	0,17	24,96	-	-	KPH	0,87	35	KPH	KPH
2	NN05: Mining well of Ben Luc town water plant (Ben Luc district)	BL-01	6,54	140	473	5	0,154	245	1,096	0,12	86,08	-	-	KPH	0,72	18	KPH	KPH
3	NN06: Mining well of Thuan Dao IP water plant – Ben Luc district (Hoang Long water supply company)	BL-03	6,07	232	1,029	5	0,184	360	1,101	0,14	63,82	KPH	KPH	KPH	0,11	22,8	KPH	KPH
TCVN 7704:2007		Feed water	8,5 - 10,5	1	15	-	1	-	-	-	≤ 0.02	-	-	-	-	0.3	-	-

Source: Monitoring and environmental technical services center, 2013

Notes:

TCVN 7704:2007 - National technical regulations on boilers - technical requirements for the design, structural fabrication, installation, use and repair. “-“: Not regulation

Comparing monitoring results of Center of Environmental Monitoring and Technical Services present on table 10 and table 11 with TCVN 7704:2007 with parameters as pH, **Hardness**, amonium, total iron as follow:

1). pH

Results comparing the pH of the groundwater samples with standards TCVN 7704: 2007 are shown in Figure 10.

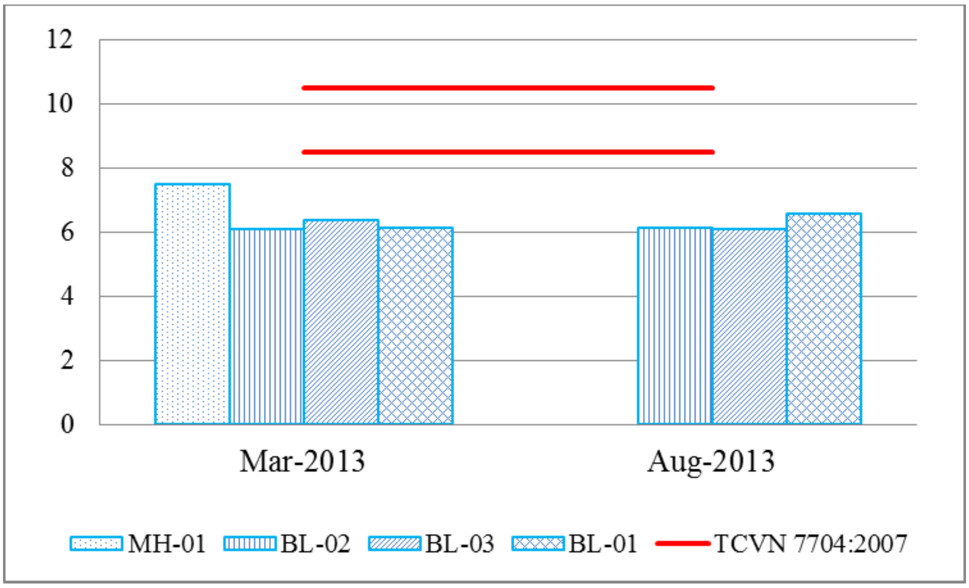

Figure 10. Compare the pH of the groundwater samples Ben Luc district with TCVN 7704: 2007

Figure 10 show that, the value of pH paremeter on groundwater sample from 6.06 to 7.5, average is 6.5, much lower than TCVN 7704:2007.Therefore, pH parameter do not meet TCVN 7704:2007.

2). Hardness

Results comparing Hardness of the groundwater samples with standards TCVN 7704: 2007 are shown in Figure 11.

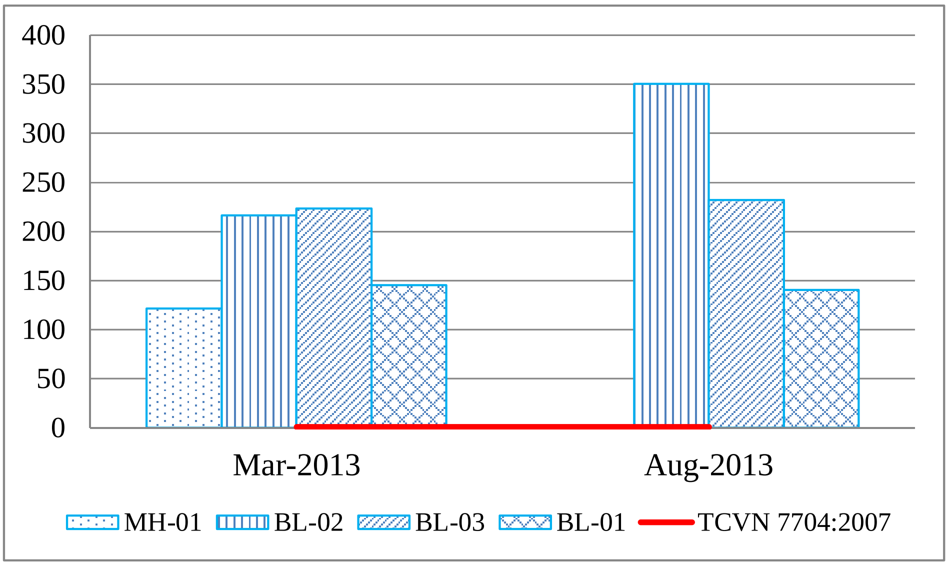

Figure 11. Compare the handness of the groundwater samples Ben Luc district with TCVN 7704: 2007

Figure 11 show that, the value of handness paremeter on groundwater sample from 121 to 350, average is 178.38, exceeded TCVN 7704:2007. Therefore, handness parameter do not meet TCVN 7704:2007.

3). TSS

Results comparing TSS concentrations of the groundwater samples with standards TCVN 7704: 2007 are shown in Figure 12.

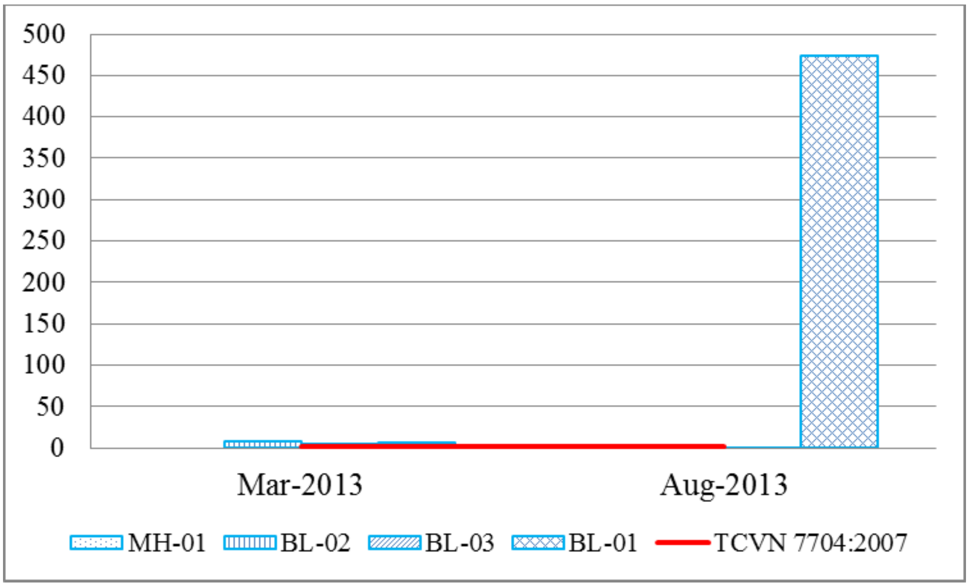

Figure 12. Compare the TSS concentrations of the groundwater samples Ben Luc district with TCVN 7704: 2007

Figure 12 shows that, the TSS concentrations ranging from 0 - 473 mg/l, the average of value is 61.8 mg/l, most of the samples exceeded TCVN 7704: 2007, except for sample MH-01.

4). Ammonium

Results comparing ammonium concentrations in the groundwater samples with standard TCVN 7704: 2007 is presented in Figure 13.

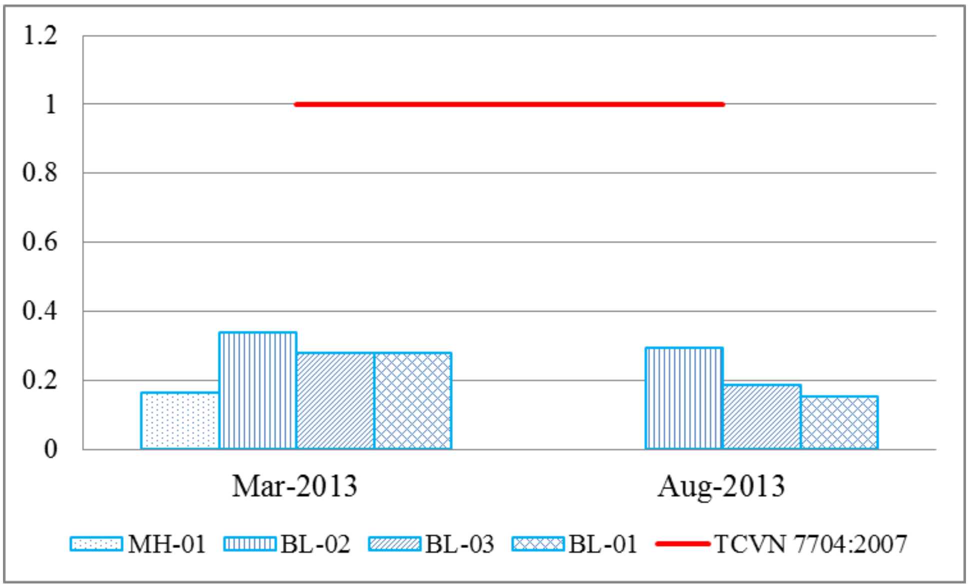

Figure 13. Comparing ammonium concentrations in the groundwater samples with standard TCVN 7704: 2007

Figure 13 show that, ammonium concentrations ranged from 0.15 to 0.34 mg/l, the average of value is 0.21 mg /L, the samples meet the standard TCVN 7704: 2007.

5). Total iron

The results comparing the iron contentrations in groundwater samples compared to standard TCVN 7704: 2007 is presented in Figure 14.

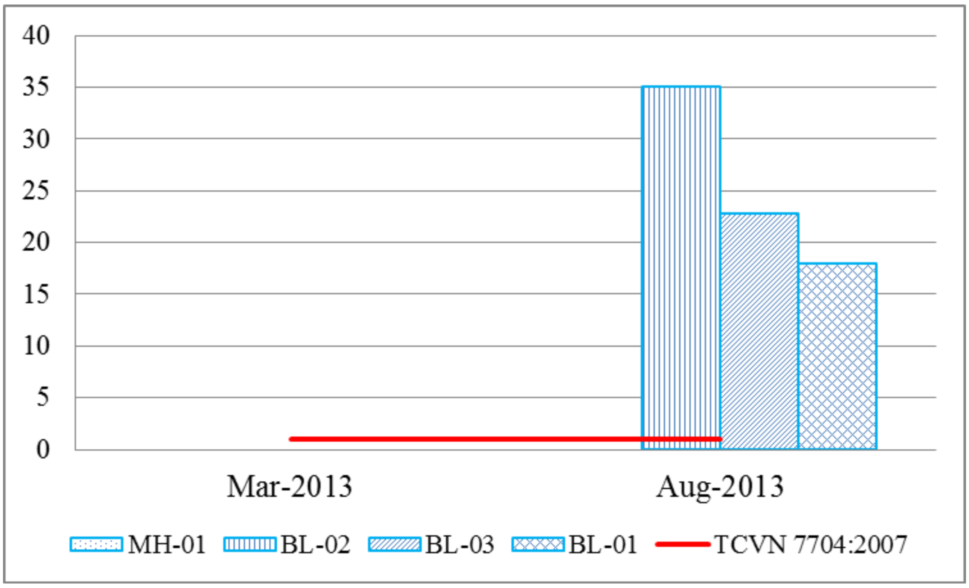

Figure 14. Comparing the iron contentrations in groundwater samples compared to standard TCVN 7704: 2007

Figure 14 show that, the iron content ranged from 0-35 mg/L, averaging 9.5 mg/L, the sample monitoring phase 1 (March 2013) meet the standard TCVN7704: 2007, the sample monitoring phase 2 (August 2013) exceeded significantly from standard.

2.2.3. Quantity and quality assessment of ground water in project area

(1). Quantity

From the results obtained showed that ground water quantity in the project area can provide enough water for the project, especially in Pliocene and Miocene aquifers.

(2). Quality

Comparison of the results collected groundwater quality in the project area with TCVN 7704: 2007 show:

pH and ammonium parameters at most monitoring sites were substandard water supply to the boiler;

Iron and TSS concentrations measured at three water supply plants (BL-01, BL-02, BL-03) does not meet TCVN 7704: 2007.

Therefore, want to use groundwater supply for incinerator, Tsuneishi company should handle parameters such as pH, ammonia, TSS, iron.

2.3. Current status of water supply and surface water quality in Thuan Dao Industrial Park

The receiving source of wastewater from Thuan Dao IP is the Chanh canal, then discharging into the Vam Co Dong river, distance from the discharge point of Industrial Park to the Vam Co Dong River is about 200 m. The width and depth of the Chanh canal are 10 - 15 m and 5 - 7 m, respectively, therefore, it is easy to drainage.

Currently, water source supplied for the production of Thuan Dao industrial zone is taken from Go Den water plant within Long An Water Supply Company with capacity of about 10,000 m^3/day. In addition, in the project area, there is also a water supply plant within Hoang Long Corporation with a capacity of about 5,000 m^3/day. Therefore, the ground water is satisfied for water supply for the project activities.

3. SURVEY AND ANALYSIS OF WATER IN THE PROJECT AREA.

3.1. Survey and Analysis of Surface Water

3.1.1. Sampling locations and time

To assess the current status of surface water quality in the project area, July 30, 2014, Environmental Technology Centre - ENTEC conducted taking 12 samples of surface water (6 position in 2 time falling tide and rising tide). Location of sampling points is presented in Table 14 and Figure 15

Table 14. Location of surface water quality monitoring in Ben Luc district

No.	Symbol	The water level	Position	Purpose
1	NM1-1	Falling tide	Vam Co Dong River before the confluence with the Ben Luc River	Assessment of river water quality of receiving water VCD before Ben Luc River
2	NM1-2	Rising tide		
3	NM2-1	Falling tide	Ben Luc River before the confluence with the Vam Co Dong River	Evaluation Ben Luc River water quality
4	NM2-2	Rising tide		
5	NM3-1	Falling tide	Vam Co Dong River after the confluence with the Ben Luc River	Assessment of river water quality of receiving water VCD after Ben Luc river
6	NM3-2	Rising tide		
7	NM4-1	Falling tide	Chanh canal before flowing through Thuan Dao Industrial Park	Assessing the quality surface water of Chanh canal after through Thuan Dao IP.
8	NM4-2	Rising tide		
9	NM5-1	Falling tide	Chanh canal flowing through Thuan Dao Industrial Park	Assessing the quality surface water of Chanh canal before through Thuan Dao IP.
10	NM5-2	Rising tide		
11	NM6-1	Falling tide	Vam Co Dong River after flowing into Chanh canal	Assessment of river water quality VCD after through Thuan Dao Industrial Park
12	NM6-2	Rising tide		

Figure15. Locations of surface water sampling points

Location coordinates of sampling water quality in the area for Ben Luc District dated July 30, 2014 is presented in Table 15.

Table 15. Location coordinates of water quality sampling in Ben Luc District

No.	Low tide		Tide		Latitude	Longitude
	Symbol samples	Times	Symbol samples	Times		
1	NM1-1	10h15	NM1-2	16h10	10°38'43.16"N	106°26'33.60"E
2	NM2-1	9h25	NM2-2	16h45	10°38'37.40"N	106°28'52.40"E
3	NM3-1	9h45	NM3-2	16h30	10°38'17.80"N	106°28'29.90"E
4	NM4-1	10h45	NM4-2	14h20	10°37'7.66"N	106°29'55.31"E
5	NM5-1	11h00	NM5-2	15h00	10°36'53.50"N	106°29'12.50"E
6	NM6-1	11h40	NM6-2	14h30	10°36'5.53"N	106°28'57.47"E

3.1.2. Methods of analysis

The parameters of surface water quality analyzes are presented in Table 16.

Table 16. Analysis parameters of surface water quality

No.	Parameter	Unit	Analysis method
1	Transparency	NTU	SWEWW 2012-Transparency

No.	Parameter	Unit	Analysis method
2	pH	-	TCVN 6492:2011
3	Electric conductivity (EC)	μs/cm	SMEWW 2012 (2510B)
4	Total hardness	$mgCaCO_3/l$	SMEWW 2012 (2340C)
5	Total suspended solid (TSS)	mg/l	TCVN 6625-2000
6	Total Dissolved Solids (TDS)	mg/l	SMEWW 2012 (2540B)
7	Total Alkalinity	$mgCaCO_3/l$	SWEWW 2012 (2320B)
8	Dissolved oxygen	mgO_2/l	TCVN 7325:2004
9	Soluble SiO_3^{2-}	mg/l	APHA 4500.Si.E
10	Total Fe	mg/l	SMEWW 2012 (2130C)
11	Sodium Sulfite SO_3^{2-}	mg/l	SMEWW 2012 SO_3^{2-}
12	Phosphate PO_4^{3-}	mg/l	TCVN 6202-1996
13	Chloride Cl^-	mg/l	SMEWW 2012 (4121B)
14	Hydrazine N_2H_4	mg/l	SMEWW 2012-Hydrazine
15	Total hydrocarbon	mg/l	US EPA Method 1664
16	Copper (Cu)	mg/l	SMEWW 2012 (3120C)
17	Ammonium	mg/l	SMEWW 4500-NH_3-2005
18	Nitrite	mg/l	TCVN 6178-1996
19	Nitrate	mg/l	TCVN 6180-1996

3.1.3. The analytical results

The analysis results of water quality in the area for Ben Luc district at falling tide are presented in Table 17.

Table 17. The analysis results of water quality in Ben Luc district at falling tide

No.	Parameter	Unit	Symbol samples						Water standards (TCVN 7704:2007)	Water furnace standard VBC company
			NM1-1	NM2-1	NM3-1	NM4-1	NM5-1	NM6-1		
1	Turbidity	NTU	108.0	85.4	86.8	89.2	90.8	112.0	≤ 23 (*)	≤ 23 (*)
2	pH	-	6.0	5.8	6.2	6.1	6.5	6.1	8.5 – 10.5	10.5 – 11.5
3	Electrical conductivity (EC)	µs/cm	113	118	133	114	119	101	1000	1000
4	Total hardness	$mgCaCO_3/l$	10	15	27	15	15	10	1	1
5	Suspended solid	mg/l	49	41	47	40	41	48	15 (**)	15
6	Total Dissolved Solids (TDS)	mg/l	56	59	71	57	59	51	< 640	< 4.480
7	Total Alkalinity	$mgCaCO_3/l$	5	5	9	5	5	5	250 - 1000	250 - 1000
8	Dissolved oxygen	mgO_2/l	5.9	6.4	6.3	5.9	6.0	6.0	≤ 0.4	
9	Soluble SiO_3^{2-}	mg/l	23.2	17.6	19.2	17.3	17.6	23.6	≤ 0.04	75 - 300
10	Total Fe	mg/l	2.550	2.162	3.090	1.803	1.846	2.838	≤0.3	≤0.3
11	Sodium Sulfite SO_3^{2-}	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	20 - 40	20 - 40
12	Phosphate PO_4^{3-}	mg/l	0.249	0.264	0.405	0.390	0.316	0.405	30 - 60	30 - 60
13	Chloride Cl^-	mg/l	17.0	20.9	16.4	22.4	23.8	18.5	-	-
14	Hydrazine N_2H_4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	0.03 - 0.1	0.03 - 0.1
15	Total hydrocarbon		KPH	KPH	KPH	KPH	KPH	KPH	≤ 3 (***)	≤ 3 (***)
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 0.007	≤ 0.007
17	Ammonium	mg/l	0.4	0.3	0.4	0.4	0.4	0.3	1	1
18	Nitrite	mg/l	0.680	0.490	0.560	0.610	0.545	0.610	-	-
19	Nitrate	mg/l	0.151	0.141	0.175	0.185	0.159	0.154	-	-
20	Total nitrite and nitrate(****)	mg/l	0.831	0.631	0.735	0.795	0.704	0.764	≤ 0.02	≤ 0.02

The analysis results of water quality in the area for Ben Luc district at high tide are presented in Table 16.

Table 18. The analysis results of water quality in Ben Luc district at rising tide

No.	Parameter	Unit	Symbol samples						Water standards (TCVN 7704:2007)	Water furnace standard VBC company
			NM1-2	NM2-2	NM3-2	NM4-2	NM5-2	NM6-2		
1	Turbidity	NTU	73.6	71.6	90.6	55.9	68.0	75.6	≤ 23 (*)	≤ 23 (*
2	pH	-	5.9	6.1	6.2	6.3	6.1	6.0	8.5 – 10.5	10.5 – 11.5
3	Electric conductivity (EC)	µs/cm	109	134	123	188	106	106	1000	1000
4	Total hardness	$mgCaCO_3/l$	15	15	24	25	10	15	1	1
5	Suspended solid	mg/l	39	39	83	42	26	34	15 (**)	15
6	Total Dissolved Solids (TDS)	mg/l	55	67	65	94	53	53	< 640	< 4.480
7	Total Alkalinity	$mgCaCO_3/l$	5	5	9	5	5	5	250 - 1000	250 - 1000
8	Dissolved oxygen	mgO_2/l	5.8	6.1	7.2	6.2	6.3	5.6	≤ 0.4	
9	Soluble SiO_3^{2-}		16.2	16.8	19.2	17.1	15.3	17.1	≤ 0.04	75 - 300
10	Total Fe	mg/l	1.950	1.822	3.240	1.661	1.690	7.548	≤0.3	≤0.3
11	Sodium Sulfite SO_3^{2-}	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	20 - 40	20 - 40
12	Phosphate PO_4^{3-}	mg/l	0.271	0.271	0.249	0.219	0.242	0.390	30 - 60	30 - 60
13	Chloride Cl^-	mg/l	16.7	23.4	13.6	36.6	21.3	19.9	-	-
14	Hydrazine N_2H_4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	0.03 - 0.1	0.03 - 0.1
15	Total hydrocarbon	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 3 (***)	≤ 3 (***)
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 0.007	≤ 0.007
17	Ammonium	mg/l	0.4	0.3	0.4	0.4	0.3	0.3	1	1
18	Nitrite	mg/l	0.690	0.475	0.585	0.545	0.505	0.585	-	-
19	Nitrat	mg/l	0.141	0.154	0.146	0.105	0.115	0.139	-	-
20	Total nitrite and nitrat (****)	mg/l	0.831	0.629	0.731	0.65	0.62	0.724	≤ 0.02	≤ 0.02

Notes:

(*)According to the converting of University of Wisconsin Green Bay
(**)Boiler's feed water standard according to ABMA
(***)THC concentrations in water as a function of the origin of oil;
(****)Total analysis results of nitrite and nitrate concentrations measured in the parameters 18 and 19 .

KPH: Undetected

3.1.4. Surface Water Quality Assessment

3.1.4.1. Assesment follow dosmetic supply standard

According Regulation QCVN 02:2009/BYT on domestic water quality, prescribe conditions for domestic water quality, including the following parameters: color, odor, turbidity, residual chlorine, pH, concentration of ammonium , the total iron content, Anat Pecman index, hardness, chloride content, fluoride content, content of total arsenic, total coliform, E. coli or thermo-tolerant coliform. However, the purpose of water quality sampling service of boiler operation, the team only conducted sampling and analysis parameters: turbidity, pH, ammonia concentration, total iron content, hardness, chloride concentrations.

The results compare the quality of surface water samples with Ben Luc District Regulations QCVN 02: 2009 / BYT of the Ministry Health is presented in Table 19.

Table 19. The results comparison with surface water quality standards QCVN 02: 2009/BYT

No.	Parameter	Unit	Symbol samples												QCVN 02:2009/BYT
			NM1-1	**NM2-1**	**NM3-1**	**NM4-1**	**NM5-1**	**NM6-1**	**NM1-2**	**NM2-2**	**NM3-2**	**NM4-2**	**NM5-2**	**NM6-2**	
1	Turbidity	NTU	108.0	85.4	86.8	89.2	90.8	112.0	73.6	71.6	90.6	55.9	68.0	75.6	5
2	pH	-	6.0	5.8	6.2	6.1	6.5	6.1	5.9	6.1	6.2	6.3	6.1	6.0	6 - 8.5
3	Electric conductivity (EC)	µs/cm	113	118	133	114	119	101	109	134	123	188	106	106	-
4	Total hardness	mgCaCO3/l	10	15	27	15	15	10	15	15	24	25	10	15	350
5	Suspended solid	mg/l	49	41	47	40	41	48	39	39	83	42	26	34	-
6	Total Dissolved Solids (TDS)	mg/l	56	59	71	57	59	51	55	67	65	94	53	53	-
7	Total Alkalinity	mgCaCO3/l	5	5	9	5	5	5	5	5	9	5	5	5	-
8	Dissolved oxygen	mgO2/l	5.9	6.4	6.3	5.9	6.0	6.0	5.8	6.1	7.2	6.2	6.3	5.6	-
9	Soluble SiO32-	mg/l	23.2	17.6	19.2	17.3	17.6	23.6	16.2	16.8	19.2	17.1	15.3	17.1	-
10	Total Fe	mg/l	2.550	2.162	3.090	1.803	1.846	2.838	1.950	1.822	3.240	1.661	1.690	7.548	0.5
11	Sodium Sulfite SO32-	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	-
12	Phosphate PO43-	mg/l	0.249	0.264	0.405	0.390	0.316	0.405	0.271	0.271	0.249	0.219	0.242	0.390	-
13	Chloride Cl-	mg/l	17.0	20.9	16.4	22.4	23.8	18.5	16.7	23.4	13.6	36.6	21.3	19.9	300
14	Hydrazine N2H4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	-
15	Total hydrocarbon		KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	-
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	-
17	Ammonium	mg/l	0.4	0.3	0.4	0.4	0.4	0.3	0.4	0.3	0.4	0.4	0.3	0.3	3
18	Nitrite	mg/l	0.680	0.490	0.560	0.610	0.545	0.610	0.690	0.475	0.585	0.545	0.505	0.585	-
19	Nitrat	mg/l	0.151	0.141	0.175	0.185	0.159	0.154	0.141	0.154	0.146	0.105	0.115	0.139	-

Notes:
QCVN 02: 2009/BYT: National Technical Regulation on domestic water quality;
“_” : Not specified.

Comment:

According Table 19 comparison quality of surface water Ben Luc District with QCVN 02: 2009/BYT show that:

– Value of turbidity parameters ranged from 55.9 -112 NTU, average value is 84 NTU, exceeded so many times over the Regulation QCVN 02:2009/BYT;

– pH values ranging from 5.8 - 6.5, the average value is 6.1, most of the samples meey QCVN 02:2009/BYT, except samples NM2-1 and NM1-2;

– Value of hardness surface in Ben Luc district ranged 10-27 mgCaCO3/kg, average is 16.3, meet QCVN 02: 2009/BYT;

– The total iron contentation in the water samples ranged 1.67 - 7:54 mg/l, average is 2.68 mg/l, exceeding significantly from QCVN 02: 2009/BYT;

– Chloride concentration of the water samples in the area for Ben Luc district ranged from 13.6 - 36.6 mg/L, The average is 20.9 mg/L, lower than the QCVN 02: 2009 / BYT;

– Value ammonium concentrations in surface water samples ranged from 0.3 - 0.4 mg/L, the average is 0:35 mg/L, lower than the QCVN 02: 2009/BYT.

Thus, the water quality in the area for Ben Luc district do not meet the Regulation on QCVN 02: 2009/BYT to target domestic water supply.

3.1.4.2. Assesment follow feedwater for incinerator standard

Comparing the results of water quality analysis at 6 locations at the high tide and low tide with TCVN 7704 : 2007 shows that :

– Electrical conductivity, TDS , SO_3^{2-}, phosphate, chloride, N_2H_4, THC, Cu, ammonium meet the standard in both rising tide and falling tide ;

– The parameters such as turbidity, hardness, DO, SiO_3^{2-}, total iron do not meet the standard. pH range from 5.6 - 6.5 , much lower than the standard for boiler feed water (8.5 – 9.5).

Detailed assessment for each parameter on the locations of water quality monitoring in Ben Luc district on July 30, 2014 is presented below:

(1). Turbidity

Comparing the turbidity analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 16:

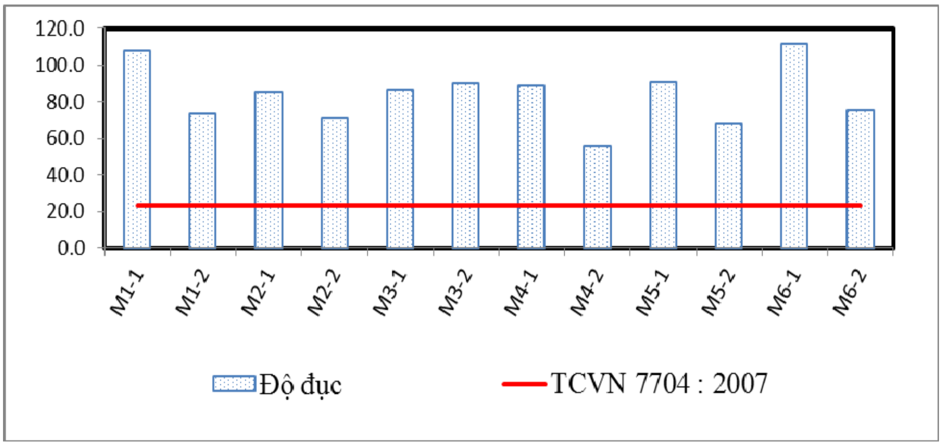

Figure 16. Comparing the turbidity analysis results of surface water in Ben Luc district with TCVN 7704:2007

Figure 11 shows that turbidity ranged from 55 – 112 NTU, the average value is 84 NTU, exceeded TCVN 7704:2007 at both time of high tide and falling tide;

(2). pH

Comparing the pH values of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 12:

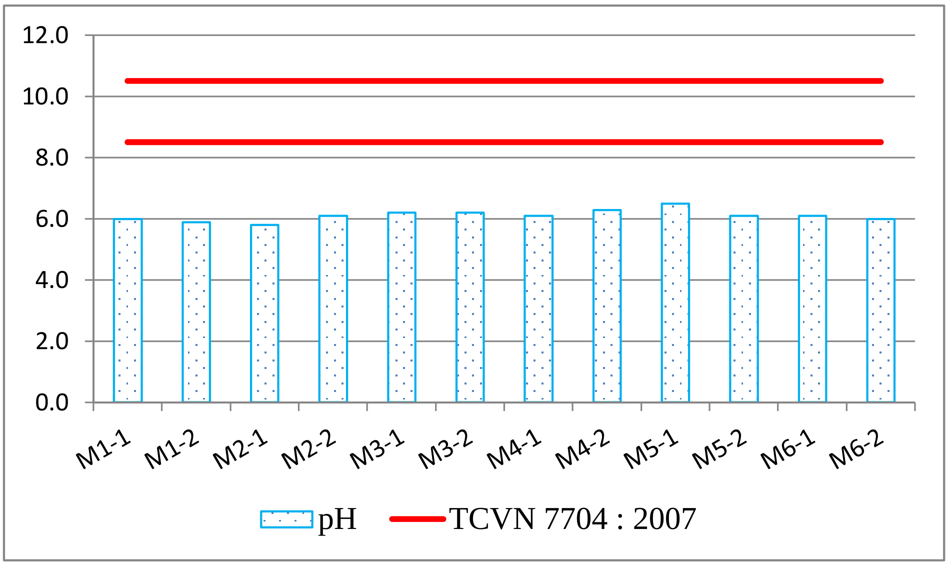

Figure 17. Comparing the pH analysis results of surface water in Ben Luc district with TCVN 7704:2007

Figure 17 shows that pH ranged from 5.8 – 6.5, the average value is 6.1, did not meet TCVN 7704:2007 at both time of rising tide and low tide;

(3). Electrical conductivity (EC)

Comparing the electrical conductivity measurement results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 18:

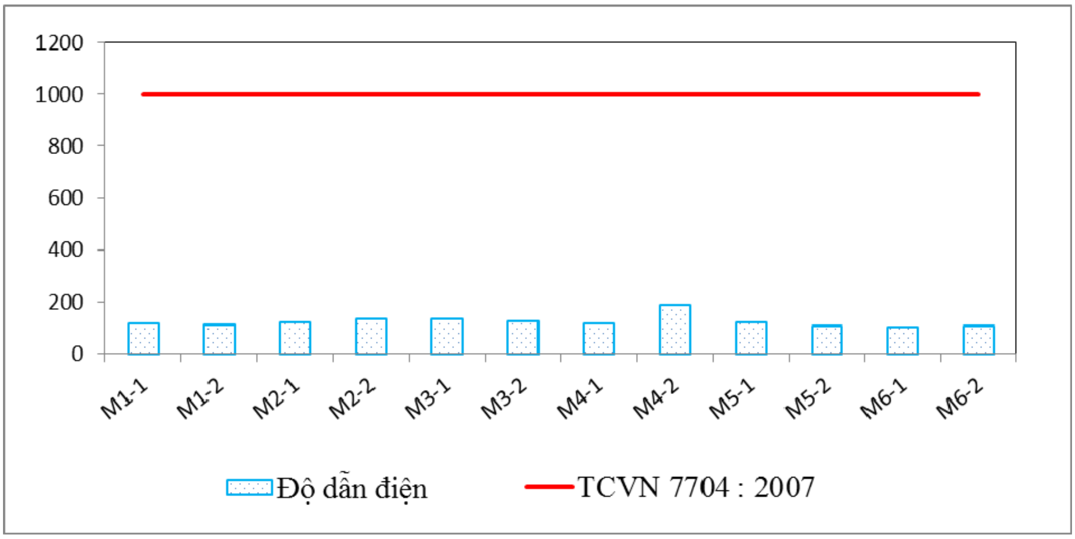

Figure 18. Comparing the electrical conductivity of surface water in Ben Luc district with TCVN 7704:2007

Figure 18 shows that Electrical conductivity in the range of 101-188 µs/cm, the average value is 122 µs/cm, meet TCVN 7704:2007 at both time of rising tide and falling tide.

(4). Hardness

Comparing the hardness analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 19:

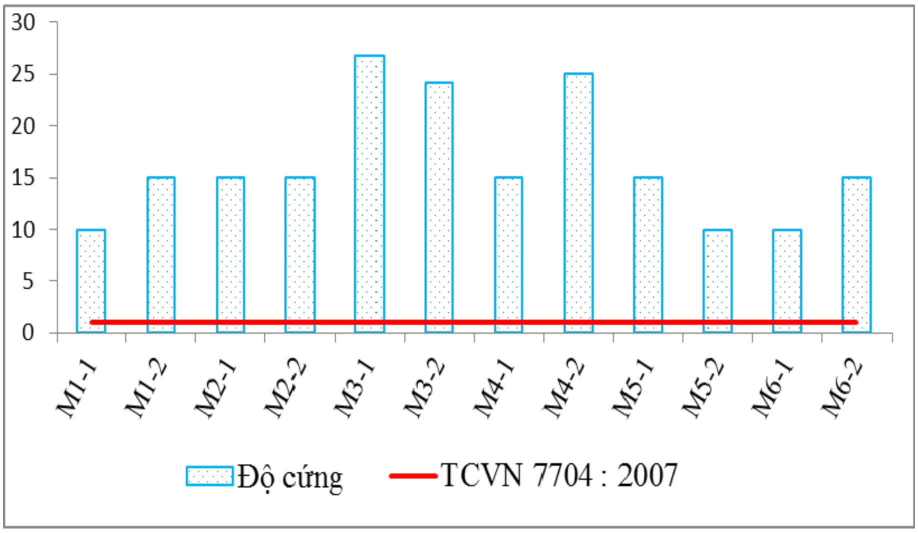

Figure 19. Comparing the hardness values of surface water in Ben Luc district with TCVN 7704:2007

Figure 19 shows that hardness ranged from 101-188 mg$CaCO_3$/l, the average value is 122 mg$CaCO_3$/l, exceeded TCVN 7704:2007 at both time of rising tide and falling tide.

(5). TSS

Comparing the TSS analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 20:

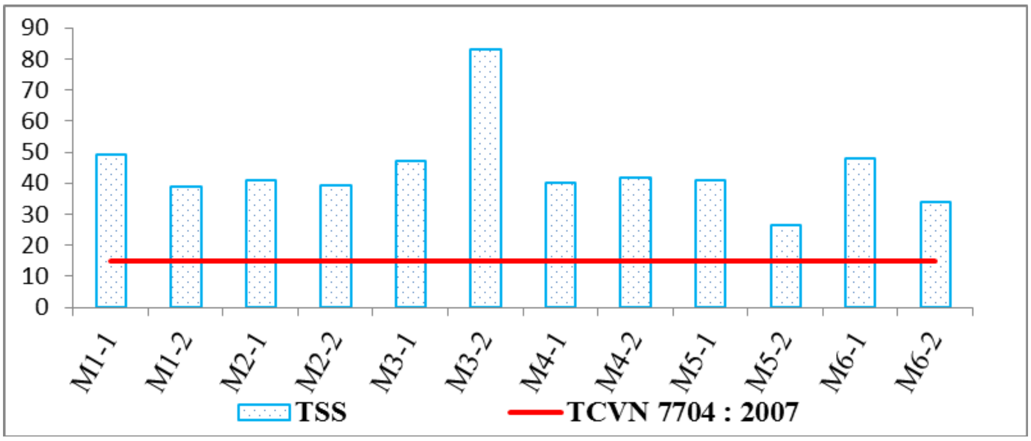

Figure 20. Comparing the TSS concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 20 shows that TSS concentrations ranged from 26-83 mg/l, the average value is 44.1 mg/l; exceeded TCVN 7704:2007 at both time of rising tide and falling tide.

(6). TDS

Comparing the TDS analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 21:

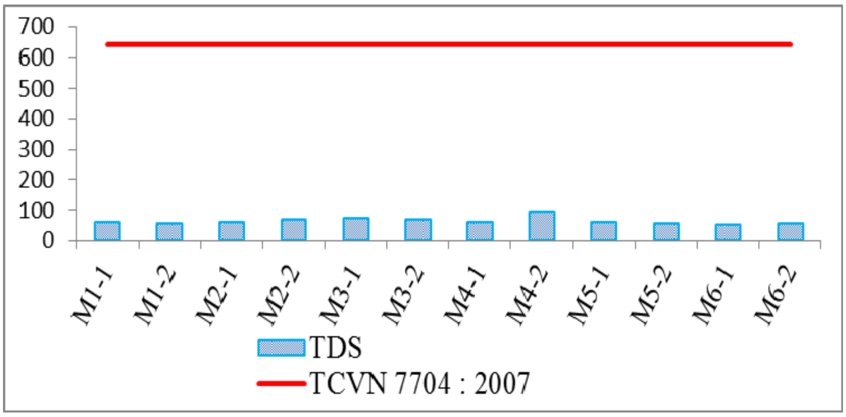

Figure 21. Comparing the TDS concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 21 shows that TDS concentrations in the range of 51-94 mg/l, the average value is 61.7 mg/l, meet TCVN 7704:2007 at both time of rising tide and falling tide.

(7). Alkalinity

Comparing the alkalinity analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 22:

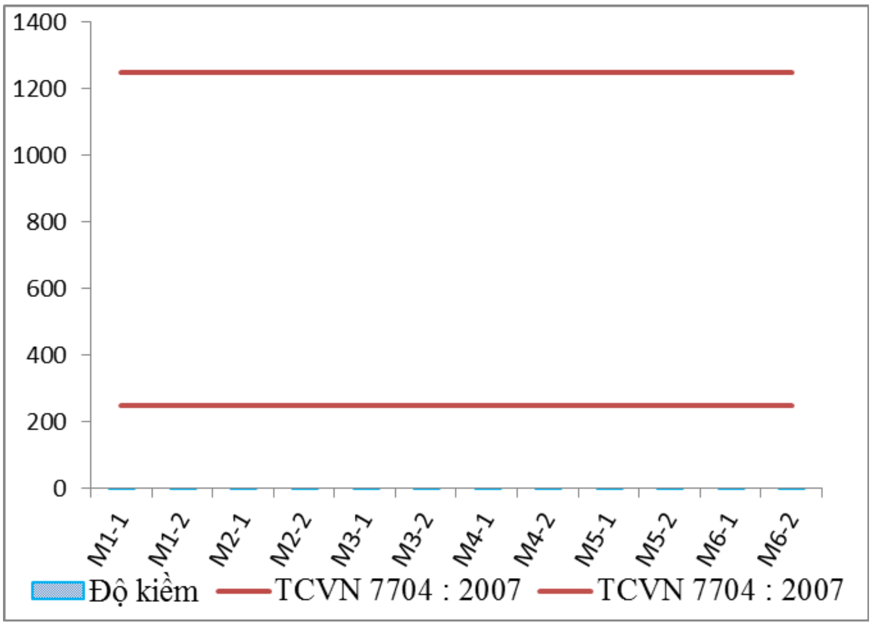

Figure 22. Comparing the alkalinity of surface water in Ben Luc district with TCVN 7704:2007

Figure 22 shows that alkalinity values in the range of 5-9 $mgCaCO_3/l$, the average value is 7 $mgCaCO_3/l$, meet TCVN 7704:2007 at both time of rising tide and falling tide.

