5 Environmental and Social Considerations

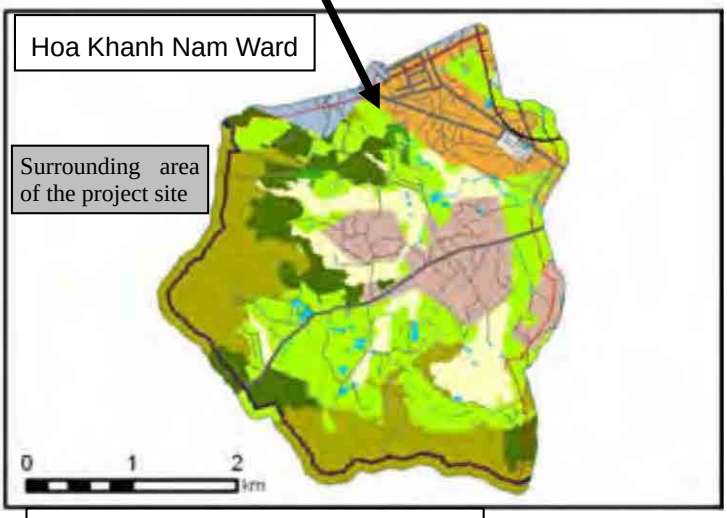
5.1 Project Components which will have Environment and Social Impacts

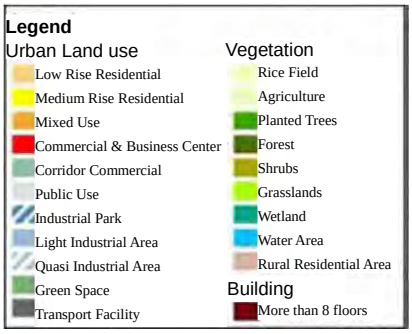
In this Chapter, the necessary environmental and social considerations that must be made when constructing and operating the waste treatment facility (MRF and WTE facilities) which will contribute to prolonging the lifetime of the current Khanh Son landfill and to improving the environment in the landfill are examined. For details of the facilities, please refer to Chapter 4.

5.2 Current Environmental and Social Conditions

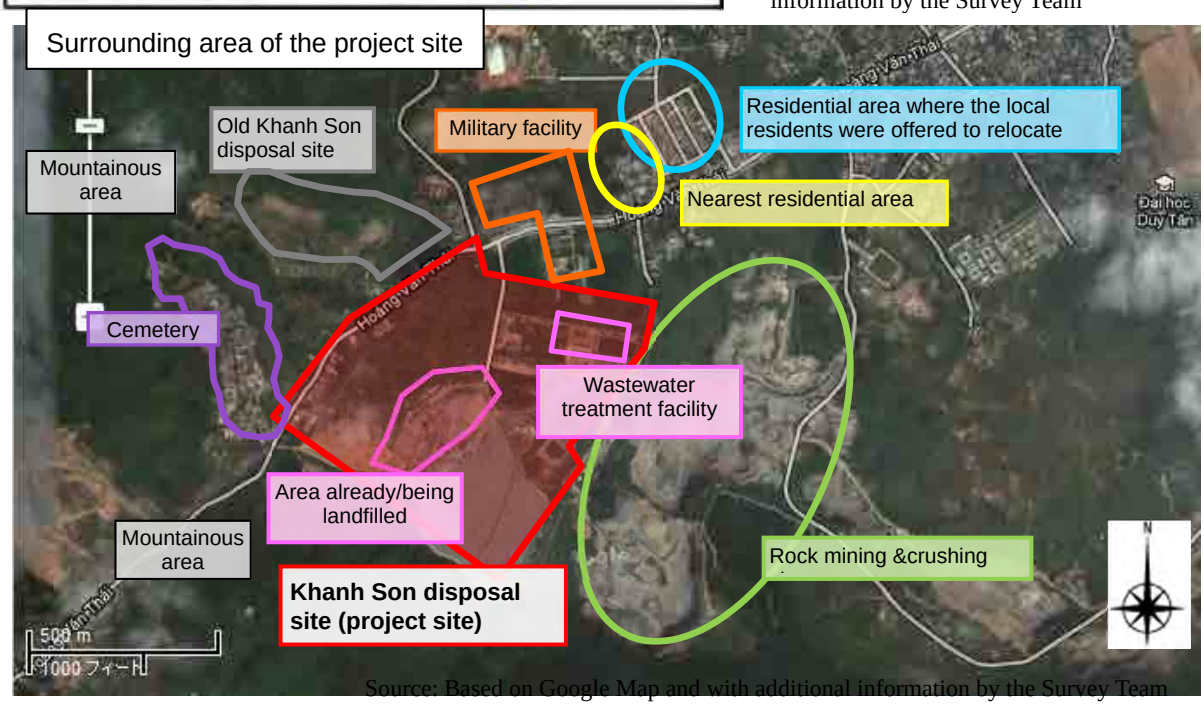
The project site is located inside the Khan Son disposal site in Hoa Khanh Nam Ward, Lien Chiu Urban District, Da Nang City. The land use of the surrounding areas is shown in the figure in the next page. This section (5.2) outlines the environmental and social conditions in Da Nang city and the surrounding areas of the project site based on literature and interviews (for detailed environmental and social survey conducted for this Survey, please see 5.6).

Source: Based on Google Map and with additional information by the Survey Team





Source: Based on JICA, The study on integrated development strategy for Danang City and its neighboring area in the Socialist Republic of Vietnam (DaCRISS) Annex 6, 2010 with additional information by the Survey Team



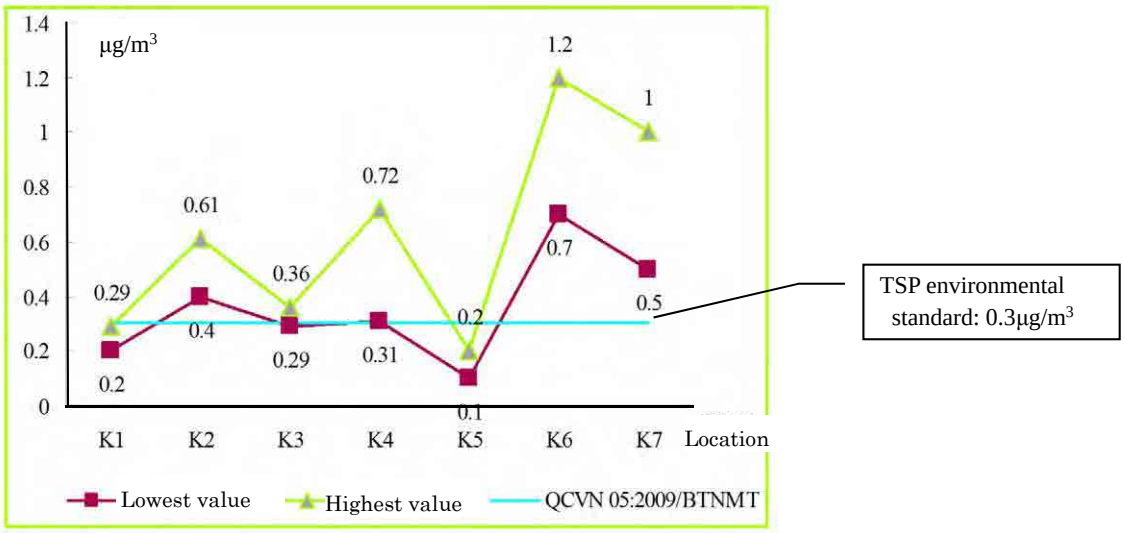
Source: Based on Google Map and with additional information by the Survey Team

Figure 5-1: Map of the area around Khanh Son Landfill

5.2.1 Environmental Conditions

a. Air

Although levels of CO, NO_2 and SO_2 have met the standards at most of the monitoring points in Da Nang city, the dust level have exceeded the standards in some points of the city (Figure 5-3, 5-4)[3]. According to Report Danang State of Environment Period 2005 – 2010 and Orientation to 2015", 70% of the pollution source is transportation and other sources include industry and construction. In order to solve this problem, Da Nang city has limited number of cars and improved transportation network according to DONRE. The volume of traffic near the project site is low, as Khanh Son disposal site is surrounded by grasslands and forests and there are no industrial facilities close by.



K1 – Hải Vân Nam, K2 –Hue intersection, K3 - Trương Vương Theatre, K4 - Nguyễn Trãi High School, K5 - Sơn Trà Penilsula, K6 - Non Nước intersection, K7 - Ngô Quyền - Phạm Văn Đồng crossroads

Figure 5-2: TSP Concentration in Da Nang City (2006 – 2010)

[3] Danang People's Committee, "Report Danang State of Environment Period 2005 – 2010 and Orientation to 2015", December, 2011

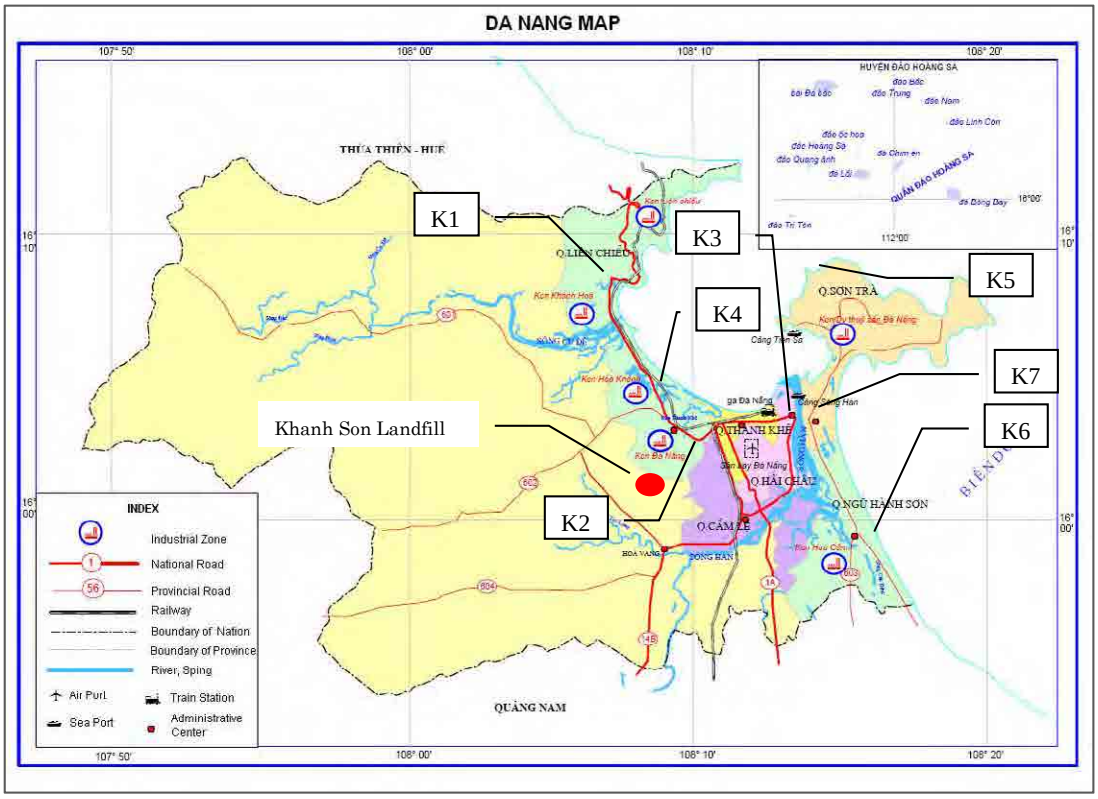


Figure 5-3: Map of TSP Monitoring Points

b. Water

b.1. Surface water

There are no large rivers around Khanh Son disposal site. There is a small channel where water flows during the rainy season, and the treated leachate is released to this channel. The channel joins the Phu Loc River after running through the residential area. The levels of COD, BOD, NH4+-N and coliforms have not met the standard for a long time in the Phu Loc River due to the leachate and wastewater from industrial facilities and households. Recent monitoring results are shown in the table below.

Table 5-1: Recent Monitoring Results of the Phu Loc River

Item	Unit	Range of results	Measurement period	Standard (QCVN 08:2008/BTNMT)
BOD5	mg/L	27.83 ～61.33	Approx. 2006～2010	25
COD	mg/L	33.33 ～135.17	Approx. 2006～2010	50
$NH4^{+}$	mg/L	6.83 ～17.46	2005～2009	1
$PO4^{3-}$	mg/L	1.31～9.41	2005～2009	0.5
Coliforms	MNP/100ml	4,600～ 10,200	Approx. 2006～2010	10,000
		583,127	2009	
Oil	mg/L	0.4～4.2	2009	0.3

According to DONRE, Da Nang city has introduced drainage system for domestic wastewater and wastewater treatment and monitoring system for industrial facilities and hospitals near the Phu Loc River in order to improve its water quality. For leachate from the old Khanh Son disposal site, Effective Microorganisms (EM) are used in the retention pond for treatment. In addition, the city will take

appropriate measures to close the site in an environmental friendly with the financial support received from the government in 2012.

b.2. Groundwater

The levels of NH_4^+-N and coliforms in the groundwater around the landfill have been high due to leachate discharged from the old Khanh Son disposal site and the current Khanh Son Landfill and effluent from household septic tanks which are not connected to drainage system. These polluted waters have penetrated through the soil and affected the groundwater quality.

c. Soil

According to the environmental report of Da Nang for years 2005 to 2010 published in 2011, the land in residential area around Khanh Son Landfill has been contaminated by leakage water from both landfills.

d. Noise and Vibration

The rock mining and crushing site next to Khanh Son disposal site is a noise source in the area. In addition, about 120 vehicles per day come in and out the landfill to transport wastes to Khan Son disposal site (the current noise and vibration level is noted in 5.6.1 e.1).

e. Odor

The residence area that is the closest to the Khanh Son disposal site is about 250m far from the boundary of the disposal site and about 500m far from the landfill area. According to URENCO, there are sometimes complaints from the residents about the odor from the disposal site. The odor is especially strong during night time when the wind blows from the disposal site to the residential area or when the height of the landfilled wastes becomes high. However, as the third cell that is now being landfilled is still comparatively low, recently the odor is not that strong.

f. Biodiversity

There are no primeval forests, tropical forests and ecologically valuable habitats (e.g. coral reefs, mangroves, or tidal flats) in and around the project site. There are no protected habitats inside the site[4].

5.2.2 Social Conditions

a. Living conditions

Basic infrastructure, namely electricity, tap water, sewage, paved roads, can be found in the project site and the area surrounding the project site. There are also public facilities such as educational institutions in the Hoa Khanh Nam, namely kindergartens, primary, and secondary schools and a clinic.

With regard to water, the local residents did not have access to tap water until a few years ago. Currently, they use tap water for drinking and groundwater for purposes such as washing clothes. Regarding sewage, although a system exists, parts of it are currently broken and are not meeting the demands of the area. Regarding insects, currently there are almost no complaints from the residents

[4] According to People's Committee of Hoa Khanh Nam ward

because insecticides are sprayed in the landfill area. Before this was done, there were times when a large number of insects such as flies appeared in the area.

In order to reach the city center of Da Nang from the Khanh Son disposal site, which is approximately 8 km far, it takes approximately 10 minutes by car or motorbike. The amount of traffic in the area surrounding the Khanh Son disposal site is relatively low, probably due to the fact that Hoang Van Thai Street which runs in front of the Khanh Son disposal site is not fully paved. Although it is paved between Khanh Son disposal site and the city center of Da Nang which is to its East, the West side of the road is not paved and is in poor condition. However, as there are currently plans to pave the West side of the road, the amount of traffic may increase in the future.

b. Livelihood

The main economic activities in the area are handicrafts, commerce, and agriculture (e.g. rice farming, livestock farming). According to URENCO, many of the local residents used to be farmers. However, as their lands were bought by the city for the construction of the Khanh Son disposal site, 125 households lost their agricultural land and 41 households lost their homes. Many of the members of these households are currently earn a living in the Khanh Son disposal site as waste pickers or other workers (see 5.6.2 b.1 for details).

c. Health conditions

An interview survey regarding health conditions was conducted with 80 local residents that live within 500m from the boundary of the Khanh Son disposal site and 94 waste pickers that work inside Khanh Son disposal site. In the interview, 61% of the local residents and 89% of the waste pickers answered "yes" to the question "Do you currently have any health issue(s)?", and it was found that a high percentage of the waste pickers have health issues. The health issues that were common among the local residents were stomach pain, respiratory issues, and dermatitis. Among the waste pickers, the common health issues were muscular pain, headache, backache, dizziness, and rheumatism. Regarding the cause of the health issues, many of the local residents answered "Khanh Son disposal site" and "pollution caused by Khanh Son disposal site", and many waste pickers answered "hard work", "poor working conditions", and "old age" (see Table 5-2 and Table 5-3 for detailed results).

Table 5-2: Summary of Interview Results concerning Health Conditions

Question	Response	Number of respondents (%)*	
		Local residents (80 respondents)	Waste pickers in Khanh Son Disposal Site (94 respondents)
Have you been to health institutions for health checkups?	Yes	49 (61%)	84 (89%)
	No	31 (49%)	10 (11%)
Do you currently have any health issue(s)?	Yes	44 (55%)	88 (93%)
	No	36 (45%)	6 (7%)
Do you feel that the level of your health issue(s) have changed in the recent years?	It has drastically improved	1 (1%)	0 (0%)
	It has slightly improved	8 (10%)	3 (3%)
	It is the same	39 (49%)	30 (32%)
	It has slightly become worse	24 (30%)	30 (32%)
	It has drastically become worse	8 (10%)	31 (33%)

*The percentage of number of respondents has been rounded off to the nearest number.

Table 5-3: Health Issues claimed by Waste Pickers and Residents living near Khanh Sonh Disposal Site (by order of frequency)

Local residents (80 respondents)		Waste pickers in Khanh Son Disposal Site (94 respondents)	
Health problem (in descending order of number of respondents)	Number of respondents (%)*	Health problem (in descending order of number of respondents)	Number of respondents (%)*
Stomach pain	9 (11.25%)	Muscular pain	32 (34%)
Respiratory problems	9 (11.25%)	Headache	21 (22%)
Dermatitis	5 (6%)	Backache	19 (20%)
Arthritis	4 (5%)	Dizziness	18 (19%)
Sinusitis	3 (4%)	Rheumatism	12 (18%)
Kidney stones	2 (3%)	Low calcium	7 (7%)
Pneumonia	2 (3%)	Numbness	6 (6%)
High blood pressure	2 (3%)	Dermatitis	6 (6%)
Low blood pressure	2 (3%)	Gastritis	6 (6%)
Vascular accident	2 (3%)	Women's disease	6 (6%)
Gastroenteritis	1 (1%)	Eye issue	5 (5%)
Spinal degeneration	1 (1%)	Fatigue	3 (3%)
Hepatitis	1 (1%)	Catch cold	3 (3%)
Cough	1 (1%)	Pneumonia	2 (2%)
Cardiovascular disease	1 (1%)	Blood pressure issue	2 (2%)
Eyes pain	1 (1%)	Cough	2 (2%)
Backache	1 (1%)	Allergic rhinitis	2 (2%)
Blurred vision	1 (1%)	Intercostal neuralgia	2 (2%)
Cancer	1 (1%)	Kidney stone	2 (2%)
Hepatitis	1 (1%)	Osteophyte	2 (2%)
Cholera during the rainy season	1 (1%)	Myositis	2 (2%)
Agent Orange	1 (1%)	Itchy all over	2 (21%)
Lack of calcium	1 (1%)	Vestibular disorder	1 (1%)
		Inadequate health	1 (1%)
		Kidney issue	1 (1%)
		Worm issues	1 (1%)
		Rhinitis	1 (1%)
		Fatty liver	1 (1%)
		Uteritis	1 (1%)
		Severe bronchitis	1 (1%)
		Shoulder pain	1 (1%)
		Knee pain	1 (1%)
		Insomnia	1 (1%)
		Colitis	1 (1%)
		Stress	1 (1%)
		Sinusitis	1 (1%)
		Calf tension	1 (1%)
		Chest pain	1 (1%)
		Swelling ears	1 (1%)
		Myelitis	1 (1%)
		Gall issue	1 (1%)
		Tuberculosis	1 (1%)
		Asthma	1 (1%)

*The percentage of number of respondents has been rounded off to the nearest number.

d. Heritage

According to the Chairman of Hoa Khanh Nam Ward Peoples Committee, there are no significant archeological, historical, cultural, or religious heritage sites near the Khanh Son disposal site. However,

there is a cemetery across the street from the Khanh Son disposal site which is managed by the Hoa Khanh Nam Ward.

e. Landscape

As shown in the Figure 5-1, this disposal site is surrounded by a military facility, the old Khanh Son final disposal site, cemetery, rock mining and crushing site, and mountains. There are no scenic spots (e.g. touristic scenic spots) in the area.

f. Ethnic minorities and indigenous peoples

According to the Chairman of Hoa Khanh Nam Ward Peoples Committee, there are no ethnic minorities and indigenous peoples in the area.

5.3 Institution and Organizations regarding Environmental and Social Consideration in Vietnam

The rules regarding environmental impact assessment is provided in Chapter III in "Law on environmental protection (No. 52/2005/QH11)" which was amended in 2005. The law stipulates that strategic environmental assessment, environmental impact assessment, or environmental protection commitment should be conducted according to the size of the each project[5]. Details such as target projects, application procedure, and appraisal organizations are stated in the government decree "The Government Decree Providing Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitment (No. 29/2011/ND-CP)" (hereafter Decree). The contents to be included in the EIA report are noted in "Circular No.26/2011/TT-BTNMT of July 18, 2011, Detailing a number of articles of the Government's Decree No. 29/2011/ND-CP of April 18, 2011, on strategic environmental assessment, environmental impact assessment and environmental protection commitment.

5.3.1 Environmental Impact Assessment in Vietnam

a. Projects subject to environmental impact assessment

Types of projects subject to environmental impact assessment are listed in Annex II of the Decree. There are 146 project types in total such as construction projects, transport projects, power generation projects, waste treatment projects and food processing projects. Our Project would be classified as "construction of centralized waste treatment facilities"

b. Approval of EIA report

b.1. Approval body

There are four categories of bodies that approve EIA reports, namely (1) MONRE, (2) ministries and cabinet-level/governmental agencies other than MONRE, (3) the Ministry of National Defense or the

[5] Kajima Corporation, "H19 year CDM/JI Project Survey, Municipal Waste 3R Promotion and Stabilization Treatment Project Survey in Vietnam", Report, March in H20 year.

Ministry of Public Security, and (4) provincial-level People's Committees (Decree Article 18).

MONRE approves EIA reports for projects that fall under 11 categories listed in Appendix III of the Decree. Our Project which will construct and operate waste treatment facilities with daily treatment capacity of 250 tons or more is one of these projects and thus the EIA report would be approved by MONRE.

Ministries and cabinet-level/governmental agencies other than MONRE approve EIA reports of projects under their respective competence except for the projects provided in Appendix III to Decree. The Ministry of National Defense or the Ministry of Public Security approves EIA reports of projects under its competence and security or defense-related projects as assigned by competent authorities. Provincial-level People's Committees approve EIA reports of investment projects in their localities except those provided above.

b.2. Contents of EIA reports

The main contents of EIA reports are the followings (Decree Article 17).

A) Indication of the project origin, project owner, agency competent to approve the project, sources of information and data, and used methods, organization and process of environmental impact assessment reporting, consultation of the community in the process of environmental impact assessment reporting;
B) Listing and detailed description of the project's activities and work items which likely have adverse environmental impacts, indicating the size in terms of space and time, construction volume, operating technology of each work item and the entire project;
C) General assessment of the current status of the environment of the project site and its neighborhood, level of environmental sensitivity;
D) Assessment and prediction of the project's impacts on natural conditions, natural environmental components, the community and related socio-economic elements, results of consultation of the community;
E) Proposal of measures to mitigate adverse impacts on natural conditions, natural environmental components, community health and related socio- economic elements;
F) Listing of works and programs for managing and controlling environmental issues in the course of project implementation;
G) Estimation of costs for construction of environmental protection works in the project's total cost estimate;
H) The project owner's commitment to taking environmental protection measures in the course of project construction and operation proposed in the environmental impact assessment report and to observing other regulations on environmental protection related to the project.

b.3. Appraisal and approval process of EIA reports

For a project with a work item subject to construction licensing, the EIA reports of such a project needs

to be submitted before the project owner proposes a competent agency to grant the construction license, since the decision approving the EIA report is a basis for a competent authority to grant a construction license (Decree, Sub article 2c in Article 13).

Before requesting appraisal of EIA reports, it is necessary to consult with the People's Committee of the commune, ward or township (hereafter commune level) in which the project is to be implemented, and representatives of communities and organizations directly affected by the project (Decree, Sub article 1 in Article 14). The opinions of consulted organizations and persons need to be reflected in the reports (Decree, Sub article 1e in Article 15), and the opinions and meeting record have to be attached as an annex to the reports (Decree, Sub article 2 in Article 15).

For appraisal of EIA reports, the project owner needs to submit a dossier of request to a competent agency. After receiving such a dossier, an appraisal agency checks it and notifies in writing the project owner if the dossier is complete and valid, or not (Decree, Sub articles 1 and 2 in Article 19).