(8). Dissolved oxygen (DO)

Comparing the DO measurement results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 23:

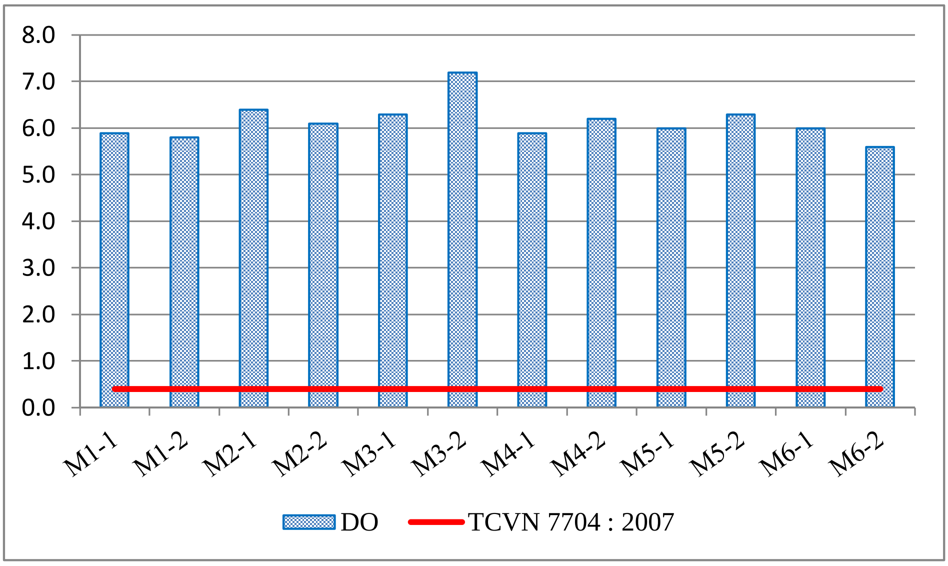

Figure 23. Comparing the DO of surface water in Ben Luc district with TCVN 7704:2007

Figure 23 shows that DO concentration values ranged from 5.8 - 7.2 mgO_2/l, the mean value is 6.1 mgO_2/l, did not meet TCVN 7704:2007 at both time of rising tide and falling tide.

(9). SiO_3^{2-} concentrations

Comparing the SiO_3^{2-} analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 24:

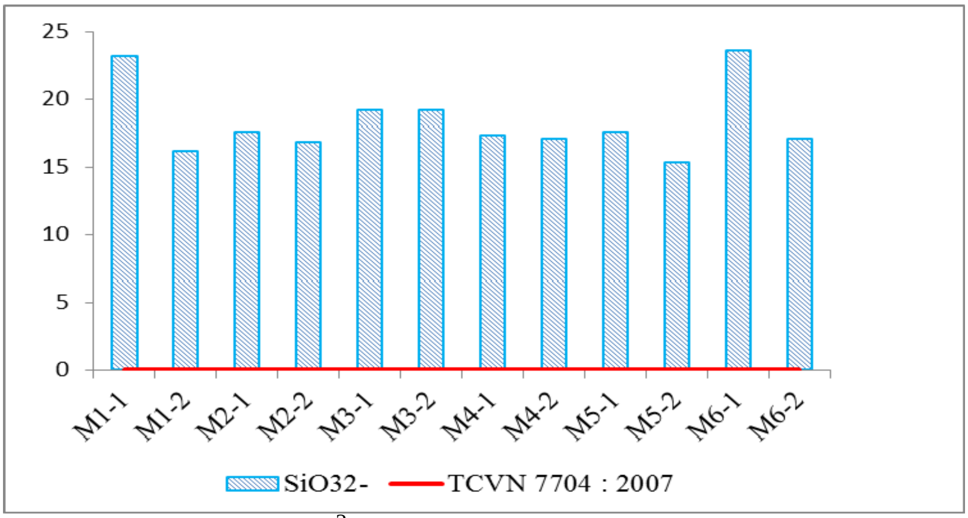

Figure 24. Comparing the SiO_3^{2-} concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 24 shows that SiO_3^{2-} concentrations values in the range of 15.3 - 23.6, the average value is 18.4; exceeded many times compared with the technical standards TCVN 7704:2007 at both time of rising tide and falling tide.

(10). Total iron

Comparing the total iron analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 25:

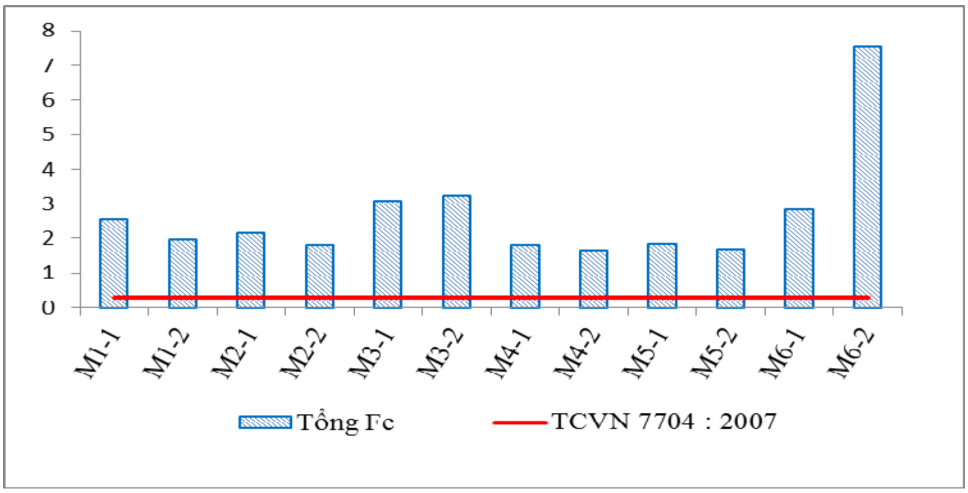

Figure 25. Comparing the total iron of surface water in Ben Luc district with TCVN 7704:2007

Figure 25 shows that total iron values ranging from 1.82 – 7.54 mg/l, the average value is 2.70 mg/l, exceeded TCVN 7704:2007 at both time of rising tide and falling tide.

(11). SO_3^{2-} concentrations

The analysis results shows that SO_3^{2-} values in water samples are not detectable.

(12). Phosphate

Comparing the PO_4^{3-} analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 21:

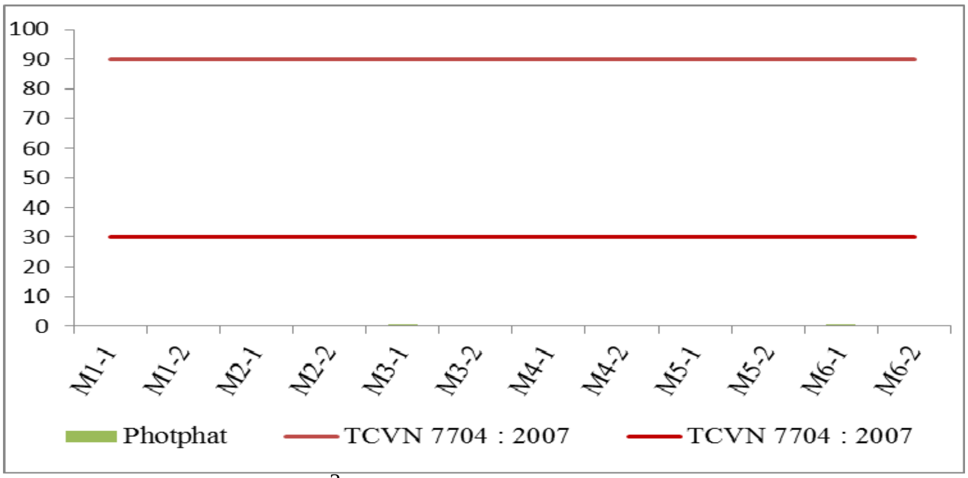

Figure 26. Comparing the PO_4^{3-} concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 26 shows that PO_4^{3-} values in the range of 0.24 to 0.40 mg/l, the average value is 0.34 mg/l; meet TCVN 7704:2007 at both time of rising tide and falling tide.

(13). Chloride

The analytical results shows that Cl^- values ranged from 12.6 to 33.6 mg/l, the average value is 20.9 mg/l; meet TCVN 7704:2007 at both time of rising tide and falling tide.

(14). N_2H_4

The analysis results shows that N_2H_4 values in water samples are not detectable.

(15). THC

The analysis results shows that THC values in water samples are not detectable.

(16). Cu

The analysis results shows that copper concentrations in water samples are not detectable.

(17). Amoni

Comparing the ammonium analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 27:

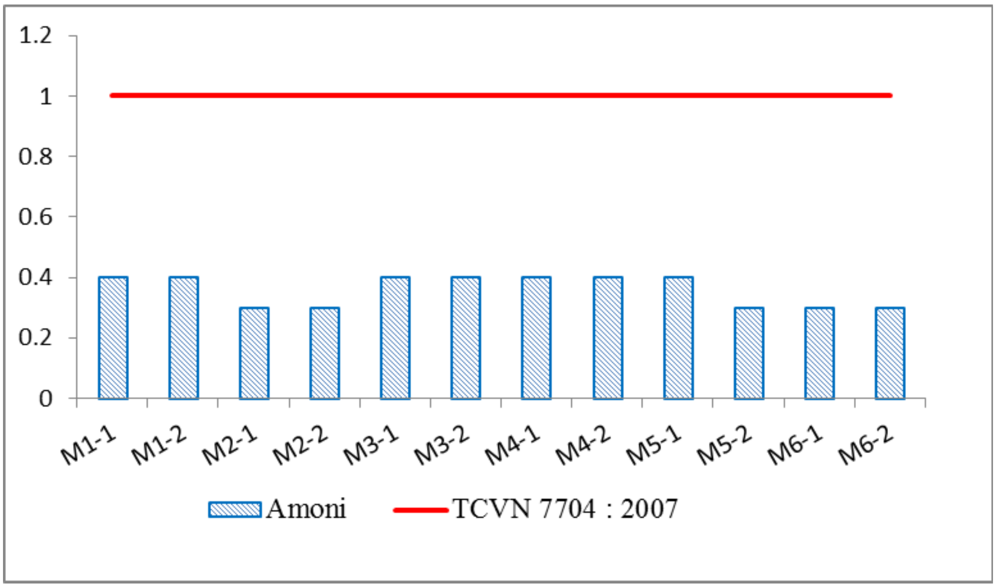

Figure 27. Comparing the ammonium concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 27 shows that ammonium values in the range of 0.3 to 0.4 mg/l, the average value is 0.35 mg/l; meet TCVN 7704:2007 at both time of rising tide and falling tide.

(18). Total nitrite and nitrate

Comparing Total nitrite and nitrate analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 28:

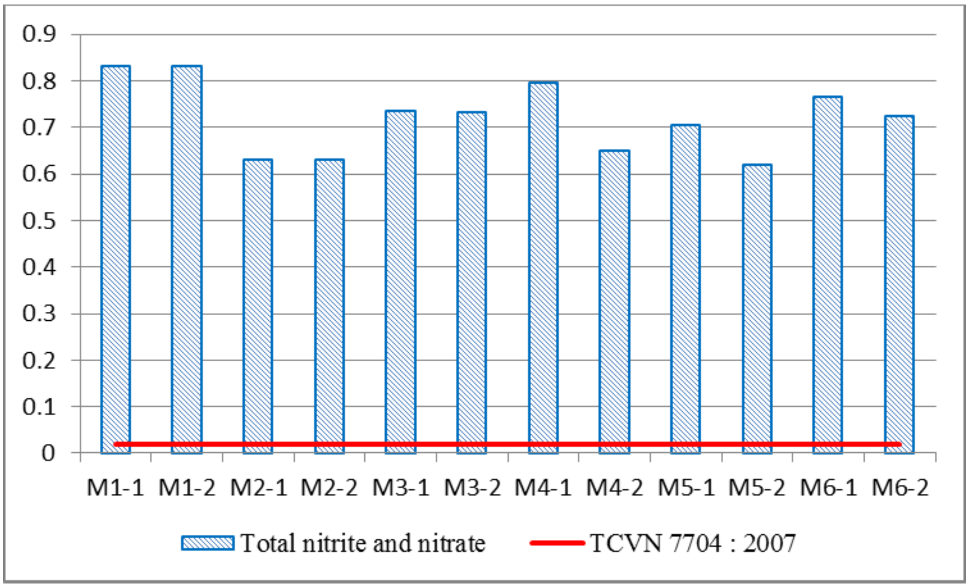

Figure 28. Comparing total nitrite and nitrate concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 28 shows that the total amount of nitrite, nitrate ranged from 0.62 - 0.83 mg/l, the average value is 0.7 mg/l; exceeded TCVN 7704: 2007 at both time of rising tide and falling tide.

(19). Summary of the water quality analysis results

The summary of the water quality analysis results of 12 surface water samples in Ben Luc District, Long An Province versus TCVN 7704-2007 is presented in Table 19.

Table 20. Summary results of the surface water quality analysis in comparison with TCVN 7704: 2007

No.	Parameter	Unit	The range of values	Average	Water supply standard (TCVN 7704:2007)	Conclusion
1	Transparency	NTU	55.9 - 112.0	84.0	≤ 23 (*)	**Do not meet**
2	pH	-	5.8 – 6.5	6.1	8.5 – 10.5	**Do not meet**
3	Electric conductivity (EC)	µs/cm	101.4 – 187.5	122.0	1000	meet
4	Total hardness	$mgCaCO_3/l$	10.0 – 26.8	16.3	1	**Do not meet**
5	Total suspended solid (TSS)	mg/l	26.4 – 83.0	44.1	15 (**)	**Do not meet**
6	Total Dissolved Solids (TDS)	mg/l	50.7 – 93.8	61.7	< 640	meet
7	Total Alkalinity	$mgCaCO_3/l$	5.0 – 8.6	5.6	250 - 1000	**Do not meet**
8	Dissolved oxygen	mgO_2/l	5.6 – 7.2	6.1	≤ 0.4	**Do not meet**
9	Soluble SiO_3^{2-}	mg/l	15.3 – 23.6	18.4	≤ 0.04	**Do not meet**
10	Total Fe	mg/l	1.7 – 7.5	2.7	≤0.3	**Do not meet**
11	Sodium Sulfite SO_3^{2-}	mg/l	0	0	20 - 40	meet
12	Phosphate PO_4^{3-}	mg/l	0.2 – 0.4	0.3	30 - 60	meet
13	Chloride Cl^-	mg/l	13.6 – 36.6	20.9	-	meet
14	Hydrazine N_2H_4	mg/l	0	0	0.03 - 0.1	meet
15	Total hydrocarbon	mg/l	0	0	≤ 3 (***)	meet
16	Copper (Cu)	mg/l	0	0	≤ 0.007	meet
17	Ammonium	mg/l	0.3 – 0.4	0.4	1	meet
18	Nitrite	mg/l	0.5 – 0.7	0.6		

No.	Parameter	Unit	The range of values	Average	Water supply standard (TCVN 7704:2007)	Conclusion
19	Nitrate	mg/l	0.1 - 0.2	0.1		
20	Total NO_2^- and NO_3^-	mg/l	0.6 – 0.8	0.7	≤ 0.02	**Do not meet**

Table 19 shows that there are 9 parameters such as turbidity, pH, suspended solids, alkalinity, SiO_3^{2-}, total Fe, Total NO_3^- and NO_2^- exceeded the standard many times.

3.2. Survey and Analysis of Ground Water

3.2.1. The sampling locations and time

To assess the quality of groundwater in the project area, Environmental Technology Centre (ENTEC) have taken 06 ground water samples. Sampling locations is presented in Table 21.

Table 21. Groundwater sampling locations

No.	Symbol	Position	Deep (m)	Distance to Thuan Dao Industrial Zone (km)
01	NN01	Groundwater wells No. 7 at Go Den Water Supply Plant	210	3.5
02	NN02	Groundwater well at Ben Luc Water Supply Plant	220	2.4
03	NN03	Groundwater wells No. 8 at Go Den Water Supply Plant	220	3.6
04	NN04	Groundwater well No. 1 at Hoang Long Water Supply Plant	215	1.3
05	NN05	Groundwater well No. 2 at Hoang Long Water Supply Plant	220	1.7
06	NN06	Groundwater well No. 10 at Go Den Water Supply Plant	215	4.2

Location's coordinates and time of sampling groundwater in Ben Luc district area are presented in Table 22.

Table 22. Location coordinates and time of groundwater sampling

No	Symbol	Latitude	Longitude	Time sampling
01	NN01	10°38'48.80"N	106°29'59.50"E	15h30
02	NN02	10°38'25.45"N	106°29'8.78"E	13h00
03	NN03	10°38'59.40"N	106°30'8.04"E	15h40
04	NN04	10°37'57.60"N	106°29'36.80"E	13h40
05	NN05	10°37'51.10"N	106°29'38.40"E	13h50

No	Symbol	Latitude	Longitude	Time sampling
06	NN06	10°39'19.80"N	106°30'20.40"E	15h45

Location map of groundwater sampling in Ben Luc District is presented in figure 29.

Figure 29. Location map of groundwater sampling in Ben Luc District

3.2.2. Analysis methods

The analytical methods of groundwater quality parameters are presented in Table 14.

3.2.3. The analytical results

The analytical results of groundwater quality in Ben Luc district area are presented in Table 23.

Table 23. The analytical results of groundwater quality in Ben Luc district

No.	Parameter	Unit	Symbol sample						Water supply (TCVN 7704:2007)	Water furnace standard VBC company
			NN01	NN02	NN03	NN04	NN05	NN06		
1	Turbidity	NTU	260.0	3.2	13.0	62.5	9.2	13.9	≤ 23 (*)	≤ 23 (*)
2	pH	-	6.5	6.8	6.6	6.8	6.4	6.6	8.5 – 10.5	10.5 – 11.5
3	Electric conductivity (EC)	µs/cm	618	805	395	1055	1074	280	1000	1000
4	Total hardness	$mgCaCO_3/l$	95	117	55	135	125	35	1	1
5	Total suspended solid (TSS)	mg/l	631	527	352	986	1004	229	15 (**)	15
6	Total Dissolved Solids (TDS)	mg/l	309	495	197	527	537	140	< 640	< 4.480
7	Total Alkalinity	$mgCaCO_3/l$	30	54	80	40	45	100	250 - 1000	250 - 1000
8	Dissolved oxygen	mgO_2/l	0	0	0	0	0	0	≤ 0.4	
9	Soluble SiO_3^{2-}	mg/l	29.4	48.2	30.3	53.4	53.9	33.9	≤ 0.04	75 - 300
10	Total Fe	mg/l	7.549	0.270	8.602	7.747	5.205	7.166	≤0.3	≤0.3
11	Sodium Sulfite SO_3^{2-}	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	20 – 40	20 - 40
12	Phosphate PO_4^{3-}	mg/l	0.026	0.011	0.086	0.115	0.101	0.405	30 – 60	30 - 60
13	Chloride Cl^-	mg/l	174	228	99	153	160	51	-	-
14	Hydrazine N_2H_4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	0.03 - 0.1	0.03 - 0.1
15	Total hydrocarbon	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 3 (***)	≤ 3 (***)
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 0.007	≤ 0.007
17	Ammonium	mg/l	0.2	KPH	0.2	0.2	0.3	0.2	1	1
18	Nitrite	mg/l	0.075	0.045	0.060	0.045	0.020	<0,01	-	-
19	Nitrat	mg/l	0.004	0.005	0.040	0.010	0.020	0.050	-	-
20	Total nitrite, nitrate (****)	mg/l	0.079	0.050	0.100	0.055	0.040	0.050	≤ 0.02	≤ 0.02

Notes:

(*)According to the converting of University of Wisconsin Green Bay
(**)Boiler feed water standards according to ABMA
(***)THC concentrations in water as a function of the origin of oil;
(****)Total analysis results of nitrite and nitrate concentrations measured in the parameters 18 and 19 .
KPH: Undetected

3.2.4. Ground Water Quality Assessment

3.2.4.1. Assesment follow dosmetic supply standard

The results compare the quality of groundwater samples with Ben Luc District Regulations QCVN 02: 2009 / BYT of the Ministry Health is presented in Table 24.

Table 24. The results comparison with groundwater quality standards QCVN 02: 2009/BYT

No.	Parameter	Unit	Symbol samples						QCVN 02:2009/BYT
			NN01	NN02	NN03	NN04	NN05	NN06	
1	Turbidity	NTU	260.0	3.2	13.0	62.5	9.2	13.9	5
2	pH	-	6.5	6.8	6.6	6.8	6.4	6.6	6 - 8.5
3	Electric conductivity (EC)	µs/cm	618	805	395	1055	1074	280	-
4	Total hardness	mgCaCO3/l	95	117	55	135	125	35	350
5	Suspended solid	mg/l	631	527	352	986	1004	229	-
6	Total Dissolved Solids (TDS)	mg/l	309	495	197	527	537	140	-

No.	Parameter	Unit	Symbol samples						QCVN 02:2009/BYT
			NN01	NN02	NN03	NN04	NN05	NN06	
7	Total Alkalinity	mgCaCO3/l	30	54	80	40	45	100	-
8	Dissolved oxygen	mgO2/l	0	0	0	0	0	0	-
9	Soluble SiO32-	mg/l	29.4	48.2	30.3	53.4	53.9	33.9	-
10	Total Fe	mg/l	7.549	0.270	8.602	7.747	5.205	7.166	0.5
11	Sodium Sulfite SO32-	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	-
12	Phosphate PO43-	mg/l	0.026	0.011	0.086	0.115	0.101	0.405	-
13	Chloride Cl-	mg/l	174	228	99	153	160	51	300
14	Hydrazine N2H4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	-
15	Total hydrocarbon		KPH	KPH	KPH	KPH	KPH	KPH	-
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	-
17	Ammonium	mg/l	0.2	KPH	0.2	0.2	0.3	0.2	3
18	Nitrite	mg/l	0.075	0.045	0.060	0.045	0.020	<0,01	-
19	Nitrat	mg/l	0.004	0.005	0.040	0.010	0.020	0.050	-

Notes:
QCVN 02: 2009/BYT: National Technical Regulation on domestic water quality;
“_” : Not specified.

Comment:

According Table 24 comparison quality of surface water Ben Luc District with QCVN 02: 2009/BYT show that:

– Value of turbidity parameters ranged from 3.2 -260 NTU, average value is 60.3 NTU, exceeded so many times over the Regulation QCVN 02:2009/BYT, except sample NN02;

– pH values ranging from 6.4 - 6.8, the average value is 6.6, meet QCVN 02:2009/BYT;

– Value of hardness surface in Ben Luc district ranged 35-135 mgCaCO3/kg, average is 93.6, meet QCVN 02: 2009/BYT;

– The total iron contentation in the water samples ranged 0.27 – 8.6 mg/l, average is 6.08 mg/l, most of sample exceeding QCVN 02: 2009/BYT, except sample NN02;

– Chloride concentration of the water samples in the area for Ben Luc district ranged from 51 - 228 mg/L, The average is 144.1 mg/L, lower than the QCVN 02: 2009/BYT;

– Value ammonium concentrations in surface water samples ranged from 0.3 - 0.4 mg/L, the average is 0:35 mg/L, lower than the QCVN 02: 2009/BYT.

Thus, the water quality in the area for Ben Luc district meet the Regulation on QCVN 02: 2009/BYT to target domestic water supply, however, be treated as turbidity parameters and check the remaining parameters ensure QCVN 02: 2009/BYT.

3.2.4.2. Assesment follow feedwater for incinerator standard

Comparing the results of analysis of groundwater quality at 6 locations with national technical standards TCVN 7704: 2007 shows that :

– Parameters such as TDS, SO_3^{2-}, phosphate, chloride, N_2H_4, THC, Cu, ammonium meet the standards;

– Parameters such as pH, hardness, TSS, SiO_3^{2-}, total NO_2^- and NO_3 did not meet the standards

– Transparency parameter of all samples meet TCVN 7704: 2007, except for samples NN01 NN01 exceeded the standard;

– Electrical conductivity (EC) at 4/6 sampling locations meet the standard, 2/6 sampling locations have conductivity exceeding the standard.

– Total Fe of most samples do not meet the standard, except for sample NN02 meeting the standard

Detailed assessment for each parameter on the locations of water quality monitoring in Ben Luc district on July 30, 2014 is presented below:

(1). Turbidity

Comparing the turbidity analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 30.

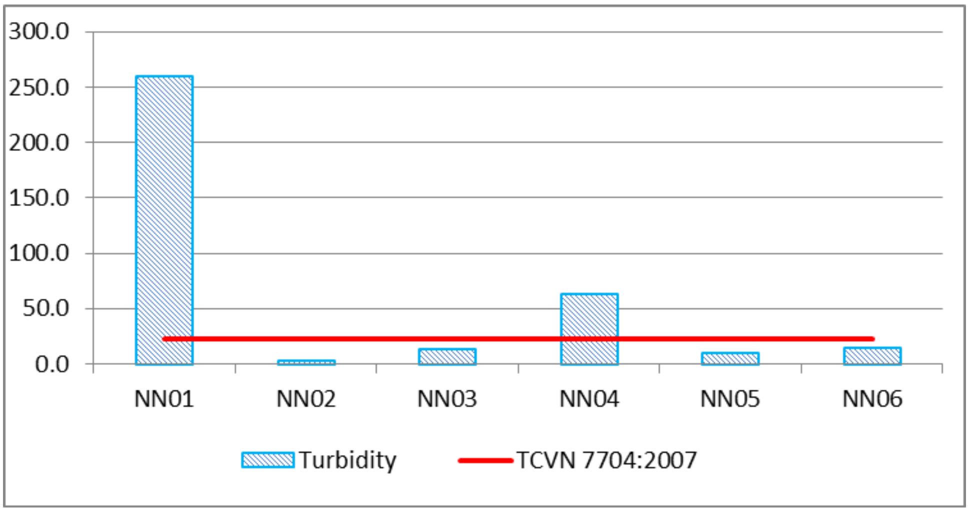

Figure 30. Comparing the turbidity analysis results of ground water in Ben Luc district with TCVN 7704:2007

Figure 30 shows that turbidity ranged from 3.2 – 260 NTU, the average value is 60.3 NTU, most parameters meet TCVN 7704: 2007 except samples NN01 and NN04;

(2). pH

Comparing the pH values of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 31:

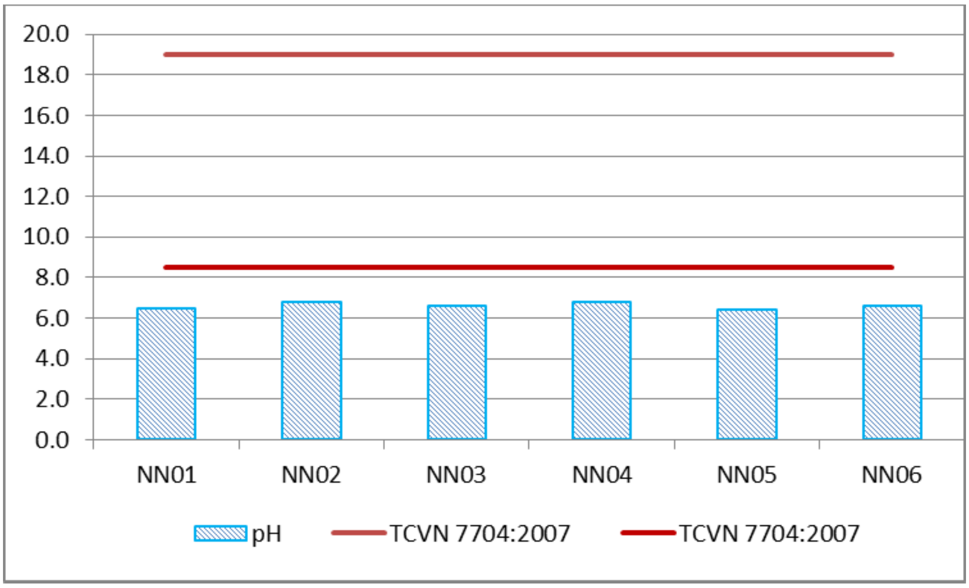

Figure 31. Comparing the pH analysis results of groundwater in Ben Luc district with TCVN 7704:2007

Figure 31 shows that pH ranged from 6.4 – 6.8, the average value is 6.6, did not meet TCVN 7704:2007.

(3). Electrical conductivity (EC)

Comparing the electrical conductivity measurement results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 32:

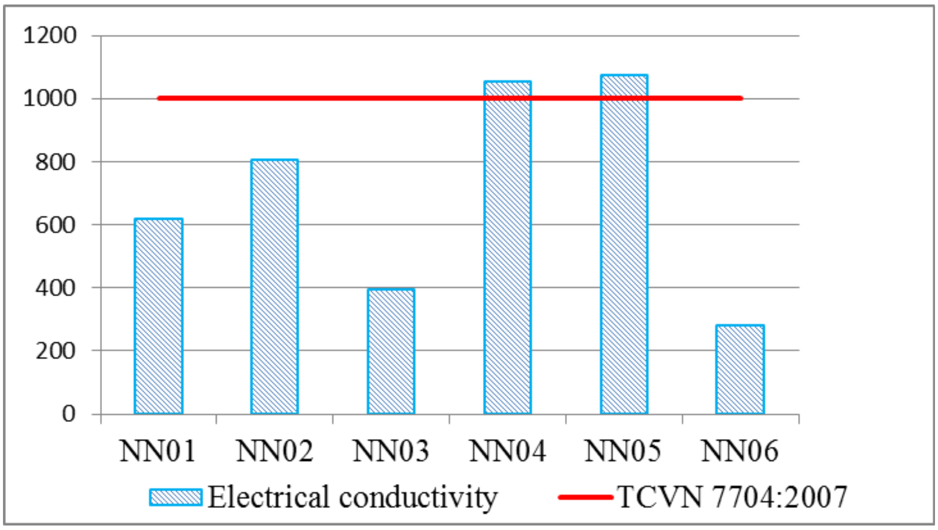

Figure 32. Comparing the electrical conductivity of groundwater in Ben Luc district with TCVN 7704:2007

Figure 32 shows that electrical conductivity ranged from 280 to 1084 µs/cm, the average value is 704.5 µs/cm, meet TCVN 7704:2007, except for samples NN04 and sample NN05.

(4). Hardness

Comparing the hardness analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 33:

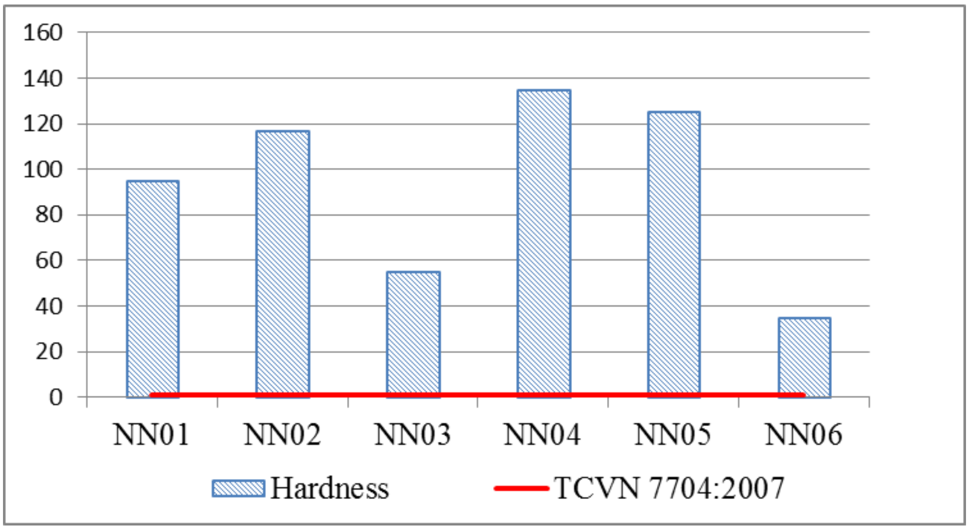

Figure 33. Comparing the hardness values of groundwater in Ben Luc district with TCVN 7704:2007

Figure 33 shows that hardness ranged from 35-135 mg$CaCO_3$/l, the average value is 93.7 mg$CaCO_3$/l, exceeded TCVN 7704:2007.

(5). TSS

Comparing the TSS analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 34:

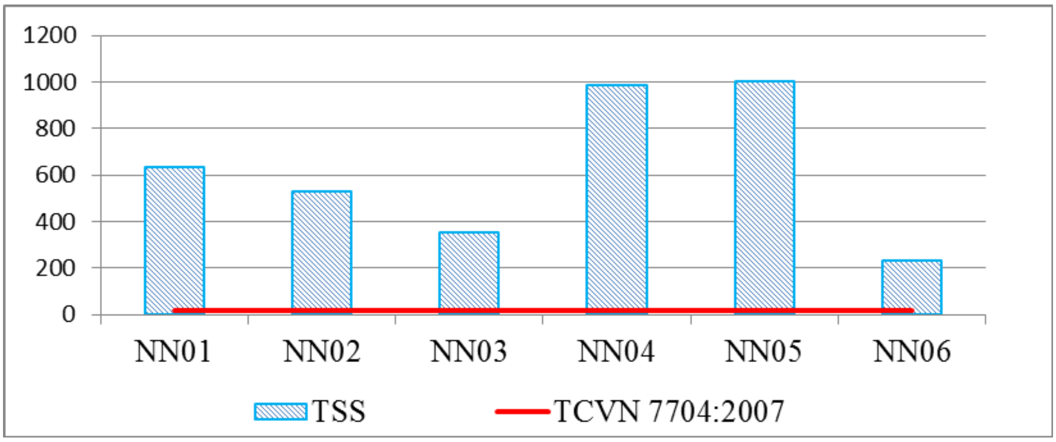

Figure 34. Comparing the TSS concentrations of groundwater in Ben Luc district with ABMA standard

Figure 34 shows that TSS concentrations ranged from 229.2 – 1004.4 mg/l, the average value is 621.67 mg/l; exceeded ABMA standard .

(6). TDS

Comparing the TDS analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 30:

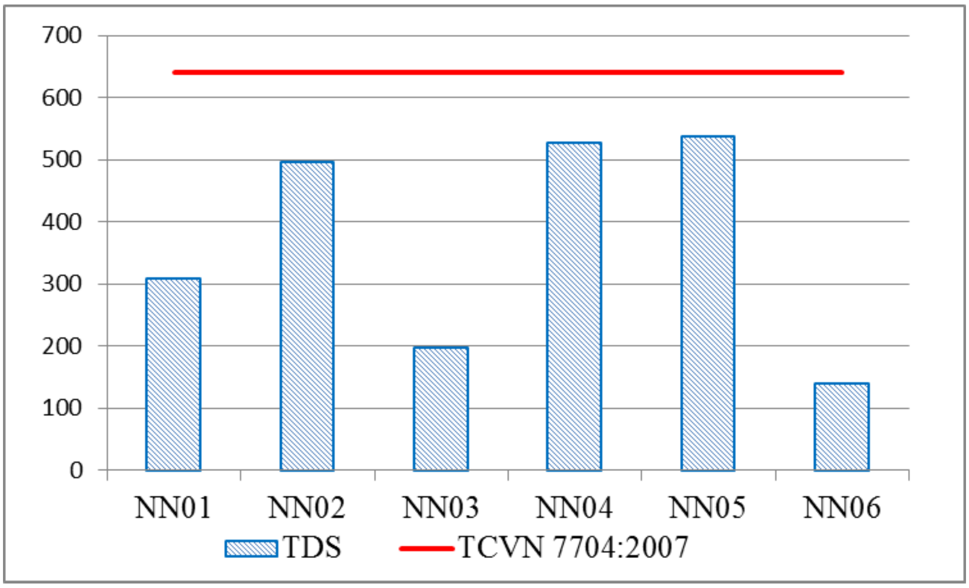

Figure 35. Comparing the TDS concentrations of groundwater in Ben Luc district with TCVN 7704:2007

Figure 35 shows that TDS concentrations ranged from 140 to 537 mg/l, the average value is 376.5 mg/l, meet TCVN 7704:2007.

(7). Alkalinity

Comparing the alkalinity analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 36:

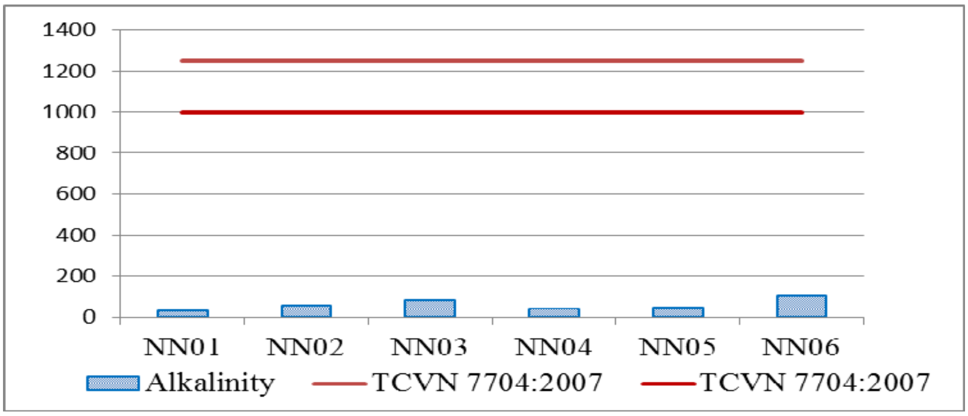

Figure 36. Comparing the alkalinity of groundwater in Ben Luc district with TCVN 7704:2007

Figure 36 shows that alkalinity values ranged from 30 to 100 mg$CaCO_3$/l, the average value is 58.08 mg$CaCO_3$/l, do not meet TCVN 7704:2007.

(8). Dissolved oxygen (DO)

The analysis results shows that DO values in groundwater samples are not detectable.

(9). SiO_3^{2-} concentrations

Comparing the SiO_3^{2-} analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 37:

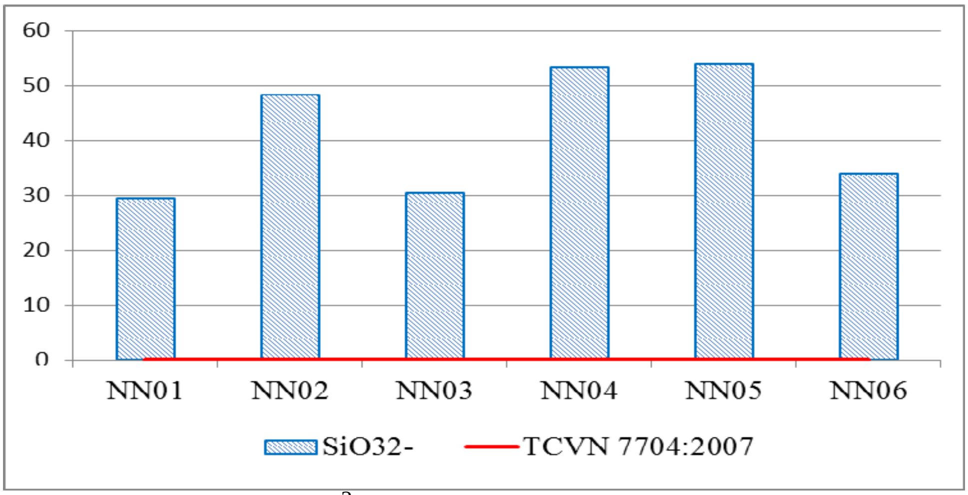

Figure 37. Comparing the SiO_3^{2-} concentrations of groundwater in Ben Luc district with TCVN 7704:2007

Figure 37 shows that SiO_3^{2-} concentrations ranged from 29.4 to 53.9 mg/l, the average value is 41.5; exceeded TCVN 7704:2007 many times.

(10). Total iron

Comparing the total iron analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 38:

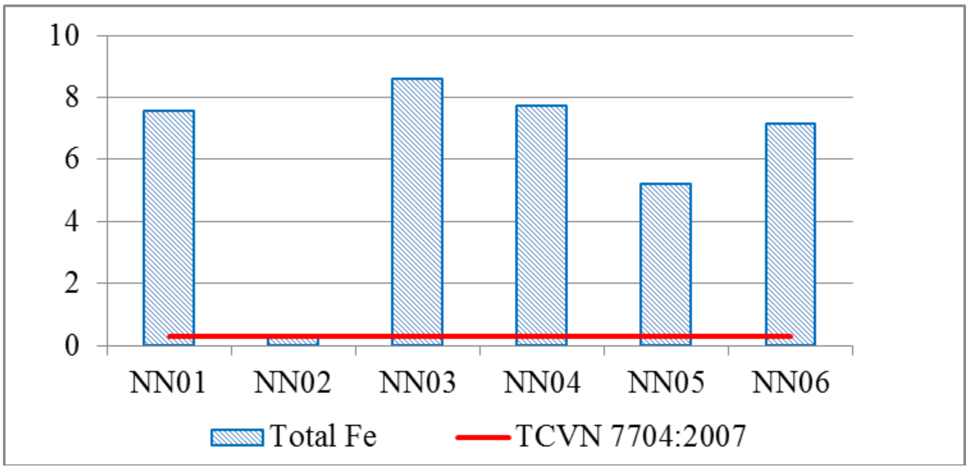

Figure 38. Comparing the total iron of groundwater in Ben Luc district with TCVN 7704:2007

Figure 38 shows that total iron values ranged from 0.27 to 8.6 mg/l, the average value is 6.1 mg/l, exceeded TCVN 7704:2007 except sample NN02.

(11). SO_3^{2-} concentrations

The analysis results shows that SO_3^{2-} values in groundwater samples are not detectable.

(12). Phosphate

Comparing the PO_4^{3-} analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 39:

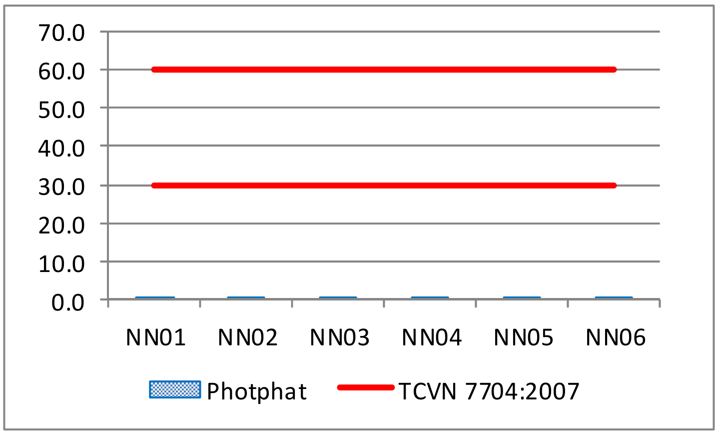

Figure 39. Comparing the PO_4^{3-} concentrations of ground water in Ben Luc district with TCVN 7704:2007

Figure 34 shows that PO_4^{3-} values ranged from 0.01 to 0.41 mg/l, the average value is 0.12 mg/l; meet TCVN 7704:2007.

(13). Chloride

The analytical results shows that Cl^- values ranged from 51.48 to 228 mg/l, the average value is 144.2 mg/l; meet TCVN 7704:2007.

(14). N_2H_4

The analysis results shows that N_2H_4 values in groundwater samples are not detectable.

(15). THC

The analysis results shows that THC values in water samples are not detectable.

(16). Cu

The analysis results shows that copper concentrations in water samples are not detectable.

(17). Amonium

Comparing the ammonium analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 40:

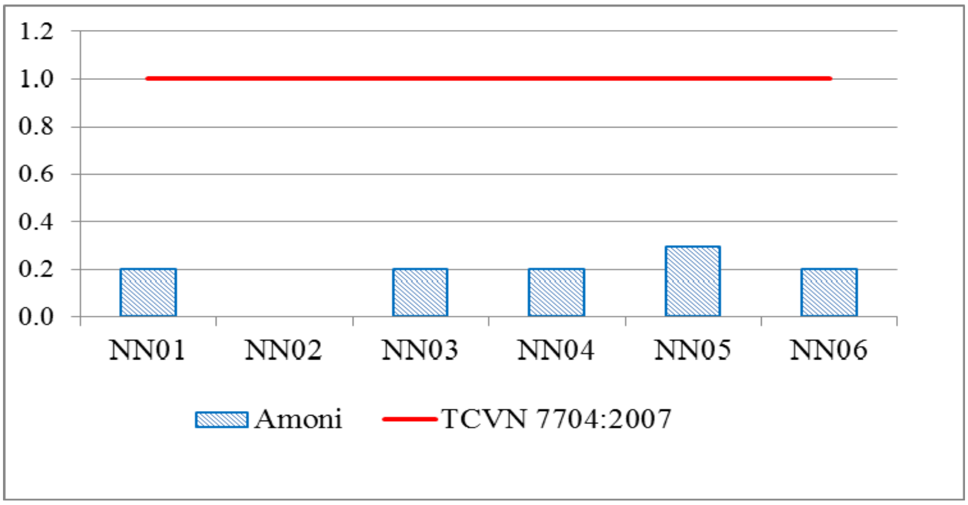

Figure 40. Comparing the ammonium concentrations of groundwater in Ben Luc district with TCVN 7704:2007

Figure 35 shows that ammonium values ranged from 0.0 to 0.3 mg/l, the average value is 0.2 mg/l; meet TCVN 7704:2007.

(18). Total nitrite and nitrate

Comparing Total nitrite and nitrate analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 41:

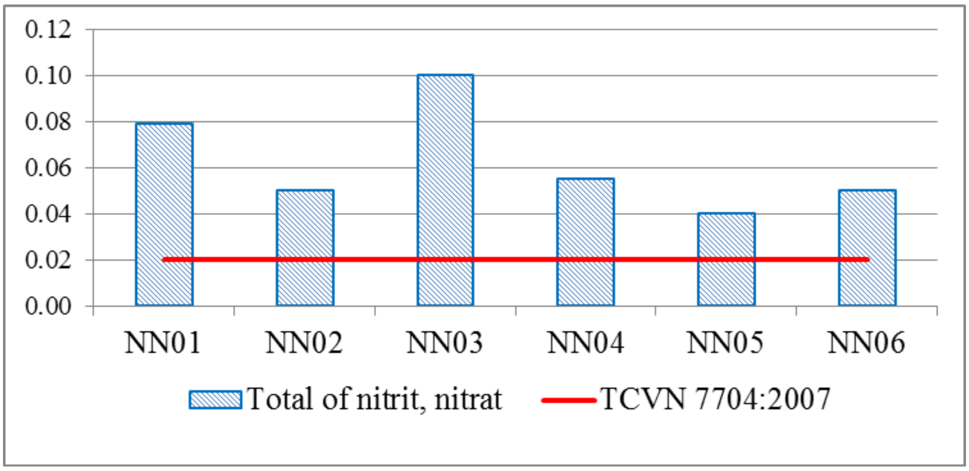

Figure 41. Comparing total nitrite and nitrate concentrations of groundwater in Ben Luc district with TCVN 7704:2007

Figure 41 shows that the total amount of nitrite, nitrate ranged from 0.04 to 0.1 mg/l, the average value is 0.06 mg/l; exceeded TCVN 7704: 2007.

(19). Summary of the ground water quality analysis

Summary results of the groundwater quality analysis versus TCVN 7704: 2007 are presented in Table 25.

Table 25. Summary results of the ground water quality analysis versus TCVN 7704: 2007

No.	**Parameter**	**Unit**	**The range of values**	**Average**	**Water supply standard (TCVN 7704:2007)**	**Conclusion**
1	Transparency	NTU	3.2 - 260	60.3	≤ 23 (*)	Meet the standard, except sample NN01
2	pH	-	6.4 – 6.8	6.6	8.5 – 10.5	Do not meet
3	Electrical conductivity (EC)	µs/cm	280 - 1074.00	704	1000	Meet the standard, except samples NN04 and NN05
4	Total hardness	$mgCaCO_3/l$	35 – 135	93.67	1	Do not meet
5	Suspended solid	TSS	229.2 – 1004.4	621.67	15 (**)	Do not meet
6	Total Dissolved Solids (TDS)	mg/l	140 – 537	367.5	< 640	meet
7	Total Alkalinity	$mgCaCO_3/l$	30 – 100	58.08	250 - 1000	Do not meet

No.	Parameter	Unit	The range of values	Average	Water supply standard (TCVN 7704:2007)	Conclusion
8	Dissolved oxygen	mgO_2/l	0	0	≤ 0.4	meet
9	Soluble SiO_3^{2-}		29.4 – 53.9	41.5	≤ 0.04	Do not meet
10	Total Fe	mg/l	0.27 -8.60	6.09	≤0.3	Do not meet, except for sample NN02
11	Sodium Sulfite SO_3^{2-}	mg/l	0	0	20 - 40	meet
12	Phosphate PO_4^{3-}	mg/l	0.01 – 0.41	0.12	30 - 60	meet
13	Chloride Cl^-	mg/l	51.48 – 228.0	144.2	-	meet
14	Hydrazine N_2H_4	mg/l	0	0	0.03 - 0.1	meet
15	Total hydrocarbon	mg/l	0	0	≤ 3 (***)	meet
16	Copper (Cu)	mg/l	0	0	≤ 0.007	meet
17	Ammonium	mg/l	0.2 – 0.3	0.22	1	meet
18	Nitrite	mg/l	0.02 – 0.08	0.05		
19	Nitrate	mg/l	0 - 0.05	0.02		
20	Total nitrite, nitrate (****)	mg/l	0.05 – 0.1	0.06	≤ 0.02	Do not meet

Notes:

(*)According to the converting of University of Wisconsin Green Bay
(**)Boiler feed water standards according to ABMA
(***)THC concentrations in water as a function of the origin of oil;
(****)Total analysis results of nitrite and nitrate concentrations measured in the parameters 18 and 19 .

Table 25 shows that there are 6/18 parameters (pH, hardness, TSS, alkalinity, SiO_3^{2-}, total nitrite, nitrate) which did not meet the standard at all sampling points, and 3/18 parameters (i.e. turbidity, conductivity , total iron) which did not meet the standard at some points.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

- Surface waters in Ben Luc district are abundant with Vam Co Dong river system (which is a major tributary of the Dong Nai river system) flowing through, besides also Ben Luc River with a length of 33km and interlaced canals. However, plan to build the waste-to-energy incinerator plant with capacity of 300 tons/day is located at about 30 km from the sea. Therefore, the water quality in Ben Luc district is unstable over time (between rising tide and falling tide, between the dry season and the rainy season), which is saline and acidified sometimes.

– The result of the investigation and the actual survey of water quality in Ben Luc district showed that the ground waters are main sources of water supply for production and domestic purposes. The ground waters are treated at the Go Den water plant, Ben Luc water plant, Hoang Long water plant. Some companies or investment projects has the individual groundwater wells to supply waters by themselve for production and domestic purposes.

– Comparison of the analysis results of water quality in Ben Luc District in July 2014 with TCVN 7704: 2007 showed that 10/19 parameters (including turbidity, pH, hardness, solids suspended, alkalinity, DO, SiO_3^{2-}, total Fe, total NO_2^- and NO_3^-) did not meet the standard and 9/19 parameters (including conductivity, TDS, SO_3^{2-}, PO_4^{3}, Cl, N_2H_4, total hydrocarbon, total compounds of Cu, NH_4^+). Combined with reference data from Center of Environmental Monitoring and Technical Services of Long An Province in 2013 one can make conclusion that the surface water in Ben Luc district does not meet the standard for feeding the boiler of the waste-to-energy incinerator with capacity of 300 tonnes/day.

– Comparison of analytical results of groundwater quality in Ben Luc District in July 2014 with TCVN 7704: 2007 shows that groundwater quality at depths of about 210-230 m in Ben Luc district is slightly acidified, which have 6/18 parameters (i.e. pH, hardness, TSS, alkalinity, SiO_3^{2-}, total nitrite, nitrate) did not meet the standard at all sampling points, 3/18 parameters (i.e. turbidity, conductivity , total iron) did not meet the standard at some points. Combined with reference data from Center of Environmental Monitoring and Technical Services of Long An Province in 2013 one can make conclusion that groundwater in Ben Luc district can meet the standards for feeding the boiler of the waste-to-energy incinerator with capacity of 300 tonnes/day if some parameters, including electrical conductivity (EC), pH, hardness, suspended solids, alkalinity, SiO_3^{2-}, total NO_2^- and NO_3^- will be improved to meet TCVN 7704: 2007.

– The survey results also show that actual groundwater in the project area is sufficient to provide 500 m^3/day for feeding the boiler of the waste-to-energy incinerator with capacity of 300 tonnes/day.

4.2. Recommendations

-On the basis of the mentioned above results, it can recommend Tsuneishi to sellect the groundwater for supplying water to the boiler of the waste-to-energy incinerator with capacity of 300 tonnes/day.

- Tsuneishi may consider the alternative to sign contracts with Go Den water plant, Ben Luc water plant, Hoang Long water plant to provide water for the waste-to-energy plant's operation.

- To have proactively source of water supply for the waste-to-energy plant’s operation, Tsuneishi may request permission from DoNRE of Long An province to exploit and treat groundwater by themselves. However, Tsuneishi must prepare the documents for extraction and use of groundwater, then submit DoNRE of Long An province for review and People Committee of Long An province for getting license. In addition, Tsuneishi have to make a report on environmental impact assessment for groundwater exploitation and treatment project with capacity of 500 m^3/day to submit the Economic Zone Management Board of Long An province for review and approval.

3-2 FINAL REPORT

SURVEY OF PRESENT STATUS OF INDUSTRIAL SOLID WASTE, HAZARDOUS WASTE, MEDICAL SOLID WASTE IN HO CHI MINH CITY AND SURROUNDING PROVINCES FOR PROPOSAL OF SOLID WASTE INCINERATION PROJECT WITH CAPACITY OF 300 TONS/DAY

TSUNEISHI KAMTECS CORPORATION

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REPRESENTATIVE **TKC**	**REPRESENTATIVE** **ENTEC**

Ho Chi Minh City, June, 2014

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LIST OF ABBREVIATIONS

BIWASE	Binh Duong Water Supply Sewerage Environment Co.Ltd.
BR-VT	Ba Ria-Vung Tau Province
CITENCO	Ho Chi Minh City Urban Environmental Company Ltd.
Co, Ltd	Company limited
DIT	Department of Industry and Trade
DOH	Department of Health
DONRE	Department of Natural Resources and Environment
DOST	Department of Science and Technology
DPI	Department of Planning and Investment
ENTEC	Environmental Technology Center
EPZ	Export Processing Zone
GDP	Gross Domestic Produst
HCMC	Ho Chi Minh City
Ics	Industrial Clusters
IPs	Industrial Parks
IZA	Industrial Zone Administration
IZs	Industrial Zones
MONRE	Ministry of Natural Resources and Environment
PPC	People's Committees
QCVN	Vietnam Technical Regulation
TCVN	Vietnam Standards
TKC	Tsuneishi Kamtecs Corporation
VSIP	Vietnam Singapore Industrial Park

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BACKGROUND

At the present, the Representative Office of Tsuneishi Kamtecs Corporation in Vietnam (hereinafter referred to as Tsuneishi) is being investigated and surveyed on the management of industrial solid waste, hazardous waste and medical waste in Ho Chi Minh City and neighboring provinces (including Dong Nai, Binh Duong, Ba Ria - Vung Tau and Long An) in order to propose the solid waste incineration project with capacity of 300 tons per a day (hereinafter referred to as the Work).

Tsuneishi has asked the Environmental Technology Centre (ENTEC) to cooperate with Tsuneishi implementing the "Work" above.

This work will be undertaken to:

(1). To evaluate by the most accurate way, with scientific and practical basis on the present status of industrial solid waste, hazardous waste and medical waste management in Ho Chi Minh City and neighboring provinces (i.e. Dong Nai, Binh Duong, Ba Ria - Vung Tau, Long An), including the volume and types; collection, transportation, treatment or disposal organization; rate of solid waste collection, treatment and disposal; price of collection, treatment and disposal);

(2). To predict the volume of industrial solid waste, hazardous waste and medical waste generated in Ho Chi Minh City and neighboring provinces (i.e. Dong Nai, Binh Duong, Ba Ria - Vung Tau and Long An) by the year of 2020 and 2025;

(3). To advise Tsuneishi on proposal of solid waste incineration project, including project's size, project's location, unit prices and supplies for estimation of project's operating costs, legal licensing and permitting procedures for the project, marketing strategy, capital structure division of the proposed project.

Scope of work is presented in the Scope of Work in Appendix 1.

CHAPTER 1
ASSESSING THE CURRENT STATE OF INDUSTRIAL SOLID WASTE, HAZARDOUS WASTE AND MEDICAL WASTE MANAGEMENT

1.1. DETERMINATION OF THE VOLUME OF INDUSTRIAL SOLID WASTE, HAZARDOUS WASTE AND MEDICAL WASTE

1.1.1. Determination of volume of industrial solid waste, hazardous waste and medical waste in Ho Chi Minh city

Ho Chi Minh City is a special municipality, the large center of economic, cultural, education and training, science and technology, there is an important role of the country; international transport hub; multidisciplinary services industrial centers in the Southeast Asian region. With the area of 2,095 km^2 and a population of over 9 million people (in 2010), located in the most dynamic economic region including Mekong Delta and Southeast regions, Ho Chi Minh city is not only the economic center of the region but also of the country, the rate of annual GDP growth above 12%.

Besides producing a large volume of products to meet domestic demand and exports, Ho Chi Minh City also consumes a huge amount of natural resources and energy (49 million kWh/day), and released into the environment a corresponding amount (more than 2 million tons/day) of waste (liquid, solid, gas), including hazardous waste and hazardous waste, the recycling capable waste and non-recycling capable. The quality of the natural environment and human life are threatened by unsustainable development and due to this waste.

With an average population of over 9 million people, hundreds of small markets and large supermarkets, hundreds of restaurants, hotels, schools, research institutes and agencies; approximately 53,601 industrial establishments; approximately 12,502 health facilities. HCMC generates about 8,000 tons of municipal solid waste daily includes household waste from households, offices and factories. In which, the volume collected and transported to landfills around 6,500-6,700 tons/day, the rest is selling of scrap for recycling. Only a small portion of the organic waste is discharged into the lowlands in the suburbs. Estimated annual increased rate of about 7 -8%.

The management of solid waste in the city's industrial zones and urban is pretty good today. According to statistics, by 2010, the rate of collection, handling average solid waste is only about 6500 tons/day, reached 84% and the proportion is mainly concentrated in urban areas. The collection and transportation of solid waste throughout the city by units and individuals. Volume collection of main units in the urban areas in the city are presented in Table 1.1.

Table 1.1. Volume of solid waste collected in each district

No	Units's Name	Collected volume (ton/day)
01	Urban Envirnment Company (CITENCO)	2,601.17

No	Units's Name	Collected volume (ton/day)
02	Cooperatives	799.42
03	1 Dictrict	109.71
04	2 Dictrict	27.08
05	3 Dictrict	53.92
06	4 Dictrict	83.67
07	5 Dictrict	269.07
08	6 Dictrict	150.67
09	7 Dictrict	122.25
10	8 Dictrict	102.17
11	9 Dictrict	211.69
12	10 Dictrict	212.23
13	12 Dictrict	261.18
14	Phu Nhuan	164.26
15	Go Vap	403.19
16	Tan Binh	110.37
17	Tan Phu	215.31
18	Thu Duc	119.92
19	Hoc Mon	39.41
20	Binh Thanh	142.37
21	Binh Tan	154.23
22	Nha Be	25.78
23	Cu Chi	119.93
Total		6,500

Source: Department of Natural Resources and Environment, 2010.

Thus, compared with Decision 789/QD - TTg May 25, 2011 of the Prime Minister approving the investment program of solid waste disposal for the period 2011 to 2020, according to which specific targets from 2011-2015: "85% of the total solid waste generated in urban centers are collected and processed to ensure the environment", Ho Chi Minh city has achieved the goal of government regulations. However, the real rate of collection and disposal of household solid waste higher, can reach 100% at the time of collection defined because a part of household solid waste generated from waste sources have been classified and recycling of waste from source to landfill and the treatment plant, or another part of the waste still stored at the waste source.

The collection of household solid waste in the city by 3 unit group perform: public System by Urban Environment Company and 22 public services company the county/district (Tan Phu and Binh Tan new start-up with no public services company), this entire company was converted into company Limited; Addition, The private system was establish by private forces, it is outside forces or in 30 collected trade unions; and 3 cooperative solid waste collection (2 District, 4 District, 6 District, Go Vap and Thu Duc District). From the statistics show that 60% of the volume of solid waste generated from households due to the private system, 40% by cooperatives and public services company.

For Industrial waste and hazardous waste in Ho Chi Minh City. Apart from the main sources of factories and industrial establishments in the city, another source of industrial solid waste and hazardous waste is plants and facilities in the surrounding province as Dong Nai , Binh Duong, Ba Ria - Vung Tau, all provinces are shipping waste to the city for recycling and disposal, because Ho Chi Minh City has needed facilities and equipment for recycling, disposal hazardous waste.

According to statistics in recent years, the volume of industrial waste and hazardous waste arising from industrial activities of more than 12,000 large, medium and small facility in and out of 17 industrial zones, export processing zones, have volume generated about 80% of the total volume of industrial solid waste, hazardous waste generated in the city of Ho Chi Minh. The volume of industrial solid waste and hazardous solid waste generated in the city of Ho Chi Minh City is shown in Table 1.2.

Table 1.2. The volume of industrial solid waste and hazardous waste in HCMC

No.	Type of waste	Volume (ton/day)
01	Non-hazardous industrial solid waste	1,500 - 2,000
02	Hazardous industrial solid waste	250 - 350

Source: Department of Natural Resources and Environment, 2010

According to the survey of industrial production of 24 kinds of industries in the city, the volume waste generated by the kinds with highly hazardous materials such as pesticides, plating chemicals accounted rate below 10%; textile dyes, paints the volume generated 3.0 -5.0%; the type of tanning generated large volumes of hazardous sludge accounted for 16.5%, in which the type of metal and mechanical processing accounted for the highest percentage is 39.2%, but real that can recycle, reuse. Percentage volume of hazardous waste generated by industry is shown in Table 1.3.

Table 1.3. The volume of waste generated by industry kinds in HCMC

No.	Type	Rate %
01	Pesticides	0.68
02	Plating	0.57
03	Tanning	16.5
04	Chamical	0.17
05	Battery	0.51
06	Electronic	2.27
07	Metal and mechanical processing	39.16
08	Textile dyes	3.5
09	Painting	5.45
10	Ink and print	3.64
11	Leather shoes	5.76
12	Oil and petroleum products	1.72
13	Pharmacy	0.23
14	Rubber	0.25
15	Repair and maintenance of vehicles	0.04

No.	Type	Rate %
16	Wood and wood products	3.75
17	Plastic and plastic products	2.34
18	Glass	0.05
19	Building	0.2
20	Soaps and Cosmetics	0.94
21	Paper	2.49
22	Apparel	2.26
23	Food	2.79
24	Others	4.73

Source: Department of Natural Resources and Environment, 2010

The composition of the hazardous wastes generated typical in Ho Chi Minh city are shown in Table 1.4.

Table 1.4. The composition of the hazardous wastes generated in HCMC

No.	Type	Volume rate (%)	Treatment method
01	Packaging, plastic container, iron drum (stick) contaminated hazardous components	24.2	Rinse – Recycle
02	Materials, abrasive material used (iron stamping oil contamination)	22.4	Cleaning oil, recycle
03	Oils (sewage sludge)	13.3	Recycle
04	Absorbents, filter materials (including oil filter materials), rags, fabric protection components hazardous waste contamination	13.1	Incineration
05	Sludge generated from the wastewater treatment system of the production facilities, industrial parks, export processing zones	8.3	Recovery, burning, landfill
06	Acid-base sewage, heavy metals, solvents, paint, oil, …	7.5	Water waste treament system
07	Solvents (residual) waste	3.4	Incineration, Recycle
08	Chemical Waste (chemicals used expired, damaged, poor quality)	2.5	Recovery, burning, landfill
09	Ash, dust, waste activated carbon	1.7	Solidification – landfill
10	Alloys, welding rod, lead residue, lead slag	1.5	Recycle
11	The types of hazardous waste containing other hazardous components	1.3	Incineration
12	Batteries, lead emissions	0.6	Solidification, landfill, recycle
13	Fluorescent bulbs waste	0.3	Solidification – landfill

No.	Type	Volume rate (%)	Treatment method
14	Waste toner box	0.1	Incineration, recycle
15	Electronics equipment waste	0.1	Incineration, recycle
16	Plant protection products, pesticides harmful insects	0.1	Incineration

Source: Department of Natural Resources and Environment, 2010

The results are shown in Table 1.4 shows, the composition of hazardous waste generated in the city of Ho Chi Minh City accounted for bulk packaging, containers, materials and abrasive material, oil, hydraulic oil , mops, gloves contaminated with hazardous component, sewage sludge, ... The majority of industrial waste generated is capable of recycling high, though only through early processing and cleaning, hazardous waste industrial waste into non-hazardous, high commercial value and recycling into other products. Hazardous waste recycling likely accounted for between 55% and 70%, hazardous waste must be handled by means of combustion accounts for 15% to 18%, about 8% solidification, treated waste water treatment system 5 %. The volume of hazardous waste statistics in the end of 2010 from all emissions sources (including activities in and outside the industry) approximately 300 tons/day, which exists in solid form around 70%, the remaining liquid around 15% and 15% slurry.

To collect, transport, reuse, recycle and disposal the entire of industrial and hazardous solid waste, the city has established a wide network with over 1,000 scrap buying units, 49 transportation units of hazardous waste, 13 transportation and disposal hazardous waste units (August, 2011).

Hazardous waste in industrial parks, export processing zones, industrial clusters collecting reach over 80%. Almost of the large factories outside industrial parks, export processing zones distributed in districts done transferring waste contract stipulated.

However, the types of hazardous waste (mainly light bulbs, batteries, mops incurred but very little) arising from the small industrial business neither collecting thoroughly nor collecting properly according to path regulations. Hazardous waste is sold at scrap or pour into the general household waste.

1.1.2. Determination of volume of industrial solid waste, hazardous waste and medical waste in Binh Duong province

Now, the social economic development of the country, people's lives is improved. Urban, residential, commercial areas have been considerably enlarged compared with before. Warranted rate of growth, there are many projects, industrial zones were built. The projects have the potential to attract investment and job creation. Beside the positive elements, solid waste is generally increasing in both quantity and category. The quantity of solid waste, including urban and industrial solid waste originated from the year of 2005 to 2010 is increasing.

With the average population of over 1,550,000 inhabitants (Source: Statistical Yearbook of Vietnam, 2010), hundreds of markets, supermarkets, hundreds of restaurants, hotels, schools, research institutes, agencies, nearly 2,796 factories located in the 24 industrial zones and industrial clusters; about 8,138 other industrial bases, about 100 health care facilities, every day, about 884 tons of solid waste, including municipal and industrial solid waste, non-hazardous waste are dumped in Binh Duong province.

Currently, the management of solid waste in urban and industrial areas of Binh Dương is still weak. According to statistics, in 2010, the average rate of solid waste collection and treatment is 84%, equivalent to 710 tons/day and mainly concentrated in urban areas. The collection and transportation of solid waste in Binh Duong province are realized by 65 organizations and individuals. Collected volume of main organizations, at urban areas in Binh Duong province is presented in Table 1.5.

Table 1.5. Main collecting organizations and collected quantity of solid waste in Binh Duong province

No.	**Collection facilities**	**Volume of collect (ton/day)**	**Rate (%)**
01	BIWASE	620	87
02	Works Enterprise Urban Tan Uyen district	55	7.9
03	Public facilities Dau Tieng district	20	2.9
04	Public facilities Phu Giao district	15	2.2

Source: Environment Status Report 2005 -2010 of Binh Duong Province

Currently, majority of non-hazardous solid waste originated from Thu Dau Mot town, Di An, Thuan An districts etc. are collected, transported and treated in Nam Binh Duong solid wastes complex with volume about 620 ton/day. Besides, Dau Tieng, Phu Giao and Tan Uyen districts located far from Nam Binh Duong solid wastes complex, so, solid waste is collected and disposed at the open landfill pit of the districts.

For industrial and hazardous solid wastes in Binh Duong province in 2010, thre are 13 transportation and treatment companies, of which only 4 companies located in Binh Duong province. These companies have been awarded the license for hazardous waste transportation and treatment. In fact, only about 15% of total quantity of hazardous waste is collected and transported in accordance with regulations. Only large enterprises met ISO 9001:2000 and ISO 14000 standards are interested in reducing waste at source, which occupied about 14.5% of total number of enterprises.

Table 1.6. The total quantity of industrial and hazardous solid waste generated in Binh Duong province

Area	**Generated Quantity**	
	Industrial Solid Waste	**Hazardous Solid Waste**
Industrial zones	85,626	21,821
Industrial clusters	2,179	553

Outside industrial zones		234,559	39,245
Total	**Ton/year**	**322,364**	**61,619**
	Ton/day	***883***	***169***

Source: Environment Status Report 2005 -2010 of Binh Duong Province

For medical solid waste, there are 17 provincial and district hospitals with the total number of beds is 2,370 bed, and 106 health care centers and clinics. For hospitals, medical solid wastes are classified at hospital in accordance with regulations of the Ministry of Health. The rate of medical waste collected and treated in the province is about 91.3%. Details are as follows:

– The rate of medical solid waste is collected and treated is 100%;

– The rate of medical waste solid at clinics and private clinics are collected, treated is 10%.

Medical waste treatment technologies in the hospitals of the province are burning technology. At the present, there are 07/17 hospitals equipped with medical waste incinerators, total quantity of medical waste burned is about 142 kg/day. However all incinerators do not equipped with the completed air emission treatment system, which has caused serious environmental impact when operating those, especially there are 02 medical waste incinerators in Thuan An and Di An hospitals located in the urban and residential areas. Although the incinerators do not guarantee requirements on environmental protection, however, the hospitals also received medical waste from other hospitals. The medical waste treatment at the hospitals of Binh Duong province is faced with many difficulties now, because the most of the hospitals located in inner urban areas, so each hospital equipped with a medical waste incinerator also generate the distributed emission sources to be difficult to manage.

At the present, most of solid waste was collected, transported and disposed at Nam Binh Dương waste treatment complex. Besides that, at Dau Tieng, Phu Giao and Tan Uyen districts, solid waste is collected and disposed at open landfills. This disposal doesn't guarantee the sanitary procedure, therefore, cause pollution to the environment.

The industrial and medical hazardous wastes were not properly treated and investment for that is still low. Nevertheless, in practice, the cooperation between the companies licensed for hazardous waste management and the unlicensed companies is existed. According to surveyed results, at the present, there are 13 companies licensed for hazardous waste collection, transportation and disposal and 159 other collecting scrap companies, those can contribute to the better waste management.

For medical waste, only 2/15 companies have the license for hazardous waste collection, transportation and treatment. Besides that, the medical waste treatment procedure is insufficient, which cause the pollution to the surrounding air, water and land. Among the 7 hospitals equipped with the medical waste incinerators, there is no any completed air emission treatment system installed, only 3/7 incinerators have the simple air emission treatment facilities, which remove the dust generated from combustion process. The collected dust and ash ware buried together with domestic waste without any pollution control measures.

1.1.3. Determination of volume of industrial solid waste, hazardous waste and medical waste in Dong Nai province

Up to end of 2012, Dong Nai has 31 industrial zones have been established with a total planned area of 9,838.31 hectares, of which 27 industrial zones in operation and 37 industrial clusters were approval planning with a total area of 1,942.7 hectares, of which 28 industrial clusters have the infrastructure investment with a total area of 1,442 ha, 11/28 industrial clusters have active.

Along with industrial growth is the huge increase in volume and types of non-hazardous solid waste and hazardous waste generated by industrial activities in the province need to be collected and treated to meet environmental regulations to ensure sustainable development goals.

According to statistics in 2012, the total volume of non-hazardous solid waste and hazardous waste generated in the province is 2694.5 tons/day, the volume of collected and processed 2489.9 tons/day, reached 92,4%, in particular:

– Non-hazardous solid waste (including solid domestic waste and industrial solid waste non-hazardous): the volume of generated approximately 2,568 tons/day, the volume of collected and processed about 2,382 tons/day, reached 93%, in which:

+ Household solid waste: volume generated 1,361 tons/day, gathering, processing approximately 1,176 tons/day, reached 86%; which, hygienic handling about 606 tons/day (including Bien Hoa, Tan Phu, Thong Nhat and Long Khanh town) rate of 52% compared to the volume collected. According to statistics, there are 71 organizations and individuals (including 25 cooperatives and 05 companies) engaged in collection, transportation, handling household solid waste.

+ Non-hazardous Industrial solid waste (including scrap): volume generated 1,206 tons/day, gathering, processing reached 100%. According to statistics, 56 units engaged in sorting, collection of non-hazardous industrial waste (as reported by 08/11 district, including: Bien Hoa City, Long Khanh Town, Long Thanh, Xuan Loc, Thong Nhat, Trang Bom, Vinh Cuu, Tan Phu). Particularly, Dong Nai Urban Environment Services Company Limited (URENCO Dong Nai) processed non-hazardous by hygienic landfills.

– Hazardous waste: According to the registration of the hazardous waste generator, volume of hazardous waste registration incurred approximately 126.5 tons/day; volume collected, processed approximately 107.9 tons/day, reached 85.3% rate. According to statistics, there're 54 units can manage hazardous waste in the province, including 20 units collection and treatment of waste (17 units allowed by Ministry of Natural Resources and Environment, 3 units allowed by the provincial People's Committee, capacity of hazardous waste treatment units licensed by the province is 19,881 tons/year, equivalent to 54.5 tons/day).

The status general and collection, treatment solid waste in Dong Nai provinces are presented in Table 1.7.

Table 1.7. The status general and collection, treatment solid waste in Dong Nai province

Type	Non-hazadous wastes (ton/day)				Hazardous wastes (ton/day)			Total (ton/day)
	DA	ID	HC	Total	ID	HC	Total	
Arising	1,361.0	1,206.0	4.5	*2,571.5*	125.0	1.5	*126.5*	2,698.0
Collection and Treatment	1,176.0	1,206.0	4.5	*2,386.5*	106.4	1.5	*107.9*	2,494.4

Note:

- *DA:Domestic Activitiy*
- *ID : Industrial Activity*
- *HC: Health Care*

The volume of solid waste were separated by treatment measure are shown in Table 1.8.

Table 1.8. The volume solid waste follow treatment measure in Dong Nai province

Type of measure	Volume (ton/day)
Landfill	972.3
Burn	1.5
Sell of scrap	844.2
Other measures	676.4
Total	**2,494.4**

Overall, with the participation of many organizations and individuals in and outside the province collecting and handling solid waste and hazardous waste has contributed to significant increase in the volume of generated waste is collected and processed. However, despite the fact that the volume of waste collected is high percentage, but the volume of waste treatment to meet environmental regulations is very low or difficult to monitor treatment quality (only about 41% of domestic solid waste generated is treated sanitary; 90% of hazardous waste is collected by the organization or individual by the Ministry of Natural Resources and Environment licensed and pass for the outside treatment, so monitoring the quality of treatment is not promptly, the coordination between the central authorities and the local and the local each other in checking, monitoring is limited). Violations in the field of waste management are increasing, especially in pouring down waste not regulations, the cause of environmental degradation and pressing in people.

The main reason leads to such behavior due to no legal regulations about technical norms and economic to waste treatment - the lowest price to handling a certain amount of waste reaching environmental regulations, while there are so many organizations and individuals are licensed in the field of collecting and processing waste. So to get the waste disposal contract and capable of recycling (scrap) waste collection , the collection units willing to accept the handling prices very low but actually not capable to handle the waste after collection, therefore lead to pouring down waste not regulations frequently (particularly in the area of Bien Hoa city in 2012, the provincial authorities arrested and processed above 9 steals discharged waste, mainly from the collection facilities in Binh Duong province pass out).

Dong Nai province and in the southern economic key region has been formed medium-sized and small collection, treatment and disposal industrial solid waste and hazardous waste (Example: Tan Phat Tai private enterprise (Dong Nai), Vietnam - Australia Environment JSC, Green Environment Co., Ltd., Le Hoang Tuan Co., Ltd., Thao Thuan Co., Ltd., Quoc Viet Co., Ltd. (HoChiMinh city), Sao Mai Xanh Co., Ltd. (Tien Giang), Song Xanh Co., Ltd. (Ba Ria Vung Tau)). Tan Phat Tai private enterprise (Dong Nai) were collected, sorting, reuse, recycle about 40-45% of leather shoes waste; has invested in footwear industrial waste incinerators and some assortments of others non-hazardous waste.

1.1.4. Determination of volume of industrial solid waste, hazardous waste and medical waste in Long An province

According to statistics in 2013, the total volume of non-hazardous solid waste and hazardous waste generated in the province is 2,241.1 tons/day, the volume of collected and processed 1,633.0 tons/day, reached 72,8%. The volume of solid waste and hazardous solid waste generated in the Long An province is shown in Table 1.9.

Table 1.9. The volume of solid waste and hazardous solid waste generated in the Long An province

Type	Non-hazadous wastes (ton/day)				Hazardous wastes (ton/day)			Total (ton/day)
	DA	ID	HC	Total	ID	HC	Total	
Arising	1,099.0	937.0	0.6	*2,036.6*	204.0	0.5	*204.5*	2,241.1
Collection and treatment	802.3	625.7	0.6	*1,428.5*	204.0	0.5	*204.5*	1,633.0

Note:

- *DA:Domestic Activitiy*
- *ID : Industrial Activity*
- *HC: Health Care*

Treatment measures:

– For domestic waste: most businesses have contracts with collection agencies and burial as prescribed.

– For industrial waste: The business of collecting, sorting units for sale to collectors wishing to reuse. Software does not sell, the company collected together with household waste or rental units collected and processed.

– For hazardous waste: The unit will operate in the IP register generators of hazardous waste to the Department of Natural Resources & Environment Long An, Hazardous waste will be collected for temporary storage and contracted with functional units collected, handled in accordance with regulations.

The volume solid waste separated by measure treatment is show in Table 1.10.

Table 1.10. The volume solid waste treatment by measures in Long An province

Type of measure	Volume (ton/day)
Landfill	802.9
Burn	0.5
Other measures	829.7
Total	**1,633.0**

Overall, solid waste generated was collected and contracts with businesses function shipping and handling. The management of hazardous waste gradually put into place, however, hazardous waste volume is small, it is difficult to sign a contract with the functional unit management practice to hazardous waste handling.

Currently, the province can not handle areas of industrial solid waste, while enterprises in industrial parks in operation and generate more waste. We have 5 business investment industrial waste but only project of Ngoc Tan Kien Co., Ltd (in Duc Hoa 1 IZ) and Nguyet Minh Co., Ltd. (handles lead batteries) goes into operation action. Therefore, enterprises must deal with the functional units to handle outside the province.

Accordingly, Long An province and Ho Chi Minh city had done to coordinate complex projects of solid waste handling Tan Thanh Commune, Thu Thua district, area 1.760 ha, to dispose of domestic waste and industrial. The compensation for land clearance to the project was essentially completed, Ho Chi Minh City People's Committee and the Ministry of Construction agreed to Co. Solid Waste Vietnam project as an investor. Co. Solid Waste Vietnam's geological survey, report a feasibility study and selection process of appropriate technologies to apply to the project. Of progress, according to the explanation of the investor wins 11/2013 began the construction of bridges and roads connected to the N2 route to cater for the construction of infrastructure and basic items. In 2014, treatment centers began receiving domestic waste generated in the province to handle. Then continue to build other items in the form of active medium, medium build.

For medical waste, currently only 7 medical waste incinerators focused mainly in the older district hospitals, for private clinics, the management of solid waste volume generated, as well as other processing difficulties and inadequacies polluting air, water and land.

1.1.5. Determination of volume of industrial solid waste, hazardous waste and medical waste in Ba Ria – Vung Tau province

Currently, the province of the total waste volume is about 1,677.3 tons/day, including: domestic waste, industrial waste and hazardous waste. Status of collection and disposal of waste are shown in Table 1.11.