After receiving a complete and valid dossier, the appraisal agency sets up an appraisal council or select an appraisal service provider, notifies the project owner to pay the fee for the appraisal and notifies in writing appraisal results to it (Decree, Sub article 3 in Article 19). The time limit for appraising EIA reports to be appraised by MONRE is 45 working days and 60 working days for projects with complicated environmental impacts after receiving complete and valid dossiers, (Decree, Sub article 1a in Article 20).

On the basis of the appraisal agency's notice of appraisal results of the EIA report, the project owner makes another EIA report and submits it to the appraisal agency for appraisal if its EIA report is not approved. The appraisal time limit and procedures are the same as for the first report (Decree, Sub article 4a in Article 19). The project owner modifies and supplements the EIA report and submits it to the appraisal agency for consideration if the EIA report is approved on condition of modification and supplementation (Decree, Sub article 4b in Article 19). The project owner sends the EIA report to a competent agency for issuance of an approval decision if the report is approved without modification and supplementation (Decree, Sub article 4c in Article 19). The approval is issued within 15 working days after receiving a complete and valid dossier (Decree, Sub article 2 in Article 20). The process flow chart is shown in the next page.

Table 5-4: Flow of EIA Approval

No	Works	Departments and agencies in charge	Duration	Note
I	**EIA report preparation**			
1	Prepare EIA report	**Investor or consulting company**		The structure of the EIA report follows: Annexes 2.4 and 2.5 of Circular No. 26/2011/TT-BTNMT
2	Corresponding member of community	Investor, Ward People's Committee, and other related organizations	15 working days (A.15, Decree 29/2011/NĐ-CP)	The form follows: Circular No. 26/2011/TT-BTNMT, Annexes 2.1 + 2.2
3	Improve the EIA report after getting comments from members of community	**Investor or consulting company**		
II	**Submission of EIA report**			
1	The documents submitted: - Request for EIA report appraisal: 01 copy - EIA reports: 07 copies -Project feasibility study report: 01	**Investor or consulting company**		Circular No. 26/2011/TT-BTNMT, Article 13
III	**The process of reception and approval of EIA report**			
1	Receive the report Check of the dossier NO	MONRE	5 working days	
2	OK Setting up appraisal council Notification of payment for the fee for the appraisal to the project Notification of the appraisal results to the project owner Not approved Approved Need to modify No need to modify	MONRE	* For EIA reports that are subject to get approved by - MONRE: 45 - 60 working days, depending on how complicated the project is (A.19 and A.20, Decree 29/2011/NĐ-CP) * For EIA reports that are not subject to get approved by MONRE: 30 - 45 working days, depending on how complicated the project is (A.19 and A.20, Decree 29/2011/NĐ-CP)	
3	Modify the EIA report	**Investor or consulting company**		
4	NO Appraisal Council	MONRE		
5	OK Submission of the report to competent agency to request for issuance of an approval decision Acceptance of EIA Report	MONRE	15 working days	

5.3.2 National standards related to EIA

The following standards are related to EIA for this project.

Table 5-5: List of National Technical Regulations related to this project

Category	Standards
Air	QCVN 05:2009/BTNMT "National technical regulation on ambient air quality"
	QCVN 30:2012/BTNMT "National Technical Regulation on Industrial Waste Incinerator"
Water	QCVN 08:2008/BTNMT "National technical regulation on surface water quality"
	QCVN 09:2008/BTNMT "National technical regulation on groundwater quality"
	QCVN40:2011/BTNMT "National Technical Regulation on Industrial Wastewater"
	QCVN 25:2009/BTNMT "National technical regulation on wastewater of the solid waste landfill site"
Noise	QCVN 26:2010/BTNMT "National technical regulation on noise"
Vibration	QCVN 27:2008/BTNMT "National technical regulation on vibration"

5.3.3 Strategic Environmental Assessment (SEA)

In Vietnam, SEA was introduced when Law on Environmental Protection was amended in 2005. While EIA targets individual projects, SEA is a method to assess impacts of policies, programs and plans[6]. The general description of SEA is as follows.

a. Projects subject to SEA

Appendix I to Decree stipulates projects subject to SEA as described below.

i. Socio-economic development strategies and master plans
ii. Development strategies and master plans of national-level sectors and domains
iii. Master plans on inter-provincial river basins
iv. Development master plans of national-level sectors and domains
v. Master plans on land use, forest protection and development and exploitation and use of other natural resources on inter- provincial or -regional scale
vi. Other strategies, master plans and plans as directed by the National Assembly, the Government and the Prime Minister

Our project is not classified into the projects which require SEA.

b. Approval process of SEA

b.1. Appraisal body

The Ministry of Natural Resources and Environment appraises strategic environmental assessment reports of strategies, master plans and plans approved by the National Assembly, the Government or the Prime Minister. The Ministry of Public Security or the Ministry of National Defense assumes the prime responsibility for, and coordinate with the Ministry of Natural Resources and Environment in,

[6] The Global Environmental Forum. "Environmental measurements and social responsibility of business entities in Vietnam, CSR in Asia", March 2007, http://www.env.go.jp/earth/coop/oemjc/H18_csr_asia/H18_all.pdf (accessed in July, 2013)

appraising strategic environmental assessment reports of strategies, master plans and plans involving security or defense secrets approved by the National Assembly, the Government or the Prime Minister. Ministries, ministerial-level agencies and government-attached agencies appraise strategic environmental assessment reports of strategies, master plans and plans falling under their respective approving competence. Provincial-level People's Committees appraise strategic environmental assessment reports of strategies, master plans or plans falling under their approving competence and provincial-level People's Councils. (Decree, Article 7)

b.2 Contents of SEA reports

SEA reports have the following major contents. (Decree, Article 5)

a) Brief description of the strategy, master plan or plan;
b) The strategic environmental assessment process; description of the scope of study of the strategic environmental assessment and major environmental issues related to the strategy, master plan or plan;
c) Description of past developments and prediction of major environmental trends in case of failure to implement the strategy, master plan or plan;
d) Assessment of conformity of viewpoints and objectives of the strategy, master plan or plan with environmental protection viewpoints and objectives; assessment and comparison of development options of the strategy, master plan or plan;
e) Assessment of impacts on major environmental issues in case of implementation of the strategy, master plan or plan;
f) Consultation of involved parties in the process of strategic environmental assessment;
g) Proposals on adjustment of the strategy, master plan or plan and measures to prevent and mitigate adverse environmental impacts

b.3. Appraisal and approval process

It is required that SEA is conducted concurrently with the formulation of a strategy, master plan or plan and SEA results is integrated into documents of a strategy, master plan or plan (Decree, Article 4).

The time limit for appraising a detailed strategic environmental assessment report is 45 working days after receiving a complete and valid dossier. For a strategic environmental assessment report to be appraised by a provincial-level People's Committee, and a brief strategic environmental assessment report, the limit is 30 working days. (Decree, Article 8)

5.3.4 Gaps between JICA Guidelines for Environmental and Social Considerations (April 2010)

In order to conduct EIA in an appropriate manner, the gaps among the Vietnamese regulation (Circular No.26/2011/TT-BTNMT of July 18, 2011, Annex 2.5, detailing a number of articles of the Government's Decree No. 29/2011/ND-CP of April 18, 2011, on strategic environmental assessment, environmental impact assessment and environmental protection commitment) and JICA guidelines for environmental and social considerations and World Bank Safeguard Policy were examined. The result of comparison is shown in Table 5-6.

Table 5-6: Comparison of JICA Guideline and World Bank Operational Policy 4.01 with Vietnamese regulation

	Item	JICA Guidelines	World Bank Safeguard Policy	Circular No.26/2011/TT-BTNMT of July 18, 2011, Annex 2.5	Gaps (If gaps exist, measures to fill the gaps)
Principles of EIA Report	Compliance	When assessment procedures already exist in host countries, and projects are subject to such procedures, project proponents etc. must officially finish those procedures and obtain the approval of the government of the host country.	(Same with the left column)	Procedures regarding EIA is stipulated by the Vietnamese law	No gap
	Language	EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them;	(Same with the left column)	There is no rule regarding language of the EIA report	There is a gap EIA report will be written in Vietnamese
	Disclosure	EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted	For a Category A project, the borrower makes the draft EA report available at a public place accessible to project-affected groups and local NGOs.	After its approval, EIA report must be made public in the office of the People's Committee of the Commune	No gap
	Consultation	In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared	Consultation with stakeholders and public information disclosure should be conducted.	The owner of the project requests to the People's Committee of the Commune, and it organizes consultation meetings with stakeholders as necessary. The opinions expressed during these consultations must be noted in the EIA report.	There is a gap Requests would be made to Da Nang city to involve relevant stakeholders in the consultations.

	Item	JICA Guidelines	World Bank Safeguard Policy	Circular No.26/2011/TT-BTNMT of July 18, 2011, Annex 2.5	Gaps (If gaps exist, measures to fill the gaps)
	Time of consultation	Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared	For all Category A and B projects, the borrower initiates consultations with project-affected groups and local NGOs about the project's environmental aspects and takes their views into account as early as possible.	There are rules regarding stakeholder consultation but there are no rules regarding its timing.	There is a gap Stakeholder consultations would be conducted at the scoping stage.
Contents of EIA Report	Executive summary	This concisely discusses significant findings and recommended actions.	Concisely discusses significant findings and recommended actions.	States the necessity of the project, the relationship with other development plans appraised and approved by state management agencies, information on EIA implementation organization.	There is a gap. We will state the necessity of the project, the relationship with other development plans and information on EIA implementation organization.
	Policy, legal, and administrative	This is the framework within which the EIA report is to be carried out.	Discusses the policy, legal, and administrative framework within which the EA is carried out. Explains the environmental requirements of any co-financers. Identifies relevant international environmental agreements to which the country is a party.	Lists laws and technical documents, standards and applicable regulations which are as a base for EIA implementation and EIA report. States competent agencies and organizations which approve EIA report of the project.	No gap

	Project description	This describes the proposed project and its geographic, ecological, social and temporal context, including any off-site investments that may be required (e.g. dedicated pipelines, access roads, power plants, water supply, housing, or raw material and product storage facilities). It also indicates the need for any resettlement or social development plan. It normally includes a map showing the project site and the area affected by the project.	Concisely describes the proposed project and its geographic, ecological, social, and temporal context, including any offsite investments that may be required (e.g., dedicated pipelines, access roads, power plants, water supply, housing, and raw material and product storage facilities). Indicates the need for any resettlement plan or indigenous people's development plan. Normally includes a map showing the project site and the project's area of influence.	Contents of Chapter 1 1.1 Project name 1.2 Project owner (name, address, contact, position of the head of the project owner) 1.3 Geographical location Clearly describes - The geographical location including coordinates; - The natural objects (roads system, river systems, lakes, mountain system, protected areas) - Socio- Economic objects (residential and urban areas, favcilities for production, business and services, cultural and religious facilities, and historical relics) - Other objects around the project area, particularly those are likely to be affected by the project 1.4 The main content of the project (Option) Describes - Project goals - Volume and scope of the project (including auxiliary items for the operation of the main facility) - Measures and volume of construction works of the project - Production and operation technology A detailed description of specific production and operation technology which has potentially impacts on the environment together with illustrative diagrams, and the possible environmental impacts. - List of machinery and equipment - Materials and fuel (input) and the types of products (outputs) of the project - Progress of the project from start to official operation - Investment capital including investment amount for environmental protection activities	No gap

	Item	JICA Guidelines	World Bank Safeguard Policy	Circular No.26/2011/TT-BTNMT of July 18, 2011, Annex 2.5	Gaps (If gaps exist, measures to fill the gaps)
				- Organization and management for project implementation	
	Baseline data	This assesses the dimensions of the study area and describes relevant physical, biological, and socio-economic conditions, including all changes anticipated to occur before the project commences. Additionally, it takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project site, design, operation, or mitigation measures, and it is necessary to indicate the accuracy, reliability, and sources of the data.	Assesses the dimensions of the study area and describes relevant physical, biological, and socioeconomic conditions, including any changes anticipated before the project commences. Also takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigatory measures. The section indicates the accuracy, reliability, and sources of the data.	Contents of Chapter 2 2.1 Natural environmental conditions - Geographical and , geological condition - Meteorological Condition - Hydrological and oceanographic condition - Physical components of the environment - Current status of biological resources 2.2 Socio-economic condition - Economic condition - Social condition	No gap

	Item	JICA Guidelines	World Bank Safeguard Policy	Circular No.26/2011/TT-BTNMT of July 18, 2011, Annex 2.5	Gaps (If gaps exist, measures to fill the gaps)
	Environmental impacts	This predicts and assesses the project's likely positive and negative impacts in quantitative terms, to the extent possible. It identifies mitigation measures and any negative environmental impacts that cannot be mitigated, and explores opportunities for environmental enhancement. It identifies and estimates the extent and quality of available data, essential data gaps and uncertainties associated with predictions, and it specifies topics that do not require further attention.	Predicts and assesses the project's likely positive and negative impacts, in quantitative terms to the extent possible. Identifies mitigation measures and any residual negative impacts that cannot be mitigated. Explores opportunities for environmental enhancement. Identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions, and specifies topics that do not require further attention.	Contents of Chapter 3 3.1Impact assessment - Impact assessment of preparation phase - Impact assessment of construction phase - Impact assessment of operation phase - Impact assessment of other phase (dismantlement, closing, environmental restoration, etc.) - Impacts form risks and incidents 3.2 Comments on the level of detail and the reliability of the assessment	No gap

	Item	JICA Guidelines	World Bank Safeguard Policy	Circular No.26/2011/TT-BTNMT of July 18, 2011, Annex 2.5	Gaps (If gaps exist, measures to fill the gaps)
—	Analysis of alternatives	This systematically compares feasible alternatives to the proposed project site, technology, design, and operation including the "without project" situation in terms of the following: the potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, it quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. It also states the basis for selecting the particular proposed project design, and offers justification for recommended emission levels and approaches to pollution prevention and abatement.	Systematically compares feasible alternatives to the proposed project site, technology, design, and operation--including the "without project" situation--in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. States the basis for selecting the particular project design proposed and justifies recommended emission levels and approaches to pollution prevention and abatement.	N/A	There is a gap. Comparison of alternatives to the proposed project is not required by Vietnamese regulation, but it will be included according to JICA Guidelines and World Bank Safeguard Policy.

	Item	JICA Guidelines	World Bank Safeguard Policy	Circular No.26/2011/TT-BTNMT of July 18, 2011, Annex 2.5	Gaps (If gaps exist, measures to fill the gaps)
	Environmental Management Plan (EMP)	This describes mitigation, monitoring, and institutional measures to be taken during construction and operation in order to eliminate adverse impacts, offset them, or reduce them to acceptable levels.	Covers mitigation measures, monitoring, and institutional strengthening	Contents of Chapter 4 Describes 4.1Measures to be taken during the following phases to prevent or minimize negative impacts of the project - Preparation phase - Construction phase - Operation phase - Other phase if necessary 4.2 Measures to prevent and respond to risks and incidents - Preparation phase - Construction phase - Operation phase - Other phase if necessary Contents of Chapter 5 5.1 Environmental Management Plan 5.2 Environmental monitoring plan	No gap
	Consultation	This includes a record of consultation meetings (date, venue, participants, procedures, opinions of major local stakeholders and responses to them, and other items), including consultations for obtaining the informed views of the affected people, local NGOs, and regulatory agencies.	Record of interagency and consultation meetings, including consultations for obtaining the informed views of the affected people and local nongovernmental organizations (NGOs). The record specifies any means other than consultations (e.g., surveys) that were used to obtain the views of affected groups and local NGOs.	Contents of Chapter 6 States opinions of commune level People's Committee, and if appropriate, those of community representatives, organizations directly affected by the project, and appraisal bodies of EIA Report of the infrastructure construction projects for production areas and centralized service areas. Includes correspondence on the project.	No gap

5.3.5 Role of relevant organizations[7][8]

The organizations which are related to environmental and social consideration of this project and their roles are as follows.

a. MONRE

MONRE is the competent authority of environmental administration in Vietnam, and it has the following main duties:

a) To submit to the Government for promulgation, or to promulgate legal instruments on protection of the environment;

b) To submit to the Government for decision national policies, strategies and plans on protection of the environment;

c) To formulate and issue systems of environmental standards;

d) To evaluate and approve SEA reports and EIA reports

b. DONRE

DONRE is an organization which was established under the People's Committee of Da Nang, and it is in charge of environmental administration of the city. Its main duties are the followings: a) to monitor environmental quality, such as air and water, b) to evaluate reports related to SEA and EIA, c) to supervise environmental protection measures in environmental protection area, biodiversity protection area, etc., d) to collect fee for appraisal of EIA reports and environmental protection cost, e) to inspect plants and treatment and disposal facilities, f) to detect violation act.

5.4 Examination of Alternatives

In Section 3.4.6 of Chapter 3, it was concluded that the best option would be to first introduce Option 3 with the tipping fee of 3,000 JPY/ton in order to reduce the amount of final disposal and then to introduce Option 2 and Option 2-1 as financial capacity of Danang City improve. The outline of options considered and its outline including major environmental and social impacts are shown in the table below.

There is no major difference in social and environmental impacts by Option 2 and 3, as both may cause negative impacts to air and water quality while both may cause positive impacts such as job creation and improvement of leachate quality. However, under the business-as-usual scenario (Option 0), after the lifetime of the current disposal sites, collected wastes will have nowhere to go and thus this could cause serious environmental and social impact.

[7] No. 52/2005-QH11, LAW ON PROTECTION OF THE ENVIRONMENT
[8] Ministry of the Environment, Government of Japan, "Development and enforcement of legal systems in Vietnam", March 2011, http://www.env.go.jp/air/tech/ine/asia/vietnam/SeidoVT.html (accessed in July 2013)

Table 5-7: Comparison of Options for Waste Treatment in Da Nang City (including Environmental and Social Impacts)

	Option 0	Option 1	Option 2	Option 3
Treatment Process	Direct Landfill	MBT	Waste-to-Energy	MRF + Waste-to-Energy
Treatment Capacity	-	MBT: 1,000 to 1500 ton/day	Waste-to-Energy: 1,500 ton/day	MBT: 1,000 ton/day W-to-E: 300 ton/day
Amount of waste treated	927 to 1,500 ton/day	927 to 1,500 ton/day	1,356 ton/day (Remaining amount is directly disposed at landfill)	850 ton/day
The expected reduction rate of waste volume to be landfilled	0%	40%	Approximately 90%	Approximately 70% (If the focus is only on incineration facility, approximately 90%)
Major environmental and social impacts	If the current disposal site becomes full, collected wastes will have nowhere to go. If new landfill is to be constructed, land acquisition may be difficult. Even if land is acquired, serious environmental and social impact may be caused, such as resident resettlement.	• 3rd highest waste volume reduction rate • No gas emission • Water quality of leachate from the disposal site may improve • New jobs would be created	• Highest waste volume reduction rate • Gas emission from facilities • Water quality of leachate from the disposal site may improve • New jobs would be created	• 2nd highest waste volume reduction rate • Gas emission from facilities • Water quality of leachate from the disposal site may improve • New jobs would be created

5.5 Scoping of Impacts and TOR for Environmental and Social Impact Survey

5.5.1 Preliminary Scoping of Impacts

The result of the preliminary scoping of the environmental and social impacts for implementing this project is shown in the following tables. The items for which impacts were reviewed are the items listed in the "Environmental Check List: 13. Waste Management" which is a reference document of the JICA guidelines for environmental and social considerations (published in April 2010).

Table 5-8: Preliminary Scoping of Environmental and Social Impacts

Category		Item	Evaluation		Reasons
			During Construction	During Operation	
Pollution	(1)	Air pollution	B-	A-	During construction: The local air quality may temporarily be affected by their emission gas from construction vehicles and dusts from construction works. During operation: An incinerator will generate air pollutants.

Category		Item	Evaluation		Reasons
			During Construction	During Operation	
	(2)	Water pollution	B-	B±	During construction: Effluent from construction work might have adverse impacts on the local water quality. During operation: Liquids from wastes and wastewater from the facilities may affect local water quality, but leachate quality of the disposal site may improve.
	(3)	Wastes	D	B-	During construction: Soil generated by construction works would be used as cover soil in the disposal site. No hazardous wastes will be generated. During operation: There will be residue from intermediate treatment.
	(4)	Soil pollution	D	D	No soil pollution by the Project is expected.
	(5)	Noise and Vibration	B-	B-	During construction: Construction works and transporter vehicles will generate noise and vibration. During operation: Facilities will generate noise and vibration.
	(6)	Odor	D	B+	During construction: There will be no works which will generate odor. During operation: As the new facilities will be operated inside the existing disposal site, operation of the new facilities will not increase the level of odor. Rather, the level of odor may decrease due to intermediate treatment.
Natural Environment	(7)	Protected Areas	D	D	There are no protected areas designated by the Vietnamese laws or international treaties in or near the project site.
	(8)	Ecosystem	D	D	There are no primeval forests, tropical rain forests, or ecologically valuable habitats (e.g. coral reefs, mangroves, or tidal flats) in or near the project site. No endangered species have been found in or near the project site.
	(9)	Management of Abandoned Sites	D	D	As the project will not include operation of the disposal site, there will be no management of abandoned sites.
Social Environment	(10)	Resettlement	D	D	There will be no resettlement as the project site is within the Khanh Son disposal site where there are no residents.
	(11)	Living	D	D	N.B. Issues regarding “noise and vibration” and “odor” are already mentioned above.
	(12)	Livelihood	B+	B+	During construction: There will be new job opportunities and more business for the restaurants and commerce in the neighborhood. During operation: There will be new job opportunities

Category		Item	Evaluation		Reasons
			During Construction	During Operation	
					for the operation of new facilities.
	(13)	Heritage	D	D	There are no archeological, historical, cultural, and religious heritages in or near the project site.
	(14)	Landscape	D	D	There are no important landscapes which for instance bring tourists.
	(15)	Ethnic Minorities and Indigenous Peoples	D	D	There are no ethnic minorities or indigenous peoples in or near the project site.
	(16)	Working Conditions	B-	B-	During construction: There are risks that accidents would occur among people such as construction workers. During operation: There are risks that accidents would occur among people such as workers in the intermediate facilities.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C: Extent of impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

5.5.2 Terms of Reference (TOR) for the Environmental and Social Impact Survey

As a result of the preliminary scoping of impacts, the draft terms of reference (TOR) for the environmental and social impact survey was elaborated as shown in Table 5-9. The target area for the survey is the area within 1km radius from the center point of the Khanh Son disposal site except for the impact related to "Livelihood (for local economy)". For this item, Da Nang City will be the target area for the survey.

Table 5-9: Draft TOR for Environmental and Social Impact Survey

Environmental items	Survey items	Survey methods
Consideration of alternative options	Capacity and type of intermediate facilities	Efficiency of life time extension of the current landfill, construction, operation and maintenance cost, tipping fee, and environmental and social impacts
Air pollution	(1) Vietnamese relative standards (2) Current air condition (3) Dispersion prediction of emission gas from an incinerator (4) Impacts of construction	(1) Review of regulations (2) Actual measurement (3) Implementation of emission gas dispersion simulation (4) Check of contents of construction work, period, location, etc.
Water pollution	(1) Vietnamese relative standards (2) Water quality of the water channel which leachate from the landfill flows into, and that of the nearest well. (3) Current usage of the channel water (4) Impacts of construction	(1) Review of regulations (2) Literature review and actual measurement (3) Hearing with relevant organizations (4) Check of contents of construction work, period, location, etc.
Wastes	Current condition	Waste quality survey, etc.
Soil pollution	(1) Current condition (2) Impacts of construction	(1) Literature review (2) Check of contents of construction work, period, location, etc.
Noise And Vibration	(1) Vietnamese relative standards (2) Current noise and vibration level (3) Impacts of construction	(1) Review of regulations (2) Actual measurement (3) Check of contents of construction work, period, location, etc.
Odor	(1) Vietnamese relative standards (2) Current level of odor	(1) Review of regulations (2) Literature review, hearing with relevant organizations and local residents
Livelihood (for local economy)	(1) Current conditions of the local economy (economic	(1) Review of previous studies, field study, interviews with relevant organizations (2) Number of staffs to be employed at the new facilities and expected wage for the staffs

Environmental items	Survey items	Survey methods
	activities, income level) (2) Impact of the project on the local economy	
Livelihood (for waste pickers)	(1) Current conditions of the waste pickers (income level, items being collected) (2) Impact of the project on the waste pickers	(1) Review of previous studies, field study, interviews with waste pickers and relevant organizations (2) Identification of assignment of personnel, identification of expected income level of the waste pickers during the project period
Landscape	(1) Current landscape (2) External view of the facilities) (3) Opinion of the stakeholders regarding external view of facilities	(1) Review of previous studies, field study (2) Identification of external design with little impact on local landscape (3) Interview with relevant organizations
Working Conditions	(1) Current working conditions at the Khanh Son disposal site (2) Regulations on work safety (3) Impact of the project on work safety	(1) Review of previous studies, interview with stakeholders including waste pickers (2) Identification of relevant regulations (3) Identification of risks at work
Stakeholder Consultation	Opinion of the stakeholders regarding: - result of scoping of environmental and social impacts - TOR of environmental and social impact survey - result of the above	(1) Period: End of July 2013 Participants: Staffs/members of relevant organizations such as People's Committee of Da Nang City, Lien Chieu District, and Hoa Khan Nam Ward, DPI, URENCO, and DONRE Content of consultation: Explanation of preliminary scoping of impact, environmental and social impacts, their mitigation measures, and discussions on the issues above (2) Period: End of August 2014 (after preparation of draft final report) Participants: Staffs/members of relevant organizations such as People's Committee of Da Nang City, Lien Chieu District, and Hoa Khan Nam Ward, DPI, URENCO, DONRE, Women's Union, Youth Union, Fatherland Front, Farmer Union, mass media Content of consultation: Explanation of draft EIA report, discussions on draft EIA report

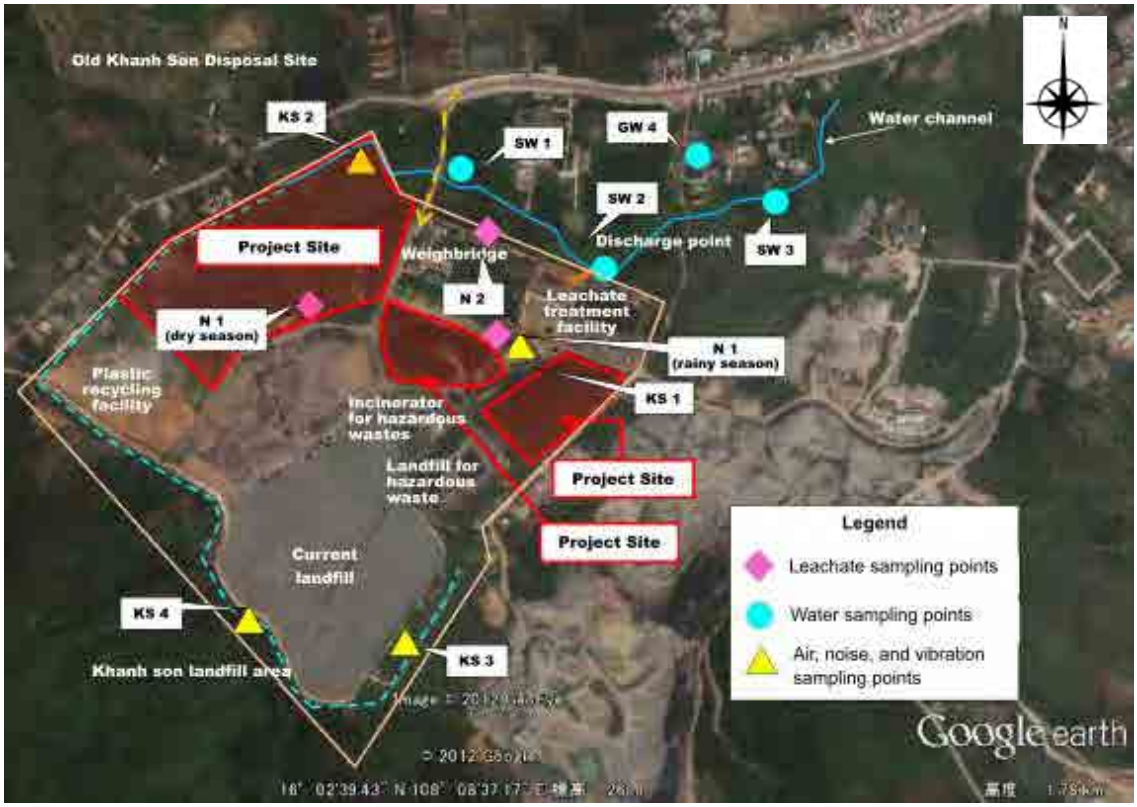
5.6 Survey Results of Environmental and Social Consideration

5.6.1 Results of the Survey

The followings are the results of environmental and social survey implemented based on the above TOR.

Environmental Impacts

The environmental survey was conducted at the existing Khanh Son Landfill and in its neighboring area twice, once in dry season and once in rainy season, in order to assess the current state of the environment in these areas. The map of sampling points is shown below.



N1：Untreated leachate, N2：Treated leachate

Figure 5-4: Map of Sampling Points

The scope of the survey was air, noise and vibration at 4 points inside the landfill site, surface water of the drainage channel, groundwater from a household dig well in the downstream of the drainage, and untreated and treated leachate from Khanh Son Landfill. In addition, literatures on soil quality and odor around the site were reviewed, and hearing was also conducted for odor. The details of each survey are as follows.

a. Air

a.1. Air quality survey results

In accordance with "National technical regulation on ambient air quality" (QCVN 05:2009/BTNMT), the following parameters were measured to assess the air quality. Although TSP and PM10 levels were high at some points during the dry season, all results in both of the seasons were below the standard values.

Table 5-10: Air Quality Monitoring Results

ND: Not detectable

No	Parameters	Unit	Test methods	Dry season (Sampling: 30-31/08/2012 (except for PM10) 28-29/09/2012 (PM10))				Rainy season (Sampling:8-10/11/2012)				Maximum allowable concentrations (QCVN 05:2009/BTNMT) KS2
				KS1	KS2	KS3	KS4	KS1	KS2	KS3	KS1	
1	SO_2 (1 h average)	µg/m3	TCVN 5971-1995	ND (<20)	ND (<20)	ND (<20)	ND (<20)	32.1	ND (<20)	ND (<20)	27.0	350
2	NOx (1 h average)	µg/m3	TK. TCVN 7245:2003 TCVN 6137:1996, PK2- E.39	ND (<10)	ND (<10)	ND (<10)	ND (<10)	18.2	12.4	ND (<10)	ND (<10)	200
3	CO (1 h average)	µg/m3	TCVN 7242:2003 PK2- E.38	5,376	3,137	9,941	1,841	9,794	4,021	8,469	2,725	30,000
4	TSP (1 h average)	µg/m3	TCVN 5067:1995	245	294	222	ND (<200)	ND (<200)	ND (<200)	ND (<200)	ND (<200)	300
5	O_3 (1 h average)	µg/m3	MDHS 70	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	180
6	Pb (24 h average)	µg/m3	TCVN 6152:1996	0.033	0.046	0.001	0.017	0.033	0.017	0.025	0.025	2
7	PM10 (24 h average)	µg/m3	TCVN 5067:1995	110	89.1	104	62.4	ND (<50)	ND (<50)	ND (<50)	ND (<50)	150

URENCO has conducted monitoring of air quality inside the Khanh Son and old Khanh Son landfill. The results are as follows.

Table 5-11: Monitoring Results of Air Quality inside Khanh Son Landfill sites by URENCO

Para-meter	Unit	5/3/2009		Test method	30/6/2011		9/1/2012	
		Test method	Old Khanh Son Landfill		Old Khanh Son Landfill	Khanh Son Landfill	Old Khanh Son Landfill	Khanh Son Landfill
NH_3	mg/m^3	Method determined by decision of Ministry of Health	7.33	Nessler	3.54	4.78	1.17	0.97
H_2S	mg/m^3	Method determined by decision of Ministry of Health	9.11	p-Amino Dimetyl anilin	0.97	1.35	0.34	0.23
CH_4	mg/m^3	Gas chromatography	5.22	N/A	N/A	N/A	N/A	N/A

N/A: No Data

Para-meter	Unit	Test method	26/07/2012	29/10/2012	12/01/2013
			Khanh Son Landfill	Khanh Son Landfill	Khanh Son Landfill
NH_3	mg/m^3	Nessler	4.05	3.18	3.26
H_2S	mg/m^3	p-Amino Dimetylanilin	1.23	1.73	1.79
Dust	mg/m^3	TCVN5067:1995	1.32	0.63	0.72
SO_2	mg/m^3	TCVN5967:1995	0.31	0.27	0.18
NOx	mg/m^3	TCVN6138:1996		0.25	
CO	mg/m^3	TCVN5972:1995		9.78	

N/A: No Data

a.2. Impacts of the project during construction

The volume of exhaust gas and dusts will increase due to construction vehicles and construction works.

a.3. Impacts of the project during operation

As air pollutants will be emitted from the incinerators, funnel emission dispersion prediction of proposed facilities was conducted. The results are shown in the tables in the next page. Based on the results, it is not likely that this Project would degrade the air quality to the level that air pollutants would exceed the standards.

Table 5-12: Results of Funnel Emission Dispersion Prediction for capacity 300t/day (Standard wastes)

Item*	Max concentration at the ground level: A ($\mu g/Nm^3$)	Background concentration : B**	Environmental concentration C (=A+B)	Attributable fraction A/C×100	Environmental standard ($\mu g/m^3$) (QCVN05:2009/BTNMT)
SOx	4.8	32.1	36.9	13.01%	350
NOx	8.0	18.2	26.2	30.53%	200
CO	0.11	9,941	9941.11	0.001%	30,000
Dust	2.40	294	296.4	0.81%	300
Pb	0.0002	0.046	0.0462	0.43%	2
PM2.5	0.006	110	36.9	0.01%	150

*Due to the limitation of the experience of predictive calculation, PM10 was replaced with PM2.5 and O_3 could not be calculated.

**Maximum values of the results of our environmental survey at borderline of the landfill site were used as background concentration.

According to the results, maximum contribution ratios toward environmental concentration were c.24.5% for SOx and c.36.4% for NOx. Those of CO, dust and PM2.5 were significantly small, 0.004 ~ 1.3%. Environmental concentrations of all items were below each environmental standard. Considering this, the project will not cause the gas emission to exceed the standards. The details of funnel emission dispersion prediction are described below.

(1) Calculation condition

Item	Unit	
Stack height	(m)	GL+59
Effective top diameter	(m)	1.60
Wind velocity (U)	(m/s)	5.00*
Inlet gas temp.	(°C)	See table below
Funnel height	(m)	GL+10.00
Total number of incinerators	—	1

*According to the wind direction and velocity data from 2007 to 2011, the dominant wind direction was NNW, E and ENE. The dominant wind velocities of these directions were 4m/s and 5m/s, and 5m/s was selected for this calculation.

Volume of emission gas and concentration of air pollutants per incinerator

Item	Unit	Waste characteristics		
		Low calorie	Standard	High calorie
Emission gas volume (wet base)	Nm^3/h	59,100	68,200	85,300
SOx(wet base)	mg/Nm^3	278	281	292
NOx(wet base)	mg/Nm^3	464	468	486
Dust(wet base)	mg/Nm^3	139	140	146
CO(wet base)	mg/Nm^3	6.44	6.50	6.75
PM2.5(wet base)	mg/Nm^3	0.31	0.31	0.32
Pb(wet base)	mg/Nm^3	0.01	0.01	0.01
Inlet gas temp.	°C	165	170	175

(2) Stack equivalent height and calculation

a) Calculating formula (Bosanquet formula)

$$He = Ho + 0.65(Hm + Ht)$$

$$Hm = \frac{4.77}{1 + 0.43 \cdot \frac{U}{V}} \cdot \frac{\sqrt{QV}}{U} = \frac{0.795\sqrt{Q \cdot V}}{1 + \frac{2.58}{V}}$$

$$Ht = 6.37g \times \frac{Q \cdot \Delta T}{U^3 \cdot T}(\ell nJ^2 + \frac{2}{J} - 2)$$

$$= 2.01 \times 10^{-3} Q \cdot \Delta T(2.30 \log J + \frac{1}{J} - 1)$$

$$J = \frac{U^2}{\sqrt{Q \cdot V}} \cdot (0.43\sqrt{\frac{T}{gG}} - 0.28\frac{V}{g} \cdot \frac{T}{\Delta T}) + 1$$

$$= \frac{1}{\sqrt{Q \cdot V}}(1460 - 296\frac{V}{\Delta T}) + 1$$

He : Effective stack height (m)

Ho : Actual stack height (m)

Hm : Rising height of emission gas by velocity (m)

Ht : Rising height of emission gas by buoyancy (m)

V : Emission velocity (m/s)

U : Wind velocity (m/s)

Q : Emission gas volume at T°C (m^3/s)

T : Temperature at which emission gas velocity is equal to atmospheric density = 288 °K

ΔT : Difference between emission gas temp. and T (°C)

G : Temperature gradient (°C /m)=0.0033°C /m

g : Gravity acceleration (m/s^2)=9.81

b) Input data

Waste characteristic	Emission gas volume (per incinerator) (Nm^3/h)	Emission gas temp. (°C)	Emission gas velocity V(m/s)
Low calorie	59,100	160	19.62
Standard	68.200	165	22.90
High calorie	85,300	170	28.97

c) Calculation results

Waste characteristic	Velocity rising height of emission gas Hm(m)	Buoyancy rising height of emission gas Ht(m)	Effective stack height He(m)
Low calorie	15.85	26.32	86.41
Standard	18.66	29.89	90.56
High calorie	23.90	35.59	97.67

(3) Calculation of maximum concentration at the ground level and its position

a) Calculation formula

$$P\max = \eta \cdot \frac{0.234Q}{UHe^2} \cdot (\frac{Cz}{Cy}) \cdot 10^6$$

$$= 5830\frac{Q}{He^2}$$

$$X\max = (\frac{He}{Cz})^{\frac{2}{2-n}}$$

P max : Max. concentration at the ground level (mg/Nm^3)

X max : Its appearance position (m)

Q : Emission strength of SOx (m^3/s 15℃)

Cz : Vertical turbulence coefficient of atmosphere

n : Coefficient regarding atmospheric stability =0.25

η : Dilution coefficient =0.15

U : Wind velocity (m/s)

Note: In general, Cy is equal to or higher than Cz in turbulence, and theoretically concentration at the ground level is the highest when Cy is equal to Cz. The value of Cz, which determines the position of the maximum concentration was decided by referring Air pollution Hand book (1956).

b) Input data

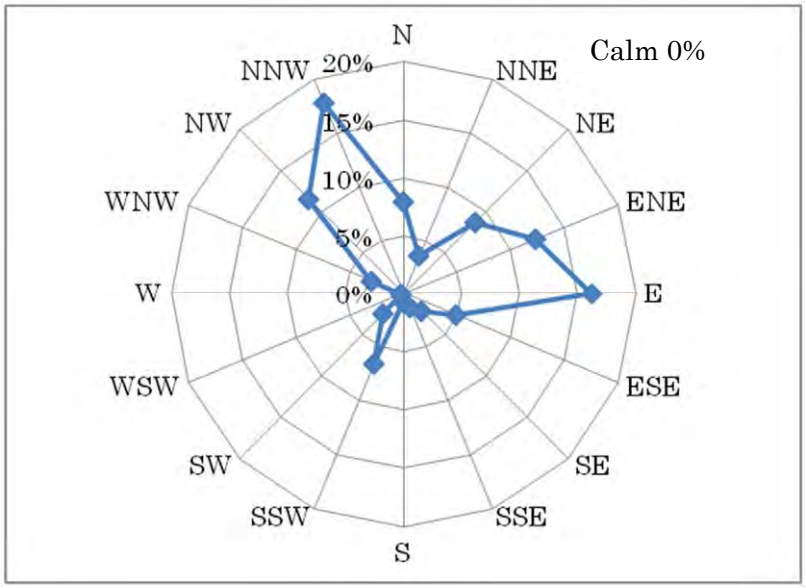
No. of incinerators	Waste characteristic	He	Emission gas volume	SOx	NOx	Dust	CO	PM2.5	Pb	Cz
		(m)	(Nm^3/h)	(mg/Nm^3)						—
1	Low calorie	86.41	59,100	6.44	464	139	6.44	0.31	0.01	0.077
	Standard	90.56	68,200	6.50	468	140	6.50	0.31	0.01	0.077
	High calorie	97.67	85,300	6.75	486	146	6.75	0.32	0.01	0.060

c) Calculation results of maximum concentration at the ground level

No. of incinerator	Waste characteristic	SOx	NOx	Dust	CO	PM2.5	Pb	Appearance position of max. concentration
		($\mu g/Nm^3$)						(m)
1	Low calorie	3.1801	3.1801	0.1590	0.110420	0.005300	0.00017667	3,350
	Standard	3.4580	3.4580	0.1729	0.120070	0.005763	0.00019211	4,963
	High calorie	3.5678	3.5678	0.1784	0.123883	0.005946	0.00019821	5,466

(4) Wind rose

Wind rose of wind direction of daily maximum wind velocity in 2011 is shown below.



b. Water

b.1. Surface water

b.1.1. Water quality survey results

In accordance with "National technical regulation on surface water quality" (QCVN08:2008/BTNMT), water quality of surface water was surveyed at the channel into which leachate from the landfill is discharged. The measured items and results are as follows. Two sampling points were selected; one was at stream above the discharged point of leachate (SW1) and one was at stream down the point (SW3).

Table 5-13: Surface Water Analysis Results

: Over the standard

No.	Parameters	Unit	Test methods	Dry season (Sampling: 30/8/2012)		Rainy season (Sampling: 9/11/2012)		Maximum allowable concentrations (QCVN 08:2008/BTNMT)
				SW1	SW3	SW1	SW3	Category: B2*
1	pH (25°C)	—	TCVN 6492:2011	7.64	8.27	7.03	8.27	**5.5-9**
2	DO	mg/L	TCVN 7324:2004	ND (< 0.2)	2.66	2.2	ND (<0.2)	**≥ 2**
3	TSS	mg/L	SMEWW 2540-D	40.4	55.8	18.6	82.0	**100**
4	CODCr	mg/L	TCVN 6491:1999	101	276	12.3	384	**50**
5	BOD_5	mg/L	TCVN 6001-1:2008	84	40	4.6	16	**25**
6	NH_4^+-N	mg/l	TCVN 5988-1995 PK2-E13	30.5	160	13.4	365	**1**
7	Cl^-	mg/L	TCVN 6194:1996	146	1,100	28.4	454	**—**
8	F^-	mg/L	AOAC 939.11 (2010)	ND (< 0.05)	0.44	0.061	0.19	**2**
9	NO_2^--N	mg/L	TCVN 6178:1996	0.087	0.039	ND (<0.002)	ND (<0.002)	**0.05**
10	NO_3^--N	mg/L	TCVN 6180-1996	0.010	1.27	1.49	0.16	**15**
11	PO_4^{3-}-P	mg/L	TCVN 6202:1996	0.043	0.026	0.030	0.31	**0.5**
12	CN^-	mg/L	SMEWW 4500- CN^-	ND (<0.001)	0.005	0.003	0.006	**0.2**
13	As	mg/L	TCVN 6626:2000	0.0027	0.021	0.0033	ND (< 0.0005)	**0.1**
14	Cd	mg/L	SMEWW 3500- Cd	ND (< 0.002)	ND (< 0.002)	ND (< 0.002)	ND (< 0.002)	**0.01**
15	Pb	mg/L	SMEWW 3500- Pb	0.076	0.14	0.042	0.13	**0.05**
16	Cr (III)	mg/L	TCVN 6222:2008	0.014	0.026	0.060	ND (<0.01)	**1**
17	Cr (VI)	mg/L	TCVN 7939:2008	ND (< 0.005)	ND (< 0.005)	ND (< 0.005)	ND (< 0.005)	**0.05**
18	Cu	mg/L	TCVN 6193:1996	ND (<0.01)	0.015	0.060	ND (<0.01)	**1**
19	Zn	mg/L	TCVN 6193:1996	0.018	2.26	3.44	0.038	**2**
20	Ni	mg/L	SMEWW 3500- Ni	ND (<0.01)	0.098	0.041	ND (<0.01)	**0.1**
21	Fe	mg/L	TCVN 6177:1996	4.06	6.7	2.46	8.87	**2**
22	Hg	mg/L	TCVN 7877:2008	ND (< 0.0005)	ND (< 0.0005)	ND (< 0.0005)	ND (< 0.0005)	**0.002**
23	Surfactants	mg/L	TCVN 6622-1:2009	ND (<0.05)	ND (<0.05)	0.12	0.87	**0.5**
24	Oil and grease	mg/L	SMEWW 5520-B	9.0	17.0	2.0	6.8	**0.3**
25	Phenol	mg/L	TCVN 6216:1996	ND (< 0.005)	ND (< 0.005)	0.013	0.025	**0.02**
26	Total radiation α	Bq/L	QTTN/KT3 072:2011	ND (<0.1)	ND (<0.1)	ND (<0.1)	ND (<0.1)	**0.1**
27	Total radiation β	Bq/L	QTTN/KT3 072:2011	3.45	22	ND (<1.0)	8.4	**1**
28	E. Coli	MPN/ 100mL	TCVN 6187-2:1996	9.2×10^4	9.2×10^3	1.5×10^4	3.6×10^3	**200**
29	Coliforms	MPN/ 100mL	TCVN 6187-2:1996	2.3×10^5	1.5×10^4	4.3×10^4	2.3×10^4	**10,000**
Organochlorine pesticides								

No.	Parameters	Unit	Test methods	Dry season (Sampling: 30/8/2012)		Rainy season (Sampling: 9/11/2012)		Maximum allowable concentrations (QCVN 08:2008/BTNMT)
				SW1	SW3	SW1	SW3	Category: B2*
30	Aldrin	µg/L	PK2-E.32, US EPA SW 846 Method 8081A	ND (<0.002)	ND (<0.002)	ND (<0.002)	ND (<0.002)	**0.01**
31	Dieldrin	µg/L		ND (<0.002)	ND (<0.002)	ND (<0.002)	ND (<0.002)	**0.01**
32	Endrin	µg/L		ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	**0.02**
33	BHC	µg/L		ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	**0.15**
34	Lindane	µg/L		ND (<0.04)	ND (<0.04)	ND (<0.04)	ND (<0.04)	**0.4**
35	Chlordane	µg/L		ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	**0.03**
36	DDT	µg/L		ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	**0.005**
37	Endosulphan	µg/L		ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	**0.02**
38	Heptachlor	µg/L		ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	**0.05**
Organophosphate pesticides								
39	Parathion	µg/L	PK2-E.32, US EPA SW 846 Method 8141A	ND (<0.1)	ND (<0.1)	ND (<0.1)	ND (<0.1)	**0.5**
40	Malathion	µg/L		ND (<0.1)	ND (<0.1)	ND (<0.1)	ND (<0.1)	**0.4**
Herbicides								
41	2,4 D	µg/L	US EPA SW 846 Method 8151A	ND (<0.1)	ND (<0.1)	ND (<0.1)	ND (<0.1)	**500**
42	2,4,5 T	µg/L		ND (<0.1)	ND (<0.1)	ND (<0.1)	ND (<0.1)	**200**
43	Paraquat	µg/L	EPA Method 549.1	ND (<100)	ND (<100)	ND (<100)	ND (<100)	**2,000**

* There are 4 categories of standard values; A1, A2, B1 and B2. The surveyed water channel falls into B2, which is the least strict standard.

Table 5-14: Surface Water Flow Rate

Survey period	Dry season (Sampling: 30/8/2012)		Rainy season (Sampling: 9/11/2012)	
Sampling points	SW1	SW3	SW1	SW3
Flow rate	Almost no flow	Almost no flow	507m^3/h	1,080m^3/h

In dry season, COD_{Cr}, NH_4^+-N, Oil and grease, E. Coli and Coliforms at SW1 and SW3, and in rainy season, COD_{Cr} at SW3 and NH_4^+-N, Oil and grease, E. Coli and Coliforms at SW1 and SW3 exceeded the standard comparably to a large extent.

The results of our survey showed that some parameters exceeded the standard even at the stream above the discharged point. Although old Khanh Son Landfill is located at the upstream of the channel, URENCO said that the cause of this pollution was unknown since the flow path of the surveyed channel was not clear. The water of the channel, however, has not been used any more even for farming by the residents around the channel.

According to the exiting literature, it is also said that the Phu Loc River, which the channel joints, has been contaminated by leachate from Khanh Son Landfill (see "5.2.1 Environmental Conditions").

b.1.2. Impacts of the project during construction

Muddy water could be generated by drilling works and sprinkling, and this would affect water quality near the site.

b.1.3. Impacts of the project during operation

Contaminated effluent generated from wastes stored in the pit will be incinerated. Only in the case that the volume exceeds the capacity of the incinerator, the effluent will be discharged into the landfill site. Under the existing condition, effluent has already been discharged into the site. Therefore, the operation of the facility will not cause negative impacts. In addition, a septic tank will be installed to treat sewage from the facility. Furthermore, the amount of pollution sources will decrease and the quality of leachate will be improved since wastes will be landfilled after intermediate treatments. This will result in the reduction of pollution load on the Phu Loc River.

b.2. Leachate

b.2.1. Water quality survey results

Leachate quality was analyzed according to “National Technical Regulation on wastewater of the solid waste landfill site” (No. QCVN 25:2009/BTNMT). Analyzing parameters and the results are shown in Table 5-15. URENCO has also conducted monitoring of leachate regularly. The results are shown in Table 5-17.