Table 1.11. The status general and collection, treatment solid waste in Ba Ria Vung Tau province

Type	Non-hazadous wastes (ton/day)				Hazardous wastes (ton/day)			Total (ton/day)
	DA	**ID**	**HC**	**Total**	**ID**	**HC**	**Total**	
Arising	**742.0**	**726.3**	**1.8**	***1,470.1***	**208.4**	**0.6**	***209.0***	**1,679.1**
Collection and Treatment	571.3	726.3	1.4	*1,299.0*	208.4	0.6	*209.0*	**1,508.0**

Note:

- *DA:Domestic Activitiy*
- *ID : Industrial Activity*
- *HC: Health Care*

The volume of solid wastes were separated by treatment measure is show in Table 1.12.

Table 1.12. The volume of solid wastes were separated by treatment measure in Ba Ria – Vung Tau province

Type of measure	Volume (ton/day)
Landfill	1,248.7
Burn	0.6
Sell of scrap	50.3
Other measures	208.4
Total	**1,508.0**

Status of collection and disposal of waste each as follows:

– Domestic waste: So far about 77% of domestic solid waste equivalent 571 tons/day is handled in accordance with the closed landfill, sanitary. In particular, the total amount of solid waste activities in Vung Tau and Ba Ria City, and Long Dien District and Tan Thanh district is transported to landfill waste in 100 hectares focus of the company KBEC VINA to handle sanitary landfill. The rest are further processed in accordance with the burial at the landfill for temporary including: landfill Toc Tien Tan Thanh district, landfill Cong Trang Ba Ria town, landfill Binh Ba Chau Duc District, landfill Loc An Dat Do district, landfill Phuoc Thuan Xuyenn Moc District, landfill Nhat Bon streem Con Dao district. The entire amount of domestic solid waste generated in urban areas is collected by the company local urban environment.

– Industrial Solid Wastes: For steel slag: In recent years, there are 03 waste treatment project was licensed industrial investment including: Green Materials Co., Ltd. processing capacity of 1,000 tons/day, VINA Co. KBEC treatment capacity 500-700 tons/day, Co., Ltd Viet Ninh invested and commercial processing capacity of 200 tons/day. Currently, 02 factories Green Materials Co., Ltd and KBEC VINA Co., Ltd. went into operation with a total processing capacity of about 1500-1700 tons/day, ensure capacity to handle the volume of steel slag generated in the province.

+ For steel scales: Currently, most of the steel mass scales approximately 50.3 tons/day generated from the smelter, steel will be collected and transferred to a number of units for export, reuse as raw materials for production (MTV Xuan Phuoc Co., Ltd located in Dong Nai, Vuong Anh CO., Ltd located in Thai Nguyen Province, Viet Phat Corporation invested import and export trade in Hai Phong, EWIC Co. and EG Cooperation company in Korea. Particularly Dông Tien smelter, rolling is kept at the plant for reuse.

+ For slag: Total For slag 57 tons/day generated from companies using fuel such as coal: Bunge VN Ltd - Phu My I Industrial Zone, CCN Boomin Vina - My Xuan Commune, Eclat FABRICS Co., Ltd - My Xuan A2 Industrial Zone, Tong Kong CO., Ltd - My Xuan A2 Industrial Zone, Phu My Plastic Chemical Company – Cai Mep Industrial zone. In recent years, the volume of coal slag arising from the above unit was transferred to a number of units collected and processed as: KBEC VINA Co., Ltd. (waste treatment centers focus 100 ha), Trang Anh CO., Ltd (Tan Thanh district), Thuy Trieu Phat CO., Ltd (Long Thanh district, Dong Nai Province), Thuan Hai Company (District 7, Ho Chi Minh City), cooperative integrated environmental services Dong Hoa (Town. Di An, Binh Duong province). In addition, My Xuan ceramic tile factory, Tan Thanh district also uses a portion of coal ash as a raw material for mixing brick production.

– Hazardous waste: As of now there are 12 home practice management hazardous waste in the province. Of these 04 units practicing transportation and handling of hazardous waste (Department of Natural Resources license: Song Xanh CO., Ltd; General environmental licensing: Sao Viet environment corporation, Ha Loc Co., Ltd, Dung Ngoc CO., Ltd) and and 8 units operating hazardous waste transportation (Department of Natural Resources license: Company services oil port, Quy Tien CO., Ltd, bay Tuong private enterprise,Thanh Danh private enterprise, Vietsovetro Joint Venture; General environmental licensing: Hung Giang CO., Ltd, Bao Ngoc corporation Green Environment, PTSC Marine ships oil and gas services).

Currently, the amount of hazardous waste was plants in the province collected and processed at about 135 tons/day including: Song Xanh CO., Ltd, Sao Viet environment corporation, Ha Loc Co., Ltd. The volume of hazardous waste remaining is collected and processed at the unit as: Moi Truong Xanh CO., Ltd (HCM), Viet Xanh environment corporation (Binh Duong), Tan Phat Tai Co., Ltd (Dong Nai), Tuong Sang CO., Ltd (Tien Giang).

– For medical waste: Ba Ria - Vung Tau province has invested in 09 medical waste incinerators for hospitals and medical centers to handle the wastes directly generated and support the collection and disposal of medical waste generated from the station health and private health facilities. Statistically hazardous waste in the health sector about 600 kg/day is handled by burning spot, but only 02 large provincial hospitals (B a Ria Hospital and Le Loi Hospital) is invested 02 medical waste incinerators HOVAL produced by Switzerland to handle with a capacity of processing about 200 kg/batch during the period from 6 to 8 hour. The medical waste generated rest of health centers in the provincial, private health facilities in the province are not collected and handling regulations are mostly handled manually by burning.

To ensure sufficient resources to treat the solid waste generated in the province, province is currently allocated for Planning and Investment to build criteria call for economic institutions capable of investment 01 projects furnace dust processing, ensure project put into operation in 2014.

1.2. AMOUNT OF INDUSTRIAL SOLID WASTE, HAZARDOUS WASTE AND MEDICAL WASTE COLLECTED, TREATED AND DISPOSED

Currently, the total amount of solid waste generated in the city of Ho Chi Minh. Dong Nai, Binh Duong, Ba Ria - Vung Tau, Long An is 16,623.1 tons/day (In which, HCMC - approximately 8,000 tons/day, Binh Duong - approximately 2,004.9 tons/day, Dong Nai approximately 2,698.0 tons/day, Long An approximately 2,241.1 tons/day, Ba Ria - Vung Tau is about 1,679.1 tons/day) (See Table 1.13 and Appendix 5).

Table 1.13. The volume of solid waste generated in Ho Chi Minh City and neighboring provinces

No.	**Province**	**Non-hazardous waste (ton/ day)**				**Hazardous waste (tons/day)**			**Total (Tons/day)**
		DA	**ID**	**HC**	**Total**	**ID**	**HC**	**Total**	
01	HCM City	5,694.4	1,976.0	10.2	7,680.6	316.0	3.4	319.4	**8,000.0**
02	Binh Duong	947.0	883.0	4.7	1,834.7	169.0	1.2	170.2	**2,004.9**
03	Dong Nai	1,361.0	1,206.0	4.5	2,571.5	125.0	1.5	126.5	**2,698.0**
04	Long An	1,099.0	937.0	0.6	2,036.6	204.0	0.5	204.5	**2,241.1**
05	Ba Ria – Vung Tau	742.0	726.3	1.8	1,470.1	208.4	0.6	209.0	**1,679.1**
	Total	***9,843.4***	***5,728.3***	***21.8***	***15,593.5***	***1,022.4***	***7.2***	***1,029.6***	**16,623.1**

Note:

- *DA:Domestic Activitiy*
- *ID : Industrial Activity*
- *HC: Health Care*

The volume of waste typically generated approximately 15,593.5 tons/day in that volumes of domestic waste generated approximately 9,843.4 tons/day accounting for 59.21% of the total amount of waste, non-hazardous industrial waste generated approximately 5,728.3 tons/day, non-hazardous medical waste is approximately 21.8 tons/day.

Hazardous waste generated from industrial activities and health care activities generate a relatively large amount of waste, on average 1,029.6 tons/day. In this volume of industrial solid waste hazardous approximately 1,022.4 tons/day, the volume of hazardous waste generated from healthcare activities about 7.2 tons/day.

Ho Chi Minh City is the locality with largest volumes of solid waste generated. On average, approximately 7,680.6 tons of non-hazardous waste and 319.4 tons of hazardous wastes are discharged every day. In which the total volume of hazardous and non-hazardous waste, generated from industrial sectors is around 2,392 tons/day.

Ba Ria Vung Tau province has the smallest volume of waste generated in the 5 provinces and cities surveyed. However, the proportion of hazardous waste accounted 12.45% of the total waste generated in the province, which is higher those from other provinces (HCMC 4.94%, 8.49% Binh Duong, Dong Nai 4.69%, Long An 9.13%).

With the amount incurred 16,623.1 tons/day, in which the volume of waste generated from the industrial production and healthcare activities was 6,779.7 tons/day. This is a relatively large number, which have to be collected and incinerated.

The total amount of solid wastes is collected and disposed in Ho Chi Minh City and neighboring provinces is presented in Table 1.14.

Table 1.14. The volume of solid waste collected and disposed in Ho Chi Minh City and neighboring provinces

Province	Non-hazadous wastes (ton/day)				Hazardous wastes (ton/day)			Total (ton/day)
	DA	ID	HC	*Total*	ID	HC	*Total*	
HCM City	5,549.6	592.8	10.2	*6,152.6*	316.0	3.4	*319.4*	6,472.0
Binh Duong	710.0	264.9	4.3	*979.2*	25.4	1.1	*26.4*	1,005.7
Dong Nai	1,176.0	1,206.0	4.5	*2,386.5*	106.4	1.5	*107.9*	2,494.4
Long An	802.3	625.7	0.6	*1,428.5*	204.0	0.5	*204.5*	1,633.0
Ba Ria – Vung Tau	571.3	726.3	1.4	*1,299.0*	208.4	0.6	*209.0*	1,508.0
Total	8.809,2	2.209,7	21,0	*12.245,8*	860,2	7,1	*867,2*	13.113,1

Note:

- *DA:Domestic Activitiy*
- *ID : Industrial Activity*
- *HC: Health Care*

The total amount of solid wastes collected and disposed is 13.113,1 ton/day, including 6,472.0 ton/day in Ho Chi Minh City, 1,005.7 ton/day in Binh Duong province, 2,494.4 ton/day in Dong Nai province, 1,633.0 ton/day in Long An province, and 1,508.0 ton/day in BR-VT province.

1.3. THE PRIVATE COLLECTION, TREATMENT AND DISPOSAL COMPANIES OF INDUSTRIAL SOLID WASTE, HAZARDOUS WASTE AND MEDICAL WASTE

1.3.1. Status of solid waste collection and processing at 25 surveyed industrial and hazardous waste collection and disposal enterprises

Surveyed results on the collection and treatment of industrial and hazardous solid waste of 25 base is clearly shown in Appendix 3 of the report.

1.3.2. Multi-criteria analysis for selection of collaborative enterprises of solid waste collection and transportation

The selection of units of the collection and transportation of waste is done by the method of multi-criteria evaluation. The criteria used to choose the basis of cooperation include: the number of vehicles, the variety of treatment methods, and the ability to cooperate (as evaluation and review of ENTEC). The choice of evaluation points based on the following criteria.

Table 1.15. Score evaluation criteria for choosing the basis of cooperation

Score	Number of Transportation	Treatment capacity (tons/day)			
		Burning	Landfill	Other treatment methods	Ability to cooperate
01	<10	<5 tons/day	<50 tons	<10 tons/day	Ability to cooperate lower profits due to differences
02	<20	<10 tons/day	<200 tons	<20 tons/day	The ability to cooperate is dominated by low handling forms
03	<30	<15 tons/day	<1,000 tons	<100 tons/day	Ability to cooperate because the average carrying capacity
04	<40	<25 tons/day	<3,000 tons	<120 tons/day	High possibility of cooperation
05	≥40	≥25 tons/ day	≥3,000 tons or more	≥120 tons/ day or more	Ability to work under conditions of actual

The multi-criteria evaluation results are shown in Appendix 4 of the report.

Name of five private companies leading in the collection, treatment and disposal of industrial solid wastes, hazardous waste and medical waste located in Ho Chi Minh City and the neighboring provinces, including Dong Nai, Binh Duong, Ba Ria-Vung Tau, Long An are as follows :

- Sonadezi J/S Service Co.;
- Vietnam Waste Solution Co.Ltd,;
- HCM City Urban Environmental Company (Citenco);
- Holcim Vietnam Cement Co.;
- Binh Duong Water Supply Sewerage Environment Co.;

The amount of waste collected, treated and disposed by 05 leading companies in one year is presented in Table 1.16.

Table 1.16. The amount of waste collected, treated and disposed by 05 leading companies in one day

No	Company's name	Capacity (tons/day)		
		Incineration	Landfill	Other disposal measures
01	Sonadezi J/S Service Co.	12.4	60	250

No	Company's name	Capacity (tons/day)		
		Incineration	Landfill	Other disposal measures
02	Vietnam Waste Solution Co.Ltd,	-	3,020	-
03	HCM City Urban Environmental Company (Citenco)	32.0	5,200	95
04	Holcim Vietnam Cement Co.	720	-	5
05	Binh Duong Water Supply Sewerage Environment Co.	98.4	420	782
	Total	**862.8**	**8,700**	**1,132**

1.4. COST OF COLLECTION, TREATMENT AND DISPOSAL OF INDUSTRIAL SOLID WASTE, HAZARDOUS WASTE AND MEDICAL WASTE

The costs of collection, treatment and disposal of industrial solid waste, hazardous waste and medical wastes are presented in Table 1.17.

Table 1.17. The costs of collection, treatment and disposal of industrial solid waste, hazardous waste and medical wastes

No.	Treatment methods	Cost (VND/kg)	Note
1	**SONADEZI SERVICE JOINT STOCK COMPANY**		
1.1	**Non-hazardous waste**		
	Burying hygienic	800 – 1,100	Depending on the composition, properties, workability of each type of waste that appropriate treatment before burying. Since then handle unit price for each type of waste.
1.2.	**Hazardous waste**		
1.2.1.	– Burying safety; – Solidification, safety burying; – Crushing, solidification, burying safe	5,500 – 18,500	Depending on the kind of waste, with each different manufacturing process, will analyze samples representative of indicators as a basis for calculating the cost of processing.
1.2.2.	Combustion method	5,500 – 18,500	
1.2.3.	Physicochemical - biological methods	7,000 – 21,000	
2	**TIEN TAI CO. LTD.**		
2.1.	**Non-hazardous waste**		
2.1.1.	Burying hygienic	3,500	Receipt of waste: non-hazardous sludge
2.1.2.	Combustion method	6,000	Receiving waste: The waste materials flammability, heat corrosion.
2.2	**Hazardous waste**		

No.	Treatment methods	Cost (VND/kg)	Note
2.2.1.	Combustion method	6,500 – 35,000	Depending on the composition and characteristics of each type of waste will be handled unit price for each type of waste.
2.2.2.	Turns solid, safety burying	9,000 – 35,000	Depending on the composition and characteristics of each type of waste will be handled unit price for each type of waste.
2.2.3.	Rinse drums, metal contaminated hazardous constituent handle	6,000	
2.2.4.	Physicochemical - Microbiological methods	3.000 – 5.000	Depending on the composition and characteristics of each type of waste will be handled unit price for each type of waste.
3	**DAI LAM SON CO. LTD.**		
	Oil Waste Recycling	1.000 – 1.500	Depending on the composition and characteristics of each type of waste will be handled unit price for each type of waste.
4	**DONG NAI URBAN ENVIRONMENT SERVICES COMPANY LIMITED**		
4.1	Combustion method:		- Only functional group gathering and processing medical waste. - Depending on the distance the waste generation facility that can handle different rates.
4.1.1.	For medical facility focused	12,279 – 13,944	
4.1.2.	For medical facility not focus	30,399 – 32,063	
5	**HOLCIM VIETNAM CO. LTD.**		
5.1.	At the same handled in cement kilns:		Depending on the composition and characteristics of each type of waste will have its application processed for each category of waste.
5.1.1.	- Solid waste:	To 6,000	
5.1.2.	- Liquid waste:	To 6,600	
6	**MOI TRUONG XANH VN JOINT STOCK COMPANY**		
6.1.	Combustion method	5,500 – 8,000	Depending on the composition and characteristics of each type of waste will be handled unit price for each type of waste.
6.2.	Chemical and physical methods	6,000 – 7,000	
6.3.	Recycling of waste grease	3,000 – 4,000	
6.4.	Turns solid, safety burying	6,000 – 11,000	
7	**THANH LAP ENVIRONMENT PROCESSING TRADE CO., LTD.**		
7.1.	Combustion method	6,000	
7.2.	Solidification method, safety burying	3,000	
7.3.	Rinse drums, metal handle contaminated hazardous constituent	1,500	
7.4.	Recycling of waste	1,500	

No.	Treatment methods	Cost (VND/kg)	Note
	grease		
7.5.	Chemical and physical methods	1,000	
7.6	The other method type	5,000	
8	**SAO VIET ENVIRONMENTAL JOINT-STOCK COMPANY**		
8.1.	Solvent waste	2,000	
8.2.	Oil, oil sludge waste	2,000	
8.3.	Battery-lead battery waste	4,000	
8.4.	Wastewater containing hazardous components	4,500	
8.5.	Flammable solid waste	5,000	
8.6.	Sludge	6,000	
8.7.	Fluorescent Lamp	12,000	
9	**TUOI SANG ENVIRONMENTAL COMPANY LIMITED**		
9.1.	Wastewater containing hazardous components	6,000 – 9,000	
9.2.	Electronic Components Waste	7,000 – 9,000	
9.3.	Hazardous sludge	7,000 – 10,000	
9.4.	Absorbents contaminated hazardous ingredients	7,000 – 10,000	
9.5.	Packaging contaminated hazardous waste	8,000 – 10,000	
9.6.	Waste oils	8,000 – 10,000	
9.7.	Paint sludge Waste	8,000 – 10,000	
9.8.	Battery - lead battery waste	8,000 – 12,000	
9.9.	Waste Ink	12,000 – 15,000	
9.10.	Fluorescent Lamp waste	15,000–25,000	
10	**BINH PHUOC XANH ENVIRONMENTAL TECHNOLOGY COMPANY LIMITED**		
10.1.	The packaging contaminated hazardous	5,000	
10.2.	Flammable wastes, high calorific value	6,000	
10.3.	The refractory waste	8,000	
10.4.	The other wastes	6,000 – 30,000	Depending on the composition and characteristics of each type of waste will have handled unit price for each type of waste.
11	**QUOC VIET ENVIRONMENTAL SCIENCE AND TECHNOLOGY**		

No.	Treatment methods	Cost (VND/kg)	Note
	COMPANY LIMITED		
11.1.	The waste from the manufacturing process, plating, rinsing and cleaning metal surfaces	1,500 – 2,000	

CHAPTER 2
PREDICTION OF AMOUNT OF INDUSTRIAL SOLID WASTE, HAZARDOUS WASTE AND MEDICAL WASTE GENERATED BY THE YEAR OF 2020 AND 2025

2.1. ANALYSIS OF SOCIO-ECONOMIC DEVELOPMENT PLAN TO THE YEAR OF 2020 AND 2025

Key economic region of the South is the most developed region in the country in both scale and efficiency; Attracted over 40% of total investment in the country; 60% of total direct investment abroad; investment-to-GDP ratio of 50%, 1.5 times higher than the national; paced economic growth higher than about 1.4 to 1.6 times the growth rate of the national average. With the development of dynamic and diverse economic region in the southern key role really motivated, boosted the economic development of the southern provinces in particular and the country in general.

Ho Chi Minh City and Binh Duong, Dong Nai, Ba Ria Vung Tau, Long An is 5 in 8 provinces and cities in the Southern Key Economic-growth Areas with the most dynamic economy of country. In parallel with the development process to create economic value, the development activities as well environmental release of large amounts of waste, especially waste arising from industrial activities. The development industrial city of Ho Chi Minh City and neighboring provinces are briefly summarized as follows:

2.1.1. Ho Chi Minh City

2.1.1.1. Current state

Until now, HCMC has 17 industrial zones was established with the total planned area of 2315.86 ha, distributed in the districts: Thu Duc District has 3 IPs - EPZ with an area of 151.04 ha, 7 District has one EPZ with an area of 300 ha; Binh Tan District has one IP with an area of 380.15 ha; Tan Phu District one IP with an area of 128.7 ha; Binh Chanh District has 2 IPs with total area of 326.51; Cu Chi District has 5 IPs with the total area of 1,237.4 ha; 2 District has one IP with an area of 124 ha; 12 District has one IP with an area of 28 ha.

Table 2.1. List of the IPs – EPZs in Ho Chi Minh City

No	IP/EPZ	Area (ha)	Rate (%)	District
01	Tan Thuan IP	300	81	7
02	Linh Trung 1 IP	62	100	Thu Duc
03	Linh Trung 2 IP	61.7	100	Thu Duc
04	Tan Tao IP	380.15	87.7	Binh Tan
05	Tan Binh IP	128.7	100	Tan Phu
06	Le Minh Xuan IP	100	100	Cu Chi
07	Vinh Loc IP	203	100	Binh Chanh
08	Tan Thoi Hiep IP	28	100	12

No	IP/EPZ	Area (ha)	Rate (%)	District
09	Northwest Cu Chi IP	208	100	Cu Chi
10	Binh Chieu IP	27.34	100	Thu Duc
11	Hiep Phuoc (Phase I) IP	311.4	91.61	Nha Be
12	Hiep Phuoc (Phase II) IP	597	6	Nha Be
13	Cat Lai II IP	124	88.74	2
14	An Ha IP	123.51	23.22	Binh Chanh
15	Tan Phu Trung IP	542.64	24	Cu Chi
16	Dong Nam IP	286.76	27.68	Cu Chi
17	Hoa Phu IP	100	11.82	Cu Chi
Total		**2,315.86**		

For scale of IPs, the average area about 136.2 ha/region. The largest IP is Hiep Phuoc Industrial Park Phase 2 in Nha Be District with an area of 597 ha, the smallest IP is Binh Chieu Industrial Park with an area of 27.34 ha. Since its establishment, the industrial park has been leased 1947.67 ha, reached for 56.36% fill rate. There are 8 IP reached the rate of 100% (Linh Trung 1, Linh Trung 2, Tan Binh, Le Minh Xuan and Vinh Loc, Tan Thoi Hiep, Tay Bac Cu Chi, Binh Chieu), 01 Industrial Park was over 90% (Hiep Phuoc Industrial Park phase 1); 3 IPs was over 70% (Tan Thuan, Tan Tao, Cat II).

In general, most of the IPs are deployed to build infrastructure proper with the approved detailed plan, although in recent years, there were times when the impact by the financial economic crisis have significantly affected to the attracting investment situation, but the investment and construction company, infrastructure business still conducting infrastructure construction-in-progress with the proposed utility such as internal transport system IPs are connected to the trunk roads of the city and the harbor, airport; water supply systems and drainage, electrical systems, telecommunications, focus sewage treatment plants , service area ... have a good meet requirements of investors domestic and abroad.

2.1.1.2. Master plan

To ensure economic growth on average in the period 2011 - 2015 to reach between 10 % - 10.5 %/year, the period from 2016 to 2020 reached 9.5 % - 10 %/year and the period 2021 - 2025 from 8.5 % - 9 %/year . GDP per capita in real to 2015 reach from 4856 - 4967 USD, to 2020 reach from 8430-8822 USD, to 2025 reach from 13,340 – 14,285 USD. GDP average period 2011 – 2020 higher than 1.5 times the average growth of the country. Industrial development - building in Ho Chi Minh City focus on the sectors has high increased value levels ; developing 04 industry groups have scientific content - technology and high value-added , ... GDP growth industry - construction in period from 2011 to 2015 averaged 8.7 % /year , period 2016 - 2020 at an average rate of 8.7 % /year and the period from 2021 to 2025 averaged 8.5 %/year.

According to Resolution No. 03/2013/NQ-HDND May 13, 2013 of the People's Council of Ho Chi Minh City on "Through the master plan of economic - social development, Ho Chi Minh City in 2020, vision 2025", to 2020 , Ho Chi Minh city has 24 Industrial Parks was established with the total planned area of 6152.8 ha, are located in the districts: Thu Duc District has 3 IPs - export Processing Zone with the area of 151.09 ha, 7 District has one export processing zone with an area of 300 ha; Binh Tan District has 3 Industrial Parks with the area of 583.33 ha ; Tan Phu District has 2 zones with the area of 195.25 ha; Binh Chanh District has 8 zones with an area of 1327.97 ; Cu Chi District has 7 zone with the total area of 1685.48 ha; 2 District has 1 zone with an area of 124 ha; 12 District has one region with an area of 28.41 ha; and 9 District has 1 zone with an area of 114 ha . IPs and EPZ Location map are shown in Figure 2.1.

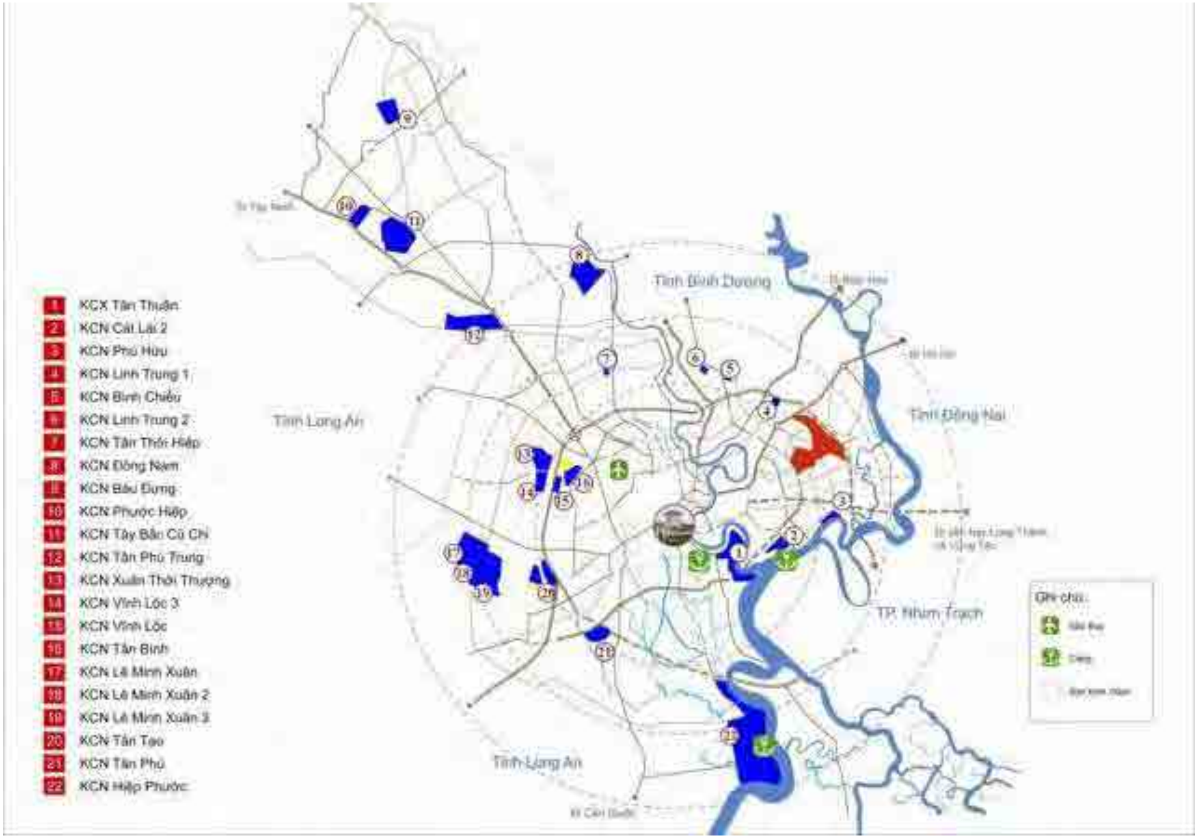

Figure 2.1. Location map of IPs and EPZs in HCMC by the year of 2020

List of planning IPs and EPZ shown in Table 2.2.

Table 2.2. List of planned IPs and EPZ to 2020 in HCMC

No	IPs/EPZ's Name	Located (Dictrict)	Planning Area (ha)
01	Tan Thuan EPZ	7 Dictrict	300.00
02	Sai Gon – Linh Trung EPZ	Thu Duc	62.00
03	Linh Trung 2 EPZ	Thu Duc	61.75
04	Binh Chieu IP	Thu Duc	27.34
05	Tan Tao IP	Binh Tan	175.57
	Tan Tao – expand IP	Binh Tan	204.58
06	Tan Binh IP	Tan Phu & Binh Tan	105.95
07	Le Minh Xuan – expand IP	Binh Chanh	120.00
08	Vinh Loc IP	Binh Tan	203.18
	Vinh Loc - expand IP	Binh Chanh	56.06
09	Tan Thoi Hiep IP	12 Dictrict	28.41

No	IPs/EPZ's Name	Located (Dictrict)	Planning Area (ha)
10	Northwest Cu Chi IP	Cu Chi	208.00
	Northwest Cu Chi – expand IP	Cu Chi	173.24
11	Cat Lai 2 - Phase 1 & 2 IP	Quận 2	124.00
12	Hiep Phuoc – Phase 1 IP	Nha Be	311.40
	Hiep Phuoc - Phase 3 IP	Nha Be	500.00
13	Tan Phu Trung IP	Cu Chi	542.64
14	Phong Phu IP	Binh Chanh	148.40
15	Phu Huu IP	9 Dictrict	114.00
16	Dong Nam IP	Cu Chi	286.76
17	Bau Đung IP	Cu Chi	175.00
18	Phuoc Hiep IP	Cu Chi	200.00
19	Xuan Thoi Thuong IP	Hoc Mon	300.00
20	Vinh Loc 3 IP	Binh Chanh	200.00
21	Le Minh Xuan 2 IP	Binh Chanh	338.00
22	Le Minh Xuan 3 IP	Binh Chanh	242.00
23	An Ha IP	Binh Chanh	123.51
24	Hoa Phu IP	Cu Chi	100.00
	Total		**6,152.80**

2.1.2. Binh Duong province

2.1.2.1. Current state

Until now, Binh Duong province has 28 industrial zones established with a total planned area of 9,093.25 ha, distributed in four districts: Di An town has six industrial zones with an area of 854.1 ha; Thuan An town has three industrial zones with an area of 694.18 ha; Ben Cat District has 9 industrial zones with an area of 4,112.93 hectares; Tan Uyen district has three industrial zones with an area of 1,839.84 and Thu Dau Mot town has 7 industrial zones (under the Binh Duong Industrial - Urban - Services Complex) with total area of 1,730.91 hectares. Location Map of IPs is shown in Figure 2.2.

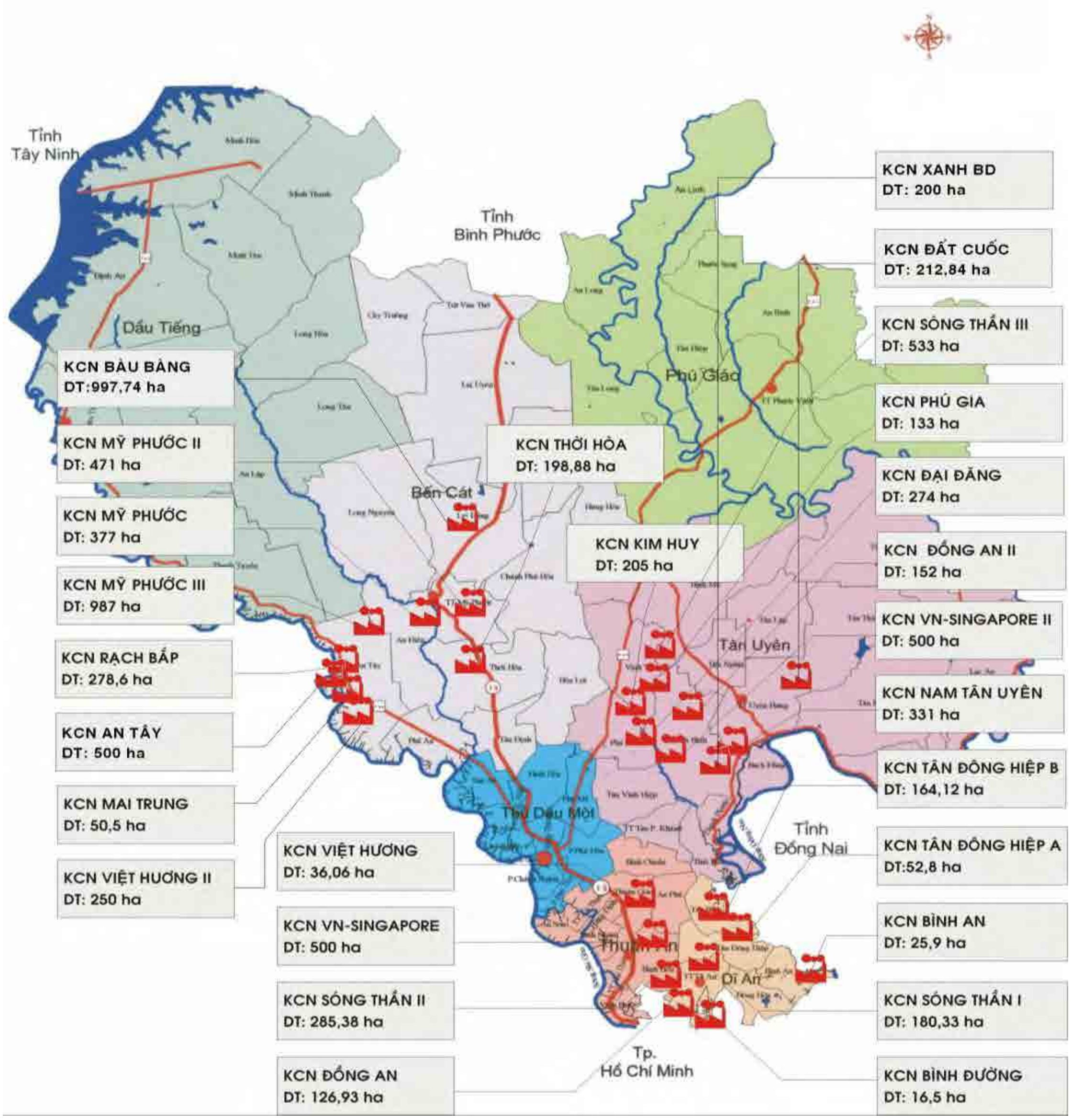

Figure 2.2. Location map of IPs in Bind Duong Province

From the first Song Than Industrial Park was established with an area of 180.33 ha (now adjusted to 178 ha), in the year of 2000 there were 8 Industrial Parks established with an area of 1,438 ha; in the period of 2001 – 2005 there were additional 7 IPs established with area of 1,652 hectares; in the period of 2006 – 2010, there were 13 new industrial zones established and expanded with an area of 6,003.25 hectares, an increase of 1.8 times in the number of Ips and 3.6 times in the area over the period 2001 – 2005. Compared to the year of 2000, the end of 2010, the number of newly established industrial zone is increased 2.5 fold and 5.3 fold increased in area.

Currently there are 24 official industrial zones in operation with a total area of 7308.85 hectares; remaining four IPs are in the period of construction (Thoi Hoa, An Tay, Mapletree, VSIP II-A) with a total area of 1,784.4 hectares. There are 19 enterprises of different economic sectors to participate in the infrastructure construction and business, including three 100% state-owned enterprises, two joint venture, 9 stock company (which 4 state owned company), 4 Company Limited (2 companies with 100% foreign capital) and one private enterprise.

Concenrning to Scale of industrial zones, the average area is esmated about 324 ha/IP. Largest Industrial Zone is VSIP II-A in Tan Uyen district with an area of 1008 hectares, the smallest IP is Binh Duong Industrial Zone with an area of 16.5 ha. Comparing to the end of 2005 year, IZ scale is increases up 1.5 times (IZ scale in the 2005 was 206 hectares/IP). Total industrial land for rent of 24 operating IPs is 4,770 hectares. Since its establishment, the industrial parks has leased 3,102 hectares, fill rate is 65%. There are 6 IPs achieved the rate of 100% (Song Than, Dong An, Viet Huong Tan Dong Hiep A, VSIP, My Phuoc 2), 4 IPs with rate of 95% or more (Song Than 2, Binh Duong, Binh An, VSIP II), 01 IPs with rate of over 90% (Nam Tan Uyen Industrial Park); 4 IPs with rate of over 70% (Dong An 2, Viet Huong 2, U.S. Phuoc Tan Dong Hiep B).

In general, most of the zones are deployed to build infrastructure in the approved detailed planning of industrial zones, although in recent years the IPs are affected by the financial and economic crisis, had no small influence on the situation calls for investment, but the infrastructure construction and investment companies, business have proceed with the construction of infrastructure, in accordance with the schedule set out with the utility such as: IPs internal transport system connected to the shaft of the province's traffic and the ports and airports; water supply and drainage system, electricity, telecommunications, centralized wastewater water treatment plant, service centers etc. has met the requirements of the domestic and foreign investors. To date, the total investment made on 7.758 billion VND and US$ 150 million; compared to the approved total investment of over 81% (Binh Duong Industrial Zone) and 87% (VSIP). VSIP II-A has completed 70% of the first phase with an investment made nearly US$100 million; Mapletree Industrial Park made over 68 million dollars.

2.1.2.2. Mater plan

Continue to attract development investment industry towards product diversification, industry focused high technology content, using domestic materials. Construction industry reached advanced level and modern, products have high competitiveness on the domestic market as well as abroad. In 2020, Binh Duong will become major industrial centers, national and regional. The value of industrial production increased by 30.6%/year in the period 2006-2010; 26%/year in the period 2011-2015 and 24.1%/year in the period 2016-2020. Increase the proportion of local content from 55% in 2010 to 60% in 2015 and 70% by 2020, reduce the rate of. Increase in concentration of high-tech industrial products. Increase the percentage of clean industries from 20% to 40% in 2010; 50% in 2015 and 60% in 2020.

Promote the development of small and medium industries, the traditional industries solve many jobs in place in rural areas and attract workers from outside the province.

Strengthen and improve the efficiency of industrial parks in the area, choosing the industries with high levels of localization. By 2020, the province is expected to have 31 industrial parks with a total area of 9,360.5 ha and 23 industrial parks with a total area of 2,704 ha.

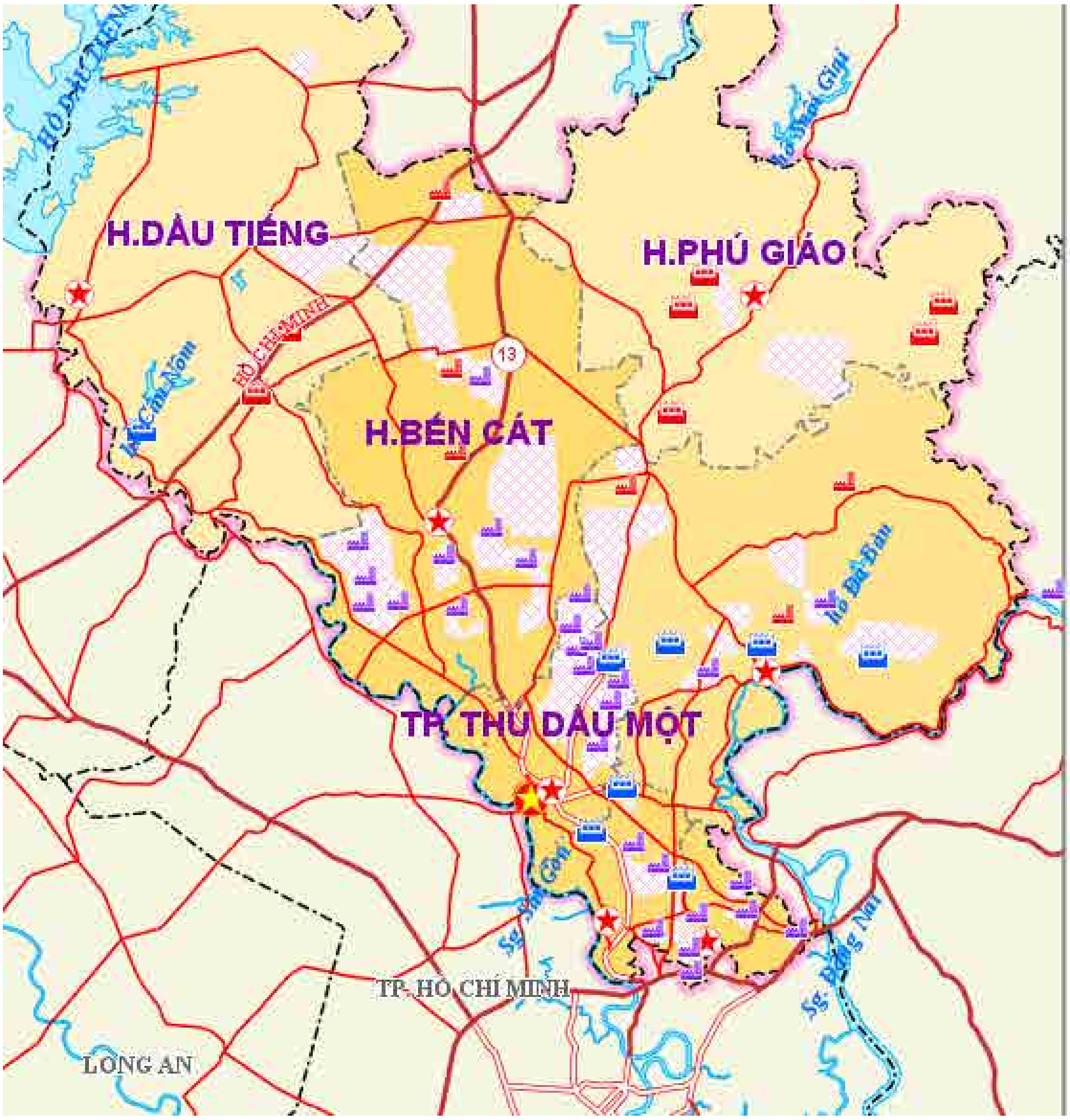

Figure 2.3. Zoning map for industrial development in Binh Duong

2.1.3. Dong Nai province

2.1.3.1. Current state

Up to December 2010, 30 industrial zones in Dong Nai had invested by 35 countries and territories. It include 1,124 projects, in which 817 foreign projects with the total investment is 12,736 million USD and 307 domestic projects with the total investment is 31,227.69 billion VND.