Table 5-15: Untreated and Treated Leachate Analysis Results

: Over the standard

No.	Item	Test method	Unit	Dry season (Sample taken on 13 Sep 2013)		Reduction efficiency (%)	Wet season (Sample taken on 9 Nov 2012)		Reduction efficiency (%)	Maximum allowable concentration
				N1	N2		N1	N2		Category: B1*
1	COD_{Cr}	SMEWW 5220-C	mg/L	13,818	845	93.9%	3,240	76	76.3%	400
2	BOD_5 (20°C)	TCVN 6001-1:2008	mg/L	4,663	85	98.2%	1,187	18	98.5%	100
3	Total N	TCVN 6638:2000	mg/L	1,554	340	78.1%	896	488	45.5%	60
4	NH_4^+-N	TCVN 5988:1995, PK2-E13	mg/L	1,166	298	74.4%	861	337	60.9%	25

Table 5-16: Leachate Monitoring Results conducted by URENCO

: Over the standard, N/A: No Data

Item	Unit	Test method	30 Jun 2011		Reduction efficiency (%)	9 Jan 2012		Reduction efficiency (%)	Maximum allowable concentration (QCVN 25:2009/BTNMT)
			Before treat-ment	After treat-ment		Before treat-ment	After treat-ment		
pH	-	TCVN 6492:1999	6.8	6.9	-	6.9	7.2	-	-
DO	mg/L		N/A	N/A	N/A	N/A	N/A	N/A	-
TSS	mg/L	TCVN 6625:2000	690	247	64%	420	185	56%	-
COD	mg/L	TCVN 4565:1998	11,340	186	98%	1,476.8	504	66%	400
BOD_5 (20°C)	mg/L	TCVN 6001:1995	7,088	124	98%	923	436.8	53%	100
NH4+ (as N)	mg/L	TCVN 6179-1:1996	125	19.8	84%	92.6	44.7	52%	25
N	mg/L	TCVN 5987:1995	247	341.6	-38%	132	95.4	28%	60
P	mg/L	TCVN 6202:1996	68.2	12.5	82%	21.6	18.3	15%	-
Coliform	MPN/ 100mL	TCVN 6187-1:96	$1.2x10^5$	$4.7x10^4$	61%	$8.7x10^4$	$3.2x10^4$	63%	-
Pb	mg/L		N/A	N/A	N/A	N/A	N/A	N/A	-
As	mg/L		N/A	N/A	N/A	N/A	N/A	N/A	-

Item	Unit	Test method	26 Jul 2012		Reduction efficiency (%)	29 Oct 2012		Reduction efficiency (%)	Maximum allowable concentration (QCVN 25:2009/BTNMT)
			Before treat-ment	After treat-ment		Before treat-ment	After treat-ment		
pH	-	TCVN 6492:1999	6.7	6.8	-	6.5	7.0	-	-
DO	mg/L		N/A	N/A	N/A	N/A	N/A	N/A	-
TSS	mg/L	TCVN 6625:2000	720	117	84%	755	1,401	-86%	-
COD	mg/L	TCVN 4565:1998	9,700	146	98%	3,690	1,580	57%	400
BOD_5 (20℃)	mg/L	TCVN 6001:1995	6,450	98.3	98%	2,306	988	57%	100
NH4+ (as N)	mg/L	TCVN 6179-1:1996	176	13.8	92%	162	32.6	80%	25
N	mg/L	TCVN 5987:1995	480	42.5	91%	520	132	75%	60
P	mg/L	TCVN 6202:1996	119	9.6	92%	128	21	84%	-
Coliform	MPN/ 100mL	TCVN 6187-1:96	$1.5x10^5$	$1.5x10^4$	90%	$1.5x10^4$	$4.7x10^4$	-208%	-
Pb	mg/L		N/A	N/A	N/A	N/A	N/A	N/A	-
pH	mg/L		N/A	N/A	N/A	N/A	N/A	N/A	-

Item	Unit	Test method	12 Jan 2013		Reduction efficiency (%)	Maximum allowable concentration (QCVN 25:2009/BTNMT)
			Before treatment	After treatment		
pH	-	TCVN 6492:1999	6.8	7.1	-	-
DO	mg/L		N/A	N/A	N/A	-
TSS	mg/L	TCVN 6625:2000	960	182	81%	-
COD	mg/L	TCVN 4565:1998	12,600	1,260	90%	400
BOD_5 (20℃)	mg/L	TCVN 6001:1995	8,400	788	91%	100
NH4+ (as N)	mg/L	TCVN 6179-1:1996	230	13.5	94%	25
N	mg/L	TCVN 5987:1995	530	36	93%	60
P	mg/L	TCVN 6202:1996	180	32	82%	-
Coliform	MPN/ 100mL	TCVN 6187-1:96	$1.9x10^4$	$1.3x10^4$	32%	-
Pb	mg/L		N/A	N/A	N/A	-
pH	mg/L		N/A	N/A	N/A	-

Item	Unit	Test method	17 Jul 2013		Reduction efficiency (%)	Maximum allowable concentration (QCVN 25:2009/BTNMT)
			Before treatment	After treatment		
pH	-	OAKTON pH5	6.9	6.5	94.2%	-
DO	mg/L		N/A	N/A	N/A	-
TSS	mg/L	Standard Method-5220D	5.130	176	3430.8%	-
COD	mg/L	TCVN 6001:1995	2.210	81	3665.2%	400
BOD_5 (20℃)	mg/L	TCVN 6053:1995	230	110	47.8%	100
NH4+ (as N)	mg/L	HACH-Method 10071	1.252	315	25159.7%	25
N	mg/L	HACH-Method 8190	17,2	0,31	1.8%	60
P	mg/L	HACH-Method 8038	9,1	6,2	68.1%	-
Coliform	MPN/100mL	TCVN 6187-1996	$93x10^3$	$75x10^3$	80.6%	-
Pb	mg/L		N/A	N/A	N/A	-
pH	mg/L		N/A	N/A	N/A	-

Compared water quality of untreated and treated leachate, reduction rates were c. 94% for COD_{Cr}, c. 98% for BOD_5, c. 78% for Total N, c. 74% for NH_4^+-N in dry season, and c. 76% for COD_{Cr}, c. 99% for BOD_5, 46% for Total N and c. 61% for NH_4^+-N in rainy season. Only BOD_5 was below the standard value, and the others were over the standards, even though some reduction rates were high. As long as considering the results of the survey, there is a possibility that concentrations of pollutants in untreated leachate are over the treatment capacity of the facility.

According to the results of monitoring which URENCO has conducted regularly, the reduction rates have fluctuated. It can also be said that the treatment system of leachate does not work stably.

b.2.2. Impacts of the project during construction

Since Khanh Son Landfill has a structure which prevents leachate from contacting others, the muddy water from construction works will not affect the quality of leachate.

b.2.3. Impacts of the project during operation

Our survey results and monitoring results of URENCO showed that many parameters exceeded the standards. As wastes will be landfilled after intermediate treatments in this project, the amount of pollution sources on leachate will decrease, and the quality will be improved. This can also result in the reduction of pollution load on the Phu Loc River. On the other hand, incineration will cause fly ash to contain high concentration of hazardous substances. If proper treatment is not conducted,

leachate quality will be adversely affected by the ash, and this will cause negative impacts on local water quality such as surface water and groundwater.

b.3. Groundwater from a household dig well

b.3.1. Water quality survey results

As for groundwater, "National technical regulation on groundwater quality" (QCVN 09:2008/BTNMT) was used for conducting the analysis at the nearest household well to Khanh Son Landfill. The analyzing parameters and the results are as follows.

Table 5-17: Groundwater Analysis Results

: Over the standard

No	Parameters	Unit	Test methods	Analyzed results		Maximum allowable concentrations (QCVN 09:2008/BTNMT)
				Dry season (Sampling: 30/8/2012)	Rainy season (Sampling: 09/11/2012)	
1	pH (25°C)	-	TCVN 6492:2011	5.55	5.62	5.5-8.5
2	Hardness	$mgCaCO_3/L$	SMEWW 2340-C	42.9	38.0	500
3	TSS	mg/L	SMEWW 2540-B	147	122	1,500
4	COD_{Mn}	mg/L	TCVN 6186:1996	1.2	ND (<0.5)	4
5	Mn	mg/L	TCVN 6193:1996	0.068	0.11	0.5
6	NH_4^+-N	mg/l	TCVN 5988-1995, PK2-E13	0.43	ND (<0.02)	0.1
7	Cl^-	mg/L	TCVN 6194:1996	34.1	16.0	250
8	F^-	mg/L	AOAC 939.11 (2010)	ND(< 0,05)	0.061	1
9	NO_2^--N	mg/L	TCVN 6178:1996	0.014	ND (<0.002)	1
10	NO_3^--N	mg/l	TCVN 6180-1996	11.2	1.92	15
11	SO_4^{2-}	mg/L	SMEWW 4500-S^{2-}E	28.4	20.9	400
12	CN^-	mg/L	SMEWW 4500- CN^-	ND (<0.001)	ND (<0.001)	0.01
13	As	mg/L	TCVN 6626:2000	ND (<0.0005)	ND (<0.0005)	0.05
14	Cd	mg/L	SMEWW 3500- Cd	ND (< 0.002)	ND (< 0.002)	0.005
15	Pb	mg/L	SMEWW 3500- Pb	ND (< 0.01)	ND (< 0.01)	0.01
16	Cr (VI)	mg/L	TCVN 7939:2008	ND (< 0.005)	ND (< 0.005)	0.05
17	Cu	mg/L	TCVN 6193:1996	ND (<0.01)	ND (<0.01)	1
18	Zn	mg/L	TCVN 6193:1996	0.017	0.012	3
19	Fe	mg/L	TCVN 6177:1996	0.22	0.091	5
20	Hg	mg/L	TCVN 7877:2008	ND (< 0.0005)	ND (< 0.0005)	0.001
21	Se	mg/L	SMEWW 3500-Se	ND (<0.01)	ND (<0.01)	0.01
22	Phenol	mg/L	TCVN 6216:1996	ND (< 0.001)	0.006	0.001
23	Total radiation α	Bq/L	QTTN/KT3 072:2011	ND (<0.1)	ND (<0.1)	0.1
24	Total radiation β	Bq/L	QTTN/KT3 072:2011	ND (<1.0)	ND (<1)	1
25	E. Coli	MPN/100m	TCVN 6187-2:1996	2.1×10^2	9.2×10^2	ND

No	Parameters	Unit	Test methods	Analyzed results		Maximum allowable concentrations (QCVN 09:2008/BTNMT)
				Dry season (Sampling: 30/8/2012)	Rainy season (Sampling: 09/11/2012)	
		L				
26	Coliforms	MPN/100mL	TCVN 6187-2:1996	1.5×10^3	1.5×10^3	3

In both season, E. Coli and coliforms severely exceeded the standard.

According to the existing literature, the groundwater near the landfill suffers adverse impacts from the leachate (see "5.2.1 Environmental Conditions").

b.3.2. Impacts of the project during construction

As main constituent in muddy water from construction works will be materials which are mainly dug from the ground, it will not likely to happen that the water will affect groundwater quality.

b.3.3. Impacts of the project during operation

Under normal condition, there will be no direct discharge of effluent from incineration facilities (see b.1.3.), therefore, groundwater does not seem to be negatively affected by the project. The leachate quality will be improved due to the intermediate treatment, and this will result in the improvement of groundwater quality since it is said in the existing literature that groundwater has been contaminated by leachate from Khanh Son Landfill.

c. Wastes

c.1. State of waste

Currently, the wastes in Da Nang City are directly landfilled in Khanh Son disposal site. As the amount of waste is likely to increase in the coming years, if these wastes are not treated, it is expected that the landfill in the Khanh Son disposal site will become full in 2019.

c.2. Impacts of the project during construction

Treating the wastes through incineration will greatly reduce the amount of wastes that would be landfilled and it is expected that the lifetime of the Khanh Son landfill would be extended to the year 2036. The bottom ash from incineration which meets the standard would be landfilled, and fly ash that would be collected from bag filters would be properly treated as it is likely to be toxic[9]. The proper method of treatment is currently being examined.

[9] "Bottom ash" is the ash that can be found in the bottom of the furnace and "fly ash" is the ash that can be found captured by filtration equipment such as bag filters.

d. Noise and Vibration

d.1. Survey results of noise and vibration level

Noise and vibration levels were monitored and measured according to "National Technical Regulation on noise" (QCVN 26:2010/BTNMT) and "National technical regulation on vibration" (QCVN 27:2010/BTNMT) respectively. Parameters and measurement results are shown below.

The results showed that noise levels satisfied the standards, and vibration levels were below the detection limit in both seasons.

Table 5-18: Noise and Vibration Monitoring Results

No	Parameters	Unit	Test methods	Dry season (Measurement: 30-31/08/2012)				Rainy season (Measurement:8-9/11/2012)				Maximum allowable level (Noise: QCVN 26:2010/BTNMT Vibration: QCVN 27:2010/BTNMT)
				KS1	KS2	KS3	KS4	KS1	KS2	KS3	KS4	
1	Noise (6.00 - 21.00)	dBA	TCVN 7878-2:2010	59	56	58	57	49	45	58	56	70
2	Noise (21.00 - 6.00)	dBA	TCVN 7878-2:2010	46	42	42	42	47	48	48	48	55
3	Vibration - at frequency range from 1 Hz - 10 KHz (6.00 - 21.00)	dB	TCVN 6963:2001	ND (<54)	ND (<54)	ND (<54)	ND (<54)	ND (<54)	ND (<54)	ND (<54)	ND (<54)	70
4	Vibration - at frequency range from 1 Hz - 10 KHz (21.00 - 6.00)	dB	TCVN 6963:2001	ND (<54)	ND (<54)	ND (<54)	ND (<54)	ND (<54)	ND (<54)	ND (<54)	ND (<54)	60

d.2. Impacts of the project during construction

Noise and vibration will temporally be up due to the transportation of construction materials and construction works.

d.3. Impacts of the project during operation

This project will utilize some machines which cause noise and vibration. Therefore, their levels can be increased during operation.

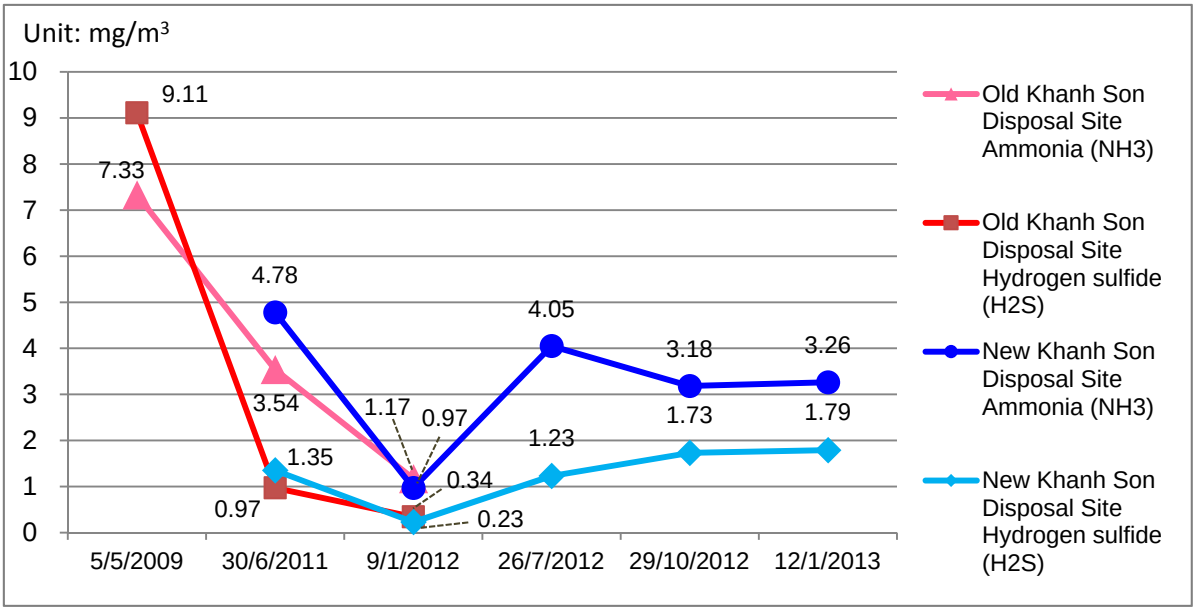
e. Odor

e.1. State of odor

As a regulation on odor, there are standard values for malodorous substances stipulated in "National technical regulation on hazardous substances in ambient air" (QCVN 06: 2009/BTNMT). The targeted substances are ammonia, acetaldehyde, propionic acid, hydrogen sulfide, methyl mercaptan, styrene,

toluene and xylene. According to DONRE, Vietnam does not have regulation on odor from an incineration plant.

As for Khanh Son Landfill, URENCO has monitored ammonia and hydrogen sulfide at the center of Old Khanh Son Landfill site in 2009, 2011 and 2012, and at that of Khanh Son Landfill site from 2011 to 2012. The results showed that the concentrations of these substances decreased once in January in 2012, they returned to original level in July (see Figure 5-5). The residents living near the landfill sites have complained about the odor. According to URENCO, the number of complaints about odor has drastically decreased as the old Khanh Son disposal site was closed and the new Khanh Son disposal site started its operation. Currently, the number of complaints is only about 2 or 3 per year. However, as the landfilled wastes gain height, the odor may become stronger especially under hot or wet weather.



Source: URENCO

N.B. Testing method on 5/5/2009 is that specified by the Ministry of Health and for other dates it is Nessler method for detecting ammonia and p-Amino Dimetylanilin method for detecting hydrogen sulfide

Figure 5-5 Odor Substance Monitoring Results by URENCO

According to interview survey with 80 residents that live near Khanh Son disposal site, 98% of the respondents answered that they feel bad odor in their neighborhood, and 67% respondents answered that the level of odor is either "very strong and offensive" or "strong and offensive". When asked "What do you think is the source of the bad odor?" (open-ended question, multiple answers allowed), 100% answered "Khanh Son disposal site". Meanwhile, there were other answers such as "passing of garbage truck" or "sewer". Regarding the change in level of odor in the recent years, 27.5% responded "slightly improved" while 25% responded either "slightly worse" or "drastically worse".

Table 5-19: Result of Interview Survey with Local Residents on Odor

No.	Question	Response	Number of responses (%)
1	***Do you feel that there is bad odor in your neighborhood?****	Yes	78 (98%)
		No	2 (2%)
2	*For those who answered "Yes to Question No.1:* ***How often do you feel the bad odor?****	Almost everyday	41 (53%)
		A few days a week	18 (23%)
		A few days a month	19 (24%)
		A few days a year	0 (0%)
3	*For those who answered "Yes to Question No.1:* ***How strong is the bad odor when it is the strongest?****	Very strong and offensive	23 (29%)
		Strong and offensive	30 (38%)
		Slightly offensive	16 (21%)
		Noticeable	9 (12%)
4	***What do you think is the source of the bad odor?***	Khanh Son Disposal Site	80 (100%)
		Passing of garbage trucks	10 (12.5%)
		Residential sewer close to home	5 (6.3%)
		Recycling activities near home activities (drying plastics at Khanh Son, junk shop)	3 (3.8%)
		Charcoal business close to home	1 (1.3%)
		URENCO's waste collection point close to home	1 (1.3%)
		Odor from soil on rainy days	1 (1.3%)
		Pool close to home which contains wastewater on rainy days	1 (1.3%)
5	***How has the level of odor changed in the recent years?****	It has drastically improved	0 (0%)
		It has slightly improved	22 (27.5%)
		It is the same	38 (47.5%)
		It has slightly become worse	14 (17.5%)
		It has drastically become worse	6 (7.5%)

* : Closed-ended question

**: *Open-ended question, multiple answers allowed*

Source: Survey Team

e.2. Impacts of the project during operation

Now wastes which contain many organic substances are directly landfilled, and this causes the substances to be decomposed under anaerobic condition and to become source of odor. By conducting our project, the level of odor generated in the whole landfill site will become lower since the wastes will be incinerated before landfilled. At present, most of the complaints from the people living near the landfill are regarding odor. So the reduction will be significant benefit for them.

5.6.2 Social Impacts

a. Livelihood (for local economy)

a.1. Current conditions of the local economy (economic activities, income level)

RGDP in Da Nang is 28,902 billion VND (Vietnamese dongs) at current prices (approx. 1.45 billion US dollars) in 2010. Per capita RGDP in 2010 is 35.87 million VND or about 1,800 US dollars. About 54% of RGDP in Da Nang comes from service industry, followed by manufacturing and construction (42%). The primary industry (Agriculture, forestry and fishing) occupies about 4% of RGDP in Da Nang.

In Hoa Khan Nam Ward, the main industries are handicrafts, commerce, and agriculture (rice farming and raising livestock)[10]. The value of each industry is shown in table below. According to the People's Committee of the Hoa Khanh Nam Ward, the average level of annual income was 14,400,000 VND/person in 2011 and 18,000,000 VND/person in 2012. In addition, the level of unemployment in 2008 was 6 to 7%.

Table 5-20: Value of Industries in Hoa Khanh Ham Ward in 2008

Industry	Value (in VND)
Handicrafts	20 billion
Commerce	18.725 billion
Agriculture	0.442 billion

Source: EIA Report for Clean Development Mechanism (CDM) Project in the old Khanh Son Disposal Site

a.2. Impact of the project on the local economy

Approximately 1,000 people will be recruited locally for the construction work of incineration facilities, as those works would be implemented by the local contractors. For the operation of the facilities, approximately 235 staffs would be recruited locally (see table below for breakdown).

Table 5-21: List of Staffs for Operation of MRF (350t x 3 lines) and WTE (300t x 1 incinerator)

Type	Position	Main responsibilities	Number of persons
General	Total management of the facilities	Total management of the facilities	1
	Management of MRF facilities	Management of MRF facilities	1
	Management of WTE facilities	Management of WTE facilities	1

[10] EIA Report for Clean Development Mechanism (CDM) Project in the old Khanh Son Disposal Site

Type	Position	Main responsibilities	Number of persons
	Administration and accounting	Administration and accounting	1
	Administrative works within SPC (e.g. take record of material balance, keep financial records, pay salaries)	Administrative works within SPC (e.g. take record of material balance, keep financial records, pay salaries)	2
	Maintenance of the facilities and stock of spare parts	Maintenance of the facilities and stock of spare parts	1
	Maintenance of machineries	Maintenance of machineries	4
	Maintenance of electrical system	Maintenance of electrical system	2
MRF facilities	Chief operator (one for each shift)		4
	Machine operator	Operation of breaker, trommel	24
	Hand-sorting staff	Sorting of recyclable materials	120
	Driver (machines)	Transport of RDF, recyclables, and residues	24
	Driver (trucks)	Transport of RDF and residues	24
WTE facilities	Chief operator (one for each shift)	Control of chemical stocks	4
	Operator	Monitoring of the central control panel Patrol within the facilities	12
Others	Security officer	Control of security in and around the facility (N.B. Same officers who currently control security at the Khanh Son disposal site will take the responsibility)	-
	Truck control officer	Control of trucks that bring in wastes	3
	Waste control officer	Adjustment of size and composition of wastes, removal of unwanted objects from wastes, removal of ash	2
	Cleaning staff	Cleaning of the facilities	5
		Total	235

Source: study team elaborates.

b. Livelihood (for waste pickers)

b.1. Current conditions of the waste pickers (income level, items being collected

According to URENCO, many of the local residents used to be farmers. However, as their lands were bought by the city for the construction of the Khanh Son disposal site, 125 household lost their agricultural land and 41 household lost their houses. Thus could no longer practice agriculture. A part of these people are currently working as waste pickers at the Khanh Son disposal site. Although there were about 400 waste pickers before, currently there are only about 200 because now only those who are registered can enter Khanh Son disposal site and pick the wastes. Only the residents who live in the nearby communities are allowed to register and those who live far from the disposal site may not register.

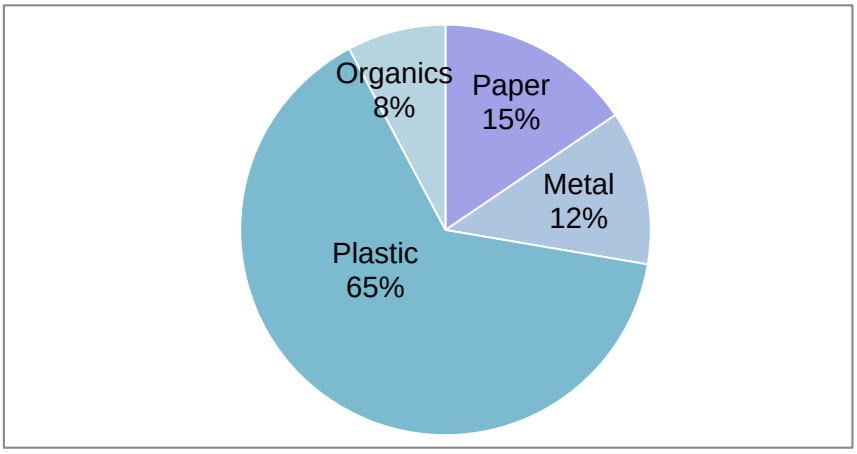
Photo 5.1: Waste Pickers at the Khanh Son Disposal Site

Source: Photo taken by the Survey Team

The waste pickers mainly pick recyclables such as plastic bottles, plastic bags, cans, and paper. According to an interview to 20 waste pickers in Khanh Son disposal site, their average income is 4,112,100 VND/month or 137,070VND/day. The amount of recyclables that they collect, their sales, and the types of recyclables collected are shown in the following table and figure. As the sales depend on the waste that they were able to collect, their income fluctuates and is not stable.

Table 5-22: Amount of Collected Recyclables by the Waste Pickers at Khanh Son Disposal Site and their Sales

Type of recyclables		(a): Collected amount (kg/person/day)	(b): Buying price of primary dealers/ junk shops (VND/kg)	(a)x(b): Daily sales by waste pickers (VND/person/day)
Paper	Other papers	7.8	1,400	10,920
			Subtotal	**10,920**
Metal	Aluminum can	0.7	21,000	14,700
	Steel can	4.8	4,250	20,400
	Iron	0.6	6,000	3,600
			Subtotal	**38,700**
Plastic	PET plastics	5.4	6,250	33,750
	Colored plastics	2.7	6,000	16,200
	Plastic pieces	6.1	1,000	6,100
	hard PET	15.1	1,000	15,100
	PET bags	3.1	4,000	12,400
			Subtotal	**83,550**
Organics	Bones	3.9	1,000	3,900
			Subtotal	**3,900**
			TOTAL	**137,070**



Source: Result of interview with 20 waste pickers

Figure 5-6: Composition of Recyclables Collected by Waste Pickers at Khanh Son Disposal Site (by weight)

When the 20 waste pickers were asked whether they would be willing to change jobs if they were offered the chance, all 20 answered "yes". Among them, 7 said that it would be on condition that the income of the new job would be above 150,000 VND/day and 3 said that it would be on condition that the income of the new job would be above 200,000 VND /day.

b.2. Impact of the project on the waste pickers

The SPC will make efforts to hire all 200 waste pickers as workers in the facilities such as sorting staff in MRF facilities, truck drivers, etc. The level of wage would be the same or higher with their current income from material recovery at the disposal site. The issue of whether they would be hired by the SPC or by a third party (i.e. whether they would be directly recruited or recruited through a subcontractor) would be determined after consultations among stakeholders before the initiation of the Project.

c. Working Conditions

c.1. Current working conditions at the Khanh Son disposal site

According to URENCO, new work safety measures have been introduced at the Khanh Son disposal site in 2012 in line with regulations by the Ministry of Health. For instance, workers at the site wear protection uniforms and receive trainings on safety. With regard to waste pickers, URENCO has no control over their safety, and there are sometimes accidents when waste pickers who enter the site at night. However, as URENCO has informed them of such danger, such cases are now few.

c.2. Regulations on work safety

The rights, the obligations, and the responsibilities of the employer and the employee are outlined in the Labour Code (Law No. 10/2012/QH13) which was amended in June 2012. Chapter 9 of this Law stipulates the general rules regarding occupational safety and health, and Article 138 stipulates the obligation of the employers regarding occupational safety and health as shown below.

Article 138. Obligations of the employer and employee for the work of labor safety and hygiene

1. The employer has the following obligations:

a) To ensure the workplace meets the requirements of space, ventilation, dust, steam, toxic gas, radiation, electro-magnetic field, heat, humidity, noise, vibration and other harmful elements specified in the relevant technical regulations and those factors must be tested and measured periodically.

b) To ensure the conditions on labour safety and hygiene for machinery, equipment, workshop to reach the national technical regulations on labor safety and hygiene or standards on labour safety and hygiene at the workplace that has been published and applied.

c) Testing and assessing the dangerous and harmful factors, harmful at workplace of the facility to set out the exclusion measures to minimize hazards, harmfulness and improve the working conditions and health care for the employees;

d) Periodically testing and maintaining the machinery, equipment, workshops and warehouses;

dd) There must be instruction table on labour safety and hygiene for the machinery, equipment and workplace and it should be put at the legible and visible place labour safety and hygiene the workplace;

e) Gathering opinions of the representative organization of labor collective at the grassroots level when making a plan and implementing the activities to guarantee the labour safety and hygiene.

Source: English Translation of Labour Code (Law No. 10/2012/QH13) found on ILO website

c.3. Impact of the project on work safety

As new facilities and machines would be installed in the project, the following occupational hazards may occur for those who work in or near the WTE facility for its construction or operation if appropriate safety measures are not taken. With regard to waste pickers, their work safety is likely to improve as they would be able to work in environments such as inside the MRF facility.

Table 5-23: Possible Occupational Hazards

Period	Facility	Possible occupational hazards
During construction	General	Falling down from scaffolding Contact with trucks and heavy machineries Falling/flying of work pieces
During operation	General	Inhaling of dust or hazardous gas Heat stroke Slips, falls Contact with trucks or heavy machineries Noise and vibration
	WTE facility	Falling into the waste pit Burns Vapor explosion, fire Electrification

Source: Survey Team

5.7 Expected Environmental and Social Impacts

Based on the above results, the expected environmental and social impacts can be summarized as follows.

Table 5-24 Preliminary Scoping of Impacts and Result of Impact Survey

Category	Item		Evaluation at scoping phase		Evaluation based on the survey results		Reasons
			During Const-ruction	During Opera-tion	During Const-ruction	During Opera-tion	
Pollution Prevention	(1)	Air Quality	B-	A-	B-	B-	During construction: The local air quality may temporarily be affected by their emission gas from construction vehicles and dusts from construction works. During operation: The facility will be designed so that the emission gas will comply with the emission standards. Furthermore, considering our dispersion prediction results, the air pollution level would not exceed the environmental standards.
	(2)	Water quality	B-	B±	B-	B±	During construction: Effluent from construction work may negatively affect to the local water quality. During operation: As wastewater from the facility will not be directly discharged, it is not likely that the project would negatively affect local water quality. Furthermore, as wastes will be treated, the quality of leachate at the disposal site may improve which may in turn improve local water quality.
	(3)	Wastes	D	B±	D	B±	During operation: Negative environmental impact may occur from some wastes such as fly ash that contain hazardous substances.
	(4)	Soil quality	D	D	D	D	No soil pollution is expected by the Project.
	(5)	Noise and Vibration	B-	B-	B-	B-	During construction: Construction works and vehicles will generate some noise and vibration. During operation: Noise and vibration may increase due to introduction of machines which generate noise and vibration.
	(6)	Odor	D	B+	D	B+	During Operation: The Project is expected to lower the level of odor, as it will incinerate the organic wastes which are often sources of odor and also promote prompt stabilization of the wastes.

Category	Item		Evaluation at scoping phase		Evaluation based on the survey results		Reasons
			During Const-ruction	During Opera-tion	During Const-ruction	During Opera-tion	
Natural Environment	(7)	Protected Areas	D	D	D	D	There are no protected areas designated by the Vietnamese laws or international treaties in or near the project site.
	(8)	Ecosystem	D	D	D	D	There are no primeval forests, tropical rain forests, or ecologically valuable habitats (e.g. coral reefs, mangroves, or tidal flats) in or near the project site. No endangered species have been found in or near the project site.
	(9)	Management of Abandoned Sites	D	D	D	D	As the project will not include operation of the disposal site, there will be no management of abandoned sites.
Social Environment	(10)	Resettlement	D	D	D	D	There will be no resettlement as the project site is within the Khanh Son disposal site where there are no residents.
	(11)	Living	D	D	D	D	N.B. Issues regarding “noise and vibration” and “odor” are already mentioned above.
	(12)	Livelihood	B+	B+	B+	B+	During construction: There will be new job opportunities for the construction work and more business for the restaurants and commerce in the neighborhood. During operation: Approximately 235 workers would be recruited total for the operation of new facilities. The current waste pickers Total of There will be new job opportunities for the operation although the number would be limited. With regard to current waste pickers, their level of income will not change as they would be allowed to continue to pick recyclables in a similar manner.
	(13)	Heritage	D	D	D	D	N.B. Issues regarding “noise and vibration” and “odor” are already mentioned above.
	(14)	Landscape	D	D	D	D	There are no important landscapes which for instance bring tourists.

Category	Item		Evaluation at scoping phase		Evaluation based on the survey results		Reasons
			During Const-ruction	During Opera-tion	During Const-ruction	During Opera-tion	
	(15)	Ethnic Minorities and Indigenous Peoples	D	D	D	D	There are no ethnic minorities or indigenous peoples in or near the project site.
	(16)	Working Conditions	B-	B-	B-	B-	During construction: There are risks that accidents would occur among people such as construction workers. During operation: There are risks that accidents would occur among people such as workers in the intermediate facilities.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C: Extent of impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

5.8 Mitigation Measures and Their Costs

For items that may be subject to negative impact, the possible mitigation measures and their costs have been summarized in the table below.

Table 5-25: Mitigation Measures and Their Costs

No.		Item	Mitigation measures	Implementing organization	Responsible organization	Cost
During construction						
1	Pollution prevention	Air pollution	• Setting up of enclosure around construction site • Sprinkling of water at and around the site • Washing of construction vehicles • Efficient operation of construction vehicles by adjusting construction schedule	Contractor for construction work	SPC	Included in CAPEX
2		Water pollution	• Discharge of clear upper portion of effluent by installing temporary grit chamber			
3		Wastes	• Daily management by Construction contractor to prevent contamination caused by hazardous materials and wastes, and to ensure that appropriate treatment is conducted			
4		Soil	• Discharge of clear upper portion of			

No.		Item	Mitigation measures	Implementing organization	Responsible organization	Cost
		pollution	effluent by installing temporary grit chamber			
5		Noise and vibration	• Adjustment of transportation and working time (No work is conducted when quiet is required like night time.)			
6	Social Environmen	Working Conditions	Implement work safety measures (refer to Table 5-26)			
During operation						
1	Pollution prevention	Air pollution	• Installing of dry gas treatment system • Preventing of Dioxins generation by firing control	JFE Engineering	SPC	Included in CAPEX
2		Wastes	• When the project is made more specific, necessary treatment methods will be considered after further identification of waste composition			
3		Noise and vibration	• Use of low noise machines (85dB(A) or less at 1m distance from the machine). When the level is exceeded, ragging and sound proof cover will be utilized. • For large machineries, vibration isolation base and sound proof enclosure may be used if necessary. Setting the machines inside concrete-made building can be also considered.			
4		Odor	• Suction and collection of odorous air from waste storage pit, and use of it for combustion air • Deodorization of combustion exhaust gas (thermal decomposition of odorous components) by implementing appropriate firing control (high temperature combustion)			
5	Social Environment	Landscape	Design the facilities with considerations to the landscape			
6		Working Conditions	Implement work safety measures (refer to Table 5-26)	SPC		

Table 5-26: Work Safety Measures to be taken

Period	Facility	Possible accidents at work	Work safety measures to be taken
During construction	General	Falling down from scaffolding	• Design walkways and stairs so that they can be easily walked on (they should have enough space and not too steep) • Put up signs to show walkways and stairs and put handrails
		Contact with trucks and heavy machineries	• Design the traffic line so that there would be no or little contact between the workers and trucks and heavy machineries
		Falling/flying of work pieces	• Require workers to wear helmets
During operation	General	Inhaling of dust or hazardous gas	• Design the facilities so that there would be enough light and ventilation in the work space
		Heat stroke	
		Slips, falls	• Design walkways and stairs so that they can be easily walked on (they should have enough space and not too steep) • Make the top of the hopper higher than the floor
		Contact with trucks or heavy machineries	• Put covers or colors for places that rotate, move, or stick out • For places that rotate or move, indicate signs to show that they are in operation • Make the height of the floor appropriate and secure enough space between the machineries and hand rails. • Put colors on dangerous places
		Noise and vibration	• Prevent noise/vibration that would be hazardous to the workers through installing anti-vibration devices such as anti-vibration rubber.
	WTE facility	Falling into the waste pit	• Put handrails or walls in the upper part of the waste pit • Use wired glass for the windows of the central control room
		Burns	• Seal the dust conveying device and insulate high temperature places
		Vapor explosion, fire	• Prevent gas in the furnace from shooting out by using heat-resistance glass for places that periodically open and close for inspection • Design the system that will automatically stop at time of emergency or when the operator pushes "emergency stop button" • Install emergency exits and escape door as necessary
		Electrification	• Put up signs for places with high voltage • Design electric system so that electric leakage and electrification would be prevented • If water pipes and electric lines cross, always make the water pipes below the electric lines. • Install lightning protection for the stacks

5.9 Monitoring Plan

According to interview with URENCO, URENCO submits to DONRE the results of monitoring conducted inside the premises of the disposal site. DONRE then considers whether the results are within the standards or not, and issues penalties if the results exceed the standards. Environmental management will be appropriately fulfilled by applying the same system based on SPC monitoring plan after the facilities start their operation. For items that may be negatively impacted, monitoring would be conducted as shown in the table below.

Table 5-27: Monitoring Plan

Item	Monitoring item	Location	Method	Frequency	Responsible organization	Cost (USD)
During construction						
Air quality	TSP, PM10, CO, NOx, SO_2	Around construction site	Sampling test	Once a month	Construction contractor, SPC	960 (sampling and analysis for one point)
Water quality	pH, SS	At discharge point to outside the site boundary	Sampling test	Once a month	Construction contractor, SPC	200 (sampling and analysis for one point)
Noise and vibration	Level of noise and vibration	One point on the site borderline closest to the nearest residential area	On-site measurement	Once a month	Construction contractor, SPC	360 (sampling and analysis for one point)
Working Conditions	Number of reported accidents	N/A		Once a month	SPC	—
During operation						
Air quality	SOx, NOx, CO, HCl, dust, O_2, Temperature, etc.*	At flue of the incinerator	Continued measurement	Continuance measurement (For 20 years)	SPC	This will be considered when the project is made more specific.
	HF, Cd, Pb, HC, Dioxins, Total heavy metals (As, Sb, Ni, Co, Cu, Cr, Sn, Mn, TI, Zn)	At flue of the incinerator	Sampling test	Once per six months (For 20 years)	SPC	1,000 (sampling and analysis for one point)
Water quality	Temp., Color (Pt/Co), pH, BOD5, COD, TSS, As, Hg, Pb, Cd, Cr3+, Cr6+, Cu, Zn, Ni, Mn, Fe, CN-, Phenol, Oil and grease, S, F-, NH4+-N, T-N, T-P, Cl-, Residual chlorine, Total organochlorine	At discharge point from the incineration facility	Sampling test	Once per six months (For 20 years)	SPC	1,300 (sampling and analysis for one point)

Item	Monitoring item	Location	Method	Frequency	Responsible organization	Cost (USD)
	pesticides, Total organophosphate pesticides, PCB, Coliform, Total radiation α, Total radiation β (QCVN40:2011/ BTNMT)					
Noise and vibration	Level of noise and vibration	One point on the site borderline closest to the nearest residential area	On-site measurement	Once per six months (20 years)	SPC	360 (sampling and analysis for one point)
Wastes	Items stipulated in QCVN07:2009/BTNMT and related to fly and bottom ash**	Fly and bottom ash generated from incineration plants	Sampling test	12 times per year (20 years)	SPC	This will be considered when treatment methods are determined.
Odor	Number of complaints about odor from residents	N/A	N/A	Once a month (20 years)	SPC	—
Livelihood	Number of employees and their salaries, Level of livelihood	N/A	Record of paid salaries, interviews	Once a month (20 years)	SPC	—
Working Conditions	Number of reported accidents	N/A	N/A	Once a month	SPC	—

* When the project is made more specific, monitoring items will be determined after further identification of waste composition.

** When required treatment methods for hazardous wastes are determined, monitoring methods will be considered.

Draft monitoring form is shown below.

a. During construction

a.1. Air

Parameter	Unit	Date	Location	Measured Value	Standard (QCVN05:2009 /BTNMT)	Remarks
TSP (1h av.)	µg/m^3				300	
PM10 (24h av.)	µg/m^3				150	
CO (1h av.)	µg/m^3				30,000	
NOx (1h av.)	µg/m^3				200	
SO_2 (1h av.)	µg/m^3				350	

a.2. Wastewater

Parameter	Unit	Date	Location	Measured Value	Standard (QCVN 40:2011/BTNMT)	Remarks
pH	-				5.5 - 9	
SS	mg/l				100	

a.3. Noise and vibration

Parameter	Unit	Date	Location	Measured Value	Standard (Noise: QCVN 26:2010/BTNMT Vibration: QCVN 27:2010/BTNMT)	Remarks
Noise (6.00-21.00)	dBA				70	
Noise (21.00-6.00)	dBA				55	
Vibration (6.00-21.00)	dB				70	
Vibration (21.00-6.00)	dB				60	

b. During operation

b.1. Emission gas（Continuance measurement）

Parameter	Unit	Date	Location	Measured Value (24h av.)	Standard (QCVN30:2012/BTNMT)	Remarks
To be determined						

b.2. Emission gas （Sampling）

Parameter	Unit	Date	Location	Measured Value	Standard (QCVN30:2012/BTNMT)	Remarks
HF	mg/Nm^3				250	
Cd	mg/Nm^3				0.16	
Pb	mg/Nm^3				1.2	
HC	mg/Nm^3				50	
Dioxins	$ngTEQ/Nm^3$				0.6	
Total heavy metals (As, Sb, Ni, Co, Cu, Cr, Sn, Mn, TI, Zn)	mg/Nm^3				1.2	

b.3. Wastewater

Parameter	Unit	Date	Location	Measured Value	Standard (QCVN 40:2011/BTNMT)	Remarks
Temperature	℃				40	
Color	Pt/Co				150	
pH	-				5.5 - 9	
BOD_5	mg/l				50	
COD	mg/l				150	
SS	mg/l				100	
As	mg/l				0.1	
Hg	mg/l				0.01	
Pb	mg/l				0.5	
Cd	mg/l				0.1	
Cr3+	mg/l				1	
Cr6+	mg/l				0.1	
Cu	mg/l				2	
Zn	mg/l				3	

Parameter	Unit	Date	Location	Measured Value	Standard (QCVN 40:2011/BTNMT)	Remarks
Ni	mg/l				0.5	
Mn	mg/l				1	
Fe	mg/l				5	
CN-	mg/l				0.1	
Phenol	mg/l				0.5	
Oil and grease	mg/l				10	
S	mg/l				0.5	
F-	mg/l				10	
NH4+-N	mg/l				10	
T-N	mg/l				40	
T-P	mg/l				6	
Cl-	mg/l				1,000	
Residual chlorine	mg/l				2	
Total organochlorine pesticides	mg/l				0.1	
Total organophosphate pesticides	mg/l				1	
PCB	mg/l				0.01	
Coliform	MPN/100ml				5,000	
Total radiation α	Bq/l				0.1	
Total radiation β	Bq/l				1.0	

b.4. Noise and vibration

Parameter	Unit	Date	Location	Measured Value	Standard (Noise: QCVN 26:2010/BTNMT Vibration: QCVN 27:2010/BTNMT)	Remarks
Noise (6.00-21.00)	dBA				70	
Noise (21.00-6.00)	dBA				55	
Vibration (6.00-21.00)	dB				70	
Vibration (21.00-6.00)	dB				60	

b.5. Wastes (fly ash and bottom ash)

Parameter	Unit	Date	Measured Value	Standard	Remarks
To be determined					

5.10 Support for organizing Stakeholder Consultation Meeting

Two stakeholder consultation meetings were organized on 31 July 2013 and 1 October 2014 with the objectives to explain to the public and to discuss with the public the following issues

- The outline of the project
- The expected environmental and social impacts of the project
- The measures that will be taken to mitigate the environmental and social impacts of the project

5.10.1 1st Stakeholder Consultation Meeting (31 July 2013)

The participants of the meeting showed understanding regarding the benefits of the proposed project and overall gave positive feedback. The other comments that were made and how they would be addressed are summarized in the following table.

Table 5-28: Comments made in the 1st Consultation Meeting and how they would be addressed

Comment (organization that made the comment)	How the comment would be addressed
1. The local residents living near the proposed project site are likely to react strongly to the project. Therefore, it is recommend to explain in detail the proposed project to them. (URENCO)	Detailed explanations will be made to the local residents as the details of the project become more concrete.
2. Please describe the details of technology of your incinerator in your report. (URENCO)	The details are explained in Chapter 4 of this report.
3. There are concerns that there would be wastewater from the sorting yard. (URENCO, Fatherland Front, DPI)	There will be no wastewater from the hand-sorting area of MRF
4. It is likely that there will be bad odor from the sorting yard. (URENCO、DPI)	It would be explained that although odor cannot be completely eliminated from the hand-sorting area of MRF, the total level of odor is expected to lower as the wastes would be immediately incinerated after sorting and the wastes to be landfilled would be mainly ashes.
5. Installing a belt conveyor for manual sorting by waste pickers is recommended. (URENCO)	A conveyor belt would be introduced in the MRF for hand-sorting
6. It is recommended to install equipment to separate metals. (DONRE)	It would be explained that as the percentage of metal in Khanh Son disposal site is very low (0.05% according to survey in this study), there would not be the need to install metal sorting facility.

The minutes of meeting of the 1st stakeholder consultation meeting is inserted in the following pages.

Minutes of Meeting of the 1st Stakeholder Consultation Meeting

Date, time	8:00-10:00, Wednesday, July 31, 2013
Place	Meeting Room in DPI office
Objective	To explain to the public and to discuss with the public the following issues - The outline of the project - The expected environmental and social impacts of the project - The measures that will be taken to mitigate the environmental and social impacts of the project
Participants	<Vietnamese side> - Ms. Le Kim Phuong / Department of Planning and Investment (DPI) - Mr. Nguyen Phuoc Chau / Department of Natural Resources and Environment (DONRE) - Ms. Phan Thi Nu / Da Nang Urban Environment Company (URENCO) - Ms. Huynh Thi Nga / Lien Chieu District People's Committee - Ms. Nguyen Thi Thu Huong/ Fatherland Front - Ms. Nguyen Thi Thu Ha/ WOMEN's UNION - Ms. Nguyen Thi Thu Hien/ YOUTH UNION - Mr. Phan Quoc Dinh/ Hoa Khanh Nam Ward People's Committee <Japanese Side> - Mr. Kubota and Mr. Nagao/ JFE Engineering - Mr. Kato, Mr. Sugimoto, Mr. Nakaishi, Ms. Matsumoto/ EX Research Institute - Mr. Le Ngoc Cau (Interpreter) - Mr. Quang Vinh Vu (Interpreter)
Program	1. Opening Remark (Representative from Director of DPI) 2. Introduction of the participants 3. Presentation - Objectives of the hearing - Current issues of solid waste management in Da Nang City - Proposed project - Expected environmental and social impacts and mitigation measures 4. Stakeholders Q & A and Discussion 5. Closing Remarks (Representatives from Vietnamese side)

URENCO: I understand that your project is necessary for Da Nang city and can provide significant benefits to the people in Da Nang. However, I'm concerned with the local people living near the proposed project site. They will be likely to react strongly. Therefore, I recommend to explain your project in detail to them I agree environmental and social impacts, and proposed mitigation measures which you showed in your slides. Currently there are 200 waste pickers in the Khanh Son Disposal site , and main social impacts of your project will be the impacts on waste pickers. According to your explanation, the project will not affect their livelihood. Do you plan to incinerate only wastes remaining after waste pickers' picking? Please describe the details of technology of your incinerator in your report. It is important to pay attention to leachate from the wastes in sorting area of waste pickers since we have rainy season in Da Nang and the volume of leachate will increase after raining. I recommend installing a belt conveyor for manual sorting by waste pickers. Since organic wastes account for a large portion of wastes in the Khanh Son Disposal site site, odor will occur from the wastes even during the retention time.

JICA Survey Team (EX Research): We will prepare place for waste pickers so that they will be able

to continue to pick materials. Therefore, they will not lose their job even after we implement our project. Your recommendation, a belt conveyor, is a good idea to improve their working condition.

Women's Union: I agree to your plan and understand benefits which your project will provide to Da Nang city. We would like to get involved with your project since most of the waste pickers in the site are women. We could also implement public campaign like at-source separation although currently we do not have enough facilities for such separation activity. Our organization can also talk with waste pickers. Has a waste to energy plant been already introduced in other area in Vietnam?

JICA Survey Team (JFE Engineering): At the moment, there is no waste to energy plant in Vietnam.

JICA Survey Team (EX Research):We will include your opinion in our draft final report.

DONRE: What is the purpose of waste separation before incineration?

JICA Survey Team (EX Research): The first purpose is maintaining waste pickers' job, and the second one is resource conservation.

DONRE: Is it possible to offer better jobs to waste pickers? If it is possible, resource conservation will be accomplished in another way. Can your facility incinerate scrap metal?

JICA Survey Team (EX Research): As metals cannot be burned, they are left in bottom ash and landfilled. If magnetic separation is equipped, they can be separated from the ash.

DONRE: I recommend installing equipment to separate metals since they are valuable resource. We have conducted at- source separation in Da Nang, so we may cooperate with you.

Hoa Khanh Nam Ward People's Committee: The information you provided to us are very comprehensive. Although construction work will affect local residents, your project will bring benefits to them since they have been affected by odor and wastewater. During construction and operation phase, local authorities will be able to work with you to make the local residents understand your project. Although you did not mention impacts on groundwater, it has been contaminated and measures to solve this problem are necessary. Construction and operation of your facility can create new jobs.

Fatherland Front: I totally agree with URENCO. I also concern the leachate from wastes to be temporally stored for waste pickers. The local residents have been heavily affected by odor from the disposal site. If Waste to Energy plant is introduced, this problem will be mitigated. Our organization could work with DPC and local authorities to make the local people understand the benefits of this project. When issues occur, you can consult with local authorities. We will help you. Regarding waste pickers' livelihood, I do not totally agree with the opinion of DONRE since it will not easy to create new jobs. I support to maintain their current livelihood.