Table 2.3. List of planned industrial parks in Dong Nai province

NO.	INDUSTRIAL PARKS	TOTAL PLANNED (ha)	DETAILS PLANNED (ha)	NOTES
I. THE INDUSTRIAL PARK HAD DECIDED TO ESTABLISH				
01	Bien Hoa I	335	335	
02	Bien Hoa II	365	365	

NO.	INDUSTRIAL PARKS	TOTAL PLANNED (ha)	DETAILS PLANNED (ha)	NOTES
03	Amata Phase 1	760	494	
	Amata Phase 2			
04	Loteco	100	100	Including export processing zones 13 ha
05	Go Dau	184	184	
06	Ho Nai Phase 1	526	226	
	Ho Nai Phase 2		271	
07	Song May Phase 1	471	250	
	Song May Phase 2		224	
08	Nhon Trach I	2700	430	
09	Nhon Trach II		347	
10	Nhon Trach III phase 1		337	
	Nhon Trach III phase 2		351	
11	Nhon Trach V		302	
12	Nhon Trach VI		315	
13	Det May Nhon Trach		184	
14	Nhon Trach II - Nhon Phu		183	
15	Nhon Trach II - Loc Khang		70	
16	Tam Phuoc	280	323	
17	An Phuoc	400	130	
18	Long Thanh	400	488	
19	Dinh Quan	50	54	
20	Xuan Loc	100	109	
21	Thanh Phu	186	177	
22	Bau Xeo	215	500	
23	Tan Phu	60	54	
24	Agtex Long Binh		43	
25	Long Đuc	450	283	
26	Ong Keo	800	823	
27	Long Khanh	300	264	
28	Giang Đien	500	529	
29	Dau Giay	300	331	
30	Loc An - Binh Son	500	497.77	
Total			**9,573.77**	
II. THE INDUSTRIAL PARK ADJUSTMENT, EXPANDED TO 2015 (according Official Letter dated 13/10/2008 8522/UBND-CNN of the PPC; Official Letter date of number 05/06/2009 4056/BKH-QLKKT of Ministry Planning and Investment; Document number 964/TTg-KTN				

NO.	INDUSTRIAL PARKS	TOTAL PLANNED (ha)	DETAILS PLANNED (ha)	NOTES
01	Dinh Quan (Phase 2)	120	107	There had on Decision 1107
02	An Phuoc (adjustment)	71		Phase to 2015
03	Aamata (expanded)	180		Phase to 2015
04	Xuan Loc (expanded)	200		Phase to 2015
05	Tan Phu (adjustment)	76		Phase to 2015
06	Long Duc (adjustment)	130		Phase to 2015
Total		**764**		
III. THE NEW ADDITION TO THE FIVE IPS (2015-2020) (according dispatch dated 13/10/2008 8522/UBND-CNN PPC; Official Letter date of 05/06/2009 4056/BKH-QLKKT number of Ministry of Planning and Investment; Official Letter date of 06/17/2009 964/TTg-KTn number of the Prime Minister).				
01	Industrial Park - Agricultural Donataba (freeway 25- Thong Nhat district)	250		There was Prime Minister additional approval
02	Long Thanh High-Tech Industrial Park, (Tam An ,Tam Phuoc social- Long Thanh district) (in downtown 1.922ha)	500		Phase to 2015
03	Phuocc Binh (Phuoc Long - Long Thanh)	190		Phase to 2015
04	Gia Kiem (Gia Kiem - Thong Nhat)	330		150ha: Phase to 2015; 180ha: to 2015 – 2020
05	Cam My (Thua Duc - Cam My)	300		2015: 100 ha from 2015 – 2020
06	Suoi Tre IP (Suoi Tre commune & Bao Vinh - Long Khanh)	150		Phase to 2015
Total		**1,720**		
Total 36 IPs		**12,057.77**		

Source: The Management Board of industrial zones in Dong Nai Province, 4/2011

The total area of 30 Industrial Park is 9,573 ha, had filled 3,724.89 ha total area 6,338.58 ha for rent, reaching 59% of the land for rent. Estimated capital investment in building infrastructure for the industrial park until now (not including available factory-built) is about 3,897.14 billion VND and 78.71 million USD.

Total number of employees in the industrial park currently around 370,000 employees, including 5,200 foreign laborers.

Table 2.4. The situation of land for rent in Dong Nai IPs

No.	District's name	Area (ha)	Industrial land for rent (ha)	Leased (ha)	Current occupancy rate
1	**BIEN HOA CITY**	**1,337**	**958.76**	**873.25**	**0.91**
1.1.	Amata	494	314.08	229.71	0.73
1.2.	Bien Hoa II	365	261.00	261.00	1.00
1.3.	Loteco	100	71.58	71.58	1.00
1.4.	Bien Hoa I	335	284.48	284.48	1.00
1.5.	Agtex Long Binh	43	27.62	26.48	0.96
2	**NHON TRACH DISTRICT**	**3,342**	**2,248**	**1,656**	**0.74**
2.1.	Nhon Trach I	430	311.25	279.41	0.90
2.2.	Nhon Trach II	347	257.24	269.51	1.05
2.3.	Nhon Trach II – Nhon Phu	183	126.31	57.84	0.46
2.4.	Nhon Trach II - Loc Khang	70	42.54	27.00	0.63
2.5.	Nhon Trach III (Phase 1)	337	233.85	233.85	1.00
2.6.	Nhon Trach III (Phase 2)	351	227.55	94.63	0.42
2.7.	Textiles Nhon Trach	184	121.00	92.75	0.77
2.8.	Nhon Trach V	302	205.00	184.03	0.90
2.9.	Nhon Trach VI	315	220.29	0.00	0.00
2.10.	Ong Keo	823	502.82	416.83	0.83
3	**LONG THANH DISTRICT**	**1,906**	**1,345**	**572**	**0.43**
3.1.	Go Dau	184	136.70	136.70	1.00
3.2.	Long Duc	283	183.29	0.00	0.00
3.3.	Tam Phuoc	323	314.74	219.12	0.70
3.4.	KCN Long Thanh	488	282.74	215.98	0.76
3.5.	KCN Loc An – Binh Son	497.77	336.05	0.00	0.00
3.6.	KCN An Phuoc	130	91.00	0.00	0.00
4	**TRANG BOM DISTRICT**	**2,000**	**1,288**	**585**	**0.45**
4.1.	Song May IP (phase 1)	250	178.13	135.39	0.76
4.2.	Song May IP (phase 1)	224	155.87	0.00	0.00
4.3.	Ho Nai (Phase 1)	226	151.17	139.46	0.92
4.4.	Ho Nai (phase 2)	271	149.96	0.00	0.00

No.	District's name	Area (ha)	Industrial land for rent (ha)	Leased (ha)	Current occupancy rate
4.5.	Bau Xeo IP	500	328.08	306.53	0.93
4.6.	Giang Dien IP	529	324.63	4.00	0.01
5	**DINH QUAN DISTRICT**	**54**	**37.80**	**44.90**	**1.19**
5.1.	Dinh Quan IP	54	37.80	44.90	1.19
6	**XUAN LOC DISTRICT**	**109**	**63.88**	**30.85**	**0.48**
6.1.	Xuan Loc IP	109	63.88	30.85	0.48
7	**VINH CUU DISTRICT**	**177**	**124.15**	**58.15**	**0.47**
7.1	Thanh Phu IP	177	124.15	58.15	0.47
8	**TAN PHU DISTRICT**	**54**	**34.98**	**4.26**	**0.12**
8.1.	Tan Phu IP	54	34.98	4.26	0.12
9	**LONG KHANH TOWN**	**264**	**169.06**	**1.00**	**0.01**
8.1.	Long Khanh IP	264	169.06	1.00	0.01
10	**THONG NHAT DISTRICT**	**331**	**205.74**	**6.52**	**0.03**
10.1.	Dau Giay IP	331	205.74	6.52	0.03
	Total (kg/day)	**9,574**	**6,475**	**3,832**	**0.59**

Source: The Management Board of industrial zones in Dong Nai Province, 4/2011

At the industrial parks, the infrastructure systems economic technical in general pretty complete, something reaches the standard, especially roads, warehouses, water, electricity, transportation, communication and service establishments financial services, banking and insurance. The important requirement of the accelerate process of economic restructuring, social labor structure is build and upgrade infrastructure systems. IPs, EPZs is the breakthrough, the optimal models for building infrastructure, help the accelerating the process of economic restructuring and labor towards industrialization and modernization.

At the local has industrial park, infrastructure is invested in sync and completing has helped to change the face of local, helped modernize the system of economic and social infrastructure, create favorable conditions for the promotion of investment in industrial zones, export processing zones, as well as promote the linkage of branches and regional economic, typically some provinces in the southern economic key as Dong Nai, Binh Duong ,Ho Chi Minh City.

2.1.3.2. Mater plan

Priority attracting high technology projects; and support for the development of key industries projects including mechanical engineering, electronics industry - information technology and telecommunications; cleaning and environmentally friendly industrial projects, saving materials, energy and proper with planning in accordance with the Southeast region was the Prime Minister for approval. Supporting industries projects: manufacturing parts, accessories, details of machinery and equipment ... as a basis to call and invite large corporations to invest in production of finished products; increase the percentage of local content and participate in the chain of value added products produced domestically and internationally, deficit reduction, stabilizing production and business enterprises.

Coordinate the central ministries, provinces in the south east, and the southern economic key to accelerating infrastructure construction; complete functional areas of Long Thanh Industrial Zone high-tech and specialized production areas.

Incessantly reforms administrative procedures to facilitate favorable land, infrastructure outside the fences of industrial parks to develop large-scale combinatorial of industrial - services and high technology of urban Long Thanh.

Adjusted growth rate of industrial production value (value 94) on average from 16.2 to 17.2%/year in the period 2011-2015 (Plan old: 17.5%/year) and 15-16%/year period 2016 – 2020 (plan old: 16.5%/year).

Continue priority development of fields: Industrial Mechanical; Electronics industry - information technology; Industrial biotechnology and pharmaceuticals; Chemical Industry; Industrial textile exports of consumer goods - textiles, leather - footwear; Industrial processing of agricultural and fishery food; The production of construction materials; Industrial electricity and water.

Planning diagrams adjusted industrial development in Dong Nai Province in 2020, the vision 2025 is presented on the following Figure 2.4.

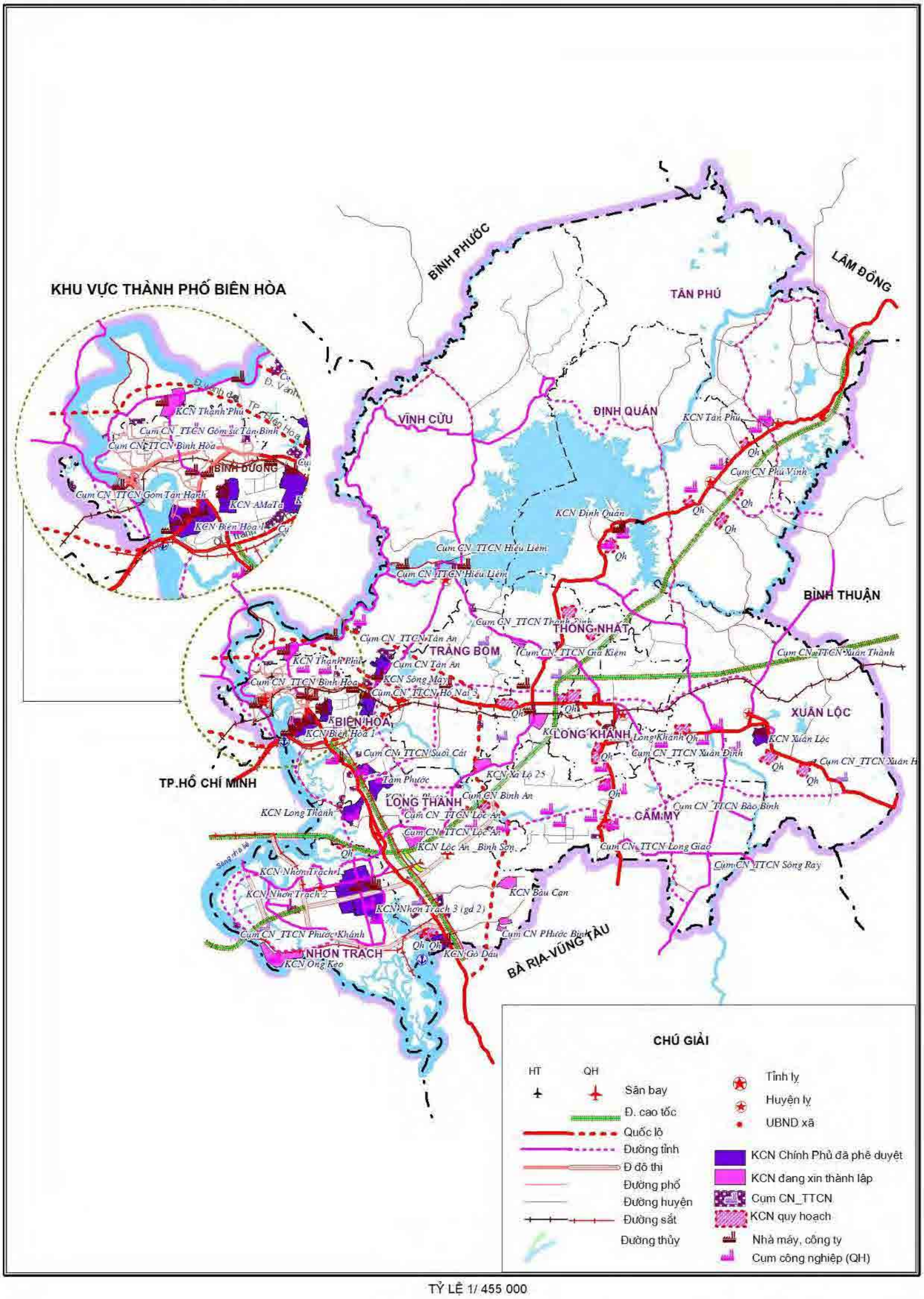

Figure 2.4. Distribution of IPs in Dong Nai province in year of 2013

(1). Development of industrial zones, specialized sectoral areas

Mobilize investors are renovating and upgrading the infrastructure of industrial zones operate for many years, building new IPs have modern infrastructure, sync in and outside the fence, there are services, utility operations serve production of enterprises and workers in industrial zones. Facilitate the development of a green industrial park, industrial park environmentally friendly, to 2015, reaching 100% of IPs operate focused wastewater treatment systems achive environmental standards. Development of industrial zones associated with building service-urban areas, apartment buildings for workers with social work services catering workers.

Adjust planned development of IPs in the province , the period to 2020 , in addition to 21 active IPs attracted investment projects, 9 IPs completed base-construction, continue to mobilize investment in building new IPs include: Phuoc Binh - Long Thanh IP (190 ha), Gia Kiem – Thong Nhat IP (330 ha), Cam My IP (300 ha) and Suoi Tre - Long Khanh IP (150 ha). Expansion of the industrial park area under planning include Amata Industrial Park, An Phuoc Industrial Park, Xuan Loc Industrial Park, Dinh Quan Industrial Park, Tan Phu Industrial park, Long Duc Industrial Park and a number of other IPs when growing conditions. In addition, the implementation of priority infrastructure investment and attract investors tech Long Thanh Industrial Park, Biotechnology Center in Cam My district, agro-industrial complex DOFICO at Xuan Loc and Thong Nhat province, the industrial park or supportive sub-zone. Striving to improve occupancy rates of the land for lease in the industrial zone to 65 % in 2015 and 80 % by 2020 .

Table 2.5. Industrial park development plan by the year of 2020

No.	**Industrial park name**	**Location**	**Area 2010 (ha)**	**Land use planning (ha)** (under Resolution No. 69 dated October 30th, 2012 of the Government)	**Reviewing additional IPs 2020**
	Total		**9.223**	**11.094**	**11.152**
1	Bien Hoa 1	Bien Hoa	335		
2	Bien Hoa 2	Bien Hoa	365	365	365
3	Loteco	Bien Hoa	100	100	100
4	Amata	Bien Hoa	527	674	674
5	Agtex Long Bình	Bien Hoa	43	43	43
6	Tam Phuoc	Bien Hoa	323	323	323
7	Bau Xeo	Trang Bom	500	500	500
8	Giang Đien	Trang Bom, Bien Hoa	529	529	529
9	Ho Nai (Phase 1)	Trang Bom	226	226	226
	Ho Nai (Phase 2)	Trang Bom, Bien Hoa	271	271	271
10	Song May (Phase 1)	Trang Bom	250	250	250

No.	Industrial park name	Location	Area 2010 (ha)	Land use planning (ha) (under Resolution No. 69 dated October 30th, 2012 of the Government)	Reviewing additional IPs 2020
	Song May (Phase 1)	Trang Bom, Vinh Cuu	224	224	224
11	Nhon Trach I	Nhon Trach	430	430	430
12	Nhon Trach II	Nhon Trach	347	347	347
13	Nhon Trach II – Nhon Phu	Nhon Trach	183	183	183
14	Nhon Trach II – Loc Khang	Nhon Trach	70	70	70
15	Nhon Trach III (phase 1)	Nhon Trach	337	337	337
	Nhon Trach III (phase 2)	Nhon Trach	351	351	351
16	Textiles Nhon Trach	Nhon Trach	184	184	184
17	Nhon Trach V	Nhon Trach	302	302	302
18	Nhon Trach VI	Nhon Trach	237	315	315
19	Ong Keo	Nhon Trach	855	823	823
20	Go Dau	Long Thanh	344	184	184
21	Long Thanh	Long Thanh	488	488	500
22	Long Duc (*)	Long Thanh	283	534	580
23	An Phuoc	Long Thanh	130	201	201
24	Tan Phu	Tan Phu	54	130	130
25	Xuan Loc	Xuan Loc	109	309	309
26	Thanh Phu	Vinh Cuu	177	177	177
27	Dinh Quan	Dinh Quan	54	161	161
28	Long Khanh	Long Khanh	264	264	264
29	Dau Giay	Thong Nhat	331	331	331
30	Loc An – Binh Son	Long Thanh	-	498	498
31	Cam My	Cam My	-	300	300
32	Phuoc Binh	Long Thanh	-	190	190
33	Suoi Tre	Long Khanh	-	150	150

No.	Industrial park name	Location	Area 2010 (ha)	Land use planning (ha) (under Resolution No. 69 dated October 30th, 2012 of the Government)	Reviewing additional IPs 2020
34	Gia Kiem	Thong Nhat	-	330	330

Table 2.6. Specialized sectoral areas development plan by the year of 2020

No.	Specialized areas	Location	Land use planning (ha) (under Resolution No. 69 dated October 30th, 2012 of the Government)	Reviewing additional IPs 2020 (ha)
01	Long Thanh Hi-tech Industrial Park	Long Thanh	420	410
02	Agro-industrial complexes DOFICO	Thong Nhat, Xuan Loc	2,187	-
03	Centre for Biotechnology	Cam My	253	253

(2). Development of industrial clusters

To encourage and support enterprises to invest manage and construction operation of industrial clusters in the planning and construction of industrial clusters have compatible technical infrastructure of power supply, water supply, drainage, traffic ensure environmental conditions and infrastructure connectivity in IC and outsite IC. Prioritize, to facilitate the production of small and medium industries, handicraft production causes environmental pollution transfer in industrial clusters.

Interested necessary conditions for enterprises, production facilities operating in the industrial clusters, developing the capabilities, expand production, increase competitiveness of product, encourage enterprises to apply pollution prevention methods for environmental protection in production.

Implementing Directive dated March 2nd, 2012 07/CT-TTg of the Prime Minister, through review the situation planning and infrastructure development of industrial clusters in the province adjust the plan for 2025 has 37 industrial clusters with a total area of 1943.2 hectares including 36 industrial clusters (1,913.2 ha) keep adding planning and addtional industrial clusters Bau Tram (30 ha) in Long Khanh town to serving for relocated of polluting environment production . Removed from the plan 04 industrial clusters (total area of 209.8 hectares) includes: Long Phuoc 2 (34.8 hectares) of land planning move to the fringes service airport in Long Thanh International ; Binh An (50 ha) due to difficulties in the process of rubber plantation land compensation ; Song Thao (50 ha) due to difficulties paddy land compensation ; Gia Kiem Socklu 2 (75 ha) due to development planning Gia Kiem - Socklu ICs 1 (75 ha), so the formation of Gia Kiem - Socklu 2 is not necessary. Besides, 06 clusters development of cottage industries handicraft villages with a total area of 20.6 ha.

Table 2.7. Industrial clusters development plan by the year of 2020 and after 2020

No.	Inductrial clusters	Location	Land use planning (ha) (under Resolution No. 69 dated October 30th, 2012 of the Government)	Reviewing industrial cum 07/CT-TTg Directive No. of the Prime Minister	Progress of infrastructure investment
I	**Development planning 2015 14 ICs (838.1 ha), of which 5 ICs (291.5 ha) has been investing in infrastructure, 9 ICs (546.6 ha) is looking for investment in infrastructure story**				
01	Construction Materials Ho Nai Ics	Ho Nai 3 communes, Trang Bom District	50	50	There completed infrastructure and filling area.
02	ceramics Tan Hanh	Tan Hanh communes, Bien Hoa District	54.5	54.5	There completed infrastructure and filling area.
03	Phu Thanh – Vinh Thanh	Vinh Thanh communes Nhon Trach District	94	94	Already have investment projects. There are investing in infrastructure.
04	Construction Materials Tan An	Tan An communes Vinh Cuu District	50	50	Being compensation for agreements and infrastructure
05	Phu Cuong	Phu Cuong communes Dinh Quan District	43	43	Being compensation for agreements
06	Doc 47	Tam Phuoc communes, Bien Hoa City	98	97.6	There is calling for investment in infrastructure
07	Tam Phuoc 1	Tam Phuoc communes, Bien Hoa City	57	57	Already have investment projects. There are investing in infrastructure.
08	Thien Tan-Thanh Phu	Thien Tan – Thạnh Phú communes, Vinh Cuu	96.5	96.6	Already have investment projects. There are investing in

No.	Inductrial clusters	Location	Land use planning (ha) (under Resolution No. 69 dated October 30th, 2012 of the Government)	Reviewing industrial cum 07/CT-TTg Directive No. of the Prime Minister	Progress of infrastructure investment
		District			infrastructure.
09	Thien Tan	Thien Tan communes, Vinh Cuu District	75	75	Being prepared the planning documents
10	Tam An	Tam An communes Long Thanh District	60	59.9	There are investing in infrastructure.
11	Thanh Binh	Thanh Binh communes Trang Bom District	49	48.7	There is calling for investment in infrastructure
12	A Ho Nai 3 – Hung Thuan	Ho Nai 3 communes, Trang Bom District	40	40	Being compensation for agreements
13	Hung Loc	Hung Loc communes, Thong Nhat District	42	41.8	Being prepared the planning documents
14	Phu Thanh	Phu Thanh communes, Tan Phu District	30	30	Being prepared the planning documents
II	**Phase 2016 - 2020: continued investment in infrastructure deployment industrial complex 13 (655.3 ha) comprising 12 ICs had 01 additional (Bau Tram ICs). Specifically include the following industrial groups:**				
15	Quang Trung	Quang Trung communes, Thong Nhat District	80	80	Being compensation for agreements
16	Gia Kiem – Socklu	Socklu communes, Thong Nhat District	75	75	Being prepared the planning documents
17	Tan An	Tân An communes, Vinh Cuu District	50	50	Being prepared the planning documents
18	Long Phuoc	Long Phuoc communes,	75	75	There is calling for investment

No.	Inductrial clusters	Location	Land use planning (ha) (under Resolution No. 69 dated October 30th, 2012 of the Government)	Reviewing industrial cum 07/CT-TTg Directive No. of the Prime Minister	Progress of infrastructure investment
		Long Thanh District			in infrastructure
19	Binh Son	Binh Sơn communes, Long Thanh District	57	57	Already have investment projects. There are investing in infrastructure.
20	Long Giao	Long Giao communes, Cam My District	57	57	There is calling for investment in infrastructure
21	Tri An	Trị An communes, Vinh Cuu District	49	48.8	There is calling for investment in infrastructure
22	Construction Materials Phuoc Binh	Phuoc Binh communes, Long Thanh District	75	75	Already have investment projects. There are investing in infrastructure.
23	Hung Thinh	Hung Thinh communes, Trang Bom District	35	35	There is calling for investment in infrastructure
24	Xuan Hung	Xuan Hung communes, Xuan Loc District	19	19	There is calling for investment in infrastructure
25	Suoi Cat	Suoi Cat communes, Xuan Loc District	20	20.5	There is calling for investment in infrastructure
26	Phu Vinh	Phu Vinh communes, Dinh Quan District	33	33	There is calling for investment in infrastructure
27	Bau Tram	Bau Tram communes, Long Khánh District	30	30	There is calling for investment in infrastructure

No.	Inductrial clusters	Location	Land use planning (ha) (under Resolution No. 69 dated October 30th, 2012 of the Government)	Reviewing industrial cum 07/CT-TTg Directive No. of the Prime Minister	Progress of infrastructure investment
III	**Phase after 2020: Deployment of infrastructure investment 10 industrial clusters (449.8 ha) including 6 ICs including planning and planning additional 4 new Ics**				
28	An Vien ICs	An Vien communes, Trang Bom district	50	50	
29	Song Ray ICs	Song Ray communes, Cam My District	50	50	
30	Cọ Dau ICs	Xuan Dong communes , Cam My District	50	50	
31	Vinh An ICs	Vinh An communes, Vinh Cuu District	50	50	
32	Vinh Tan ICs	Vinh Tan communes, Vinh Cuu District	55	54.8	
33	Phu Tuc ICs	Phu Tuc communes, Dinh Quan District	50	50	
34	Gia Tan 1&2 ICs	Gia Tan communes, Thong Nhat District	-	75	
35	Phu Trung ICs	Phu Trung communes, Tan Phu District	-	30	
36	Phu Loc ICs	Phu Loc communes, Tan Phu District	-	20	
37	Phu Lap ICs	Phu Lap communes, Tan Phu District	-	20	
	Toatal		**1,799**	**1,943.2**	

2.1.4. Long An province

2.1.4.1. Current state

As of November 2013, province has 28 industrial zones (adjusted for dispatch No. 463/TTg-KTN dated March 28th, 2013 of the Prime Minister on approving the adjustment of industrial planning issued with a list of planned industrial development Long An province in 2020) province has 28 industrial zones located in the industrial zone development planning of the country until 2015 and orientation to 2020, with a total area of 10,216.16 hectares with 49 investment projects in industrial zone (IZ projects including extensions) and 39 all infrastructure investment (Duc Hoa III Industrial Park has 13 investment projects IZ), including 3 industrial enterprises by foreign investors for investment in infrastructure ownership.

In the province's 28 industrial zones have been established 19 industrial zones with a total area of 5,805.76 hectares: Duc Hoa I Industrial Zone, Xuyen A, Tan Duc, Tan Do, Hai Son, Vinh Loc 2, Nhut Chanh, Phu An, Thanh Thinh Phat, Thuan Dao, Cau Tram, Phuoc Dong Pier, Tan Kim, Long Hau, Dong Nam A, An Nhut Tan, Long Hau – Hoa Binh, Phuc Long, and a number of IPs Duc Hoa Industrial Park III (Duc Hoa III-Minh Ngan, Resco, Song Tan, Thai Hoa, Hong Dat, Anh Hong, Slico, Viet Hoa, Lien Thanh, Cali Long Duc, Muoi Day, Long Viet), in total 24 IPs have been granted investment certificates with a total area of 8242.49 hectares, with a total investment of 77.06 million dollars and 34,111.68 billion IPs occupancy rate reached 20.04%, if private IPs operate the occupancy rate reached 43.88%.

Currently, the province has had 16 active IPs with a total area of 3,996.43 hectares including: Duc Hoa I Industrial Zone, Xuyen A, Tan Duc, Thuan Dao, Nhut Chanh, Tan Kim, Long Hau, Cau Tram, Phu An Thạnh, Vinh Loc 2, Thinh Phat, Tan Đo, Hai Son, Long Hau – Hoa Binh, Phuc Long and a number of IPs Duc Hoa Industrial Park III (Thai Hoa, Viet Hoa, Anh Hong, Hong Đat, Resco).

Cumulative from inception to the present Board, attracted 760 investment projects, 1,226.47 hectares of land have been leased, including 251 foreign investment projects capitalized at U.S. $ 1,685.135 million and 509 domestic investment projects capitalized at VND 27,228.9. Of these 127 projects subleased premises in industrial zones with a total area of 387,973 m^2.

To date, there are 360 active enterprises in total enterprises, including 145 projects with foreign investment and 215 investment projects in the country, concentrated mainly in Duc Hoa I Industrial Zone, Tan Đuc, Xuyen A, Thuan Dao, Nhut Chanh, Long Hau, Phu An Thanh, Hai Son, Thinh Phat, Tan Do, Tan Kim, Cau Tram, Duc Hoa III-Thai Hoa, Duc Hoa III-Anh Hong, Đuc Hoa III- Hong Dat, Duc Hoa III-Viet Hoa.

Table 2.8. List of IPs in Long An province

No.	Name IPs	Year of Establishment	Location	Area (ha)	Occupancy rate (%)
1	**Duc Hoa 1 IP –Hanh Phuc: Duc Hoa Dong commune, Duc Hoa district.**				
	Phase 1	1999	Duc Hoa district	70	100
	Phase 2	2005	Duc Hoa	204.23	30.33

No.	Name IPs	Year of Establishment	Location	Area (ha)	Occupancy rate (%)
			district		
2	**Xuyen A Ip: My Hanh Bac commune, Duc Hoa district**				
	Phase 1	1997	Duc Hoa district	50	100
	Phase 2	2002	Duc Hoa district	255.9157	39.95
3	Thuan Dao IP		Ben Luc District	113.9472	100
	Thuan Dao Industrial Park expansion	2011	Can Duoc district	198.8430	0.75
4	**Tan Duc IP: Duc Hoa Ha Commune, Duc Hoa district**				
	Phase 1	2004	Duc Hoa district	273	90
	Phase 2	2008	Duc Hoa district	270.3536	51.66
5	Tan Kim IP	2004	Can Giuoc district	104.1	66.85
	Tan Kim IP expansion	2013	Can Giuoc district	52.488	0
6	Vinh Loc 2 IP	2005	Ben Luc District	225.9850	20.17
7	Long Hau IP		Can Giuoc district	141.85	97.83
	Long Hau IP expansion	2009	Can Giuoc district	108.48	26.81
8	Cau Tram IP	-	Can Duoc district	77.8227	15.71
9	**Duc Hoa III IP**				
	Thai Hoa	2008	Duc Hoa district	100.2722	41.61
	Hong Dat	2008	Duc Hoa district	100.0293	16.69
	Anh Hong	2008	Duc Hoa district	55.2416	33.96
	Viet Hoa	2008	Duc Hoa district	83.2151	66.86
10	Nhut Chanh IP	-	Ben Luc District	125.27	70.67
11	Phu An Thanh IP	2009	Ben Luc District	307.23	22.06
12	Phuc Long IP	2011	Ben Luc District	78.4146	21.24
13	Thinh Phat IP	2011	Ben Luc District	73.3717	69.26

No.	Name IPs	Year of Establishment	Location	Area (ha)	Occupancy rate (%)
14	Long Hau – Hoa Binh IP	2012	Thu Thua District	117.67	6.26
15	Hai Son IP	2011	Duc Hoa district	366.4884	53.43
16	Tan DO IP	2011	Duc Hoa district	208.0432	13.09

Source: Industrial Zone Management Board Long An Province in 2013

IPs Location is shown on Figure 2.5.

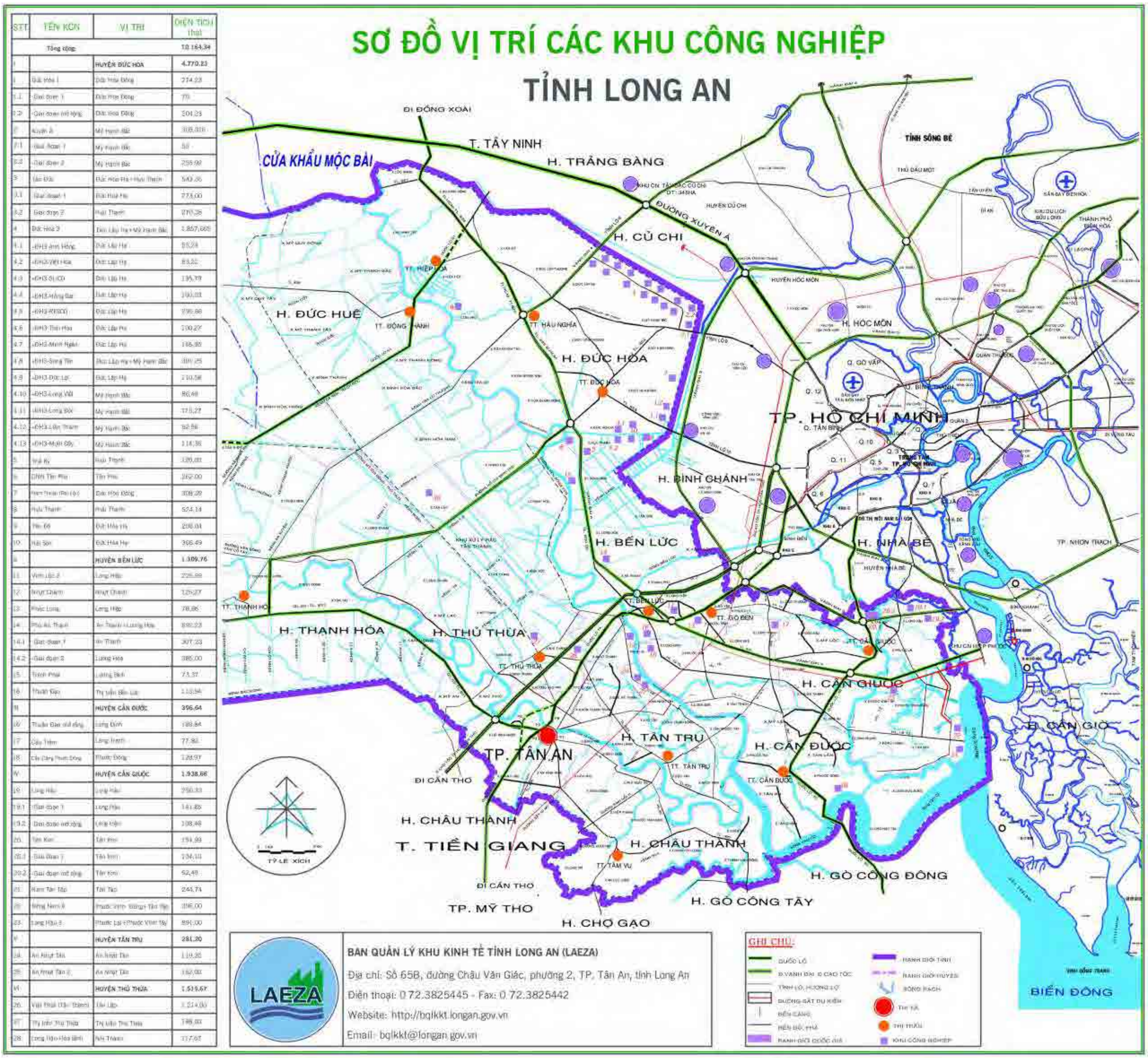

Figure 2.5. Distribution of IZs in Long An province in year of 2013

In the IZ, general infrastructure systems engineering economics rather complete, some standards, especially roads, warehouses, power, water, transport, communications and financial services establishments, banks, insurance. Accelerate the process of economic restructuring, social labor structure is first required to build and upgrade infrastructure systems. IPs, EPZs is the breakthrough point, the optimal model for building infrastructure, should have the effect of accelerating the process of economic restructuring and labor towards modernization.

At the local IPs, investing investment perfect and synchronization infrastructure has actually contributed to change the face of local, helped modernize the infrastructure system of socio-economic, creating favorable conditions for the promote investment in industrial zones, export processing zones, as well as promote economic linkages and sectoral, typically some provinces in the southern key economic as Dong Nai, Binh Duong, Ho Chi Minh City.

2.1.4.2. Mater plan

According to reports the overall planning of socio-economic development of Long An Province in 2020 was the provincial People's Council adopted Resolution No. 27/2006/NQ-HDND dated October 10th, 2006, in the future development of the province's perspective are as follows:

– Long An is on the rise, provincial target is striving to grow at a high speed, rapid increase in the number and size of industry, maximize resources, shorten the distance level of development with the provinces in the key economic Southern. Economic restructuring towards promoting the growth of the industrial sector and construction, improve the productivity, quality and modernization of agricultural production, forestry and fishery, development due to reasonable proportion to the commercial sector and service. industrial development and industrialization is the main driving force to promote high economic development of the province in the coming period

– Evelopment should be the priority, not stretched: Province needs to focus, prioritize investments prior to the industrial development because of funding limitations. When the well-developed industrial area it will contribute back to the province budget and the provincial will reallocate priorities to invest in disadvantaged areas.

– Development in integration and associated with the market : competitive stance and provincial integration is taken as a measure of effectiveness.

– Associated with regional development: The province's development associated with regional development priorities for the city of Ho Chi Minh City and the southern key economic. Exploiting the maximum advantage of the province in developing regions. Orientation Long An urban development in the general direction of urban development in Ho Chi Minh City area. Also, within the province of Long An, need to develop sub-regional harmonization.

– Economic development must go hand in hand with enhancing cultural life, spirit, implementing social justice: besides increasing focus on economies of scale in terms of quantity, to ensure the development of quality.

– Mounting social and economic development go hand in hand with the task of protecting national defense and security in the area.

– Orientation development zones and industrial clusters (residential areas, mixed urban, not clogging layout the mangrove, estuary ecology to keep, keep a reasonable distance along the national highways, expressways, arterial roads of the province). Identify sectors, the issues need to perform, the problem is not taken to ensure the direction for a fast-growing industry, in terms of sustainable land bank for industry increasingly rare (encourage the development of ICs with relevant sectors to form clusters, closely held).