DPI: The points which need to be concerned are leachate and odor from the wastes in the sorting area. They are not likely to be solved completely by the project which you currently proposed. Therefore, you need to consider the balance between maintaining of waste pickers' livelihood and prevention of odor and leachate generation.

JICA Survey Team (EX Research): We agree to your opinion about leachate and odor, but we need

to secure waste pickers' job. If new jobs other than waste picking can be created, the sorting area is not necessary and wastes can be transported directly into the facility. Meanwhile, the situation will be significantly improved even though the sorting area is set since the retention time will be significantly reduced compared to the current situation.

DPI: Some problems will remain even after the project is implemented, so please try to minimize negative impacts. If the problems of leachate and odor are solved, your project will be perfect.

JICA Survey Team (EX Research): The current condition of the Khanh Son disposal site is good compared to that in other countries. This means that URENCO has successfully operated the site. As odor generates from not only wastes but also night soil, it is necessary to solve this problem.

DPI: Currently we have worked with International Finance Corporation under World Bank for night soil treatment. In the middle of the next year, bidding process will start.

JICA Survey Team (EX Research): We appreciate your comments and understanding, and will reflect the comments into our draft final report and our project. We will prepare the report within a month, and would like to hold this kind of meeting again. Please keep this active participation in our project.

DPI: Please reflect today's comments into your report, and improve your project. We welcome your project, but the internal rate of return (IRR) and the tipping fee are very high for us. We hope you can set lower rate. If you stick to the rate of 18%, financial support from public organizations will be necessary. We also hope that JICA consults with Vietnamese central government. PPP scheme could be utilized, but we think that some of the investment cost should be covered by ODA budget.

Photos from the 1st stakeholder consultation meeting

5.10.2 2nd Stakeholder Consultation Meeting (1 October 2014)

The second meeting was attended by approximately 100 participants including the local residents. Many of the local residents expressed their dissatisfaction concerning the current environmental pollution caused by the landfill such as bad odor and water pollution, and many of them fully supported the proposed project if it is going to solve these environmental issues. The comments that were made

and how they would be addressed are summarized in the following table.

Table 5-29: Comments made in the 2nd Consultation Meeting and how they would be addressed

Comment (organization that made the comment)	How the comment would be addressed
1. Similar projects have been proposed but not realized. We want commitment regarding environmental improvement and employment (local resident)	Detailed explanations concerning the responsibilities of Vietnamese and Japanese partners will be made to the local residents as the details of the project become more concrete.
2. There are few participants from the Danang authorities. We want Danang City to take responsibility if something goes wrong in the project (local resident)	Same as above
3. There should be more trees near the disposal site (local resident)	Planting trees around the plant would be considered.
4. I support the project, but at this point, the detailed consequences of the project are not clear (local resident)	Detailed explanations concerning environmental improvement will be made to the local residents as the details of the project become more concrete.

The minutes of meeting of the 2nd stakeholder consultation meeting is inserted in the following pages.

Minutes of Meeting of the 2nd Stakeholder Consultation Meeting

Date, time	From 14:30, 1 October 2014
Place	Hoa Khanh Nam Ward Office, Lien Chieu District, Da Nang City
Objective	To explain to the public and to discuss with the public the following issues - The outline of the project - The expected environmental and social impacts of the project - The measures that will be taken to mitigate the environmental and social impacts of the project
Participants	<Vietnamese side> - Mr. Nguyen Thanh Sinh (Chairman of Farmer Union of Hoa Khanh Nam Ward) - Mr. Bui Trung Khanh (Vice Director of Hoa Khanh Nam Ward) - Mr. Tran Minh Phuong (Vice Director of VN National Front Committee, Hoa Khanh Nam Ward) - Mrs. Nguyen Thi Minh Huyen (Vice Chairwoman, Women Union, Hoa Khanh Nam Ward) - Mr. Nguyen Hoang Ha (Representative, Lien Chieu District) - Mr. Nguyen Hoang Duy (Executive, DPI) - Mr. Duong Tan Tai (Executive DONRE) - Mr. Pham Nguyen Hung (Depity Secretary of Hoa Khanh Nam Ward) <JICA Survey Team> - JFE Engineering: Mr. Gen Takahashi, Mr. Takanobu Ohara - EX Research Institute: Mr. Kazuhiro Nakaishi, Mr. Satoshi Sugimoto - Interpreters: Mr. Le Ngoc Cau, Mr. Quang Vinh Vu
Program	1. Presentation of the proposed project: Objectives, outlines 2. Expected environmental and social impacts and mitigation measures 3. Discussion

Mr. Nguyen Duc Sinh (resident of Hoa Khanh Nam Ward): Local residents at Hoa Khanh Nam

Ward, where the Khanh Son disposal site has been located from 1991 until today, has suffered from serious environmental pollution. There have been many local hearings like this in the past with promises to improve the environment pollution, but the situation has not been changed. There have been many cases where angry local residents have stopped the trucks carrying waste or septic tank sludge to Khanh Son Disposal site. We want the operations at Khanh Son Disposal site to stop. We no longer have trust in projects in Khanh Son disposal site.

JICA Survey Team: Our purpose is to build plants to improve the environment at Khanh Son disposal site.

Mr. Nguyen Duc Sinh (resident of Hoa Khanh Nam Ward): Incineration of the wastes may generate dioxin emission and cause cancer among local residents. Thus, we must hear the opinions of local residents and current leaders of the city. If majority of the people agree with the project, we will do it, but if not, we will not do it.

Mr. Luy (Captain of group 12, Hoa Khanh Nam Ward): A new disposal site would be needed after 10 to 15 years of landfilling. Then, other areas may have to suffer from environmental pollution like that from Khanh Son Landfill. Thus, I support this project which will improve the environment for the local residents. However, during construction, impacts such as noise and dust may occur. Who will take the responsibility for this?

JICA Survey Team: There are different Japanese and Vietnamese partners involved in the project. To implement the project, we have to follow the regulations and agreements signed with Da Nang City. When we reach an agreement with Da Nang City, we will fulfill our commitments. We understand how local residents suffer, and our new technologies would solve many of the problems that the local residents are suffering from. We are proposing 2 options: MBT and incineration. As the cost (tipping fee) would be higher than that of today, Da Nang City must have sufficient budget. Although Japan government and enterprises commit to support facilities, financing, and technology; we still need the support from Da Nang City. We want local residents to request to Da Nang City to improve the current environmental problems.

Mr. Kieu Van Thang (Captain of group 109, Hoa Khanh Nam): What the local people are telling are facts. I fully support this proposed project if it will solve the current environmental problems and will create jobs for waste pickers. I hope this project would be quickly implemented.

Mr. Kien (resident at Hoang Van Thai Street, nearby Khanh Son Disposal site): I am glad that there will be a project to solve the environmental problems. From 1991, Da Nang City and DONRE have promised many times to improve the environmental situation, but they have realized very little. It was written in the invitation letter that relevant departments of Da Nang City would be in this meeting but they are not here. There are only local residents. We require leaders of Da Nang City and Districts to make commitments about this project. They must take all the responsibility if any problems occur.

Mr. Nguyen Van Thanh (resident of Da Son, Hoa Khanh Nam Ward): Local people are angry because the disposal site has been there for 20 years and have moved 2 times. That polluted the soil and the environment. After many complaints from the local residents, Da Nang City

has finally supplied clean water system for the local residents nearby Khanh Son Disposal site. Before, there was a project proposed by Australia with investment of millions of US dollars with the purpose to manage the waste and improve the environment. However, it has not been realized at all. Pollution reaches to even areas about 3km away from the disposal site. The smell is worse especially early in the morning. I put my trust in the Japan team to implement this project and to improve the environment. If this is realized, local residents would be so happy. However, there must be commitments to improve the environment and create jobs for local workers. People's trust cannot be lost again.

JICA Survey Team: We are considering to hireb200 to 300 waste pickers working at the MBT facility of this project. However, this project is still under discussion with Da Nang City. To implement this project, it is essential to have the commitments of the Da Nang City and the support of the local residents. We recognize the urgent need to implement this project given the facts that the disposal site will soon become full and local residents are suffering from environmental pollution. If Da Nang City and local residents support this project, it may take only 2 to 3 years to start operation and to improve the environment at the Khanh Son Disposal site area.

Mr. Nguyen Van Son (resident of Hoa Khanh Nam Ward): Within the radius of 3km from the Khanh Son Disposal site, the environment is seriously polluted. It is especially bad during night and early morning. More trees should be planted. Trucks carrying wastes often spill leachate or leave bad smell on the streets, thus they should be improved. We can pay more to have a better living condition for our health

Male, Name unknown (Group 169, Hoa Khanh Nam Ward): I live about 500m away from the disposal site and suffer from serious pollution. Local people nearby Khanh Son Disposal site has been expecting a project like this since 1991 but there has been none. Local residents have suffered and sacrificed for Da Nang so that it can become a green and environmental city. We require DONRE to give orders to URENCO to handle the horrible odor from the septic tank sludge treatment area. Da Nang City must take the responsibility for the local living environment. I believe in this JICA Team to build the plant and to improve the environment. I really want authorities and departments to consider the local living environment. Basically I agree with this project, but the results are yet to be known. I hope the relevant participants will fulfill their commitments

JICA Survey Team (Mr. Takahashi): In Japan, the same kind of environmental pollution have occurred. In Japan, we there are technologies to prevent bad odor and environmental pollution, there are schools and hospitals even near incinerators. However, even with these technologies, gaining the consensus to installing an incinerator takes a very long time. After many meetings, we have agreed on the most suitable technology. The Japanese side will continue to cooperate with Da Nang City to realize this project. We commit to provide the best solution for Da Nang City. We thank you for your presence and your very important comments.

5.11 Environmental check list

The environmental check list for projects regarding wastes was filled as below based on the JICA guidelines for environmental and social considerations.

Category	Environmental Item	Main Check Items	Yes: Y No: N N/A: Not applicable	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)N (b)N (c)N/A (d)N/A	(a) Under preparation (b) Report is not yet submitted (c) It is not clear at this point as the report is not yet submitted (d) It is not clear at this point as the report is not yet submitted
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a)N (b)N	(a) Stakeholder consultation meeting would be organized twice in line with JICA guidelines (1st meeting was organized in July 2013 the 2nd is planned in September 2014) (b) Comments in the meetings above would be reflected
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)Y	(a) Total of 4 options have been examined (including zero option)
2 Pollution Control	(1) Air Quality	(a) Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust, and dioxins emitted from various sources, such as incinerators, and vehicles used for waste collection and transportation comply with the country's emission standards and ambient air quality standards?	(a)Y	(a) The facility will be designed so that the emission gas will comply with the emission standards. Furthermore, considering the dispersion prediction results, the air pollution level would not exceed the environmental standards.

Category	Environmental Item	Main Check Items	Yes: Y No: N N/A: Not applicable	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Water Quality	(a) Do effluents from various facilities comply with the country's effluent standards and ambient water quality standards? (b) Does the water quality of leachates from the waste disposal sites comply with the country's effluent standards and ambient water quality standards? (c) Are adequate measures taken to prevent contamination of surface water and groundwater by these effluents and leachates?	(a)Y (b)Y (c)Y	(a) Wastewater treatment facilities would be in place so that effluent standards would be met. (b) The project would not degrade the leachate quality (N.B. the disposal site is not under the responsibility of the project) (c) No negative impact is foreseen as untreated wastewater would not be discharged.
	(3) Wastes	(a) Are wastes, such as treatment residues, cinder, and fly ash generated from crushing and segregation processes, and diverted wastes from composting process properly treated and disposed of in accordance with the country's regulations? (b) Are hazardous and dangerous wastes properly segregated from other wastes, stabilized, treated, and disposed of in accordance with the country's standards?	(a)Y (b)Y	(a) The bottom ash will be disposed in the current disposal site. The fly ash would be appropriately treated so that Vietnamese elution standards would be met (treatment method is under consideration) (b) The Project will treat municipal solid wastes (i.e. waste excluding hazardous wastes). Hazardous wastes are collected and treated separately from the municipal solid wastes.
	(4) Soil Contamination	(a) Are adequate measures taken to prevent contamination of soil and groundwater by leachates from the waste disposal sites?	(a)Y	(a) As the project will not include operation of the disposal site, there will be no management of abandoned sites. Furthermore, no soil pollution is expected as leachate quality would not be degraded.
	(5) Noise and Vibration	(a) Do noise and vibrations generated by the facility operations (especially incinerators, waste segregation and crushing facilities), and vehicle traffic for waste collection and transportation comply with the country's standards?	(a)Y	(a) Standards would be met through introduction of low-noise machines and soundproof cover.
	(6) Odor	(a) Are adequate odor control measures taken?	(a)Y	(a) The Project would not increase the level of odor, as the odor in the waste pit would be controlled by pressure.

Category	Environmental Item	Main Check Items	Yes: Y No: N N/A: Not applicable	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				The odor would also be incinerated.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a)N	(a) There are no protected areas designated by the Vietnamese laws or international treaties in or near the project site
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the project will adversely affect aquatic organisms? If impacts are anticipated, are adequate measures taken to reduce the impacts on aquatic organisms? (e) Is there a possibility that the project will adversely affect vegetation and wildlife? If impacts are anticipated, are adequate measures taken to reduce the impacts on vegetation and wildlife?	(a)N (b)N (c)N (d)N (e)N	(a)(b)(c)(d)(e) There are no primeval forests, tropical rain forests, or ecologically valuable habitats (e.g. coral reefs, mangroves, or tidal flats) in or near the project site. No endangered species have been found in or near the project site.
	(3) Management of Abandoned Sites	(a) Are environmental protection and restoration plans (such as landfill gas and leachate collection and treatment systems, prevention of illegal dumping, and reforestation) after facility closure considered? (b) Is a sustainable management framework for the abandoned sites established? (c) Are adequate financial provisions secured to manage the abandoned sites?	(a)N/A (b) N/A (c) N/A	(a)(b)(c) The Project would introduce intermediate treatment facilities and not a disposal site (disposal site is under the responsibilities of URENCO)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic	(a)N (b)N (c)N (d)N (e)N (f)N (g)N (h)N (i)N (j)N	(a)(b)(c)(d)(e)(f)(g)(h)(i)(j) There will be no resettlement as the project site is within the Khanh Son disposal site where there are no residents.

Category	Environmental Item	Main Check Items	Yes: Y No: N N/A: Not applicable	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?		
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?(b) Are considerations given to the existing recovery systems, including waste pickers? (c) Is there a possibility that waste transportation will adversely affect the regional traffic? (d) Is there a possibility that effluents from the project and leachates form the waste disposal sites will adversely affect fisheries and other water uses by local inhabitants (especially drinking water)? (e) Is there a possibility that pathologic insects or other disease vectors will breed as a result of the project?	(a)Y (b)Y (c)N (d)N (e)N	(a) Although noise and vibration may occur, mitigation measures would be taken such as introduction of low-noise machines. (b) Consideration will be given to the existing recovery system (c) As the project site would be inside the site of the current disposal site, the Project would not increase local traffic for waste transportation. (d) Wastewater from the facilities would be treated to meet the effluent standards. The Project is not expected to degrade the leachate quality. (e) Pathologic insects are likely to reduce by the introduction of the intermediate treatment facility.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)N	(a) There are no local archeological, historical, cultural, and religious heritage near the project site.

Category	Environmental Item	Main Check Items	Yes: Y No: N N/A: Not applicable	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N/A	(a) There are no important landscapes which for instance bring tourists.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a)N/A (b)N/A	(a)(b) There are no ethnic minorities or indigenous peoples in or near the project site.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a)Y (b)Y (c)Y (d)Y	(a) Considerations will be given so that labor-related laws and ordinances would be complied with. (b)(c) Measures to prevent accidents such as training of workers would be taken (d) Training would be conducted for security guards as necessary
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a)Y (b)N (c)Y	(a) Although gas emission and dust are likely to occur, they would be controlled by measures such as water spray. (b) There are no primeval forests, tropical rain forests, or ecologically valuable habitats (e.g. coral reefs, mangroves, or tidal flats) in or near the project site. No endangered species have been found in or near the project site. (c) Air pollution and noise and vibration may occur, but mitigation measures would be taken

Category	Environmental Item	Main Check Items	Yes: Y No: N N/A: Not applicable	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				such as control of working hours.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)Y (b)Y (c)Y (d)N	(a)(b) Monitoring would be planned and implemented in accordance with Vietnamese laws. (c) Monitoring would be included in the business plan in order to ensure its implementation. (d) These issues will be discussed with the relevant authorities before initiation of the Project.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation).	(a)N/A	(a) No large-scale deforestation would be conducted.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a)N/A	(a) The Project is not likely to cause transboundary or global issues.

6 Key Laws and Regulations in relation to PPP Projects

6.1 Investment Laws and Regulations

The basic law on investment in Vietnam currently in vigor is Law No. 59/2005/QH11 on Investment (hereafter called as 'Law on Investment'), which was officially adopted by the People's Committee of Viet Nam and in force on July 1st, 2007. It provides the integrated legal framework that foreign and domestic investors are required to comply.

The key provisions in this law related to implementation of PPP projects are summarized below.

6.1.1 Investment Guarantees (Article 6~12)

a. Guarantees relating to capitals and assets of investors

The law provides the following guarantees by the Government of Viet Nam on capitals and assets of the investors:

- Lawful assets and invested capital of investors shall not be nationalized or confiscated by administrative measures.
- In a case of real necessity for the purpose of national defense and security and in the national interest, if the State acquires compulsorily or requisitions an asset of an investor, such investor shall be compensated or paid damages at the market prices at the time of announcement of such compulsory acquisition or requisition. Any compensation or damages payable to foreign investors shall be made in a freely convertible currency and shall be permitted to be remitted abroad.

b. Exclusion of any forced requirement upon foreign investors based on open market principle

In accordance with the provisions of international treaties, the Government of Viet Nam will not compel investors to undertake the following requirements:

- To give priority to the purchase or use of domestic goods or services; or to purchase compulsorily goods from a specific domestic manufacturer or services from a specific domestic service provider;
- To export goods or services at a fixed percentage; to restrict the quantity, value or type of goods or services which may be exported or of goods which may be manufactured domestically or services which may be provided domestically;
- To import goods at the same quantity and value as goods exported, or to self-balance compulsorily foreign currency from sources obtained from exported goods in order to satisfy their import requirements;
- To achieve certain localization ratios during manufacture of goods;
- To achieve a stipulated level or value in their research and development activities in Vietnam;
- To supply goods or provide services in a particular location whether in Vietnam or abroad;
- To establish its head office in a particular location.

c. Remittance of capital and assets abroad

After a foreign investor has discharged fully its financial obligations to the State of Vietnam, it shall

be permitted to remit abroad the following:

- Its profits derived from business activities;
- Payments received from the provision of technology and services and from intellectual property;
- The principal of and any interest on foreign loans;
- Invested capital and proceeds from the liquidation of investments;
- Other sums of money and assets lawfully owned by the investor.
- A foreigner working in Vietnam for an investment project shall be permitted to remit abroad his or her lawful income after having discharged fully his or her financial obligations to the State of Vietnam.

d. Investment guarantees in the event of changes in law or policies

If a newly promulgated law or policy contains higher benefits and incentives than those to which the investor was previously entitled, then the investor shall be entitled to the benefits and incentives in accordance with the new law as from the date the new law or policy takes effect.

If a newly promulgated law or policy adversely affects the lawful benefits enjoyed by an investor prior to the date of effectiveness of such law or policy, the investor shall be guaranteed to enjoy incentives the same as the investment certificate or there shall be resolution by one, a number or all of the following methods:

- Continuation of enjoyment of benefits and incentives;
- There shall be a deduction of the loss from taxable income;
- There shall be a change of the operational objective of the project;
- Consideration shall be given to paying compensation in necessary circumstances.

e. Dispute resolution

Any dispute to which one disputing party is a foreign investor or an enterprise with foreign owned capital, or any dispute as between foreign investors shall be resolved by one of the following tribunals and organizations:

- A Vietnamese court;
- A Vietnamese arbitration body;
- A foreign arbitration body;
- An international arbitration body;
- An arbitration tribunal established in accordance with the agreement of the disputing parties.

Any dispute between a foreign investor and State administrative body of Vietnam relating to investment activities in the territory of Vietnam shall be resolved by a Vietnamese court or arbitration body, unless otherwise provided in a contract signed between a representative of a competent State body of Vietnam with the foreign investor or in an international treaty of which the Socialist Republic of Vietnam is a member.

6.1.2 Rights and Obligations of Investors (Article 13~20)

a. Rights of Investors

Investors shall have the following rights:

- To select the sector in which to make an investment, the form of investment, the method of raising capital, the geographical location and scale of the investment; an investment partner and the duration of operation of the project;
- To register business in one or more industries and trades, to establish enterprises in accordance with law and to make its own decisions concerning its registered investment - business activities;
- Right to access and use investment resources
- Right to import and export, to conduct marketing and advertise, to process and re-process goods relevant to investment activities
- Right to purchase foreign currencies
- Right to assign or adjust capital or investment project
- Mortgage of land use rights and of assets attached to land
- Other rights of investors
    - To receive investment incentives in accordance with provisions of this Law and other provisions of the relevant laws.
    - To have access to and use public services on the principle of non-discrimination.
    - To have access to legal instruments and policies relating to investment; to data on the national economy, to data about each economic sector and to other relevant information about investment activities; and to contribute its opinions on laws and policies relating to investment.
    - To lodge complaints, to make denunciations or to institute legal proceedings relating to breaches of the law by organizations and individuals in accordance with law.
    - To exercise other rights in accordance with law.

b. Obligations of investors

Investors shall have the following obligations:

- To comply with the provisions of the laws on investment procedures; to carry out investment activities correctly in accordance with the registered investment contents [and/or] the provisions of the investment certificate. The investor shall be responsible for the accuracy and truthfulness of the contents of investment registration and of the investment project file and the lawfulness of documents on certification.
- To discharge fully financial obligations in accordance with law.
- To carry out the provisions of the laws on accounting, auditing and statistics.
- To perform obligations in accordance with the law on insurance, on labour; to respect the honour and dignity of employees and the customs of Vietnam.
- To respect and create favourable conditions for employees to establish or participate in political organizations and socio-political organizations.
- To implement the provisions of the law on protection of the environment.
- To perform other obligations in accordance with law.

6.1.3 Forms of Investment

a. Forms of direct investment

Investors shall be permitted to carry out the following forms of direct investment:

- To establish economic organizations in the form of one hundred (100) per cent capital of domestic investors or (100) per cent capital of foreign investors.
- To establish joint venture economic organizations between domestic and foreign investors.
- To invest in the contractual forms of: BCC; BO; BTO; and BT.
- To invest in business development.
- To purchase shares or to contribute capital in order to participate in management of investment activities.
- To invest in the carrying out of a merger and acquisition of an enterprise.
- To carry out other forms of direct investment.

b. Provision regarding the investment in infrastructure

Investors shall be permitted to sign a BOT, BTO and BT contract with the competent State body in order to implement projects for new construction, expansion, modernization and operation of infrastructure projects in the sectors of traffic, electricity production and business, water supply or drainage, waste treatment and other sectors as stipulated by the Prime Minister of the Government.

6.1.4 Investment Sectors and Geographical Areas (Article 27~31)

a. Incentive investment sectors

The incentive investment sectors in accordance with this law include:

- Manufacture of new materials and production of new energy; manufacture of high-tech products; bio-technologies; information technology; mechanical manufacturing.
- Breeding, rearing, growing and processing agricultural, forestry and aquaculture products; production of salt; creation of new plant and animal variety.
- Use of high technology and advanced techniques; protection of the ecological environment; research, development and creation of high-technology.
- Labour intensive industries.
- Construction and development of infrastructure facilities and important industrial projects with a large scale.
- Professional development of education, training, health, sports, physical education and Vietnamese culture.
- Development of traditional crafts and industries.
- Other manufacturing and service sectors which require encouragement

More details of incentive investment sectors are stipulated in the enforcement regulation of this Law (108/2006/ND-CP). It is necessary to confirm with the relevant authority (MPI or DPI) about whether the proposed project is included in the incentive investment sectors above.

b. Geographical areas of investment incentives

Investment shall be encouraged in the following areas:

- Areas with difficult socio-economic conditions; areas with especially difficult socio-economic conditions.
- Industrial zones, export processing zones, high-tech zones and economic zones.

c. Sectors in which investment is conditional or prohibited

The Law provides sectors in which investment is conditional or prohibited (refer to the enforcement regulation 108/2006/ND-CP for further details).