– Pursuant to the requirements of development in some key areas to updateAnd supplement oriented industrial development associated with urban residential, industrial services in the province along the Vam Co River, Vam Co Dong, Vam Co Tay and gates:

+ About the east Vam Co river, Vam Co Dong: Can Duoc district additional nearly 7,000 ha (in the southwest district – approved planning tasks), Ben Luc district of about 3,000 ha, 5,800 ha Duc Hoa district (from Hau Thanh, HIep Hoa , Tan My, Loc Giang).
+ About the west Vam Co Dong river and the east Vam Co Tay river: Tan Tru district of about 1,000 ha, about 2,000 ha Thu Thua district, Thanh Hoa district of about 1,000 ha, 1,000 ha Duc Hue District, and Moc Hoa about 600 ha;
+ About the south Vam Co river, Vam Co Tay development zones and industrial clusters associated with the urban population, services industry in Chau Thanh district (about 1,500 ha in the Thuan My, Thanh Vinh Dong), Thanh Hoa;
+ For additional IPs development planning, urban industrial clusters above, Provincial policy implementation mechanisms to mobilize investment in infrastructure in the form of BT, BOT, BTO, mainly transport, water, power supply, seaports including: expansion ĐT 830, ĐT 830 extended, ĐT 824, Long Son – Tan An, Can Đươc – Chau Thanh, Can Đươc -Tan Tru, Chau Thanh-Tan Tru, Tan Tru-Thu Thua, Thu Thua-Binh Thanh, Vam Co Tay riverwalk (Thu Thua-Moc Hoa), Vam Co Dong river road (Ben Luc-Đuc Hue), parallel lines DT 830 (Ben Luc-Đuc Hoa), Water plants in Duc Hoa, Can Đươc, Tan An thermal power plants in Can Giuoc, Can Đươc, Long An port,…

Orientation planning IPs and ICs Long An province to 2020 in Table 2.9.

Table 2.9. Orientation planning of IPs/ICs in Long An Province by the year of 2020

No.	**Name IPs**	**Location**	**Planning to 2010 Approved (ha)**	**Additional Area (ha) (according Dispatch 1214/TTg-NN)**	**Zoning Adjustment to 2010 (ha)**	**Area carried out in the period up to 2020 (ha)**	**Notes**
01	Thanh Duc IP	Ben Luc district	266.7		266.7	266.7	
02	My Yen IP	Ben Luc district	132.7		132.7	132.7	
03	Vinh Loc 2 IP	Ben Luc district	459.8		459.8	459.8	
04	Khanh Dong	Ben Luc district	70		70	70	

No.	Name IPs	Location	Planning to 2010 Approved (ha)	Additional Area (ha) (according Dispatch 1214/TTg-NN)	Zoning Adjustment to 2010 (ha)	Area carried out in the period up to 2020 (ha)	Notes
	IP						
05	Luong Hoa, Tan Buu IP	Ben Luc district		415	415	415	MR
06	Tan Phuoc IP	Can Giuoc district	56		56	56	
07	Phuoc Vinh Dong IP	Can Giuoc district	110		110	110	
08	Truong Binh IP	Can Giuoc district	320	70	390	390	
09	Dong Thanh IP	Can Giuoc district	110		110	110	
10	Cau Tram IP	Can Duoc district	100		100	100	
11	Phuoc Dong IP	Can Duoc district	65.16		65.16	65.16	
12	Phuoc Dong MR IP	Can Duoc district	140		140	140	
13	Thuan Dao MR IP	Can Duoc district	879		879	879	MR
14	Caric port IP	Can Duoc district		500	500	500	
15	Thuan Ngia Hoa IP	Thanh Hoa district	250		250	250	
16	Nhon Thanh Trung IP	Tan An city	80	120	200	200	

No.	Name IPs	Location	Planning to 2010 Approved (ha)	Additional Area (ha) (according Dispatch 1214/TTg-NN)	Zoning Adjustment to 2010 (ha)	Area carried out in the period up to 2020 (ha)	Notes
17	Nhon Thanh Trung MR IP	Tan Tru district		168	168	168	

Source: Planning socio-economic development of Long An Province in 2020.

2.1.5. Ba Ria – Vung Tau province

2.1.5.1. Current state

Until now, Ba Ria – Vung Tau province has 14 industrial parks established, with 07 industrial parks has investment project in operation, including: My Xuan A, My Xuan A2, Phu My I, Phu My II, Cai Mep, My Xuan B1 – Conac, Dong Xuyen. Distribution map IPs of industrial zones in the province , status and plans to 2020 are shown in the following figure Figure 2.6.

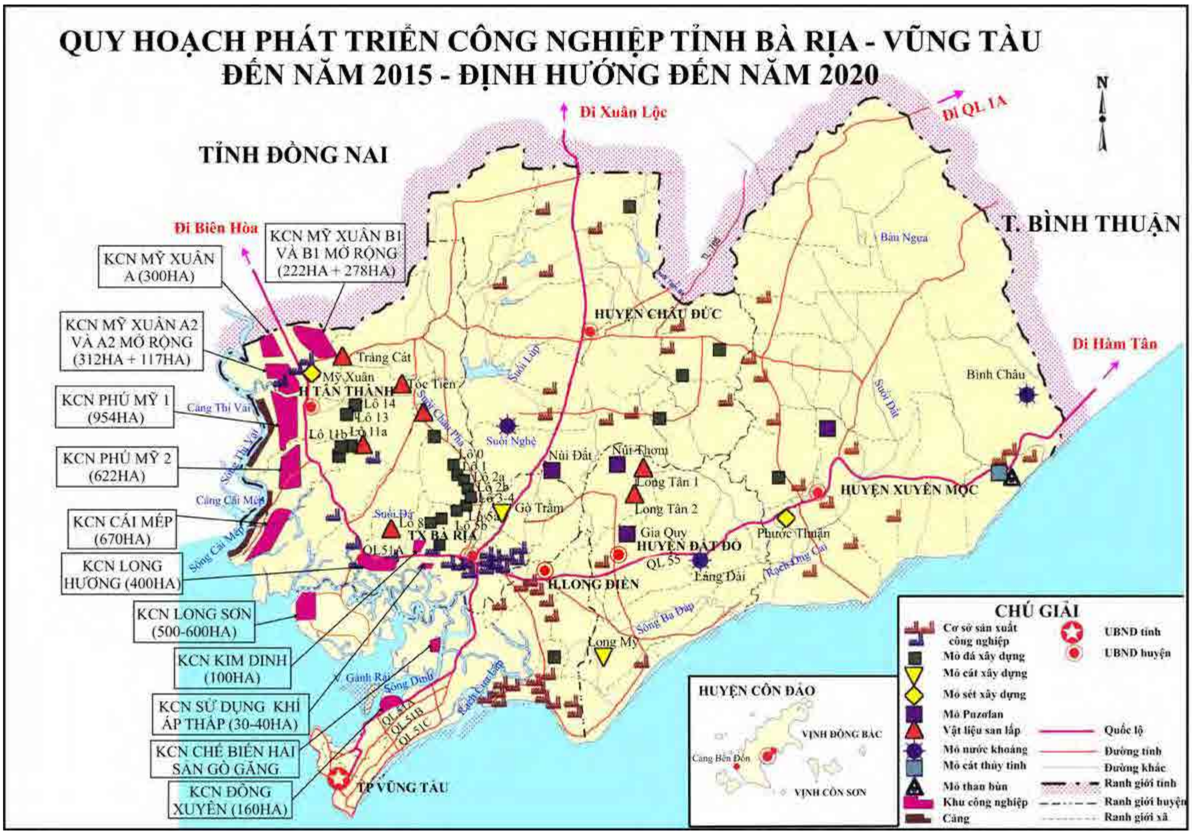

Figure 2.6. Industrial park development plan in Ba Ria – Vung Tau province by the year of 2020

2.1.5.2. Mater plan

Development of key industries on the basis of promoting the province's potentials: continue to strongly promote oil and gas exploration to increase the volume of extraction, development of service industrial, support oil and oil are used industries as materials, fule, the shipbuilding industry, industrial port services, served for shipping activities. Promote seafood processing for export and domestic consumption, noting the development of production construction materials from local materials.

Focusing complete infrastructure investment 9 industrial parks have been established to promote efficiency. Established Kim Dinh industrial zone 100 ha and High – tech zone in the Ba Ria town. Then Industrial parks occupancy rate of over 60%, Ba Ria – Vung Tau province will invest developing industrial parks: Long Huong (400 ha), Long Son (500 - 600 ha), terminals and oil services Ben Dinh (100 ha).

Ba Ria – Vung Tau province will invest development of industrial clusters, handicraft in the district, town or city to facilitate the development of small and medium businesses, industrial development for agriculture, fisheries, and rural economic development, creating jobs for local labor;

Development and distribution of industrial parks, industrial clusters based on the rational use of natural resources, labor and ensure environmental requirements;

The province will mobilize funds capital investment of economic sector at home and abroad for infrastructure development in industrial parks, industrial clusters, at the same time, budget balances to ensure coordinated development of technical infrastructure and develop a comprehensive system of social infrastructure, at the same time, budget have balances ensure coordinated development of technical infrastructure and develop a comprehensive system of social infrastructure.

2.2. PREDICTION OF AMOUNT OF INDUSTRIAL SOLID WASTE, HAZARDOUS WASTE AND MEDICAL WASTE GENERATED BY THE YEAR OF 2020 AND 2025

Forecast the total volume of industrial waste and hazardous in the area of Ho Chi Minh City and neighboring provinces is shown in Table 2.10.

Table 2.10. Forecast volume of industrial solid waste and medical incurred in 2020

No.	**Provine**	**Non-hazardous solid waste (tons/day)**			**Hazardous waste (tons/day)**			**Total (tons/day)**
		ID	**HC**	**Total**	**ID**	**HC**	**Total**	
01	HCM City	5,184.0	34.6	*5,230.1*	908.0	11.5	*908.0*	***6,138.1***
02	Binh Duong	*2,280.0*	*18.8*	*2,298.8*	*456.0*	4.7	*460.7*	***2,759.4***
03	Dong Nai	2,845.9	8.6	*2,854.4*	273.0	2.7	*275.7*	***3,130.1***
04	Long An	1,405.5	8.2	*1,413.7*	306.0	2.7	*308.7*	***1,722.4***

No.	Provine	Non-hazardous solid waste (tons/day)			Hazardous waste (tons/day)			Total (tons/day)
		ID	HC	Total	ID	HC	Total	
05	BR-VT	3,325.1	5.3	*3,330.4*	1,450.9	1.3	*1,452.2*	***4,782.6***
Total		**15,040.5**	***86.9***	***15,127.4***	***3,393.9***	***11.4***	***3,405.3***	***18,532.7***

Note : *ID: Industrial Activity*
HC: Health Care

Thus, according to the economic development of the provinces and cities, the predicted volume of industrial and hazardous solid waste is 18,532.7 tons/day. Ho Chi Minh City is the locality with the largest quantity (6,138.1 tons/day), Long An has the lowest amount of solid waste generated from domestic and industrial activities (1,722.4 tons/day).

With amount of solid waste generated only from the industrial and the health sectors in 2020 was 18,532.7 ton/day, here is a not small pressure for the waste management and environmental issues.

CHAPTER 3
ADVISING ON THE ON PROPOSAL OF SOLID WASTE INCINERATION PROJECT

3.1. ISSUES RELATED TO INCINERATOR'S SIZE

3.1.1. Advise on the size is considered suitable for the incinerator of large capacity, which will be built

Amount of combustible solid waste generated from Ho Cho Minh City and surrounding provinces is presented in Table 3.1.

Table 3.1. Amount of combustible solid waste generated from Ho Cho Minh City and surrounding provinces (year of 2013)

Province	**Non-hazadous wastes (ton/day)**				**Hazardous wastes (ton/day)**			**Total (ton/day)**
	DA	**ID**	**HC**	***Total***	**ID**	**HC**	***Total***	
Ho Chi Minh	740.3	1,247.3	6.8	1,994.3	83.4	2.3	85.7	2,080.0
Binh Duong	284.1	510.6	1.3	796.0	141.1	1.0	142.1	938.1
Dong Nai	408.3	697.4	1.2	1,106.9	104.3	1.3	105.6	1,212.6
Long An	329.7	359.0	0.1	688.9	170.3	0.46	170.8	859.6
BR-VT	222.6	420.0	0.5	643.1	174.0	0.5	174.5	817.6
Total								**5,907.9**

Note: *DA: Domestic Activitiy*
ID : Industrial Activity
HC: Health Care

The total amount of combustible solid waste generated from Ho Cho Minh City and surrounding provinces (year of 2013) is 5,907.9 tons/day, including 2,080 tons from Ho Chi Minh City, 938.1 tons from Binh Duong province, 1,212.6 tons from Dong Nai province; 859.6 tons from Long An province and 817.6 tons from BR-VT province.

Therefore, the selected capacity of 300 tons/day for the proposed project is suitable and feasible.

3.1.2. Advice and assessment of other factors as mentionned above

The proposed project's site in Thuan Dao industrial zone, Ben Luc district, Long An province is suitable. However, it is necessary to get the official permission from the People Committee of Long An province as well as from Ministry of Natural Resources and Environment (MONRE).

An other alternative site is the High-Tech Solid Waste Complex with total area of 1,760 ha, located in Thu Thua District, Long An province. The complex have been planned from the year of 2002 with total investment of 700 million USD. Vietnam Waste Solutions Company is the executing one.

3.2. REGARDING THE INVESTMENT AND OPERATION COST OF LARGE-SCALE INCINERATOR

3.2.1. Estimation of the investment cost for incinerator's installation

3.2.1.1. Introduction of several incinerators installed in Vietnam and costs

Some construction projects of industrial waste incinerators and hazardous follows:

Investment projects solid waste incinerators industrial capacity 2000kg/h, located in the complex handling of solid waste South Binh Duong, Phu Hoa Chanh Commune, Ben Cat, Binh Duong;

Investing more incinerators industrial in the complex solid waste handling South Binh Duong;

Project construction solid waste disposal stations hazardous medical HCMC. Investment rate building incinerators and corresponding investment rate capacity of 1 ton/day are shown in the following Table 3.2.

From the calculated results with corresponding investment rate capacity of 1 ton/day is 1,943,365,079 VND, we estimate the investment in the construction of the incinerator project in Table 3.3.

Table 3.2. The project to build the incinerator and the investment rate

No	Name project	Investors	Incinerator's capacity (ton/hour)	Capacity (Ton/day)	Total Investment capital (million VND)	Unit cost (million VND/Ton)
01	Investment of Industrial Waste Incinerators with capacity of 2,000kg/h located in Nam Binh Duong Solid Waste Disposal Complex in Chanh Phu Hoa commune, Ben Cat District, Binh Duong Province	BIWASE	2	16	7,300	456.250
02	Additional Investment of Industrial Solid Waste Incinerators in Nam Binh Duong Solid Waste Disposal	BIWASE	4	32	39,672	1,239.750

No	Name project	Invest ors	Incinerator's capacity (ton/hour)	Capacity (Ton/day)	Total Investment capital (million VND)	Unit cost (million VND/Ton)
	Complex					
03	Investment of Hazardous Medical Waste Incinerators in Ho Chi Minh City	CITE NCO		21	86,816	4,134.095
	Unit cost (VND/Ton)			**1**		**1,943.365**

Table 3.3. Estimation of total cost for the incinerator with capacity of 150 tons/day

Capacity of Incinerator (ton/day)	Unit cost (VND/ton)	Total Investment (VND)	Total Investment (USD)
150	1,943,365,079	291,504,761,905	13,881,179

Thus, the capacity of industrial waste incinerators and hazardous is 150 tons/day, the total investment is expected to build incinerators is 291,504,761,905 VND.

3.2.1.2. The calculation of the average colories for industrial and hazardous waste incinerator proposed by Tsuneishi

The calorific value of the waste heat generated by burning waste totally 01 kg (kcal/kg or kJ/kg). The calorific value of solid fuels, liquid formulations are Mendeleep:

$$Q\ (\text{Kcal/kg}) = 81C + 300H - 26\ (O - S) - 6(9A + W)$$

with:

+ C, H, H, O, S, A, W is the weight percentage content of the elements carbon, hydrogen, sulfur, ash, moisture in the waste;
+ Because components Cl, F, N low should be able to ignore when calculating the calorific value.

To determine the amount of heat treatment needed in furnace design and construction of Tsuneishi company based on the construction project was as follows:

(1). BIWASE's project of installation of industrial and hazardous waste incinerators with capacity of 2 tons/hour

Heat value incinerator construction of investment projects incinerator capacity of 2 tons/hour - BIWASE company is presented in Table 3.4.

Table 3.4. Calories of industrial and hazardous solid wastes incinerated in the South Binh Duong solid waste disposal complex

No.	Type of Solid Waste	Humidity waste (%)	Calorie (kcal/kg)
01	paper	11.8	4,004
02	Carton	12.0	3,894
03	Plastic	9.2	7,788
04	Fabric	13.6	4,194
05	Rubber	9.5	5,563
	Mixed Waste	**11.22**	5,088

Thus, the average heat value of the waste components that Biwase company has calculated that 5,088 (Kcal/kg).

(2). Waste Incinerator in Hai Phong province

Based on the above formula Mendeleep can calculate the amount of heat value of waste put in incinerators based on the analysis results composition of elements in waste. The composition of the volume of waste elements are presented in Table 3.5.

Table 3.5. Percentage of components in medical waste

No.	Composition	Percentage (%)	Volume element (kg/h)
01	C	50.85	101.70
02	H	6.71	13.42
03	O	19.50	39.00
04	N	2.75	5.50
05	S	2.71	5.42
06	Cl	15.10	30.2
07	Ash	1.05	2.10
08	Humidity	1.50	3.00
09	Ca	0.10	0.20
10	P	0.08	0.16
	Total	**100**	**200**

Since then we calculate the heat value for medical waste incinerators in Hai Phong City is 5,629.61 (Kcal/kg).

(3). The calculation of the average calories based on percentage of waste by type

Based on the analysis results composition of industrial solid waste Binh Duong province by type and heat specific to each type of waste calculated heat treatment average value of waste burned. The mean heat value and percentage volume of waste by type is shown in Table 3.6.

Table 3.6. The average calories calculated on the base of the waste component's percentage

No.	The composition	Percentage (%)	Heat value (Kcal/Kg)	The calorific value of 1 kg of garbage (Kcal)
01	Packaging, nylon	5.28	7,835.2	413.7
02	Sludge from waste water treatment system	0.49	500.0	2.4
03	Rubber scrap	0.86	6,051.1	51.9
04	Cardboard, shredded paper	15.40	3,894.0	599.9
05	Leather and leather products disposal	1.38	4,167.5	57.4
06	Wood chips, sawdust, shavings, wood pallets	16.57	2,880.0	477.2
07	Chemical disposal	0.20	12,166.4	24.6
08	Plastic waste	0.12	7,788.0	9.0
09	Defects (Food and Drug)	2.45	2,220.0	54.5
10	Domestic waste	36.71	2,220.0	815.0
11	Grease	0.24	6,135.4	15.0
12	Rags, scrap only	0.45	9,481.9	42.3
13	Gasoline, waste oil	0.07	9,255.0	6.5
14	Foam waste	6.72	6,000.0	403.3
15	Other	13.06	3,500.0	457.1
Total		**100**		**3,429.7**

Source: Integrated Solid Waste Management, 1993.

Thus, the average heat value incinerator is calculated 3,429.7 kcal/kg.

(4). Estimated average calories of the wastes for the proposed incinerator

Because the average heat value dependent on specific components of garbage burned, depending on the original source, generation time, the proportion of components in the garbage can of waste burned. Based on references from other incinerators, the estimated average heat value necessary for construction of the project is 3,500 – 4,500 kcal/kg.

However, to be accurate in calculating the heating value of furnace, Tsuneshi need for sampling and analysis of components in waste burned, heat treatment is expected to be ready for the incinerator project.

3.2.1.3. Estimation of the cost for landfill construction

Investment Unit Cost for Construction of the Sanitary Landfills can be estimated by on 6 existing landfills as presented in Table 3.7.

Table 3.7. Investment Unit Cost for Construction of the Sanitary Landfills

No	Project Tittle	Investors	Total capacity of the sanitary landfill (Ton)	Total Investment Cost (million VND)	Investment Unit Cost (VND/Ton)
01	Investment of Non-hazardous Industrial Waste Sanitary Landfills with capacity of 1,000 tons/day and Domestic Wastes with capacity of 700 tons/day	KBEC VINA Company Limited	1,300,000	274,998.1	211,537
02	Investment of Industrial and Domestic Waste Landfill with total area of 21.7 ha in Vinh Tan commune, Vinh Cuu District, Dong Nai Province	Dong Nai URENCO	2,355,465	392,971.351	166,834
03	Investment of Sanitary Landfill No 2 in Tay Bac Cu Chi Solid Waste Disposal Complex of Ho Chi Minh City	Management Board of Ho Chi Minh City's Environmental Improvement Project	18,210,000	793,151	43,556
04	Phuoc Hiep Sanitary Landfill of Ho Chi Minh City	Ho Chi Minh City's URENCO	4,464,000	350,000	78,405
05	Investment of Sanitary Landfill No 3 in Tay Bac Cu Chi Solid Waste Disposal Complex of Ho Chi Minh City	Ho Chi Minh City's URENCO	6,500,000	976,000	150,154
06	Investment of Centralized Solid Waste Landfill in Toc Tien commune, Tan Thanh District, Ba Ria-Vung Tau Province	KBEC VINA Company Limited	2,610,000	800,000	306,513
Average Investment Unit Cost (VND/Ton)					**159,500**

According to the calculation results in Table 3.7, the average investment unit cost to build a landfill is 159.500 VND/ton.

Total investment cost for ash and slag sanitary landfill with capacity of 100,000 tons can be estimated in Table 3.8.

Table 3.8. Estimation of total investment cost for ash and slag sanitary landfill with capacity of 100,000 tons

Capacity of the sanitary landfill (ton)	Investment Unit Cost (VND/ton)	Total Investment Cost (VND)	Total Investment Cost (USD)
100,000	159,500	15,949,982,949	759,523

From the calculation results average investment rate for the construction of solid waste landfills can envisage investment ash landfill construction of projects with volumes of 100,000 tons is $759.523.

3.2.1.4. Estimation of total investment cost of the project's construction

Total investment cost of the proposed project construction is presented in Table 3.9.

Table 3.9. Total Investment Cost for the Proposed Project construction

No	Project's components	Total Investment Cost (VND)	Total Investment Cost (USD)
01	Waste Incinerator with a capacity of 150 ton/day	291,504,761,905	13,881,179
02	Sanitary Landfill with total capacity of 100,000 tons	15,949,982,949	759,523
Total Investment Cost		**307,454,744,854**	**14,640,702**

Thus, the total estimated project construction cost is $14,640,702.

However, actual costs may vary depending on the technology incinerators and landfills, compensation for site clearance, construction of ancillary works.

3.2.2. Estimation of the operation cost for the proposed incinerator

3.2.2.1. Labor costs

The total labor costs can be estimated on the based of number of workers and their professional degrees.

The legal documents can be used for estimation of labor costs as follows :
– Decree No. 204/2004/ND-CP dated 14 December 2004 of the Government on the wage regime for officers, civil servants, officials and armed forces.
– Joint Circular No. 119/2004/TTLT-BTC-TLDLDVN dated 08 December 2004 between the Ministry of Finance and the Vietnam General Labor Confederation

guiding the fee's pay for the labor union.
– Decision 902/QD-BHXH dated 26 June 2007 of General Director of the Vietnam Social Insurance for management of social insurance, compulsory health insurance and collection.
– Decree No. 66/2013/ND-CP dated 27 June 2013 of the Government stipulated the base salary for cadres, civil servants, officials and armed forces.

The salaries for workers are presented in Table 3.10.

Table 3.10. The salaries for workers

No	Job Title/tasks	The Salary/Salary coefficient	Basic Salary (VND) (*)	Fees paid (19%) (**)	Actual Salary (VND/month)	Actual Salary (VND/day) (***)
01	Senior Researcher, Associate Professor, PhD	6.78-8/8	7,797,000	1,481,430	9,278,430	356,863
02	PhD, Senior Researcher	6.10-6/8	7,015,000	1,332,850	8,347,850	321,071
03	Engineer Level 6/ Researcher	3.99- 6/9	4,588,500	871,815	5,460,315	210,012
04	Engineer Level 5/ Researcher	3.66- 5/9	4,209,000	799,710	5,008,710	192,643
05	Technical staff	3.09-9/12	*3,553,500*	871,815	4,228,665	162,641
06	Administrative staff, secretary	2.79-9/12	*3,208,500*	799,710	3,818,115	146,851

Note :
(*)   Basic salary: 1,150,000 VND/month, valid from 1 June, 2013
(**) Fees paid : Social insurance : 15% of salary; health insurance : 2% of salary; Labor union fee : 2% of salary .
(***) Number of monthly working days is 26 days.

Survey results showed that the average wage of workers including allowances and overtime payments in 2014 reached 3,728 million/month.

In particular, the average wage that workers receive in turn from region I to region IV is: 4,358; 3,665; 3,549 and 3,153 million/month, recpectively.

3.2.2.2. Power status in the proposed project's area and the solution as needed

At the present, there is power transmission from Ben Luc substation 110/22 kV - 2 x 25 MVA through 15 KV- 22 KV line along Long Thuan Dao and Long Kim roads, which provide the electricity for Thuan Dao Industrial Zone.

3.2.2.3. Fuel price and procurement support (heavy oil A, B, recycled oil)

The fuel prices based on the Decree No 84/2009/ND-CP of the Government and Official Letter No 8328/BTC-QLG dated 23 June 2014 are presented in Table 3.11.

Table 3.11. The fuel prices

No	Expenses	Unit		Products			
				Gasoline 92	**DO 0.05S**	**Kerosine**	**FO 3,5S**
*	World price dated 26 June 2014	$/barrel, ton		123.46	123.47	123.11	622.96
01	World price (FOB) Average of 30 days	$/barrel, ton		120.02	121.19	120.45	617.27
02	Insurance fee and transportation from oversea port to Vietnam port (IF)	$/barrel, ton		2.50	2.50	3.00	30.00
03	Average sale price for 30 days (Vietcombank exchange rate)	VND/USD		21,260.73			
	Sale price (Exchange rate of Bank's union)	VND/USD		21,036.00			
04	CIF price (4=1+2)	$/barrel, ton		122.52	123.69	123.45	647.27
	Basic CIF price	VND/litter, kg		16,130	16,358	16,283	13,762
	CIF price including export tax and excise tax	VND/litter, kg		15,960	16,185	16,111	13,616
05	Import tax	Rate (%)	%	18%	14%	16%	15%
		Quantity (VND)	VND/litter, kg	2,873	2,266	2,578	2,042
06	Excise tax	Rate (%)	%	10%			
		Quantity (VND)	VND/ltt, kg	1,883			
07	The cost norm	VND/litter, kg		860	860	860	500
08	Profit	VND/litter, kg		300	300	300	300
09	Payment for Price Stabilization Fund	VND/litter, kg		300	300	300	300
10	Environmental protection tax	VND/litter, kg		1,000	500	300	300
11	VAT	VND/litter, kg		2,335	2,058	2,062	1,720
12	Basic price (12=4+5+6+7+8+	VND/litter, kg		25,681	22,642	22,683	18,924

No	Expenses	Unit	Products			
			Gasoline 92	DO 0.05S	Kerosine	FO 3,5S
	9+10+11)					
13	Present Retail Price (Petrolimex)	VND/litter, kg	25,230	22,530	22,540	18,560
14	The difference between the current retail price and the base price	%	-1,75%	-0,49%	-0,63%	-1,93%
		VND/litter, kg	-451	-112	-143	-364
15	The level use of price stabilization fund	VND/litter, kg	300	0	0	300

3.2.2.4. Unit purchase price of pharmaceutical and chemical products can be bought in Vietnam.

The market prices of pharmaceutical and chemical products in Vietnam are presented in Table 3.12.

Table 3.12. The market prices of pharmaceutical and chemical products in Vietnam

No.	Chemicals	Unit	Unit prices (VND/Unit)	Unit prices (USD/Unit)
01	Single Alum $Al_2(SO_4)_3.18H_2O$ - Al_2O_3 >14,5%	Kg	5,100	0.24
02	Iron Sulfate $FeSO_4.7H_2O$ 96%	Kg	2,800	0.13
03	Hydrochloric Acid HCl >30%	Kg	2,900	0.14
04	Iron Chloride $FeCl_3$ > 80%	Kg	25,000	1.18
05	Ammonium hydroxide NH_4OH 20%-25%	Kg	4,000-4,700	0.19
06	Superfloc A110	Kg	77,000	3.64
07	Sodium Phosphate $Na_3PO_4.12H_2O$ 96-98%	Kg	17,000	0.80
08	Hydrazine hydrate 80%	Kg	19,000	0.90
09	BP Turbinol X	Kg	63,000	3
10	Sodium hypochlorite NaClO 7% - 8%	Kg	2,900	0.14
11	Sodium chloride NaCl 94-96%	Kg	7,500	0.36
12	Aluminium Sulfate $Al_2(SO_4)_3.18H_2O$	Kg	7,000	0.35
13	Chlorine liquid 99.5%	Kg	19,700	0.94
14	PAC $(AlCl_3)n$/PAC >30%	Kg	6,700	0.32
15	Sulfuric Acid H_2SO_4 92-96%	Kg	3,800	0.18
16	Hydrazine hydrate 40%	Kg	67,200	3.2

3.3. ISSUES RELATED TO LICENSING AND PERMITTING PROCEDURES IN THE FIELD OF INDUSTRIAL SOLID WASTE DISPOSAL THAT THE COMPANY SHOULD HAVE

3.3.1. MONRE's procedures for hazardous waste management licensing

3.3.1.1. Legal documents relating to the licensing the professional hazardous waste Management

– Law on the Environmental Protection issued at November 29, 2005;
– Government Decree No. 80/2006/ND-CP issued at August 9, 2006 on detailing and guiding the implementation of some articles of the Law on Environmental Protection;
– Government Decree No. 59/2007/ND-CP issued at April 9, 2007 on solid waste management;
– Goverment Decree No. 174/2007/ND-CP issued at November 29, 2007 on environmental protection fees on solid wastes ;
– Goverment Decree No. 179/2013/ND-CP issued at November 14, 2013 on the handling of law violations in the field of environmental protection;
– Government Decree No. 21/2008/ND-CP issued at May 02, 2008 on amending and supplementing a number of articles of Government Decree No. 80/2006/ND-CP dated 09 January 08, 2006 on detailing and guiding the implementation of some articles of the Law on environmental Protection;
– Decision No 31/2014/QĐ-TTg of the Prime Minister dated at May 05, 2014 on supporting mechanisms to develop the power generation projects using solid wastes in Vietnam.
– Circular No. 12/2011/TT-BTNMT issued at April 14, 2011 of the Ministry of Natural Resources and Environment on regulating the solid waste management.

3.3.1.2. Implementation procedures

Please see the articles from No 17 to No 24 of Circular No. 12/2011/TT-BTNMT issued at April 14, 2011 of the Ministry of Natural Resources and Environment on regulating the solid waste management (See box 1).

Box 1: Sequence and Procedures for Grant or Revocation of Hazardous Waste Management Licenses and Relevant Procedures

Section 2 SEQUENCE AND PROCEDURES FOR GRANT OR REVOCATION OF HAZARDOUS WASTE MANAGEMENT LICENSES AND RELEVANT PROCEDURES

Article 17. Registration of hazardous waste management practice

1. An organization or individual that registers to practice hazardous waste management shall compile a dossier for registration of hazardous waste management practice, made according to a set form provided in Appendix 2 (A and B) to this Circular, and submit 2 (two) sets of the dossier directly or by post to the competent licensing agency under Article 4 of this Circular for examination and first-time grant of a hazardous waste management practice license. Practice-registering organizations and individuals do not have to pay any hazardous waste management practice registration fee or charge.

2. Receipt of hazardous waste management practice registration dossiers:

a/ Within 10 (ten) days after receiving a hazardous waste management practice registration dossier, the licensing agency shall examine its completeness and validity. In case the dossier is incomplete or invalid, it shall notify such to the practice-registering organization or individual for dossier modification and supplementation;

b/ Within 5 (five) days after receiving a hazardous waste management practice registration dossier already modified and supplemented as requested, the licensing agency shall examine its completeness and validity and may request further modification and supplementation of the dossier when finding it necessary. Such notification shall be made no more than thrice, except times at which the practice-registering organization or individual does not satisfy or fully satisfy requirements of the licensing agency;
c/ If the registration dossier is complete or valid, the licensing agency is not required to make notification and this dossier shall automatically be accepted upon the expiration of the examination time limit.
d/ In case the licensing agency receives a modified or supplemented registration dossier more than 6 (six) months after notifying its requirements for modification and supplementation to the latest submitted dossier, this dossier shall be examined from the beginning.
3. Trial operation of hazardous waste treatment facilities:
a/ A practice-registering organization or individual shall make a plan on trial operation of hazardous waste treatment facilities according to a set form provided in Appendix 2 (C) to this Circular and submit 2 (two) copies of the plan to the licensing agency concurrently with the practice registration dossier or at a later time;
b/ The time limit for examining a trial operation plan submitted for the first time is 10 (ten) days after the dossier is received under Point c, Clause 2 of this Article (of after the receipt of the plans after the dossier is received) and 5 (five) days for a plan modified and supplemented according to the notification of the licensing agency. The notification shall be made no more than twice, except times at which the practice-registering organization or individual does not satisfy or fully satisfy requirements of the licensing agency;
c/ Within 10 (ten) days after completing the examination of a trial operation plan, the licensing agency shall issue a written approval of such plan, made according to a set form provided in Appendix 2 (D) to this Circular. This approval shall be enclosed with 1 (one) copy of the plan appended with a certification seal by the licensing agency;
d/ After obtaining a written approval 6f the licensing agency, the practice-registering organization or individual may temporarily transport hazardous wastes and operate on a trial basis the hazardous waste treatment facility. The licensing agency may extraordinarily inspect the facility and take control samples in the course of its trial operation;
e/ After completing the trial operation, the practice-registering organization or individual shall make a report on results of trial operation of the hazardous waste treatment facility according to a set form provided in Appendix 2 (E) to this Circular and submit 2 (two) copies of the report to the licensing agency for examination. In case a report is submitted more than 6 (six) months after the issuance of the written approval, the trial operation shall be reregistered;
f/ In case a report on results of trial operation of the hazardous waste treatment facility shows an unsatisfactory or incomplete item, within 10 (ten) days after receiving the report, the licensing agency shall notify such to the practice-registering organization or individual for adjustment or completion of the facility.
Article 18. Grant of hazardous waste management practice licenses
1. In case the licensing agency is the Vietnam Environment Administration, it shall collect written comments of provincial-level Natural Resources and Environment

Departments of localities in which hazardous waste treatment facilities of practice-registering organizations or individuals are located on their agreement or disagreement with the grant of hazardous waste management practice licenses; reason(s) for disagreement or matters to be considered before the grant of hazardous waste management practice licenses.
Written requests for comments of provincial-level Natural Resources and Environment Departments must be sent not later than the written approval of trial operation plans under Point c, Clause 3, Article 17 of this Circular. Provincial-level Natural Resources and Environment Departments shall reply in writing within 25 (twenty-five) days after receiving a written request of the Vietnam Environment Administration.
2. Within 25 (twenty-five) days after receiving a report on satisfactory results of trial operation, the licensing agency shall evaluate the practice conditions and grant for the first time a hazardous waste management practice license, made according to a set form provided in Appendix 2 (E) to this Circular.
A hazardous waste management practice license is valid for 3 (three) years from the date of grant. A hazardous waste management practice license bears 1 (one) hazardous waste management identification number specified in Appendix 6 to this Circular. Two registration dossier sets appended with a certification seal by the licensing agency after they are completed constitute an integral part of 2 (two) originals of the hazardous waste management license (one set to be directly handed over or sent by post to the hazardous waste management practitioner and the other to be kept at the licensing agency).
3. In case of necessity, within 25 (twenty-five) days for evaluation of the practice conditions specified in Clause 2 of this Article, the licensing agency shall choose to carry out the following assistance activities:
a/ Forming a technical consultancy team, which is composed of environmental, waste management and treatment experts, to provide advice on the grant of hazardous waste management practice licenses. The technical consultancy team is tasked to advice and assist the licensing agency in examining the registration dossier, evaluating the practice conditions, processing technologies, results of trial operation, implementation of contents of the environmental impact assessment report and requirements to be included in the decision approving the report and other related matters;
b/ Inspecting hazardous waste treatment facilities and transportation agents for no more than 2 (two) days at each facility or agent, in combination with activities specified at Point c of this Clause;
c/ Holding meetings of the technical consultancy team with the participation of the practice-registering organization or individual and related agencies, organizations and individuals to reach agreement on requests and recommendations regarding the grant of a hazardous waste management license and to discuss and clarify unclear or unsatisfactory matters (if any);
d/ Collecting written comments of related agencies, organizations and individuals in case no technical consultancy team is formed.
4. In case the practice-registering organization or individual fails to fully satisfy the practice conditions or to fulfill requirements of the technical consultancy team and related agencies, organizations and individuals, the licensing agency shall notify such conditions or requirements to the practice-registering organization or individual for satisfaction or fulfillment.
Within 20 (twenty) days after receiving a report of a practice-registering organization

or individual on its/his/her fulfillment of requirements stated in the notice of the licensing agency, enclosed with the appropriately modified or supplemented registration dossier, the licensing agency shall consider and grant a hazardous waste management practice license.

Article 19. Extension of hazardous waste management practice licenses

1. A hazardous waste management practice license may be renewed in multiple times for validity extension, with each extension of 3 (three) years from the date of expiration of the original or previously renewed license. Registration for extension of hazardous waste management practice licenses must be made at least 3 (three) months before the expiration.

2. The sequence and procedures for compilation and receipt of dossiers for registration of extension of hazardous waste management practice licenses comply with Clauses 1 and 2, Article 17 of this Circular.

3. Within 20 (twenty) days after completing the examination of the completeness and validity of a registration dossier, the licensing agency shall consider and renew the hazardous waste management practice license according to a set form provided in Appendix 2 (E) to this Circular.

The hazardous waste management identification number shall remain unchanged The number of times of renewal includes the first-time grant and subsequent times Of renewal. Two dossier sets for registration of extension of a hazardous waste management practice license appended with a certification seal of the licensing agency upon their completion and all registration dossier sets enclosed with previously granted licenses constitute an integral part of the 2 (two) originals of the renewed hazardous waste management license (one set to be handed over directly or sent by-post to the hazardous waste management practitioner and the other to be kept at the licensing agency).

4. In case of necessity, within 20 (twenty) days for consideration and renewal of a hazardous waste management practice license under Clause 3 of this Article, the licensing agency shall choose to carry out the following assistance activities:

a/ Inspecting hazardous waste treatment facilities and transportation agents for no more than 2 (two) days at each facility or agent, in combination with activities specified at Point b of this Clause;

b/ Holding meetings with the hazardous waste management practitioner and related agencies, organizations and individuals to directly discuss and clarify unclear or unsatisfactory matters (if any);

c/ Collecting written comments of the provincial-level Natural Resources and Environment Department (in case the licensing agency is the Vietnam Environment Administration) and related agencies, organizations and individuals.

5. In case a hazardous waste management practitioner encounters problems, thus failing to fully satisfy the practice conditions specified in Chapter II, or fails to discharge the responsibilities specified in Article 26 of this Circular or fails to fulfill requirements presented- by the provincial-level Natural Resources and Environment Department and related agencies, organizations and individuals at meetings or in written comments collected under Clause 4 of this Article, the licensing agency shall notify such conditions or requirements to the hazardous waste management practitioner for satisfaction or fulfillment.

Within 15 (fifteen) days after receiving a report of a hazardous waste management practitioner on its fulfillment of requirements stated in the notice of the licensing agency, enclosed with the appropriately modified or supplemented registration dossier, the licensing agency shall consider and extend the hazardous waste management practice license.

Article 20. Modification of hazardous waste management practice licenses

1. A hazardous waste management practice license shall be modified in any of the following cases:

a/ Change or addition of type, technology, size, designed capacity, area or quantity of special-use vehicles and equipment for hazardous waste management practice;

b/ Change or addition of type of, or increase in, the hazardous waste volume to be managed;

c/ Relocation or expansion of the operation area (applicable to hazardous waste management practice licenses with an operation area covering two or more provinces);

d/ Change of the hazardous waste management practitioner without relocation of the hazardous waste treatment facility or relocation of the hazardous waste treatment facility without change of the hazardous waste management practitioner and all special-use vehicles and equipment;

e/ Addition of a hazardous waste treatment facility;

f/ Change or addition of a hazardous waste transportation agent.

2. The sequence and procedures for registration and grant of a modified hazardous waste management practice license are the same as those for the first-time grant of a license specified in Articles 17 and 18 of this Circular.

Upon completion of all procedures, the licensing agency shall grant a modified hazardous waste management practice license, made according to a set form provided in Appendix 2 (E) to this Circular, with a validity duration of 3 (three) years from the date of grant.

The hazardous waste management identification number shall be changed in case of relocation or expansion of the operation area under Appendix 6 to this Circular. The number of times of grant of the license includes the first-time grant and subsequent re-grants.