6.1.5 Investment Incentives (Article 32~39)

Investors with investment projects in the investment incentive sectors and geographical areas shall be entitled to the incentives as mentioned below.

a. Tax Incentives

The tax incentives to be provided in accordance with this Law are as follows:

- Preferential tax rates, the duration of entitlement to such rates and the duration of exemption from and reduction of tax in accordance with the law on tax.
- Tax incentives on that portion of income which is distributed to them from an activity being capital contribution or purchase of shareholding in an economic organization in accordance with the law on tax after such organization has paid in full corporate income tax.
- Exemption from payment of import duty on equipment, materials, means of transportation and other goods for implementation of investment projects in Vietnam in accordance with the Law on Export and Import Duties.
- Income from activities of technology transfer applicable to projects entitled to investment incentives shall be exempt from income tax in accordance with the law on tax.

b. Carrying-over of retained losses

If an investor suffers losses after completion of tax finalization with the tax office, it shall be permitted to carry its losses forward to the following year, and the amount of such losses shall be set off against taxable income for the purposes of corporate income tax in accordance with the Law on Corporate Income Tax. The period for carrying forward losses shall not exceed five years.

c. Depreciation of fixed assets

Investment projects in investment incentive sectors and geographical areas and business projects with high economic efficiency shall be subject to accelerated depreciation of fixed assets; the maximum rate of depreciation shall not be more than twice the level of depreciation as stipulated by regulations on depreciation of fixed assets.

d. Land use incentives

Investors which invest in investment incentive sectors and geographical areas shall be entitled to an exemption from payment of or a reduction of land rent and land use fees in accordance with the law on land and the law on tax (The term of land use of an investment project shall not exceed fifty (50) years. In some special cases, it can be extended to 70 years.)

6.1.6 Investment Support (Article 40~ 44)

The Law also stipulates some investment support measures as mentioned below:

- Support for technology transfer (Protection of intellectual property right, etc.)
- Training support (Inclusion of the training cost into expenses for calculation of taxable income subject to corporate income tax.)
- Entry and exit visas (Issuance of multi-entry visa to the foreign expatriates, workers and their families with the maximum term of 5 years.)

6.1.7 Investment Procedures (Article 45~54)

a. Procedure for evaluation of foreign investment projects

Since the proposed project in this study plans to make its total investment of more than 300 billion VND (Approximately 15 million US dollars or 1.5 billion JPY), the following sets of application document are required to be prepared for evaluation of the project by the relevant authorities.

(a) Written request for issuance of investment certificate on the stipulated form
(b) Written certification of the legal status of the investor: an investor being an organization shall submit a copy of the establishment decision or business registration certificate or other equivalent document; and an investor being an individual shall submit a copy of his or her passport or identity card
(c) Report on financial capability of the investor (which the investor shall prepare and for which the investor shall be liable)
(d) Economic-technical explanatory statement, comprising the following main items: objectives, scale, location of investment, invested capital, schedule for implementation of the project, land use requirements, and technological and environmental solutions
(e) Business co-operation contract in the case of the investment form of business cooperation contract
(f) File for business registration corresponding to each form of economic organization as stipulated in the law on enterprises and relevant laws
(g) Joint venture contract in the case of establishment of a joint venture economic organization between a domestic investor and a foreign investor

The above sets of application document are to be submitted to the Department of Planning and Investment (DPI) of the relevant local authority except for the case the project is to be implemented in the designated industrial estates, export processing zones (EPZs), hi-tech parks, or special economic zones, in which those are to be submitted to the management authorities of the above areas and zones instead.

6.2 Taxation System

6.2.1 Corporate Income Tax

Corporate income tax in Viet Nam is imposed in accordance with the Law on Corporate Income Tax (Law No.14/2008/QH12 on Corporate Income Tax) with its amendment by Law 32 dated 19 June

2013. The amendment has been enforced since the 1st of January 2014.

a. Tax assessment period (Article 5)

The tax assessment period for corporate income tax shall be calculated in accordance with the western calendar year or the financial year

b. Deductible and non-deductible expenses (Article 9)

An enterprise is permitted to deduct all expenses when determining taxable income, except for those stipulated in this Law, if they satisfy both the following conditions:

The expenses actually arising and relating to the activities of production [and/or] business of the enterprise; or the expense was incurred when carrying out a task of national defense and security by the enterprise in accordance with law;

The expenses are supported by complete invoices and source vouchers as stipulated by law. Invoices for the purchase of goods and services on each occasion valued at twenty million VND or more must also have a payment voucher proving payment not using cash, except where the law does not specify mandatory non-cash payment.

The following items are non-deductible expenses when determining taxable income:

a) Expenses which fail to satisfy the conditions of deductible expenses mentioned above, except for that part of the value of a loss due to a natural disaster, epidemic or other event of force majeure for which compensation is not payable;
b) Fines for administrative offences;
c) Expenses covered by other funding sources;
d) That part of business management expenses allocated by a foreign enterprise to its resident establishment in Vietnam which exceeds the level calculated by the allocation method stipulated by the law of Vietnam;
e) That part of expenses which exceeds the level stipulated by law for establishment of contingency reserves;
f) That part of interest payments on loans for production [and/or] business to an entity which is neither a credit institution nor an economic institution which exceeds one hundred and fifty (150) per cent of the basic interest rate published by the State Bank of Vietnam at the time of the loan;
g) Depreciation of fixed assets which is incorrect in terms of the law;
h) Amounts advanced for expenses which are incorrect in terms of the law;
i) Salaries and wages of owners of private enterprises; remuneration paid to founding members of an enterprise who are not directly involved in executive management of production [and/or] business; and salaries and wages and items otherwise accounted for in order to be paid to employees but not actually expended or without invoices and source vouchers required by law;
j) That part of interest payments on loans corresponding to the unpaid portion of charter capital;
k) That part of input value added tax which has been credited, value added tax paid in accordance with the tax credit method, and corporate income tax.
l) That part of expenses for advertising, marketing, promotion and broker's commissions; of

expenses for receptions, formal occasions and conferences; of expenses for assisting marketing, of expenses for assisting costs directly related to production [and/or] business which exceeds fifteen (15) per cent of the total amount of deductible expenses. Total amount of deductible expenses does not include the expenses stipulated in this paragraph; and in the case of commercial business activities, total amount of deductible expenses does not include the purchase price of goods sold;

m) Items of financial aid [subsidies] except financial aid for education, health care, scientific research, to overcome the consequences of a natural disaster, to build various types of charitable homes or homes for policy subjects as stipulated by law and except financial aid in accordance with State programs for localities in areas with specially difficult socio-economic conditions;

n) That part of expenses being payments to a voluntary retirement fund or a fund in the nature of a social welfare fund, or to purchase voluntary retirement insurance for employees which exceed the level stipulated by law;

o) Expenses for business activities being banking, insurance, lotteries, securities and a number of other special business activities as stipulated in regulations of the Ministry of Finance.

c. Tax rates (Article 10)

The corporate income tax rate shall be twenty two (22) per cent, except for the enterprise of which the total annual turnover not exceeding twenty (20) billion VND and except for entities entitled to tax incentives by this law. The entities entitled to the tax rate of 22% above shall be entitled to the tax rate of twenty (20) per cent as from 1 January 2016.

The enterprises with total annual turnover not exceeding twenty shall be entitled to the tax rate of twenty (20) per cent.

d. Corporate income tax incentives (Article 13~18)

d.1. Preferential tax rate application

According to this law, the proposed project (waste-to-energy) can be entitled to receive corporate income tax of 10% for 15 years ((b) of 1st clause under Article 13). The duration of this preferential tax rates may be additionally extended for large scale and high-tech projects which particularly need to attract investment, but the duration of additional extension shall not exceed 15 years.

d.2. Tax exemption and reduction incentives

In addition to the tax reduction mentioned above, the proposed project may be entitled to receive tax exemption for a maximum period of 4 years and 50% reduction of the amount of corporate income tax payable for a maximum period of 9 subsequent years.

d.3. Carrying forward losses

Enterprises which suffer a loss are entitled to carry forward the loss to the following year and such loss is deductible from assessable income. Losses may be carried forward for a maximum period of 5 years as from the year following the year in which the loss arose.

6.2.2 Customs Duties

The custom duties in Viet Nam is applied in accordance with the Law on import and export duties (law 29/2001/QH10) as the basic law with several amendments made in the following years and relevant guidelines provided in the form of government decrees and ministerial decisions.

a. Types of custom duties

Regarding the import duties relevant to implementation of the proposed project, there are 4 (four) types of rates applied in Viet Nam as mentioned below.

a.1. Standard rate

The standard rate is applied to the import goods not subject to preferential and special preferential rates. The standard rates are set at higher by 50% against preferential rate.

a.2. Preferential rate

The preferential rate is applied to the imports of goods from the countries that the Government of Viet Nam has reciprocal tariff agreements.

a.3. Special preferential rate

The special preferential rate is applied to the imports of goods from the countries that the Government of Viet Nam has agreements on special import duties as a part of bilateral or multilateral free trade agreement or the likes.

a.4. Other rates (import duties)

In accordance with the domestic custom law, special import duties are levied on electronic components and their accessories, automobiles and their components, and so forth.

b. Imposition of import duties

Import duty is imposed on "ad valorem" basis in accordance with CIF price for imported goods and FOB price for exported goods. Its payment should be made in Viet Nam currency (Dong) in principle although the payment by foreign currency is also allowed based on the interbank exchange rate at the date of calculating the import duties (Decree 87/2010/ND-CP).

c. Rates applied to the imports from Japan

The rates applied to the imports of goods from Japan is provided in the Decision of the Ministry of Commerce and Industry on the date of 22, May 1999 (Decision 0616/1999/QD-BTM). On the other hand, the Japan Viet Nam Economic Partnership Agreement (JVEPA), in effect in October 2009, provides that 88% of the import goods from Japan shall be duty free in 10 years.

d. Preferential treatment tariff

In accordance with the ASEAN Trade in Goods Agreement (ATIGA), the import duties of all the manufactured products and processed or non-processed food from ASEAN countries has already been reduced to the range between 0 and 5%. In addition, the ASEAN-Japan Comprehensive Economic Partnership Agreement (AJCEP), in effect in December 2008, provides that the time schedule for custom duty reduction and removal shall be determined by each agreed countries including Viet Nam in consideration of its economic growth.

6.2.3 Other Taxes

a. Value added tax (VAT)

Value added tax, which is an indirect tax imposed on the retail prices of goods and services, is applied to the imports of goods and services as well. VAT is levied on the sum of the prices of imported goods and their import duties and extra tax. Its rates are set at 5%, 10% or tax free.

6.2.4 Exemption of Custom Duties

Based on the Law on Investment (Law No. 59/2005/QH11 on Investment), the investment in the designated priority sectors and/or areas is exempt from paying import duties for the imports of fixed assets or relevant components.

6.3 Laws and Regulations on Land Transaction

Land transaction in Viet Nam is provided by the Law on Land (Law No.13/2003/QH11) and its implementing rules and regulations in the form of decrees and decisions. Land ownership by any organization, enterprise, or individual is forbidden by law. Instead, it is possible for any organization including foreign companies to acquire the right of land use in accordance with the procedures mentioned below.

a. Lease or sub-lease of the land use right

Any legal entities established in Viet Nam can lease or sub-lease the land from the government or any other entities allowed to use the land. In the case of sub-lease of land, the owner of land use right must have leased that land before enactment of this law and paid all or majority of the leasing fee with more than 5 years of remaining paid leasing period.

The leasing period of land use right is to be determined in accordance with the period of investment and not more than 50 years except for special cases provided by this law.

b. Equity participation by local partners through investment in-kind investment of land use right

Foreign investors can acquire land use right through joint venture with Vietnamese local partners who make in-kind investment of land use right to the JV company.

In this case, the land use right to be invested in kind to the above JV company must follow the same conditions for land sub-leasing. Foreign company has to be careful about the confirmation of the status of land use right if it allows in-kind investment of land use right by the Vietnamese local partners.

6.4 Public Infrastructure Development under the Law on Public Private Partnership (PPP)

6.4.1 Public Infrastructure Development under BOT Law

Promotion of private investment in public infrastructure in Viet Nam was initiated with the public announcement of the BOT Law (Decree No. 108/2009/ND-CP: Decree on Investment in the form of

Build-Operate-Transfer, Build-Transfer-Operate or Build-Transfer Contract). BOT Law provides the scope, conditions, rules, procedures, incentives and rights and responsibilities of the relevant stakeholders in private sector investment projects on public infrastructure under BOT, BTO, or BT contracts.

The Law on PPP is formulated to complement BOT Law while it is still in effect upon the above types of investment. The key contents of BOT law is mentioned below.

a. Competent authorities to sign and perform project contracts by the Law (Article 3)

The state agencies competent to sign and perform project contracts by this law include ministries, ministerial-level agencies, government-attached agencies and People's Committees of provinces or centrally run cities. In some cases, the above agencies can authorize their attached their organizations to sign and perform the project contracts.

b. Investment domains (Article 4)

The Government encourages the implementation of projects to build, operate and manage new infrastructure facilities or to improve, expand, modernize, operate and manage existing works under this law in the following domains:

- Roads, road bridges, road tunnels and ferry landings;
- Railways, railway bridges and railway tunnels;
- Airports, seaports and river ports;
- Clean water supply systems; water drainage systems; and wastewater and waste collection and treatment systems;
- Power plants and power transmission lines;
- Other infrastructure facilities as decided by the Prime Minister.

c. Provisions regarding investment capitals (Article 5 and 6)

Investors or project enterprises can raise by themselves capital sources for project implementation as agreed in project contracts, but the minimum equity ratio is provided in accordance with the scale of investment as follows:

- For a project capitalized at up to VND 1.5 trillion, the project enterprise's equity must not be lower than 15% of the project's total investment capital.
- For a project capitalized at over VND 1.5 trillion, the project enterprise's equity shall be determined on the partially progressive principle below:
  - For the investment capital portion of up to VND 1.5 trillion, the project enterprise's equity must not be lower than 15% of this capital portion;
  - For the investment capital portion of over VND 1.5 trillion, the project enterprise's equity must not be lower than 10% of this capital portion.

Further, the total state capital for implementation of a project must not exceed 49% of the total investment capital of that project.

d. Preparation and annoucement of lists of projects (Article 9 and 10)

In January every year, ministries, branches and provincial-level People's Committees shall publish lists of projects subject to BOT Law on their websites and the Bidding Newspaper in 3 consecutive

issues. After the designated period of public announcement, the competent state agency shall publish the list of investors that have registered in writing to implement projects on the Bidding Newspaper and the websites of ministries, branches and localities.

e. Projects proposed by investors (Article 11 and 12)

Investors may request implementation of projects outside the announced list of projects and shall make and send project proposals to ministries, branches and provincial-level People's Committees for approval.

In case the project proposals are approved, ministries, branches and provincial-level People's Committees shall decide to add the projects to the lists of projects and publish the principal details of these projects on their websites and the Bidding Newspaper in 3 consecutive issues. Within 30 working days from the date of the last publication, if no other investors register to implement the projects, ministries, branches and provincial-level People's Committees shall decide to designate investors with the approved project proposals to negotiate project contracts. If other investors register to implement projects, ministries, branches and provincial-level People's Committees shall organize bidding for selecting investors.

f. Selection of investors for negotiating project contracts (Article 13~23)

For a project on the announced list of projects with 2 or more investors registering to implement, the competent state agency shall organize domestic or international open bidding for selecting investors. In case only one investor registers to implement the project, the competent agency shall enter into negotiation for project contract with that investor.

6.4.2 Background of the Law on PPP

The Government of Viet Nam has been promoting foreign and domestic private sector investment in the development of public infrastructure since the enactment of BOT Law in 2010. Although there are some significant achievement in development power plants with private sector investment, its impact was still limited to a certain sector.

According to the announcement by the Ministry of Planning and Investment Viet Nam in 2013, the total financial sources required for overall infrastructure development in the nation was estimated as 170 billion US dollars (17 to 18 trillion JPY). As the amount of fund that can be raised from the government budget, bonds, and ODA remains at its 50%, Utilization of private sector fund, especially foreign investment is recognized as indispensable for development of socio-economic infrastructure in Viet Nam.

In this context, the Law on PPP was enacted in September 2010 and enforced in January 2011 with the purpose of further acceleration of private sector investment in development of public infrastructure.

6.4.3 Outline of the Law on PPP

The law on PPP, which is officially called as “Regulations on pilot investment under the form of public and private partnerships”, provides the rules and regulations on pilot projects in relation to

development of public infrastructure and improvement of public services under PPP. In June 2013, the Government of Viet Nam submitted "Draft Regulations on Public Private Partnership Investment Form", to be enacted as the official business law on PPP.

The key elements amended or added in the new draft regulations are summarized in the table below.

Table 6-1: Amendments in the new draft regulations

Item	Current PPP Regulations	New Regulations (draft)
Maximum equity participation ratio by the Government of Viet Nam (including debt burden)	30% of the total investment cost	49% of the total investment cost
Minimum equity participation ratio by the private companies	30% of the total investment cost	To be determined based on the profitability of the project.
Project guarantee money (deposit) by the private companies	2% of the total investment cost up until 1 trillion VND. For the total investment cost exceeding 1trillion VND, 1% is applied.	1.5% of the total investment cost up until 1 trillion VND. For the total investment cost exceeding 1trillion VND, 1% is applied.

Table 6-2: Additions in the new draft regulations

Item	Content
Project income guarantee by the government of Viet Nam	The Government of Viet Nam shall provide minimum income guarantee to the project.
Application of foreign laws to the project contract	If foreign private company is included in the project partners, the project contract is allowed to be made in accordance with foreign laws.
Dispute settlement	In addition to negotiation between contracted parties and mediation by the third party, arbitration by foreign authorities (e.g. arbitration court) is also included as a method of dispute settlement.
Project domain	Expanded to include energy conversion, power generation, environmental projects, pipeline development, water supply, drainage, public housing, information technology, telecommunication, agricultural infrastructure, and so forth.
Financing feasibility study	The cost of feasibility study is covered by the Government of Viet Nam. The cost may be reimbursed to the Government at the time of preparing bidding document.
Detail of project contract	The detail of project contract is disclosed (the mortgages that can be required by lenders.
Risk of nationalization	The Government must pay compensation (indemnity for damages) to the investors if their assets are nationalized.

6.4.4 Government Contribution to PPP Projects

The Government contributions to PPP projects consist of the State Capital Contribution and Non-capital Contributions. The state capital contribution includes allocation of national budget and ODA,

issuance of government bond, and government loan guarantee while the non-capital contributions are comprised of government guarantee on off-take agreement on provision of public services, non-capital supports for project preparations, minimum project income guarantee, securing the land for project implementation.

The Government of Viet Nam is currently proposing to establish a new fund of approximately 20 trillion VND (1 billion US dollar) for the purpose of providing the above assistances to the PPP Project although it does not clarify the amount of fund to be allocated from the national budget.

On the other hand, the Government of Viet Nam also announces financial support to implementation of feasibility studies on PPP projects with the 20 million US dollar loan from the Asian Development Bank and a grant assistance of 600 thousand EURO from French Government.

6.4.5 Procedure for PPP Project Implementation

The procedure for PPP Project implementation starting with the proposal submission by private investors are illustrated in the figure below.

Figure 6-1: Procedure for PPP Project Implementation

7 Business Plan

7.1 Selection of the Project

Taking into consideration the remaining landfill capacity of the current Khanh Son disposal site and the vision of Da Nang city to become an environmental city, the best options are large-scale waste incineration and power generation facilities under Option 2 (treatment capacity of 1,000 ton/day) and Option 2-1 (1,500 ton/day). However, in order to lower the tipping fee to 30 USD/ton as requested by Da Nang city, MRF and waste incineration and power generation facility (treatment capacity of 300 ton/day) should be introduced. Under the assumption that negotiations among Da Nang city, plant operator, and investors would continue, the current project outline for each option are shown in Table 7-2.

With regard to Option 2-1, as the loan conditions and construction costs in the future cannot be easily calculated at the moment, this option is omitted in this table.

Table 7-1: Comparison of Options

	Option 2	Option 3
Treatment process	Waste incineration and power generation	MRF + Waste incineration and power generation
Treatment capacity	Waste incineration and power generation facility: 1,000 ton/day	MRF: 1,000 ton/day Waste incineration and power generation facility: 300 ton/day
Average Daily treatment amount (Daily treatment amount × annual working days/365 days)	850 ton/day	850 ton/day
Waste reduction rate by introduction of intermediate treatment facility	Approximately 90%	Approximately 70% (If the focus is only on incineration facility, approximately 90%)
Total cost for introduction of the intermediate treatment center (CAPEX and cost for 20 years between 2019 and 2038)	21.8 billion JPY (excluding income of 19 billion JPY from power sales)	12.2 billion JPY (excluding income of 6.6 billion JPY from power sales)
Tipping fee (JPY/ton)	5,350 JPY/ton	2,500 JPY/ton
Remaining lifetime of Khanh Son disposal site	18 years	14 years

7.2 Project Outline

The proposed project is intermediate treatment of solid wastes and power generation under public-private partnership in Da Nang city. The details are as shown in the table below.

Table 7-2: Project Outline

Item	Contents
Implementing organization	Consortium between Japanese private consortium and Vietnamese partner (details are explained in the following sections)
Service to be provided	- Treatment of solid wastes ▪ The project will incinerate and reduce volume of wastes generated in Da Nang City ▪ Target wastes are municipal solid wastes, non-hazardous industrial wastes, and waste water sludge that does not include hazardous substances emitted from households and businesses. - Electric power generation (waste-to-energy) ▪ The project will generate electric power through incineration of wastes and supply the generated power through public electric network.
Project site	Khanh Son waste final disposal site in Da Nang City
Project period	20 years
Capacity of facilities	(1) Waste incineration and power generation facility (1,000 ton/day) Incinerator - Treatment capacity: 1,000 ton/day - Number of operation days : 310 days/year - Waste reduction rate (by weight): Approximately 90% Power generator - Power generation capacity (per unit): 16MW - Annual power sales (per unit): 94,860 MWh/year (2) MRF + Waste incineration and power generation facility (300 ton/day) MRF - Treatment capacity: 1,000 ton/day - Number of operation days : 310 days/year Incinerator - Treatment capacity: 300 ton/day - Number of operation days : 310 days/year - Waste reduction rate (by weight): Approximately 70% Power generator - Power generation capacity (per unit): 6.4MW
Total project cost	(1) Waste incineration and power generation facility (1,000 ton/day) - Approximately 21.8 billion JPY - Initial investment: approximately 11 billion JPY - Operation and maintenance for 20 years: 10.8 billion JPY (approximately 0.54 billion JPY/year) (2) MRF + Waste incineration and power generation facility (300 ton/day) - Approximately 12.2 billion JPY - Initial investment: approximately 6.3 billion JPY - Operation and maintenance for 20 years: 5.9 billion JPY (approximately 0.3 billion JPY/year)
Financing method	(1) Waste incineration and power generation facility (1,000 ton/day) - Capital: 3 billion JPY - Joint Crediting Mechanism (JCM) Subsidy from Ministry of the Environment, Japan: 2.5 billion JPY - JICA Private Sector Investment Finance: 5.5 billion JPY (2) MRF + Waste incineration and power generation facility (300 ton/day) - Capital: 1.5 billion JPY (25% of initial investment) - Joint Crediting Mechanism (JCM) Subsidy from Ministry of the Environment, Japan: 2.5 billion JPY - JICA Private Sector Investment Finance: 3 billion JPY(including interest during construction period)
Expected revenue source	1. Solid waste treatment fee (expected be 30 USD/ton average although it would depend on the external financing option) 2. Electric power sales revenue (expected to be near 10 JPY/kWh)

Table 7-3 Project Schedule

	Project Preparation Period				Year 1				Year 2				Year 3				Year 4			
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Negotiation regarding governmental offtake agreement and SPC-related contract																				
Preparation to apply for JICA Private Sector Investment Finance and JCM Grant																				
Creation of SPC for PPP Project																				
Bidding for PPP Project																				
Preparation regarding finance																				
Investment approval, power purchase agreement, operation contract																				
Signing of contract with Da Nang City																				
Bidding for plant construction																				
Construction of plant																				
Project implementation (20years)																				

7.3 Implementing organization

This Project will be implemented by a Special Purpose Company (SPC) which would be composed of the Japanese private consortium which would be composed of JFE Engineering Corporation and Sumitomo Corporation and Vietnamese local partner (candidate partner is Da Nang URENCO) when the following conditions are met.

Table 7-4: Conditions for Implementation of the Project (Vietnamese Side)

Item	Condition
Payment guarantee from the Vietnamese central government	Payment of the tipping fee and electric power sales is guaranteed by the Vietnamese central government.
Guarantee of waste amount	Waste amount to be received by the facility and the compensation for the lost revenue (i.e. tipping fee and electric power sales) if the waste amount does not reach the agreed amount are guaranteed.
Guarantee of waste quality	Compensation for the lost revenue if the plant is forced to stop or its efficiency is lowered due to reception of unacceptable waste (i.e. incombustible wastes, bulky wastes, hazardous items, etc) are guaranteed.
Guarantee of minimum calorie of wastes	Compensation for the lost revenue if the monthly average waste calorie measured at the incineration plant is lower than the agreed minimum calorie is guaranteed.
Application of feed in tariff	Decision on "SUPPORTING MECHANISM FOR DEVELOPMENT OF POWER GENERATION PROJECTS USING SOLID WASTE IN VIETNAM" issued on 5 May 2014 is applied.
Signing of contract	Concession agreement regarding waste incineration and power purchase agreement (PPA) for the project period are signed.
Land use of the project site	Land use of the project site and use of basic infrastructure (water supply, sewage, gas, road, etc) are secured.
Long-term lease contract of the project site	Land Lease Agreement with the legitimate land owner throughout the project period is signed.
Tipping fee based on capacity to pay	Tipping fee is Capacity Payment based on "Bring or Pay".
Power transmission network	"Right-of-Way" to the power transformer station and sufficient power transmission capacity are secured.
Payment for power sales based on Available Capacity Payment	Available Capacity Payment would be payable by EVN or other relevant authorities for as long as the power generation facility is available as declared.