Two registration dossier sets for a modified hazardous waste management license which are appended with a certification seal by the licensing agency upon their completion and all registration dossier sets enclosed with previously granted licenses constitute an integral part of 2 (two) originals of the modified hazardous waste management license (one set to be handed over directly or sent by post to the hazardous waste management practitioner and the other to be kept at the licensing agency).

3. Trial operation under Clause 3, Article 17 of this Circular is not required in the following cases:

a/ The cases specified at Points c, d and f, Clause 1 of this Article;

b/ Addition of special-use vehicles and equipment for hazardous waste transportation, including also those for packaging, preservation, temporary storage and preliminary processing of hazardous wastes;

c/ Addition of hazardous wastes with characteristics and treatment plans similar to hazardous wastes and groups of hazardous wastes with which treatment facilities have been put into trial operation and been licensed;

d/ Increase in the volume of hazardous wastes with which treatment facilities have been put into trial operation and been licensed;

4. In case the licensing agency is the Vietnam Environment Administration, it shall

consider whether the collection of written comments of the provincial-level Natural Resources and Environment Department is necessary.
5. A hazardous waste management license cannot be modified but must be re-registered for first-time grant under Articles 17 and 18 of this Circular in the following cases:
a/ It was granted under Circular No. 12/2006/TT-BTNMT and is now converted into one under this Circular;
b/ It has an operation area within a province and was granted by a local licensing agency and is now converted into one granted by the Vietnam Environment Administration for expansion of the operation area;
c/ It has an operation area covering two or more provinces and was granted by the Vietnam Environment Administration and is now converted into one granted by a local licensing agency for narrowing the operation area to a province;
For the procedures for re-grant of hazardous waste management licenses, trial operation of a hazardous waste treatment facility under Clause 3, Article 17 of this Circular is required only for items not yet put into trial operation and licensed under Circular No. 12/2006/TT-BTNMT or this Circular.
Article 21. Procedures for certification of extension of hazardous waste management licenses granted under Circular No. 12/20067TT-BTNMT
1. At least 3 (three) months before the expiration of its hazardous waste management license, the hazardous waste carrier or treatment facility owner shall submit to the licensing agency 1 (one) written request for certification of extension of its license, which was granted under Circular No. 12/2006/TT-BTNMT, enclosed with the original license; 1 (one) report on implementation of programs and plans in the registration dossier set enclosed with-the license within 1 (one) year up to the date of submitting the written request.
2. Within 20 (twenty) days after receiving a written request for license extension certification, the licensing agency shall consider and give certification in the section for extension certification in the original hazardous waste management license. The extension must not last beyond December 31, 2015. For hazardous waste management licenses granted by the (former) Environmental Protection Department, the Vietnam Environment Administration shall give certification.
3. In case of necessity, within 20 (twenty) days for consideration and certification of extension of a hazardous waste management license under Clause 2 of this Article, the licensing agency shall choose to carry out the following assistance activities:
a/ Inspecting the establishment for no more than 2 (two) days, in combination with activities specified at Point b of this Clause;
b/ Holding meetings with the hazardous waste carrier, treatment facility owner and related agencies, organizations and individuals to directly discuss and clarify unclear or unsatisfactory matters (if any);
c/ Collecting written comments of the provincial-level Natural Resources and Environment Department (in case the licensing agency is the Vietnam Environment Administration) and related agencies, organizations and individuals.
4. In case a hazardous waste carrier or treatment facility owner encounters problems, thus failing to fully satisfy the practice conditions or to discharge the responsibilities specified in Articles 27 and 28 of this Circular, or fails to fulfill requirements set by the provincial-level Natural Resources and Environment Department and related agencies, organizations and individuals, the licensing agency shall notify such

conditions or requirements to the hazardous waste carrier or treatment facility owner for satisfaction. Within 15 (fifteen) after receiving a report of the hazardous waste carrier or treatment facility owner on its fulfillment of requirements stated in the licensing agency's notice, the licensing agency shall consider and certify the extension of the hazardous waste management license.

Article 22. Revocation of hazardous waste management licenses

1. A hazardous waste management license shall be revoked in any of the following cases:

a/A competent person defined in Articles 40, 41 and 42 of the Government's Decree No. 117/ 2009/ND-CP sends to the licensing agency a written request for revocation of the license, enclosed with documents serving as grounds for revocation, including a written record of examination, inspection or investigation; examination, inspection or investigation results; a decision on sanctioning of an administrative violation in environmental protection, or a prosecution dossier or court judgment;

b/ The hazardous waste management practitioner fails to operate 1 (one) year after being granted for the first time the hazardous waste management practice license;

c/ The hazardous waste carrier has all hazardous waste receipt and treatment contracts with the hazardous waste treatment facility owner or the hazardous waste management practitioner terminated and fails to sign a new contract or report such to the licensing agency within 1 (one) month, except the case in which the hazardous waste carrier is concurrently the hazardous waste treatment facility owner and was granted the license under Circular No. 12/ 2006/TT-BTNMT;

d/ The hazardous waste carrier fails to satisfy the practice conditions according to the roadmaps specified in Clauses 2 and 3, Article II of this Circular or fails to notify in writing the licensing agency of the satisfaction 2 (two) months after the date set for satisfaction of those conditions;

e/ The hazardous waste management license granted under Circular No. 12/2006/TT-BTNMT must be revoked after being converted into one under this Circular or from January 1, 2016, in case it is not converted;

f/ The hazardous waste management practitioner, carrier or treatment facility owner terminates the hazardous waste management operation;

g/ The local licensing agency revokes the hazardous waste management license which has an operation area within a province from an organization or individual after it/he/she is granted another hazardous waste management license by the Vietnam Environment Administration for expansion of the operation area under this Circular or Circular No. 12/2006/TT-BTNMT;

h/ The Vietnam Environment Administration revokes the hazardous waste management license which has an operation area covering two or more provinces from a hazardous waste management practitioner after it is granted another hazardous waste management license by the local licensing agency for narrowing of the operation area to a province under this Circular.

2. The licensing agency shall issue a decision to revoke the hazardous waste management license, clearly stating the grounds and reason for revocation, the hazardous waste management identification number, the date of grant and the name of the organization or individual having the license revoked.

3. Organizations and individuals that have hazardous waste management licenses revoked shall notify the revocation to and terminate all existing hazardous waste management contracts with their customers and partners.

Article 23. Examination and certification of implementation of contents of environmental impact assessment reports and requirements stated in decisions approving these reports for investment projects on hazardous waste treatment facilities evaluated and approved by the Ministry of Natural Resources and Environment

1. In case the licensing agency is the Vietnam Environment Administration:

a/Procedures for requesting, examining and certifying the implementation of contents of environmental impact assessment reports and requirements stated in decisions approving these reports (including the implementation and trial operation of environmental protection works and solutions) shall not be carried out separately but constitute part of procedures for registering hazardous waste management practice and granting hazardous waste management practice licenses under this Circular;

b/ A hazardous waste management practice license made according to a set form-provided in Appendix 2 (E) to this Circular" contains certification of the implementation of contents of the environmental impact assessment report and requirements stated in the decision approving this report (including implementation of environmental protection works and solutions) instead of a separate certificate made according to a set form;

c/ Hazardous waste treatment and disposal practice licenses already granted by the Vietnam Environment Administration under Circular No. 12/2006/TT-BTNMT are equivalent to certificates of implementation of contents of environmental impact assessment reports and requirements stated in decisions approving these reports.

2. In case the licensing agency is a local one:

a/ A hazardous waste management practice-registering organization or individual shall concurrently compile a dossier for registration of hazardous waste management practice at the local licensing agency and a dossier to request the Vietnam Environment Administration to certify the implementation of contents of the environmental impact assessment report and requirements stated in the decision approving this report (including implementation of environmental protection works and solutions) under regulations;

b/ A hazardous waste management practice-registering organization or individual shall combine the trial operation of environmental protection works and solutions proposed in its/ his/her environmental impact assessment report with the trial operation of hazardous waste treatment facilities under Clause 3, Article 17 of this Circular;

c/ The local licensing agency and the Vietnam-Environment Administration shall concurrently carry out the two procedures specified' in this Clause and separately grant hazardous waste management practice licenses and certificates of implementation of contents of environmental impact assessment reports and requirements stated in decisions approving these reports according to their competence.

Article 24. Other matters

1. Reports on and certification of satisfaction of the practice conditions:

a/ Upon satisfying the practice conditions according to the roadmaps specified at Points b, c and d; Clause 2, Article 9 of this Circular, a hazardous waste management practitioner, carrier or treatment facility owner shall report such to the licensing agency within 2 (two) months after these conditions are applied;

b/ Within 20 (twenty) days after receiving a report, the licensing agency shall consider and certify in writing the satisfaction of the practice conditions. The time limit for the licensing agency to make such written certification is 15 days after receiving the report

of the hazardous waste carrier on satisfaction of all requirements (if any) set by the licensing agency in the course of consideration.
c/ In case of necessity, the licensing agency shall inspect the establishment and special-use vehicles and equipment for no more than 2 (two) days within the time limit of 20 (twenty) days specified at Point b of this Clause.
2. The licensing agency shall notify in writing a change in or request suspension of some operations of a hazardous waste management practitioner, carrier or treatment facility owner when:
a/ There is a change in the agency contract or the contract on handover of vehicles not owned by the carrier or such contract terminates or expires without reported extension;
b/ The licensing agency bases itself on actual operations shown in periodical hazardous waste management reports, or on inspection, examination or investigation conclusions, or on prosecution dossiers or court judgments.

3.3.2. The documents related to landfill design

– TCVN 6696:2000 – Solid waste - Sanitary landfill.
– TCXDVN 261:2001 – Solid waste landfill. Design Standard.
– Joint Circular 01/2002/BKHCNMT-BXD : Environmental regulations for the siting, construction and operation of solid waste landfill
– TCXDVN 261201, 2002 on the design standards of solid waste landfills.
– TCXDVN 320:2004 - Hazadous waste landfill. Design Standard.
– Decision 13/2007/BXD Estimates Norm of collection, transportation and disposal of municipal solid waste.
– Estimates Norm of collection, transportation and disposal of solid waste in Hanoi, December 31th, 2008.
– Document No. 2272/BXD-VP dated November 10, 2008 on issued estimating norms of collection, transportation and disposal of municipal waste landfill.
– QCXDVN 01: 2008/BXD - National Standards of construction planning.
– QCVN 25:2009/BTNMT – National technical regulations on wastewater solid waste landfills
– TCVN 6696:2009 – Solid waste - Sanitary landfill - General requirements on environmental protection
– TCVN 6705:2009 – Non-hazardous solid waste – Classification
– TCVN 6707:2009 – Hazadous waste – Warning Sign.
– QCVN 07:2010/BXD - The construction of urban infrastructure.

3.3.3. The others legal documents related

– Circular 12/2011/BTNMT August 20, 2011 for practicing procedures for hazardous waste management;
– Dispatch No. 2272/BXD-VP on published estimates norm for the collection, transportation and municipal waste landfills;
– Decision No. 31/2014/QD-TTg of the development support mechanisms of power generation projects using solid waste in Vietnam;
– Decision No. 3307/QD-UBND June 30, 2011 on issued the interim norms for the solid waste handling activities at Landfill No. 2 - Phuoc Hiep waste treatment complex zone, Cu Chi District;

– Decision No.13/2007/QD-BXD on promulgating "the estimate norm of collection, transportation and disposal of municipal waste landfill".

3.4. MARKETING STRATEGY

According to the Decision No. 31/2014/QD-TTg dated 5 May, 2014 of the Government on the support mechanisms for the waste-to-energy projects using solid waste in Vietnam, the project will be supported by the Government as follows:

Article 14. Supports power prices for electricity generation project using waste

1. The electricity buyer is responsible for purchasing the entire power output from the generator project using solid waste for electricity purchase electricity at the point of delivery (excluding value added tax) as follows:
– For projects generating direct burning of solid waste is 2,114 VND/kWh (equivalent to 10.05 UScents/kWh).
– For gas-fired power generation projects recovered from solid waste landfills is 1,532 VND/kWh (equivalent to 7.28 UScents/kWh).

2. Generating projects using waste electricity prices applicable under the provisions of Paragraph 1 of this Article shall not apply price support mechanism for the power output of the project in accordance with the prevailing regulations; power purchase price adjusted for exchange rate fluctuations of VND/USD.

3. Purchase cost of electric power generation projects using solid waste was calculated and included in the full input parameters in the plan's annual electricity prices Electricity of Vietnam approved the competent authorities browse.

Besides those, the fees for solid waste incineration will be paid for the project owner.

The project owner can associate with the collection/transportation companies such as Sonadezi J/S Service Co; Vietnam Waste Solution Co.Ltd, HCM City Urban Environmental Company (Citenco); Holcim Vietnam Cement Co; Binh Duong Water Supply Sewerage Environment Co in the win-win priciple.

3.5. CAPITAL STRUCTURE DIVISION OF THE PROPOSED PROJECT

Since Vietnamese companies do not have any experience in management of waste to energy incinerator with capacity of 300 tons/day, therefore, it is better to make the joint-venture project with 51% of capital from Japanese sides and 49% of capital from Vietnamese sides.

According to the relevant law, Ministry of Natural Resources and Environment (MONRE) as one state management agency can not joint the project as one of the partners.

But the urban environment companies in Ho Chi Minh City and neighboring provinces, including Dong Nai, Binh Duong, Ba Ria-Vung Tau, Long An joint the projects as investors.

The Japanese partners may make the joint-venture with the leading collection/transportation companies such as Sonadezi J/S Service Co; Vietnam Waste Solution Co.Ltd, HCM City Urban Environmental Company (Citenco); Holcim Vietnam Cement Co; Binh Duong Water Supply Sewerage Environment Co.

CHAPTER 4
CONCLUSIONS AND RECOMMENDATIONS

4.1. CONCLUSIONS

Survey results source of waste in Ho Chi Minh City and neighboring provinces have been assessed a total volume of solid waste generated in the city of Ho Chi Minh City and neighboring provinces (Binh Duong, Dong Nai, Long An, Ba Ria - Vung Tau). The total volume of solid waste generated daily is 16,623.1 tons, including 9,843.4 tons of domestic waste and 6,779.7 tons of industrial waste and hazardous waste.

Currently the rate for collection and treatment of waste in Ho Chi Minh City and Binh Duong, Dong Nai, Long An, Ba Ria Vung Tau averaged 78.9%. The remaining 21.1% is not collected and treated because located in suburban, or sell scrap metal, or throw to the river, canal or bare land. This is a great pressure on the southern key economic region in the management of this waste.

Currently, the solid waste generated in Ho Chi Minh City and 4 neighboring provinces after collection, the majority treated with landfilling (80%). Other methods such as burning, solidification etc. accounting for about 20%.

According to economic development plan report of Ho Chi Minh City and neighboring provinces, and forecast the volume of solid waste generated, the total volume of industrial waste and hazardous waste in Ho Chi Minh City and neighboring provinces in 2020 is 18,532.7 tons/day. With the amount of enormous waste generated will cause large pressure to environmental quality if the waste is still being processed by landfill.

Foreseeing the problem of waste in Vietnam, especially in Ho Chi Minh City and neighboring provinces, Tsuneishi conducted investigations and forecast the volume of waste generated to building industrial waste and hazardous waste incineration plants capacity of 150 tons/day and burning ash landfill scale of 100,000 tons. Estimated total funding for building of plant is 14,640,702 USD.

4.2. RECOMMENDATIONS

The incineration plant capacity of 150 tons/day, the amount of water necessary to provide for the boiler operation is 300-400 m3/day was built in Ben Luc District, Long An Province. This is the local that has abundant surface water. With Vam Co Dong river systems run through, and dense network of rivers and canals. However, the area influenced by tides, so that surface water affected by acidity. Therefore, should be handle when using or use groundwater at a depth appropriate.

To assess water resources in the project area is exactly, necessary to determine projects area, survey and analysis of water samples before using water resources.

APPENDICES

3-3 ESTIMATE SHEET

INDUSTRY WASTE INCINERATOR FACLITY 150 TON/DAY

ESTIMATE SHEET

INDUSTRY WASTE INCINERATOR FACILITY
150 TON/DAY

(RK+STOKER)

11 - Sep - 14

(주)에스지이에너지
SGE ENERGY CO., LTD.

CONTENTS

ESTIMATE SHEET

Messrs.

Below is the estimate regarding the making, erection, and service of the specification attached you requested.

(주) 에스지이에너지

SGE ENERGY

SGE Energy Co., ltd.

1527-Ho, Keumkang Penterium IT B Tower,282, Kyung-ki-Do, South Korea. Hak-ui-Ro, Dong-An-Gu, An-yang-City,
TEL +82-31-450-0600 / FAX +82-31-450-0610
http:// www.sgeenergy.com

工 事 名 Project Name	:	Incinerator(RK+STOKER) making, installation construction
納 期 Delivery	:	Within 12 months after contract(consultation)
引 導 場 所 Site	:	KOREA PORT (But, insite installation construction included.)
支 佛 方 法 Payment Method	:	Down payment 30%, Middle payment 60%, Balance 10%
見積有效期間 Validity	:	Within 30 days from estimate date

見 積 番 號 Estimate No.	:	SGE-2014-004-01
見 積 日 Estimate Date	:	11-Sep.-2014
擔 當 者 Prep'd By	:	Young woon-Kim, Deputy head

合 計 金 額 Amount Total : 金壹百四拾億四阡九百四拾萬원整 (₩14,049,400,000)-(V.A.T 別途)-

番號 No	品 名 Description	規 格 Standard	單 位 Unit	數 量 Q'ty	單 價 Price	金 額 Amount	備 考 Remarks
	<SUPER HEATER STEAM>						
1	WASTE CRANE	2㎥	LOT	1		220,000,000	
2	INCINERATOR	150ton/day	LOT	1		2,749,000,000	
3	WASTE HEAT BOILER	26ton/hr	LOT	1		2,926,300,000	
4	FLUE GAS TREATMENT FACILITY		LOT	1		1,453,868,000	
5	FAN & STACK		LOT	1		341,000,000	
6	AIR SUPPLY FACILITY		LOT	1		124,600,000	
7	AUXILIARY BURNER FACILITY		LOT	1		79,000,000	
8	DUCT		LOT	1		105,000,000	
9	PIPING		LOT	1		160,000,000	
10	INSULATION		LOT	1		220,000,000	
11	PAINT		LOT	1		45,000,000	
12	TMS SYSTEM		LOT	1		200,000,000	
13	2'ND ELECTRIC & INSTRUMENT		LOT	1		560,000,000	
14	CORPORATE PROFIT		LOT	1		716,232,000	
15	< CONDENSING TURBINE SYSTEM >					4,149,400,000	
	Amount Total					**₩ 14,049,400,000**	

特記事項

*** Out of scope ***

1. Items not on the estimate, excluded
2. Civil work, Construction work, excluded.
3. 1'st Electric & Power substation & water, excluded.
4. Test-runnning UTILITY(Chemicals, fuel, electrictiy, water etc.) excluded
5. Conection work to National grid (1m)
6. Electricity supply during the construction, excluded.(Supplied by the ordering party)
7. Licensing excluded. (But, document and task support included.)
8. Value added tax(VAT), excluded.
9. Package, Transportation, excluded(KOREA PORT)

內　譯　書

NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
1	**INSERTING SYSTEM**						
1-1	OVER HEAD CRANE	2㎥	SET	1		220,000,000	
	TOTAL					**₩ 220,000,000**	
2	**WASTE COMBUSTION FURNACE**	150 ton/day, HL 4,500kcal/kg					
2-1	FEEDING FACILITY						
	FEEDING HOPPER		LOT	1		25,000,000	
	SLIDING CHUTE		LOT	1		20,000,000	
	RAM PUSHER		LOT	1		35,000,000	
	STRUCTURE & WALK WAY		LOT	1		42,000,000	
	KILN FRONT WALL	¢ 4,736 x 550H	LOT	1		52,000,000	
2-2	ROTARY KILN FURNACE	3.45 ton/hr					
	BODY	¢ 3,500(I.D) x 10,000L	LOT	1		310,000,000	
	RING TIRE	¢ 4,858 x 380W	SET	2		85,000,000	
	GIRTH GEAR	¢ 5,320 x 200W	SET	1		55,000,000	
	PNION GEAR	¢ 620 x 290W	SET	1		20,000,000	
	SUPPORT ROLLER etc.		LOT	1		150,000,000	
	DRIVING MOTOR	CYCLO MOTOR	LOT	1		27,000,000	
	REDUCER	gears of transmission	LOT	1		40,000,000	
	WATER STORAGE TANK	30㎥	LOT	1		25,000,000	
	WATER PUMP	3㎥ /HR x 50mh	SET	2		3,000,000	
	KILN REFRACTORY	100㎥	LOT	1		290,000,000	
2-3	STOKER FURNACE	2.8 ton/hr					
	1st FURNACE	100㎥	LOT	1		460,000,000	
	2'ND FURANCE	200㎥	LOT	1		220,000,000	
	REFRACTORY	300㎥	LOT	1		550,000,000	
	MOVING GRATE	18㎡	LOT	1		95,000,000	
	HYDRO UNIT	160ℓ/min	LOT	1		45,000,000	
	ASH HOPPER		LOT	1		10,000,000	
	FLY ASH HOPPER		LOT	1		10,000,000	
2-4	BOTTOM ASH TREATMENT SYSTEM						
	FLOW CONVEYOR		SET	2		38,000,000	
	APRON CONVEYOR		SET	1		80,000,000	
	BELT CONVEYOR		SET	1		24,000,000	
	MAGNETIC SEPARATOR		SET	1		38,000,000	
	TOTAL					**₩ 2,749,000,000**	
3	**WASTE HEAT BOILER - 35k/30k, Evaporation 26ton/hr(360℃), RAW WATER TEMPERATURE 50℃**						
3-1	2nd FURNACE & BOILER	2-DRUM, 22ton(acctual using steam)					
3-2	BODY	oper 30kg/㎠.g	LOT	1		1,250,000,000	

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NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
3-3	ECONOMIZER		LOT	1		145,000,000	
3-4	SUPER-HEATER		LOT	1		240,000,000	
3-5	DE-SUPER HEATER		LOT	1		22,000,000	
3-6	STRUCTURE & WALK WAY		LOT	1		150,000,000	
3-7	REFRACTORY		LOT	1		60,000,000	
3-8	SOOT BLOWER	LONG TYPE	SET	4	11,000,000	44,000,000	
3-9	SOOT BLOWER	FIXED TYPE	SET	6	6,000,000	36,000,000	
3-10	PANLE		LOT	1		18,000,000	
3-11	RING BLOWER	5㎥/HR×2500mmAq	SET	2	900,000	1,800,000	
3-12	ROTARY VALVE	400SQ x 540H	SET	2	3,500,000	7,000,000	
3-13	FLOW CONVEYOR	1ton/hr	SET	1		25,000,000	
3-14	DUST BOX		SET	1		3,500,000	
3-15	WATER TANK	40㎥	SET	1		40,000,000	
3-16	BOILER FEED WATER PUMP	30㎥/hr x 390mH	SET	2	36,000,000	72,000,000	
3-17	DEAERATOR FEED WATER PUMP	30㎥/hr x 70mH	SET	2	6,000,000	12,000,000	
3-18	DEAERATOR	30㎥/hr	SET	1		65,000,000	
3-19	CHEMICAL SYSTEM		LOT	1		18,000,000	
3-20	STEAM HEADER		LOT	1		12,000,000	
3-21	STEAM SILENCER		LOT	1		22,000,000	
3-22	BLOW DOWN TANK	1㎥	LOT	1		4,000,000	
3-23	BLOW DOWN EXCHANGER		LOT	1		15,000,000	
3-24	3-ELEMENT DRUM L/C		LOT	1		45,000,000	
3-25	DEAERATOR CONTROL SYSTEM		LOT	1		24,000,000	
3-26	DE-SUPER HEATER CONTROL SYSTEM		LOT	1		15,000,000	
3-27	TOP BLOW DOWN SYSTEM		LOT	1		15,000,000	
3-28	BOTTOM BLOW DOWN SYSTEM		LOT	2		10,000,000	
3-29	STEAM VENT SYSTEM		LOT	1		25,000,000	
3-30	LEVEL LOWER ALRAM		LOT	1		4,000,000	
3-31	PIPING		LOT	1		160,000,000	
3-32	INSULATION		LOT	1		66,000,000	
3-33	ERECTION AND INSTALLATION		LOT	1		300,000,000	
	TOTAL					**₩ 2,926,300,000**	
4	**FLUE GAS TREATMENT FACILITY**	62,520 S㎥/hr					
4-1	SNCR	(SELECTIVE NON-CATALYTIC REDUCTION)					
	UREA STORAGE TANK	20㎥	LOT	1		25,000,000	SUS304
	UREA DILUTION WATER TANK	5㎥	LOT	1		10,000,000	FRP
	UREA SPRAY PUMP	110L/Hr x 70mH	SET	2	4,000,000	8,000,000	
	SPRAY NOZZLE	200ℓ/hr	SET	4	2,000,000	8,000,000	

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NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
	MIXER	5ℓ	SET	1		2,000,000	SUS304
	UREA DILUTION WATER PUMP	1.5㎥/Hr x 70mH	SET	2	1,200,000	2,400,000	
	CONTROL VALVE	32A	SET	1		2,500,000	
	AIR REDUCING VALVE	40A	SET	1		800,000	
	PURGE BLOWER	1.4㎥/HR x 1500mmAq	SET	1		1,000,000	
	PIPING		LOT	1		30,000,000	
	SUB-T0TAL					**89,700,000**	
4-2	SEMI DRY REACTOR	Ø5120					
	CASING	1,042N㎥/min	LOT	1		230,000,000	SS400
	STRUCTURE & WALK WAY		LOT	1		75,000,000	
	SLIDE GATE	600A × 150H	SET	2	3,500,000	7,000,000	
	VIBRATOR	0.2kW	SET	4	300,000	1,200,000	
	SPRAY NOZZLE	500L/hr	SET	4	4,000,000	16,000,000	
	LIME SLURRY STORAGE TANK	35㎥	SET	1		30,000,000	
	AGITATOR	Φ1300×5.5kw	LOT	1		13,500,000	
	LIME FEED PUMP	6㎥/hr x 30mH	SET	2	4,000,000	8,000,000	
	LIME SPRAY PUMP	1.3㎥/hr x 80mH	SET	2		12,000,000	
	MIXING TANK	5㎥	SET	1		11,000,000	
	AGITATOR	Ø550×3.7KW	SET	1		4,000,000	
	PURGE BLOWER	27㎥/min x 300mmAq	SET	1		1,000,000	
	PENT HOUSE					out of scope	
	SUB-T0TAL					**408,700,000**	
4-3	DRY VENTURI DUCT						
	CASING	1042N㎥/min	LOT	1		7,000,000	
	SUB-T0TAL					**7,000,000**	
4-4	LIME SILO						
	CASING	35㎥	LOT	1		22,000,000	
	STRUCTURE & WALK WAY		LOT	1		50,000,000	
	AIR KNOCKER	AK80	SET	2	450,000	900,000	
	AREA PAD		SET	6	150,000	900,000	
	SHUT OFF GATE	200A	SET	1	500,000	500,000	
	METERING FEEDER	0 ~ 300kg/Hr	SET	1	5,000,000	5,000,000	
	BAGFILTER for VENT	10㎥/min	SET	1	2,500,000	2,500,000	
	SUB-T0TAL					**81,800,000**	
4-5	ACTIVATED CARBON SILO						
	CASING	5㎥	LOT	1		8,000,000	
	STRUCTURE & WALK WAY		LOT	1		28,000,000	
	AIR KNOCKER	AK60	SET	2	350,000	700,000	
	SHUT OFF GATE	150A	SET	1	500,000	500,000	
	METERING FEEDER	0 ~ 20kg/Hr	SET	1	5,000,000	5,000,000	
	MONO RAIL HOIST	1TON	SET	1		8,000,000	

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NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
	SUB-T0TAL					**50,200,000**	
4-6	BAG FILTER	15*14*6CHAMBER, ACR 0.6m/min					
	CASING	1042N㎥/min	LOT	1		450,000,000	
	STRUCTURE & WALK WAY		LOT	1		110,000,000	
	IN-LET DAMPER	Φ600 x 350H	SET	6	2,500,000	15,000,000	
	POPET DAMPER	Φ600 x 350H	SET	6	4,000,000	24,000,000	
	ROTARY VALVE	400SQ x 400H	SET	2	3,000,000	6,000,000	
	FLOW CONVEYOR	1 TON	SET	2	20,000,000	40,000,000	
	AIR KNOCKER	AK80	SET	12	450,000	5,400,000	
	FILTER BAG	Φ156 x 4,100L	EA	1260	85,000	107,100,000	
	BAG CAGE	Φ156 x 4,100L	EA	1260	34,000	42,840,000	
	VENTURI	Φ152	EA	1260	3,800	4,788,000	
	DIAPHRAGM VALVE	CA-50A	EA	90	110,000	9,900,000	
	TIMER KIT	15POINT	EA	6	240,000	1,440,000	
	PENT HOUSE		LOT	1		out of scope	
	SUB-T0TAL					**816,468,000**	
	TOTAL					**₩ 1,453,868,000**	
5	**FAN & STACK**						
5-1	I.D FAN	2200CMMx600mmAq×320kw	LOT	1		74,000,000	
5-2	KILN COOLING FAN	150CMMx700mmAq×22kw	SET	1		11,000,000	
5-3	1st F.D FAN(RK)	450CMMx400mmAq×52.5kw	SET	1	16,000,000	16,000,000	
5-4	2nd F.D FAN	300CMMx300mmAq×30kw	SET	1	14,000,000	14,000,000	
5-5	3rd F.D FAN	150CMMx300mmAq×15kw	SET	1	12,000,000	12,000,000	
5-6	4th F.D FAN	350CMMx330mmAq×37.5kw	SET	1	14,000,000	14,000,000	
5-7	STACK	Ø2000×30mH	LOT	1		130,000,000	
	STRUCTURE & WALK WAY		LOT	1		70,000,000	
	TOTAL					**₩ 341,000,000**	
6	**AIR SUPPLY FACILITY**	200HP					
6-1	AIR COMPRESSOR	28.3㎥/min	SET	2	39,000,000	78,000,000	
6-2	AIR RECEIVE TANK	5㎥	SET	2		22,000,000	
6-3	AFTER COOLER	32㎥/min	SET	1		3,000,000	
6-4	AIR DRYER	29㎥/min	SET	1		8,500,000	
6-5	PRE - FILTER	75㎥/min	SET	1		1,500,000	
6-7	LINE - FILTER	72㎥/min	SET	1		1,800,000	
6-8	COALESCENT - FILTER	42㎥/min	SET	1		1,800,000	
6-9	HOOD DUCT		LOT	1		8,000,000	
	TOTAL					**₩ 124,600,000**	

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NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
7	**AUXILIARY BURNER FACILITY**						
7-1	OIL BURNER	3,000,000 kcal/hr	SET	1	20,000,000	20,000,000	
7-2	OIL BURNER	4,500,000 kcal/hr	SET	1	22,000,000	22,000,000	
7-2	OIL BURNER AUTO REMOVAL	RAIL	SET	2	4,000,000	8,000,000	
7-3	CONTROL PANEL		SET	2	6,500,000	13,000,000	
7-4	OIL PUMP UNIT	1600L/hr	SET	2	4,000,000	8,000,000	
7-5	OIL TANK	5㎥	LOT	1		8,000,000	
	TOTAL					**₩ 79,000,000**	
8	**DUCT**	SS400	**LOT**	**1**		**₩ 105,000,000**	
9	**PIPING**		**LOT**	**1**		**₩ 160,000,000**	
10	**INSULATION**	ROCK WOOL 100/75/50t	**LOT**	**1**		**₩ 220,000,000**	
11	**PAINT**	SA #21/2, ZINC PRIMER	**LOT**	**1**		**₩ 45,000,000**	
12	**TMS SYSTEM**		**LOT**	**1**		**₩ 200,000,000**	
13	**2'ND ELECTRIC & INSTRUMENT**	PLC SYSTEM	**LOT**	**1**		**₩ 560,000,000**	
14	**CORPORATE PROFIT**		**%**	**8**		**₩ 716,232,000**	
	TOTAL					**₩ 9,900,000,000**	
	< CONDENSING TURBINE SYSTEM >	make : INDIA					
	STEAM TURBINE	4.5MWh(acctual 4MWh)	SET	1		1,572,900,000	
	GENERATOR	1800rpm, 6.6kv	SET	1		350,000,000	
	GENERATOR PANEL	GCP, VCB, NGR	SET	1		190,000,000	
	CONDENSER	13,000,000kcal/hr, -0.9kg/㎠.g	SET	1		551,250,000	
	COOLING TOWER	3200RT	SET	1		350,000,000	
	Reverse Osmotic Water Facility	4t/h	LOT	1		150,000,000	
	HMI SYSTEM		LOT	1		40,000,000	
	POWER SUBSTATION EQUIPMENT	TR, VCB, MOF etc.	LOT	1		out of scope	
	STEAM SEPARATOR & STRAINER	200A	LOT	1		20,000,000	
	PIPING & INSULATION		LOT	1		300,000,000	
	ERECTION AND INSTALLATION		LOT	1		115,000,000	
	PERMISSION & INSPECTION		LOT	1		10,000,000	
	DESIGN COST		LOT	1		40,000,000	

內 譯 書

NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
	TURBINE SPARE PARTS	2 YEAR	LOT	1		110,250,000	
	GENERAL ADMINISTRATIVE COSTS		LOT	1		200,000,000	
	CORPORATE PROFIT		LOT	1		150,000,000	
	TOTAL					**₩ 4,149,400,000**	

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1	**投入設備**								
	OHC –	OVER HEAD CRANE	1. TYPE	:	2 GRIDER 1TROLLEY		LOT	1	
			2. BUCKET CAPACITY	:	1.5 ㎥ (0.3 ton/㎥)				
			3. RATED LOAD	:	1.05 TON				
			4. LIFT	:	16.5 m 基準				
			5. SPAN	:	18 m 基準				
			6. TRAVEL LENGTH	:	36 m 基準				
			7. SPEED & MOTOR	:	HOISTING(巻上) - 30 m/min	30.0 kw ,6P, 380V	SET	1	
					TREVERSING(横行) 30 m/min	0.75 kw ,4P, 380V	SET	2	
					TRAVELLING(主行) 30 m/min	1.5 kw ,4P, 380V	SET	2	
					BUCKET –	15.0 kw ,4P, 380V	SET	1	
2	**燃焼設備**								
	INC –	INCINERATOR	1. TYPE	:	ROTARY KILN + MOVING GRATE STOKER		LOT	1	
			2. CAPACITY	:	6.3 ton/hr				

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			3.	低位発熱量	: 4009 kcal/kg				
	INC -	ROTARY KILN	1.	TYPE	: ROTARY KILN		LOT	1	
			2.	CAPACITY	: 3.4 ton/hr				
			3.	R/K SIZE	: 3,500 Ø × 10000 L				
			4.	R/K 容積	: 95 m³				
			5.	火炉熱負荷率	: 180000 kcal/m³hr				
			6.	R/K INCLINE	: 29/100				
			7.	OPERATION TEM'P	: 1,020 ℃				
			8.	MATERIAL	: SM490A + 耐火物				
		RING TIRE	1.	TYPE	: RING TIRE		LOT	2	
			2.	CAPACITY	: 4858 Ø(O.D) × 346/380 W				
			3.	HARDNESS	: 230 Hb 以上				
			4.	MATERIAL	: SCM - 440				
		GIRTH GEAR	1.	TYPE	: INVOLUTE-SPUR		LOT	1	
			2.	MODULE	: M20				
			3.	PRESSURE ANGLE	: 20 度				
			4.	NO. OF TOOTH	: 266 NT				
			5.	PCD	: 5320 Ø				
			6.	WIDE OF TOOTH	: 200				

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			7. HARDNESS : 190 Hb 以上			
			8. MATERIAL : SCMn-2A			
		PNION GEAR	1. TYPE : INVOLUTE-SPUR		LOT 1	
			2. MODULE : M20			
			3. PRESSURE ANGLE : 20 度			
			4. NO. OF TOOTH : 31 NT			
			5. PCD : 620 Ø			
			6. WIDE OF TOOTH : 290			
			7. HARDNESS : 230 Hb 以上			
			8. MATERIAL : SCM-440			
		SUPPORT ROLLER	1. TYPE : 910 Ø(O.D) × 430 W		LOT 4	
			2. HARDNESS : 230 Hb 이상			
			3. MATERIAL : SC49			
		THRUST ROLLER	1. SIZE : 450 Ø(O.D) × 300 H		LOT 4	
			2. BEARING : 23032, 23038			
			3. MATERIAL : S45C			
		DRIVING MOTOR	1. TYPE : CYCLO MOTOR(無断変速)	22 kw ,4P, 380V	LOT 1	
			2. MODEL : BHHM20A			
			3. SPEED : 335-1340 RPM			
			4. MAKER : SUMITOMO			

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		REDUCER	1. TYPE	: キアー変速		LOT	1	
			2. MODEL	: PX 8075-R4-LL-30				
			3. MAKER	: SUMITOMO				
		WATER STORAGE TANK	1. TYPE	: 垂直円筒形		SET	1	
			2. CAPACITY	: 30 ㎥				
			3. SIZE	: 3000 Φ × 4246				
			4. MATERIAL	: SS400 6T				
			5. 付属物	: LEVEL GAUGE				
				LADDER & HANDRAIL				
				MANHOLE				
		R/K COOLING FAN	1. TYPE	: TURBO BLOWER	22 kw 380V	SET	1	
			2. CAPACITY	: 150 ㎥/min × 700 mmAq				
			3. MATERIAL	: CASING - SS400				
				IMPELLA - SS400				
				SHAFT - S45C				
		WATER PUMP	1. TYPE	: 立型多段式	1.1 kw ,4P, 380V	SET	2	
			2. CAPACITY	: 3 ㎥/hr × 50 m.H				
	FD -	1'ST F.D FAN (R/K)	1. TYPE	: TURBO BLOWER	52.5 kw 380V	SET	1	VVV-F
			2. CAPACITY	: 450 ㎥/min × 400 mmAq				
			3. MATERIAL	: CASING - SS400				

No	TAG No.	EQUIPMENT	DESCRIPTION		POWER			UNIT	Q'TY	備考
			IMPELLA - SS400, SHAFT - S45C							
	BU -	1'st BURNER	1. TYPE	: 炉付着型	7.5	KW	380V	LOT	1	
			2. CAPACITY	: 2,500,000 kcal/hr						
			3. FUEL	: LNG						
			4. CONTROL METHOD	: 比例制御						
			5. ACCESSORY	: コントロールパンネル, バーナー着脱装置(自動レール, 自動シャッター)						
	INC -	STOKER	1. TYPE	: MOVING GRATE STOKER				LOT	1	
			2. CAPACITY	: 2.8 ton/hr						
			3. 低位発熱量	: 4009 kcal/kg						
			4. 火上面積	: 18 ㎡						
			5. 1次燃焼室の容積	: 100 ㎥						
			6. 火上負荷率	: 180 kg/㎥.hr						
			7. 火炉熱負荷率	: 150000 kcal/㎥hr						
			8. FLOW RATE	: 59,067 N㎥/hr						
			9. OUTLET TEMP.	: 1,020 ℃						
			10. MATERIAL	: SS400 6t + 耐火物, H-200 x 200 x 9/14t						
	BU -	2nd BURNER	1. TYPE	: Gun Type (送風機一体型)	7.5	KW	380V	LOT	1	
			2. CAPACITY	: 4,500,000 kcal/hr						
			3. FUEL	: LNG						
			4. CONTROL METHOD	: 比例制御						

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT	Q'TY	備考
			5. ACCESSORY : コントロールパンネル, バーナー着脱装置(自動レール, 自動シャッター)				
	HU -	HYDRO UNIT	1. CAPACITY : 70 ℓ/min, 110 ℓ/min,		LOT	1	
			2. PUMP : VENE PUMP	40.0 kw 380V	SET	2	
			3. TANK CAPACITY : 1000 LIT				
			4. DESIGN PRESS : MAX 140 kg/㎡				
			OPER 80 kg/㎡				
			5. ACCESSORY : FAN OIL COOLER	1.5 kw 380V	SET	1	
			: HEATER	5 kw 380V	SET	1	
			: HYDRO CYCLINDER				
			- 1'ST GATE Ø80 × 1400 ST		EA	1	
			- 2'ND GATE Ø80 × 1400 ST		EA	1	
			- RAM PUSHER Ø125 × 1600 ST		EA	1	
			- GRATE Ø140 × 260 ST		EA	3	
	FD -	2'ND F.D FAN (STOKER)	1. TYPE : TURBO BLOWER	30.0 kw 380V	SET	1	VVV-F
			2. CAPACITY : 300 ㎥/min × 300 mmAq				
			3. MATERIAL : CASING - SS400				
			IMPELLA - SS400, SHAFT - S45C				
	FD -	3'RD F.D FAN (STOKER)	1. TYPE : TURBO BLOWER	15.0 kw 380V	SET	1	VVV-F
			2. CAPACITY : 150 ㎥/min × 300 mmAq				
			3. MATERIAL : CASING - SS400				
			IMPELLA - SS400, SHAFT - S45C				

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No	TAG No.	EQUIPMENT	DESCRIPTION		POWER			UNIT	Q'TY	備考
	FD -	4'TH F.D FAN (STOKER)	1. TYPE	: TURBO BLOWER	37.5	kw	380V	SET	1	VVV-F
			2. CAPACITY	: 350 ㎥/min × 350 mmAq						
			3. MATERIAL	: CASING - SS400						
				IMPELLA - SS400, SHAFT - S45C						
		REFRACTORY	1. ROTARY KILN	: CASTING BLOCK 施工						
			2. STOKER燃焼室	: FIRE BRICK - 230t 施工				LOT	1	
				: INSULATION BRICK - 114t 施工 (B-5)						
				: SILICA BORAD - 100t						
			3. CASTABLE	: CRESTO - 75t 施工				LOT	1	
				: CRESTO -60 施工						
				: KOSACAST -60S 施工						
				: SUPPORT - SUS 304 9t						
		GRATE & SCRAPER	1. MOVING GRATE	: SIZE 295W × 510L × 120H				SET	100	예비품 10EA
				: MATERIAL SCH 22種 or 同等品						
			2. FIXING GRATE	: SIZE 295W × 510L × 120H				SET	90	
				: MATERIAL SCH 22種 or 同等品						
			3. SCRAPER	: SIZE 295W × 120L × 13t				SET	30	
				: MATERIAL SCH 13種 or 同等品						

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No	TAG No.	EQUIPMENT	DESCRIPTION			POWER			UNIT	Q'TY	備考
3	再処理設備										
	FC – 106A/B	FLOW CONVEYOR	1.	TYPE	: FLOW CON'V	2.2	kw	380V	SET	2	減速比 1/120
			2.	CAPACITY	: 1.0 ton/hr						
			3.	SPEED	: 4.36 m/min						
			4.	MATERIAL	: SS400 × S45C						
			5.	SIZE	: 300 W × 8400 L						
	AC – 107	APRON CONVEYOR	1.	TYPE	: APRON TYPE	3.75	kw	380V	SET	1	減速比 1/120
			2.	CAPACITY	: 1.0 ton/hr						
			3.	SPEED	: 1.78 m/min						
			4.	MATERIAL	: SS400						
			5.	SIZE	: 1200 W × 9000 L × 1600 H						
	BC – 108	BELT CONVEYOR	1.	TYPE	: BELT TYPE	1.5	kw	380V	SET	1	減速比 1/90
			2.	CAPACITY	: 1.0 ton/hr						
			3.	SPEED	: 11.0 m/min						
			4.	MATERIAL	: SS400						
			5.	SIZE	: 900 W × 9400 L × 2000 H						
	MS – 109	MAGNETIS SEPARATOR	1.	TYPE	: ELECTRO MAGNETIC				LOT	1	
			2.	SIZE	: 1140 W × 2620 L × 925 H						
			3.	電磁石	:	4.5	kw ,4P,	220V	SET	1	
			4.	モーター	:	2.2	kw ,4P,	380V	SET	1	減速比 1/30
4	燃焼カス冷却設備										
	BL – 201	2nd FURNACE & BOILER	1.	TYPE	: 水管式 2-DRUM				LOT	1	

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			2. GAS VOL.IN : 59,067 Nm³/Hr			
			3. INLET TEMP. : 1,020 ℃ ± 50			
			4. OUTLET EMP. : 300 ℃ ± 20			
			5. DESIGN CAPACITY : 26 ton/hr (利用可能量 22 ton/hr)			
			6. DESIGN PRESS : 35 Kg/㎠			
			7. OPERATING PRESS : 30 Kg/㎠			
			8. WATER TEMP. : 165.6 ℃			
		ECONOMIZER	1. TYPE : SHELL TUBE		LOT 1	
			2. GAS TEMP : 300 ℃ → 230 ℃			
			3. WATER TEMP : 130 ℃ → 171.7 ℃			
			4. MATERIAL : STBH 340-E			
	SB - 206A/D	SOOT BLOWER	1. TYPE : LONG RETRACTABLE	1.1 kw 380V	SET 3	
			2. MATERIAL : A216WCB+STS304			
			3. MAKER : DIAMOND POWER (CHINA)			
	SB - 206E/F	SOOT BLOWER	1. TYPE : FIXED ROTATING	0.4 kw 380V	SET 8	
			2. MATERIAL : A216WCB+STS304			
			3. MAKER : DIAMOND POWER (CHINA)			
	PF - 212	PURGE FAN	1. TYPE : RING BLOWER	2.2 kw 380V	SET 2	
			2. MATERIAL : 5 m³/hr × 2000 mmAq			
	RV - 202A/B	ROTARY VALVE	1. TYPE : MULTI BLADE	1.5 kw ,4P, 380V	SET 3	減速比 1/30
			2. SIZE : ㅁ400 x 400H			
			3. MATERIAL : BODY - GC 200, BLADE - STS304			

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No	TAG No.	EQUIPMENT	DESCRIPTION		POWER	UNIT Q'TY	備考
	FC – 203	FLOW CONVEYOR	1. TYPE	: FLOW CHAIN TYPE	3.7 kw ,4P, 380V	SET 1	減速比 1/120
			2. CAPACITY	: 1.5 ton/hr			
			3. MATERIAL	: SS400			
		DEAERATOR	1. TYPE	: 円筒立型式		LOT 1	
			2. CAPACITY	: 30 ㎥/hr			
			3. DESIGN PRESS	: 5 kg/㎠.g			
			4. OPERATING PRESS	: 2 kg/㎠.g			
			5. STEAM INLET TEMP	: 360 ℃ (at 3 kg/㎠)			
			6. WATER TEMP	: 50 ℃ → 130 ℃			
			7. 溶存酸素	: 0.1 mg/Lit			
			8. MATERIAL	: SS400			
			9. CONTROL SYSTEM	: LEVEL CONTROL : PID			
				PRESSURE CONTROL : 4~20mA			
	PP –	DEAERA FEED WATER PUMP	1. TYPE	: 多段タービン立型	11.5 kw ,Ø3, 380V	SET 2	
			2. CAPACITY	: 30.0 ㎥/hr × 60 mh			
			3. TEMPERATURE	: 20 ℃			
			4. MAKER	: GRUNDFOS			
	PP – 218A/B	BOILER FEED WATER PUMP	1. TYPE	: 多段タービン立型	45.0 kw ,Ø3, 380V	SET 2	
			2. CAPACITY	: 30.0 ㎥/hr × 270 mh			
			3. TEMPERATURE	: 130 ℃			
			4. MAKER	: OSNA			

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No	TAG No.	EQUIPMENT	DESCRIPTION		POWER	UNIT	Q'TY	備考
	TK - 217	WATER STORAGE TANK	1. TYPE	: 円筒形		SET	1	
			2. CAPACITY	: 40 ㎥				
			3. SIZE	: 3250 Ø × 4824 H				
			4. MATERIAL	: STS304				
	TK - 219	COMPOUND DOSING TANK	1. TYPE	: 立型円筒形		SET	1	
			2. CAPACITY	: 400 L				
			3. SIZE	: 790 Φ × 816.5 H				
			4. MATERIAL	: P.E 6T				
			5. 付帯施設	: AGITATOR, LOCAL PANEL, LEVEL S/W	0.4 kw 380V	SET	1	
	PP - 220A/B	COMPOUND DOSING PUMP	1. TYPE	: 定量注入式	0.2 kw ,Ø1, 220V	SET	2	
			2. CAPACITY	: 100 cc/min , 40 kgf/㎠				
			3. MATERIAL	: CASING - GFPP, DIAPHRAGM - PTFE				
	ST - 204A	STEAM HEADER	1. TYPE	: 円筒横形式		SET	1	
			2. SIZE	: 450 Ø × 2500 L				
			3. 設計圧力	: 35 Kg/㎠				
			4. MATERIAL	: STPG38, SCH#80				
	SL - 205	SILENCER	1. TYPE	: 平形		SET	1	
			2. SIZE	: 820 Ø × 3100 L, 150 A				
			3. 騒音基準	: 90 DB 以内				
			4. MATERIAL	: 岩棉 & SS400				

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No	TAG No.	EQUIPMENT	DESCRIPTION		POWER	UNIT	Q'TY	備考
	TK - 208	BLOW DOWN TANK	1. TYPE	: 円筒形		SET	1	
			2. CAPACITY	: 1000 L				
			3. SIZE	: 880 Ø × 1645 H				
			4. MATERIAL	: SS400				
	BD - 207A	TOP BLOW DOWN SYSTEM	1. TYPE	: AUTO T.D.S CONTROL	220V	SET	1	
			2. SIZE	: DN 25				
			3. VALVE	: MV5291-V				
			4. PRESSURE	: PN 40				
			5. CONTROLLER	: FAR 1 , 4~20mmA				
			6. MAKER	: SPIRAXSARCO				
	BD - 207B	BOTTOM BLOW DOWN SYSTEM	1. TYPE	: MANUAL VALVE & SET TIMER CONTROL	220V	SET	1	
			2. SIZE	: DN 50				
			3. CONTROL	: 1078-1 CONTROL UNIT				
			4. VALVE	: PV 6291				
			3. MAKER	: RTK				
		DEAERATOR CONTROL SYSTEM	1. LEVEL CONTROL	: 差圧式		SET	1	
			2. PRESSURE CONTROL	: PID CONTROLER				
			3. WATER CONTROL	: GLOBE VALVE				

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		自動圧力調節 SYSTEM	1.	TYPE	: RF 3452-G DIGITAL CONTROLLER		SET	1	
					DR 1226 SENSOR UNIT				
					NG 1534 POWER UNIT				
					MV 5411 CONTROL VALVE				
			2.	SIZE	: DN 150 A				
			3.	MAX PRESSURE	: PN 40				
			4.	MAKER	: RTK				
			5.	CONTROL	: 4-20mmA				
		自動給水調節 SYSTEM	1.	TYPE	: DRUM 3-ELEMENT LEVEL CONTROL		SET	1	
			2.	STEAM FLOW METER	: ORIFICE - DN 150				
			3.	DIFE. PRESSURE TRNSMI	: 0-1000 mmH2O				
			4.	WATER FLOW METER	: ORIFICE - DN 50				
			5.	WATER CONTROL VALVE	: 50 A				
		STEAM VENT SYSTEM	1.	TYPE	: AUTO VENT CONTROL	220V	SET	1	
			2.	SIZE	: 150 A				
		STEAM SEPARATOR	1.	TYPE	: UNIT CYCLONE		SET	1	
			2.	SIZE	: 350 A × 200 A				
		低水位警報装置	1.	TYPE	: ELK 4		SET	1	
			2.	MAX PRESSURE	: 40 kg/㎠				
			3.	MAKER	: GALAXY				

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		極低水位警報装置	1. TYPE : SG2411 CONTROLLER		SET	1	
			NI 1331 SENSOR				
			2. MAX PRESSURE : PN 40				
			3. MAKER : RTK				
5	粉塵および有害カス処理設備						
5-1.	SNCR (UREA 噴射装置)						
	TK - 111	UREA STORAGE TANK	1. TYPE : VERTICAL		SET	1	
			2. CAPACITY : 20 ㎥				
			3. SIZE : 2800 Φ × 3250 H (3,500H)				
			4. MATERIAL : FRP				
			5. ACCESSORY : FLANGE HEATER 50 A (STS304)	5 kw 380V	SET	1	
			TEM'P SENSOR				
			LEVEL TRANS MITTER				
	PP - 112A/B	UREA SPRAY PUMP	1. TYPE : HYDRA-CALL	0.75 kw 380V	SET	2	VVV-F
			2. CAPACITY : 60~110 L/hr × 70 mH				
			3. MATERIAL : PUMP HEAD - SUS316				
			GEAR - PPS				
	TK - 113	UREA MIXING TANK	1. TYPE : VERTICAL		SET	1	
			2. CAPACITY : 5 L				
			3. SIZE : 114 Φ × 490.1 H (540H)				
			4. MATERIAL : 4" PIPE , (SCH40)				

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
	SN - 114A/D	UREA SPRAY NOZZLE	1. TYPE : 二流体		SET 4	
			2. CAPACITY : 280 L/hr			
			3. MATERIAL : STS316L			
	TK - 1303	UREA DILUTION	1. TYPE : VERTICAL		SET 1	
		- WATER TANK	2. CAPACITY : 3 m^3			
			3. SIZE : 1400 Φ × 1950 H (2,300H)			
			4. MATERIAL : FRP			
			5. ACCESSORY : LEVEL TRANS MITTER			
	PP - 1304A/B	UREA DILUTION	1. TYPE : GRUNDFOS PUMP	0.75 kw 380V	SET 2	
		- WATER PUMP	2. CAPACITY : 1.5 m^3/hr × 70 mH			
			3. MATERIAL : CASING -GC200, SHAFT - STS304			
			IMPELLA - SUS304			
	PF - 312	PURGE FAN	1. TYPE : RING BLOWER	0.5 kw 380V	SET 1	
			2. CAPACITY : 1.4 m^3/hr × 1500 mmAq			
			3. MATERIAL : GC200			
5-2. SEMI DRY REACTOR						

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	SD - 301	SEMI DRY REACTOR	1.	TYPE	: CYLINDER CAL		LOT	1	
			2.	CAPACITY	: 59,067 Nm³/hr				
			3.	INLET TEMP.	: 230 ℃				
			4.	OUTLET EMP.	: 180 ℃				
			5.	VELOCITY	: 1.5 m/s				
			6.	RETENTION TIME	: 10 sec				
			7.	냉각수 소모량	: 1,012 kg/hr				
			8.	SIZE	: 5,120 Ø × 16.39 mH				
			9.	MATERIAL	: SS400 9t				
	SG - 302A/B	SLIDE GATE	1.	TYPE	: AIR CYLINDER TYPE		SET	2	
			2.	CAPACITY	: 600 A × 150 H				
			3.	MATERIAL	: BODY - GC 200, BLADE - STS304				
			4.	AIR CYLINDER	: 140 Ø × 600 ST × 2 SET				
	VB - 303A/D	VIBRATOR	1.	TYPE	: VIBR. MOTOR	0.2 kw ,2P, 380V	SET	4	
	EHT - 304	E-HEATER	1.	TYPE	: MI CABLE	3 kw 380V	SET	1	
	TK - 306	LIME SLURRY STO. TANK	1.	TYPE	: VERTICAL		SET	1	
			2.	CAPACITY	: 30 m³				
			3.	SIZE	: 2910 Φ × 4513 H (6,096H)				
			4.	MATERIAL	: SS400				

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			5. 構造 : LEVEL TRANS MITTER			
	AG - 307	LIME STO. TANK AGITATOR	1. TYPE : PADDLE	5.5 kw 380V	SET 1	
			2. CAPACITY : 30 RPM			
			3. SIZE : 1350 Ø × 5600 L			
			4. MATERIAL : STS304			
	TK - 309	L/ SLURRY MIXING TANK	1. TYPE : VERTICAL		SET 1	
			2. CAPACITY : 3 ㎥			
			3. SIZE : 1552 Φ × 1587 H (2,200H)			
			4. MATERIAL : SS400			
	AG - 310	L/S M/TANK AGITATOR	1. TYPE : PADDLE	3.75 kw 380V	SET 1	
			2. CAPACITY : 60 RPM			
			3. SIZE : 550 Ø × 2000 L			
			4. MATERIAL : STS304			
	PP - 308A/B	L/SLURRY FEED PUMP	1. TYPE : CENTRIFUGAL	1.5 kw ,4P, 380V	SET 2	
			2. CAPACITY : 6 ㎥/hr × 10 mH			
			3. MATERIAL : PUMP CASING & SHAFT - SUS304			
			IMPELLER - Hi-Cr 강, DOUBEL M/SEAL			
	PP - 311A/B	L/SLURRY SPRAY PUMP	1. TYPE : HYDRA CALL	1.5 kw ,4P, 380V	SET 2	
			2. CAPACITY : 1.5 ㎥/hr × 70 mH			

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			3. MATERIAL : PUMP HEAD - CAST - IRON			
			4. DIAPHRAGM - BUNA-N			
			CHECK V/V - CERAMIC			
	SN - 305A/D	SPRAY NOZZLE	1. TYPE : 二流体		SET 4	
			2. CAPACITY : 375 L/hr			
			3. MATERIAL : STS304 + RBSIC			
	PF - 309	PURGE BLOWER	1. TYPE : RING BLOWER	1.75 kw 380V	SET 1	
			2. CAPACITY : 4.1 m³/min × 2000 mmAq			
			3. MATERIAL : GC200			
5-3.	DRY VENTURI					
¥	DV - 401	DRY VENTURI	1. TYPE : VENTURI DUCT' TYPE		LOT 1	
			2. CAPACITY : 60,462 Nm³/hr			
			3. INLET TEMP. : 180 ℃			
			4. INLET /THROAT VELOCITY : 20m/s 60m/s			
			6. MATERIAL : SS400			
			7. SIZE : 1450 Φ, 800 Φ, 5160H			
			8. NOZZLE : ACTIVATED CARBON - 100 A			
			LIME - 100 A			

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No	TAG No.	EQUIPMENT	DESCRIPTION		POWER	UNIT Q'TY	備考
	TK – 1101	LIME SILO	1. TYPE	: 垂直円筒形		LOT 1	
			2. CAPACITY	: 30 ㎥			
			3. MATERIAL	: SS400			
			4. SIZE	: 2910 Φ × 4,513H (6,096H)			
			5. VENT FILTER	: PULSE AERATION TYPE			
				100 Ø × 250 H			
	SH – 1105	SHUT OFF GATE	1. TYPE	: SLIDE GATE		SET 1	
			2. SIZE	: 200A			
			3. MATERIAL	: SS400			
	VF – 1106	LIME VOLUMETRIC FEEDER	1. TYPE	: SCREW 定量供給型	1.5 kw 380V	SET 1	
			2. CAPACITY	: 50~100 kg/hr			
			3. SIZE	: 200 A			
			4. MATERIAL	: SS400			
	EHT – 1102	E-HEATER	1. TYPE	: MI CABLE	3 kw 380V	SET 1	
			2. MATERIAL	: SUS 304			
	AK – 1103A/B	AIR KNOCKER	1. TYPE	: AIR PISTEON TYPE		SET 2	
			2. MODEL	: AK – 80			
			3. OPERATING PRESS	: 3~5 kg/㎠			
			4. MATERIAL	: SS400			
			5. 構造	: SOLENOID V/V 1/4" × 2 SET			

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	AP - 1104	AIR PAD	1. TYPE	: PULSE AERATION				SET	6	
			2. OPERATING PRESS	: 3 kg/㎠						
			3. SIZE	: 3/8″(135 × 280 × 14㎜)						
			4. 構造	: SOLENOID V/V 3/8″ × 3 SET						
			5. MATERIAL	: BASE - SUS304						
				: SIEVE - TEFLON COATED , POLYESTER						
		VENT FILTER	1. TYPE	: AIR JET PULSING				SET	1	
			2. CAPACITY	: 10 ㎥/min						
	TK - 1201	ACTIVATED CARBON SILO	`1. TYPE	: 垂直円筒形				LOT	1	
			`2. CAPACITY	: 3 ㎥						
			`3. SIZE	: 1552 Ø × 1587 H (2,884H)						
			`4. MATERIAL	: SS400						
	SH - 1204	SHUT OFF GATE	1. TYPE	: SLIDE GATE				SET	1	
			2. SIZE	: 200 A						
			3. MATERIAL	: SS400						
	VF - 1205	A/C VOLUMETRIC FEEDER	1. TYPE	: SCREW 定量供給型	0.75	kw	380V	SET	1	
			2. CAPACITY	: 20~50 kg/hr						
			3. SIZE	: 200 A						
			4. MATERIAL	: SS400						
	EHT - 1202	E-HEATER	1. TYPE	: MI CABLE	3	kw	380V	SET	1	

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			2. MATERIAL : SUS 304			
	AK – 1203A/B	AIR KNOCKER	1. TYPE : AIR PISTEON TYPE		SET 2	
			2. MODEL : AK – 60			
			3. OPERATING PRESS : 3~5 kg/㎠			
			4. 구조 : SOLENOID V/V			
			5. MATERIAL : SS400			
	HO – 1206	HOIST	1. TYPE ELECTRIC HOIST	0.75 kw 380V	SET 1	
			2. CAPACITY 1 ton			
			3. LIFT HEAD 15 m			
			4. MATERIAL SS400			
5-4.	BAG FILTER					
	BF – 501	BAG FILTER	1. TYPE : AIR JET PULSING		LOT 1	
			2. CAPACITY : 60,462 N㎥/hr			
			3. INLET TEMP. : 171 ℃			
			4. A.C.R : 0.70 m/min			
			5. PRESSUR DROP : Max. 200mmAq			
			6. ろ過布規格 : 156 Ø × 4100 L			
			7. ろ過布数量 : 1260 EA (15 ea × 14열 × 3 Ch)			
			(15 ea × 14열 × 3 Ch)			
			8. MATERIAL : STS304 + SS400			
	DP – 502A/D	IN-LET DAMPER	1. TYPE : MANUAL		SET 6	
			2. SIZE : 760 Ø × 300 H × 3 Z			

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			3. MATERIAL : SS400			
	DP - 503A/D	OUT-LET DAMPER	1. TYPE : POPET DAMPER		SET 6	
			2. SIZE : 730 Ø 400 H			
			3. MATERIAL : SS400, SGP			
			4. AIR CYLINDER : 140 Ø × 325 ST × 6 SET			
			AIR UNIT × 6 SET			
	DP - 503	BY-PASS POPPET DAMPER	1. TYPE : POPET DAMPER		SET 1	
			2. SIZE : 1050 Ø			
			3. MATERIAL : SS400, SGP			
			4. AIR CYLINDER : 140 Ø × 1250 ST × 1 SET			
			AIR UNIT × 1 SET			
	RV - 505A/B	ROTARY VALVE	1. TYPE : MULTI BLADE	1.5 kw ,4P, 380V	SET 2	감속비 1/30
			2. SIZE : 400A			
			3. MATERIAL : BODY - GC200, BLADE - SS400			
	FC - 504A/B	FLOW CONVEYOR	1. TYPE : FLOW CON'V	2.2 kw ,4P, 380V	SET 2	감속비 1/120
			2. MATERIAL : SS400 × S45C			
			3. SIZE : 400 W × 7700 L			
	EHT - 507A/B	E-HEATER	1. TYPE : MI CABLE	3 kw 380V	SET 2	
			2. 位置 : BAG FILTER HOPPER, FLOW CONVEYOR			

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No	TAG No.	EQUIPMENT	DESCRIPTION		POWER	UNIT	Q'TY	備考
	AK - 508A/H	AIR KNOCKER	1. TYPE	: AIR PISTION TYPE		SET	12	
			2. SIZE	: AK - 80 (2SET × 4CH)				
			3. OPERATION PRESS	: 3 ~ 5kg/㎠				
			4. 構造	: SOLENOID VALVE				
				: AIR FILTER W/REGULATOR				
		FILTER BAG	1. SIZE	: 156 Ø × 4100 L		SET	1260	
			2. MATERAIL	: G/F + TEFLON MEMBRANE				
			3. WEIGHT	: 750 g/m2				
		BAG CAGE	1. SIZE	: 156 Ø × 4100 L(￠4 × 20선)		SET	1260	
			2. MATERIAL	: SS400 + SWRM				
		VENTURI	1. SIZE	: 152 Ø		SET	1260	
			2. MATERIAL	: AL				
		DIA PHRAGM VALVE	1. TYPE	: CA- 50 A		SET	90	
			2. MATERIAL	: AL				
		BLOW TUBE	1. TYPE	: 50 A		SET	90	
			2. MATERIAL	: STS304				
		TIMER KIT	1. TYPE	: 20 POINT		SET	6	
6	通風施設							
	ID - 601	I.D FAN	1. TYPE	: TURBO	320 kw ,4P, 380V	LOT	1	VVV-F
			2. CAPACITY	: 2200 ㎥/min × 600 mmAq				

No	TAG No.	EQUIPMENT	DESCRIPTION			POWER	UNIT Q'TY	備考
			3.	構造	: COUPLING 直結駆動			
			4.	MATERIAL	: CASING - SS400, SHAFT - S45C			
					IMPELLA - SUS304			
	STA - 1001	STACK	1.	TYPE	: 強制垂直円筒形		LOT 1	
			2.	CAPACITY	: 60,875 Nm³/hr			
			3.	TOP(AIR+GAS)	: 178,275 Nm³/hr			
			4.	INLET TEMP.	: 163 ℃			
			5.	VELOCITY	: 9 m/s			
			6.	SIZE	: 2000Ø 35mH			
			7.	MATERIAL	SS400+CASTABLE			
		TMS	1.	TYPE	: ディジタル伝送			
			2.	測定項目	: O2, CO, NOX, SO2, HCL, DUST, 流速, 温度			
7	圧縮空気設備							
	ACP - 1401A/B	AIR COMPRESSOR	1.	TYPE	: SCREW COMPRESSOR	150 kw 380V	SET 2	
			2.	CAPACITY	: 28 m³/min × 8.5 kg/cm²			
			3.	구조	: COOLING SYSTEM - AIR COOLED			
					STARTING - STAR DELTA TYPE			
					DRIVING - DIRECT COUPLED DRIVE			

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			4. DIS' CONNECTION SIZE : 65 A				
	TK - 1402A/B	AIR RECEIVER TANK	1. TYPE : VERTICAL TYPE		SET	2	
			2. CAPACITY : 5 m³				
			3. 構造 : DRAIN TRAP.				
			4. IN/OUT CONNECTION : 100 A				
	AFC - 1403	AFTER COOLER	1. CAPACITY : 32 Nm³/min	0.8 kw 220V	SET	1	
			2. CONNECTION SIZE : 80 A				
	AD - 1404	AIR DRYER	1. TYPE : REFRIGERATED TYPE	4.5 kw 220V	SET	1	
			2. CAPACITY : 29 Nm³/min				
			3. DIS' CONNECTION SIZE : 80 A				
		PRE - FILTER	1. CAPACITY : 75 Nm³/min(SOLID 5㎛)		SET	1	
			2. CONNECTION SIZE : 80 A				
		LINE - FILTER	1. CAPACITY : 72 Nm³/min(SOLID 1㎛)		SET	1	
			2. CONNECTION SIZE : 80 A				
		COALESCENT - FILTER	1. CAPACITY : 42 Nm³/min(SOLID 0.01㎛)		SET	1	
			2. CONNECTION SIZE : 80 A				
8	DUCT工事						
		F.D FAN - 焼却炉	1. TYPE : 円筒形		SET	1	
			2. SIZE : 500 Ø				
			3. MATERIAL : SS400 4.5t				

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			4. 付属品	: DAMPER				
		BOILER-SEMI DRY REACTOR	1. TYPE	: 円筒形		SET	1	
			2. SIZE	: 1,580 Ø				
			3. MATERIAL	: SS400 6t				
			4. INSULATION	: ROCK WOOL #80 × 75t				
		S.D.R-DRY VENTURI	1. TYPE	: 円筒形		SET	1	
			2. SIZE	: 1,450 Ø				
			3. MATERIAL	: SS400 6t				
			4. INSULATION	: ROCK WOOL #80 × 75t				
		D.V-BAG FILTER	1. TYPE	: 円筒形		SET	1	
			2. SIZE	: 1,450 Ø				
			3. MATERIAL	: SS400 6t				
			4. INSULATION	: ROCK WOOL #80 × 75t				
		BAG FILTER-I.D FAN	1. TYPE	: 円筒形		SET	1	
			2. SIZE	: 1,400 Ø				
			3. MATERIAL	: SS400 6t				
			4. INSULATION	: ROCK WOOL #80 × 75t				
		I.D FAN-PACKED TOWER	1. TYPE	: 円筒形		SET	1	
			2. SIZE	: 1,400 Ø				

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			3. MATERIAL : FRP			
		COOLING FAN-GAS CONDENSOR	1. TYPE : 円筒形		SET 1	
			2. SIZE : 1,680 Ø			
			3. MATERIAL : SS400 4.5t			
			4. INSULATION : ROCK WOOL #80 × 75t			

POWER CONSUMPTION LIST

工事名 : ベトナム産業廃棄物焼却設備の製作、設置工事(150トン/日)

No.	TAG No.	ITEM NAME	定格容量	総容量		起動容量		VOLTAGE	Spec.	REMARK
			KW	KW	SET	KW	SET			
1	OHC -	OVER HEAD CRANE								
		HOISTING MOTOR	30.00	30.00	1	30.00	1	380V × 3φ		VVV-F
		TRAVERSING MOTOR(횡)	0.75	1.50	2	1.50	2	380V × 3φ		
		TRAVELLING MOTOR(주)	1.50	3.00	2	3.00	2	380V × 3φ		
		GRAB HYDRO MOTOR	15.00	15.00	1	15.00	1	380V × 3φ		
		SUB TOTAL		49.50		49.50				
2	INC -	ROTARY KILN								
		DRIVING MOTOR	22.00	22.00	1	22.00	1			VVV-F
		R/K COOLING FAN	22.00	22.00	1	22.00	1			
		WATER PUMP	1.10	2.20	2	1.10	1			
		1'ST F.D FAN (R/K)	52.50	52.50	1	52.50	1			VVV-F
		1'st BURNER	7.50	7.50	1	7.50	1			
		SUB TOTAL		106.20		105.10				
3	INC -	STOKER								
	BU -	2nd BURNER	7.50	7.50	1	7.50	1	380V × 3φ		
	HU -	HYDRO UNIT PUMP	40.00	80.00	2	40.00	1	380V × 3φ		
		HYDRO UNIT FAN COOLER	1.50	1.50	1	1.50	1	380V × 3φ		
		HYDRO UNIT E.HEATER	5.00	5.00	1	5.00	1	380V × 3φ		
	FD -	2'ND F.D FAN (STOKER)	30.00	30.00	1	30.00	1	380V × 3φ		VVV-F
	FD -	3'RD F.D FAN (STOKER)	15.00	15.00	1	15.00	1	380V × 3φ		VVV-F
	FD -	4'TH F.D FAN (STOKER)	37.50	37.50	1	37.50	1	380V × 3φ		VVV-F
	FC -	FLOW CONVEYOR	2.20	4.40	2	2.20	1	380V × 3φ		
	AC -	APRON CONVEYOR	3.75	3.75	1	3.75	1	380V × 3φ		VS
	BC -	BELT. CONVEYOR	1.50	1.50	1	1.50	1	380V × 3φ		
	MS -	MAGNET COLD	4.50	4.50	1	4.50	1	220V × 1φ		
		MAGNETIC SEPERATOR	2.20	2.20	1	2.20	1	380V × 3φ		

POWER CONSUMPTION LIST

工事名 : ベトナム産業廃棄物焼却設備の製作、設置工事(150トン/日)

No.	TAG No.	ITEM NAME	定格容量	総容量		起動容量		VOLTAGE	Spec.	REMARK
			KW	KW	SET	KW	SET			
		SUB TOTAL		192.85		150.65				
4	BL	BOILER								
	SB －	SOOT BLOWER(LONG RETRACTING)	1.10	3.30	3	1.10	1	380V × 3φ		
	SB －	SOOT BLOWER(고정식)	0.40	3.20	8	0.40	1	380V × 3φ		
	PF －	PURGE FAN	2.20	4.40	2	2.20	1	380V × 3φ		
	RV －	ROTARY V/V	1.50	4.50	3	4.50	3	380V × 3φ		
	FC －	FLOW CONVEYOR	3.70	3.70	1	3.70	1	380V × 3φ		
		DEAERA FEED WATER PUMP	11.50	23.00	2	11.50	1	380V × 3φ		
	PP －	BOILER FEED WATER PUMP	45.00	90.00	2	45.00	1	380V × 3φ		
		COMPOUND DOSING TANK AGITATOR	0.40	0.40	1	0.40	1	380V × 3φ		
	PP －	COMPOUND DOSING PUMP	0.20	0.40	2	0.20	1	220V × 1φ		
		SUB TOTAL		132.90		69.00				
5	SNCR	SNCR								
		FLANGE HEATER	5.00	5.00	1	5.00	1	380V × 3φ		
	PP －	UREA SPRAY PUMP	0.75	1.50	2	0.75	1	380V × 3φ		VVV-F
	PP	UREA DILUTION WATER PUMP	0.75	1.50	2	0.75	1	380V × 3φ		
	PF －	PURGE FAN	0.50	0.50	1	0.50	1	380V × 3φ		
		E.HEATER	5.00	5.00	1	5.00	1	380V × 3φ		
		SUB TOTAL		13.50		12.00				
6	SDR	SEMI DRY REACTOR								
	SG －	SLIDE GATE		0.00	2	0.00		DC24V		
	VB －	VIBRATOR	0.20	0.80	4	0.20	1	380V × 3φ		
	EHT －	E.HEATER	3.00	3.00	1	3.00	1	380V × 3φ		
	AG －	L/S S/TANK AGITATOR	5.50	5.50	1	5.50	1	380V × 3φ		
	AG －	L/S M/TANK AGITATOR	3.75	3.75	1	3.75	1	380V × 3φ		
	PP －	LIME FEED PUMP	1.50	3.00	2	1.50	1	380V × 3φ		
	PP －	LIME SPRAY PUMP	1.50	3.00	2	1.50	1	380V × 3φ		VVV-F

POWER CONSUMPTION LIST

工事名 : ベトナム産業廃棄物焼却設備の製作、設置工事(150トン/日)

No.	TAG No.	ITEM NAME	定格容量	総容量		起動容量		VOLTAGE	Spec.	REMARK
			KW	KW	SET	KW	SET			
	PF −	PURGE FAN	1.75	1.75	1	1.75	1	380V × 3φ		
		SUB TOTAL		**20.80**		**17.20**				
7	**TK**	**LIME SILO**								
	VF −	VOLUMETRIC FEEDER	1.50	1.50	1	1.50	1	380V × 3φ		VVV-F
	EHT −	E.HEATER	3.00	3.00	1	3.00	1	380V × 3φ		
	AK	AIR KNOCKER		0.00	2	0.00	1	DC24V		
	AP	AERA PAD		0.00	6	0.00	1	DC24V		
		TIMER KITS		0.00	1	0.00	1	220V × 1φ		
		SUB TOTAL		**4.50**		**4.50**				
8	**TK**	**A/C SILO**								
	VF −	VOLUMETRIC FEEDER	0.75	0.75	1	0.75	1	380V × 3φ		VVV-F
	EHT −	E.HEATER	3.00	3.00	1	3.00	1	380V × 3φ		
	AK −	AIR KNOCKER		0.00	2	0.00	1	DC24V		
	HO −	HOIST	0.75	0.75	1	0.75	1	380V × 3φ		
		SUB TOTAL		**4.50**		**4.50**				
9	**BF**	**BAG FILTER**								
		POPPET DAMPER			7			DC24V		
	RV −	ROTARY V/V	1.50	3.00	2	3.00	2	380V × 3φ		
	FC −	FLOW CONVEYOR	2.20	4.40	2	2.20	1	380V × 3φ		
	EHT −	E.HEATER	3.00	6.00	2	6.00	2	380V × 3φ		
		E.HEATER	5.00	20.00	4	20.00	4	380V × 3φ		
	AK −	AIR KNOCKER			12		16	DC24V		
		TIMER KITS			6		8	220V × 1φ		
		SUB TOTAL	**11.70**	**33.40**		**31.20**				
10	**ID −**	**I.D FAN**	320.0	320.00	1	320.00	1	380V × 3φ		VVV-F

POWER CONSUMPTION LIST

工事名：ベトナム産業廃棄物焼却設備の製作、設置工事(150トン/日)

No.	TAG No.	ITEM NAME	定格容量	総容量		起動容量		VOLTAGE	Spec.	REMARK
			KW	KW	SET	KW	SET			
		SUB TOTAL	320.00	320.00		320.00				
11	ACP	AIR COMPRESSOR								
	ACP – 1401A/B	AIR COMPRESSOR	150.00	300.00	2	150.00	1	380V × 3φ		
	AFC – 1403	AFTER COOLER	0.80	0.80	1	0.80	1	220V × 1φ		
	AD – 1404	AIR DRYER	4.50	4.50	1	4.50	1	380V × 3φ		
		SUB TOTAL		305.30		155.30				
	GRAND TOTAL			1077.25		813.85				

3-4 Support letter from Long An Province

Support letter from Long An Province

ỦY BAN NHÂN DÂN
TỈNH LONG AN

Số: 3561/UBND-KT

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

Long An, ngày 04 tháng 10 năm 2012

V/v xử lý chất thải công nghiệp tại tỉnh Long An

Kính gửi: Ông Koichi Shinohara
Chủ tịch Công ty Tsuneishi Kamtecs
1083 Tsuneishi, Numakuma-cho,
Fukuyama, Hiroshima 721-0313 - Japan

UBND tỉnh đã nhận được thư ngỏ của quý công ty đề ngày 28/9/2012 về việc xử lý chất thải từ các xí nghiệp tại tỉnh Long An.

Trước hết chúng tôi chân thành hoan nghênh sự quan tâm của quý công ty đối với việc liên kết cùng Công ty Cổ phần Đồng Tâm, Công ty Kobelco Eco-Solutions cũng như các thành viên khác trong vấn đề xử lý chất thải công nghiệp tại tỉnh Long An.

Chúng tôi luôn hiểu rằng việc quản lý chất thải rắn là một trong những nhiệm vụ quan trọng trong mục tiêu hài hòa giữa nhiệm vụ công nghiệp hóa và bảo vệ môi trường trong vùng. Vì vậy chúng tôi luôn sẵn lòng hỗ trợ quý Công ty trong việc thực thi đề án nghiên cứu thực tiễn đối với dự án đang được hỗ trợ bởi JICA lần này, bằng cách cung cấp cho quý công ty những thông tin cần thiết, phục vụ cho sự thành công của công trình nghiên cứu, cũng như thành công của dự án về sau.

Chúng tôi tin tưởng rằng, việc triển khai dự án xử lý chất thải nêu trên sẽ góp phần đẩy mạnh công nghiệp hóa tại Long An phát triển ổn định, bền vững và thân thiện với môi trường. Chúng tôi rất mong quý Công ty tiếp tục hỗ trợ - làm cầu nối, giới thiệu nhiều nhà đầu tư của Nhật Bản đến đầu tư sản xuất kinh doanh tại các khu công nghiệp trên địa bàn tỉnh Long An.

Trân trọng kính chào !

TM. ỦY BAN NHÂN DÂN
KT. CHỦ TỊCH
PHÓ CHỦ TỊCH

ỦY BAN NHÂN DÂN TỈNH LONG AN

Nguyễn Thanh Nguyên

Nơi nhận:
- CT, PCT.UBND tỉnh$_{SX}$;
- Như trên;
- Sở Kế hoạch và Đầu tư;
- Sở Tài nguyên và Môi trường;
- Cty CP KCN Đồng Tâm;
- Phòng NC-KT;
- Lưu: VT, Nh;

TSUNEISHI -DA XL CHAT THAI

People's Committee
Long An Province

The Socialist Republic of Vietnam
Independence-Freedom-Happiness

Long An, October 4th , 2012

Attention: Mr. Koichi Shinohara, President
Tsuneishi Kamtecs Corporation
1083 Tsuneishi, Numakuma-cho, Fukuyama,
Hiroshima 721-0313 Japan

Subject: Industrial Waste Treatment in Long An Province

We duly received your letter on the captioned title and dated September 28th, 2012.

We appreciate your interest in establishing a Joint Venture company together with Dong Tam Group, Kobelco Eco-Solutions, and other members to treat industrial wastes in Long An Province.

Such solid waste management is one of the most important issues for harmony between industrialization and environmental protection of the areas, and, therefore, we are willing to assist your Feasibility Study of the project supported by JICA, by providing you any necessary information for successful implementation of the Feasibility Study and of the project.

We believe that the above-mentioned Waste Disposal Project will contribute for promoting industrialization of Long An Province with sustainable and eco-friendly development. We hope you will continue to support as a bridge in introducing more Japanese investors to invest in manufacturing as well as trading at the industrial parks located in Long An province

Yours faithfully,

On behalf of People's Committee of Long An Province
PP Chairman
Vice- Chairman
Nguyen Thanh Nguyen