Table 7-5: Conditions for Implementation of the Project (Loan Conditions)

Item	Condition
Long-term project finance	Tenure: More than 18 years Door-to-Door (More than 16 years after COD) Combination of Japanese Yen or US dollar with denominated local currency Fixed interest rate Non-recourse base

The percentage of investment by each party is to be discussed, but the capital needed by the SPC for starting the operations is expected to be 25% of the initial investment. The contribution from the

Vietnamese partner should basically be monetary contribution.

7.4 Project Implementing Method (Implementation Scheme)

The implementation scheme of this project is shown in the figure below. However, it should be noted that the expected SPC members would be as follows.

(1) Waste incineration and power generation facility (1,000 ton/day):
JFE Engineering, Sumitomo Corporation, Vietnamese partner

(2) MRF + Waste incineration and power generation facility (300 ton/day):
JFE Engineering, other Japanese corporation, Vietnamese partner

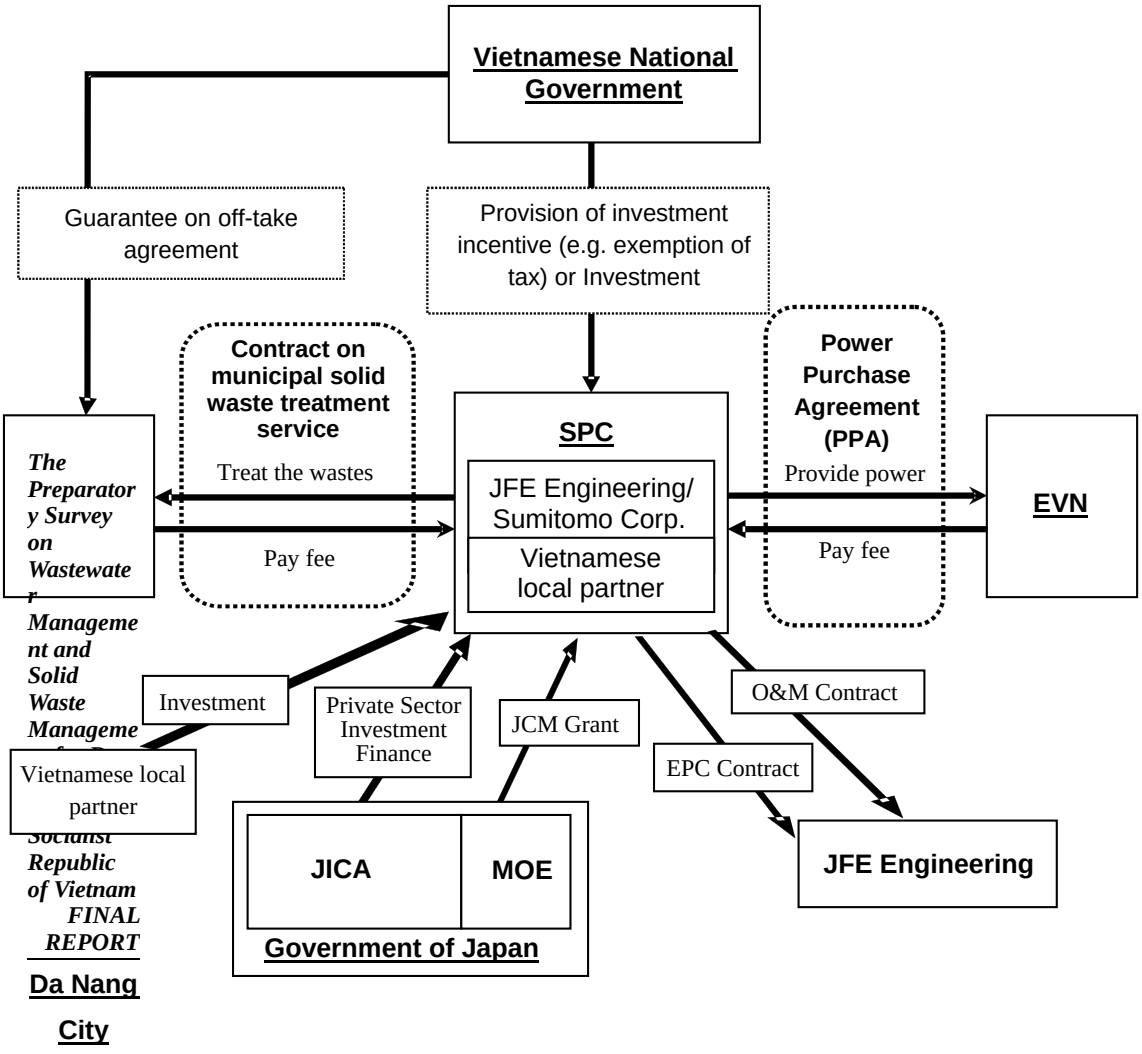


Figure 7-1: Project Implementation Scheme

In order to assure financial feasibility and sustainability of this project, the actors involved must sign numerous contracts in order to clarify details on the revenue and expenditure, financing method, and responsibilities of each actor. The required contracts include those listed below.

a. Joint venture agreement on establishment of SPC

In establishing the SPC which will be the implementing organization of this project, the Japanese and Vietnamese partners must sign a memorandum of understanding that would include information relevant to the issues below.

- Mission of the SPC and the roles and responsibilities of participating organizations
- Organization structure of the SPC
- Capital, financing, and distribution of revenue
- Standing rules of the company
- Operation of business (including rules regarding EPC by SPC, operation and maintenance contract)
- Arbitration
- Any other issues that need agreement among participating entities

b. Contract between Da Nang City and SPC regarding "municipal solid waste treatment service"

The most important contract in relation to project revenue is this contract regarding municipal solid waste treatment service between Da Nang City and SPC. This contract should clarify the following issues so that project revenue would be secured.

- Basic information (e.g. contracting party, period of contract)
- Amount and quality of the wastes to be received by SPC (e.g. guarantee of minimum waste amount, quality standards, method of evaluation, measures to be taken when standards are not met)
- Tipping fee (method of tipping fee calculation, agreement on tipping fee)
- Tipping fee payment method (currency of payment, mode of payment, time of payment)
- Standard of service to be provided by SPC (treatment method, treatment capacity, treatment standards, handling of treatment residues)
- Role and responsibilities of Da Nang City and SPC
- Measures to be taken when contract is breached or not fulfilled
- Accounting method (during or after the contract period)
- Conflict resolution

c. Contract between EVN and SPC on "power purchase agreement (PPA)"

Another important contract for securing project revenue is this power purchase agreement (PPA) between SPC and EVN. This contract must clarify the following issues so that the project revenue would be guaranteed.

- Basic information (e.g. contracting party, period of contract)
- Conditions regarding networking the power generating facility of SPC and the grid electricity (e.g. conditions on power supply, role, responsibilities and cost-sharing regarding constructing and operating grid electricity facilities)
- Selling price of electric power (Unit price and calculation method of payment amount)
- Payment method of electric power sales (currency of payment, payment method, time of payment)
- Role and responsibilities of EVN and SPC

- Measures to be taken when contract is breached or not fulfilled
- Accounting method (during or after the contract period)
- Conflict resolution

d. Contract with Ministry of the Environment, Japan regarding JCM subsidy

In order to be granted with the JCM subsidy, the SPC should sign a contract with the MOE Japan as required by the said Ministry. In order to be granted with this subsidy, the SPC must measure, report, and register with the approval of a third-party the amount of GHG reduction that would be realized by this project and handover the reduced GHG to the Japanese Government through MOE Japan. If the contents of this contract become clear and concrete, the profitability and sustainability of this project would be guaranteed, and SPC would be able to start the official procedures to realize this project through the JICA Private Sector Investment Finance scheme.

e. "EPC contract" and "O&M contract between SPC and JFE Engineering

It is planned that EPC and O&M would be contracted from SPC to JFE Engineering. In these contracts, the followings issues should be clarified.

- Contract sum and paying conditions
- Contracting period and constructing period or O&M period
- Technical specifications
- Emission standards to respect (either Vietnamese standards or standards specified by the SPC)
- Scope of work (including scope of construction works, Force Majeure, and scope of insurance
- General conditions (including measures to be taken when there is breach of contract)

Furthermore, JFE Engineering would be subject to "transfer pricing taxation" depending on the stake of JFE Engineering in the SPC. Therefore, from the stage of creating the SPC, consultations should be made in consideration of the transfer pricing taxation.

7.5 Organizational structure of project implementation and operation

The intermediate treatment and power generation by SPC would be implemented under the organizational structure as shown in the table below.

Figure 7-2: Organization structure of project implementation

Position	Main responsibilities	Number of staffs		
		Options 2	Options 3 (8-hour operation)	Option 3 (16-hour operation)
Chief executive officer (CEO)	Responsible for the management of SPC	1	1	1
Chief financial officer (CFO)	Responsible for financial affairs of SPC	1	1	1
Board of directors	Decision-making body composed of representatives of companies participating in SPC (not full-time) and CEO	3 to 4	3 to 4	3 to 4
General manager	Take responsibility in the overall management of the waste incineration and power generation facilities	1	1	1
Deputy manager	Assist the chief manager in his duties	1	1	1
Administration manager	Take responsibility in administration and accounting	1	1	1
Administration officer	Implement administrative works within SPC (e.g. take record of material balance, keep financial records, pay salaries)	3	3	3
Manager of machineries	Take responsibility in maintenance of the facilities and stock of spare parts	1	1	1
Mechanic	Maintain the machineries	6	2	2
Electrical engineer	Maintain the electrical system	2	2	2
Chief operator (one for each shift)	Control the stock of chemicals	4	2	3
Operator (work in shifts)	Control the main operation Patrol within the facility	16	26	52
Truck control officer	Control the trucks that bring in the wastes	4	4	6
Waste control officer	Adjust size and composition of wastes Remove unwanted objects from wastes Remove ash	2	4	6
Cleaning staff	Clean inside the incineration facilities	3	2	3
Total		**50**	**55**	**87**

8 Risks and Security Package

8.1 Risks at the project preparation stage

The risks that could be expected at the stage before the actual construction, maintenance, and operation are expected as follows.

8.1.1 Risks in relation to EIA

In preparation for this project, special attention is paid to the EIA process and two meetings will be organized total to explain to the local residents about the project during this survey. However, as people generally do not wish to have waste treatment facilities are often facilities in their neighborhoods (not-in-my-backyard or NIMBY syndrome), it should be noted that building the consensus of the local residents to implement this project may take much time and money.

However, as the project site would be inside the Khanh Son disposal site, it is expected that the land acquisition issue would not be very difficult.

Concerning EIA, EIA procedures should be finished before the bidding stage. Da Nang City which is the project owner should accurately explain to the public that this project would not create negative environmental impact but rather create economic, social, and environmental benefits to the area through intermediate treatment of wastes and power generation.

8.1.2 Risks in relation land acquisition and business approval

The project site is scheduled to be inside the Khanh Son disposal site which is currently owned by URENCO which is planned to participate in the project consortium. As it is planned that URENCO would provide this land free of charge to the SPC, sufficient consultations should be made in advance with URENCO to avoid risks concerning land acquisition.

In relation to business approval, there is the possibility that unforeseen time and costs may be taken in obtaining approval for investment and construction. As the SPC cannot be created without such an approval, sufficient discussions and negotiations should be made with Da Nang City and URENCO which is the candidate Vietnamese investor to avoid such risks.

Furthermore, it is unlikely that the business approval would be stopped if URENCO becomes one of the investors.

The largest risk at the project preparation stage is the risk in relation to PPP bidding. Currently, under the Vietnamese Law on BOT and Law on PPP, PPP projects that are proposed and approved by Da Nang City or Vietnamese government would become open to biding. Therefore, the proposer of the project must compete with other bidders based on technical specifications and the cost. Under the current laws, the project proposer can go into the contract negotiations without any bidding only if there is no other bidder.

Therefore, it is important to specify high standards or specify in detail the technical specifications

regarding the facility design, treatment quality, operation & maintenance, and capacity of staffs (years of experience and technical expertise in operating & maintenance) so that entities that do not fulfill a certain technical standards would not participate in the bidding.

In addition, this project is expected to be profitable only if it is financed by JCM subsidy and JICA Private Sector Investment Finance. Therefore, it should be clearly explained to the Vietnamese side that an entity from another company would not be able to receive the same financial assistance.

Vietnam is currently reviewing its regulations regarding PPP bidding. For instance, there is the possibility that the proposer of a project would be given incentives to participate in in the bidding process. Therefore, a close watch should be kept on the future developments.

8.1.3 Risks in relation to financing

In relation to financing, there is the risk regarding investment by the SPC members and the risk regarding obtaining finance. Currently, it is expected that the capital of the project would be about 30% of the initial investment. How the Japanese consortium and the Vietnamese side would share the burden must be thoroughly discussed and agreed on before establishing the SPC, and the agreement should be included in the memorandum of understanding regarding establishment of SPC. Under the Vietnamese Law on Investment, there are no regulations regarding the ratio of capital between foreign and domestic companies. Issues such as the financial capacity of the Vietnamese partner should be clarified in the discussions among SPC members. In addition, whether the investment would be made in local currency or foreign currency (USD or JPY) should also be clarified taking into account exchange risk. With regard to JICA Private Sector Investment Finance, in order to avoid exchange risk, loan in VND would be necessary.

8.1.4 Risks in relation to contracting (waste treatment service contract, power purchase agreement)

As explained in the previous sections, signing long-term contracts regarding waste treatment service and power purchase would assure the stability of the project revenue. Unless stable revenue is assured by the central government guarantee, entities with sufficient capabilities may not be able to participate in the bidding or more over there may be no winner in the bid.

Da Nang City would consider about the project based on this report and then ask for the approval of its implementation to the central government. Then, the central government would consider the project in detail. Further, as FIT for power from waste-to-energy facilities has been made public by the Vietnamese government and thus formalities regarding power purchase from the facilities in this Project are expected to be the next steps. However, as there has been no similar case in Vietnam, signing the power purchase agreement may take considerable time which may drastically delay the project, or bidding may be conducted with unfixed conditions.

8.1.5 Risks in relation to competition with the other investors

Currently, there is a small-scale composting and plastic-based oil recovery facilities in operation near Khanh Son Landfill. It partially uses the waste received in Khanh Son Landfill for its treatment and oil production.

Although the proposed facility in this Study may compete with the above facilities in the future, Da Nang City mentioned that the above facilities were still in testing operation and there was no concrete contract on solid waste management service. It also said that Da Nang City would consider and decide what types of intermediate treatment facilities should be developed after the proposal in this study.

The Study Team will continuously follow up the activities of the above facilities and Da Nang City to avoid the risk of competition.

8.2 Risks at the facility construction stage

8.2.1 Risks in relation to completing construction works

At the construction stage, as the works would take place in a developing country, there is the risk that the machineries, equipment, and facilities do not complete at the planned time, with the planned cost, or with the planned quality.

In this project, it is planned that JFE Engineering which is the member of the SPC would sign the EPC contract with the SPC. Thus, this risk could be minimized if JFE Engineering conducts sufficient preparation and planning regarding material and equipment procurement in Japan and in Vietnam.

However, with regard to materials and equipment that would be procured in Japan and the exported to Vietnam, it is important to reach an agreement with the Vietnamese government in advance so that tax exemption and reduction would be applied according to the current Law on Investment and taxation system.

8.2.2 Risks in relation to utilities

Not only during construction stage but also during operation, there are risks that the utility services required for the project (e.g. electricity, water supply, infrastructure for communications) would not be supplied as requested.

In order to minimize this risk, the utility services that would be necessary during construction and operation would be clarified and contracts would be signed with the Vietnamese authorities for the stable supply of such services. Furthermore, the current situation in Da Nang City regarding such services should be evaluated and if there are possibilities that certain services may not be stably supplied, the SPC should consider countermeasures.

8.3 Risks at the operation stage

8.3.1 Exchange risk

Although the project would be implemented based on the local currency VND, certain expenditures such as loan repayment or operation and maintenance cost would have to be paid in foreign currency. Thus, the change in exchange rate would have an important impact on the profitability of the project. There is also the exchange risk at the construction stage, as the cost for procurement from Japan may have to be paid by foreign currency. Thus, this risk should also be hedged.

In order to minimize this risk, it is important to manage the currency for revenue and expenditure through measures such as exchange marry (to settle loan repayment with the same currency to the extent possible) or advance purchase of the foreign currency. Especially for the revenue, it is important to define in the waste treatment service contract and power purchase agreement the conditions regarding exchange rate so that the impact of the change in exchange rate would be minimized (the risks would be minimized if all or a part of the payments can be paid in a currency such as USD or JPN which are relatively stable, but the Vietnamese side may not agree on such conditions).

8.3.2 Risks in relation to project revenue and expenditure

At the operation stage, there are risks that the profit would be lower than initially planned due to waste amount and/or power generation amount lower than planned or operation and maintenance costs higher than planned.

With regard to revenue, as explained in the previous sections, the risk can be minimized by assuring the minimum revenue in the contract.

Meanwhile, the risk regarding increase in costs can be minimized by designing the project so that it would be profitable even with 5 to 10% of the expected cost as physical and price contingency.

In addition, if there may be serious impact to the profitability of the project by other incidents (Force Majeure), it may be important to buy in advance project insurance. In this case, the additional cost that would be necessary should be financed by the insurance (i.e. for risks concerning natural disasters, environmental change).

As PPP projects have high public nature and are under great influence of the financial conditions of the local governments, it is essential that SPC obtain guarantee from the central government regarding its revenue.

8.3.3 Inflation risk

There is also the risk that inflation may occur during the project construction and operation period. In order to minimize this risk, a parameter (a deflator) that would indicate the level of inflation may be established when setting the tipping fee in the contract so that the tipping fee would change in accordance to the change in this parameter.

9 Necessity of the Project

9.1 Assumptions made for the financial feasibility analysis and result of analysis

The cash flow of the proposed project on waste intermediate treatment and electric power generation was analyzed under the conditions outlined in the tables below. In this Chapter, the feasibility of Option 3 (MRF + waste incinerator with capacity of 300 tons) was examined as the tipping fee of this option (30 USD/ton) fulfills the condition requested by Da Nang City.

Table 9-1: Conditions and Results of Cash Flow Analysis (1)

Item	Conditions
Implementing Organization	SPC composed of Japanese private consortium and Vietnamese partner
Project outline	Intermediate treatment (incineration) of municipal wastes in Da Nang City from households and businesses and electric power generation
Project period	20 years from 2017 to 2036 Excluding construction and preparation of operation period
Capital	Approximately 1.5 billion JPY (24% of initial investment)
Initial investment	Approximately 6.3 billion JPY
Method of financing	• Direct investment through Private Sector Investment Finance of JICA: Approximately 3 billion JPY • JCM Grant from MOE Japan: Approximately 2.5 billion JPY
Conditions of loan	• Private Sector Investment Finance of JICA: Redemption in 15 years; equal repayment during 15 years with interest rate of 13% (in VND) • JCM Grant from MOE Japan: Grant assistance (As to JCM grant, the Study Team has informed Da Nang City that the Team would try to apply for obtaining it next fiscal year. It also mentioned that the amount of GHGs emission reduction achieved by the project must be transferred for free to the Government of Japan in case the above grant is provided. Da Nang City accepted this offer.
Operation and maintenance cost	Approximately 5.9 billion JPY/year
Depreciation of facilities	Facilities will depreciate completely in 20 years under the straight-line method
Corporate tax	The project will be completely exempt from taxes for 4 years as it is an environmental project, then exempt for 50% for 5 years, and then be imposed of taxes of 10%. Procurement from overseas would be exempt from customs duties
Revenue from operation	1. Electric power sales • Power selling price: 10.05 JPY/kWh • Amount of power to be sold: Approximately 33,034 MWh/year 2. Revenue from waste treatment The fee that would realize project EIRR of 18%: 2,500 JPY/t

Table 9-2: Conditions and Results of Cash Flow Analysis (2)

<table>
<tr><th>Item</th><th>Conditions/Result</th></tr>
<tr><td>Project IRR and Equity IRR under basic scenario</td><td>Project IRR: 18.22%
Equity IRR: 20.08%</td></tr>
<tr><td>Sensitivity analysis regarding inflation risk</td><td>Project IRR and Equity IRR was calculated under the following conditions:
- Inflation occurs during the project period by annual average of 5% or 10%
- O/M increases in accordance with the inflation rate
- Revenue stays the same as the unit price stays the same
<table>
<tr><th>Average inflation rate</th><th>Project IRR</th><th>Equity IRR</th></tr>
<tr><td>5%</td><td>18.58%</td><td>20.71%</td></tr>
<tr><td>10%</td><td>16.85%</td><td>17.58%</td></tr>
</table>
If inflation occurs by 5%, as taxes will decrease, IRR will rise. Meanwhile, if inflation occurs by 10%, IRR will decrease.</td></tr>
<tr><td>Sensitivity analysis regarding exchange risk</td><td>Project IRR and Equity IRR was calculated when VND depreciates against JPY every year by 1% and 2%.
<table>
<tr><th>Annual average depreciation rate of VND against JPY</th><th>Project IRR</th><th>Equity IRR</th></tr>
<tr><td>1%</td><td>15.88%</td><td>15.46%</td></tr>
<tr><td>2%</td><td>12.11%</td><td>Unmeasurable</td></tr>
</table>
If VND depreciates against JPY by annual average of 2%, the project will not be profitable. Therefore, efforts must be made to finance the project in VND to the extent possible. If that is not an option, other measures to mitigate the exchange risk should be taken such as receiving the payments of “waste treatment service fee” and “power sales” in JPY (if the project can be financed in USD, the above fees should be received in USD).</td></tr>
</table>

Table 9-3: Cash Flow under Basic Scenario

Project Cashflow Unit: k JPY

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	TOTAL
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Cash in	**3,014,220**	**2,239,820**	**1,718,540**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**23,858,374**
Equity	514,220	539,820	418,540																					1,472,580
Long-term loan		1,700,000	1,300,000																					1,300,000
Subsidy	2,500,000																							0
Tipping fee		0	0	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	15,500,000
Electricity Sales		0	0	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	6,639,834
Cash out (excl. Repayment)	3,014,220	2,239,820	1,718,540	585,660	559,660	611,160	592,960	585,621	747,348	757,071	760,634	746,497	752,760	720,298	732,387	717,268	727,465	773,418	705,447	703,310	697,803	694,268	5,968,799	20,858,374
Initial Investment	3,000,000	2,000,000	1,300,000																					6,300,000
Project Preparation	14,220	18,820	28,540																					
O/M cost	0	0	0	195,660	195,660	195,660	195,660	195,660	297,027	374,200	418,952	370,547	418,039	263,696	356,852	298,858	381,511	662,807	311,187	299,315	268,719	249,083	412,107	6,361,200
Interest Payment	0	221,000	390,000	390,000	364,000	338,000	312,000	286,000	260,000	234,000	208,000	182,000	156,000	130,000	104,000	78,000	52,000	26,000	0	0	0	0	0	3,510,000
Depreciation	0	0	0	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	6,300,000
Profit Before Tax	0	0	0	206,332	232,332	258,332	284,332	310,332	234,965	183,791	165,040	239,445	217,953	398,296	331,139	415,134	358,480	103,185	480,804	492,677	523,273	542,908	379,885	6,358,634
Corporate Income Tax	0	0	0	0	0	0	0	15,517	11,748	9,190	8,252	11,972	21,795	39,830	33,114	41,513	35,848	10,319	48,080	49,268	52,327	54,291	37,988	481,052
Profit After Tax	0	0	0	206,332	232,332	258,332	284,332	294,815	223,217	174,602	156,788	227,472	196,158	358,466	298,025	373,620	322,632	92,867	432,724	443,409	470,945	488,618	341,896	5,877,582
Dividend	0	0	0	0	0	77,500	85,300	88,445	178,573	139,681	125,430	181,978	156,926	286,773	238,420	298,896	258,106	74,293	346,179	354,728	376,756	390,894	5,518,704	9,177,582
Single Year CashFlow	0	0	0	321,332	347,332	295,832	314,032	321,371	159,643	149,920	146,358	160,494	154,232	186,693	174,605	189,724	179,526	133,573	401,545	403,682	409,189	412,724	-4,861,807	0
Loan Repayment	0	0	0	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000						3,000,000
Remaining Loan	0	1,700,000	3,000,000	2,800,000	2,600,000	2,400,000	2,200,000	2,000,000	1,800,000	1,600,000	1,400,000	1,200,000	1,000,000	800,000	600,000	400,000	200,000	0	0	0	0	0	0	
Balance Brought Forward	0	0	0	321,332	668,663	964,496	1,278,528	1,599,898	1,759,542	1,909,462	2,055,820	2,216,314	2,370,546	2,557,239	2,731,844	2,921,568	3,101,095	3,234,668	3,636,213	4,039,894	4,449,084	4,861,807	0	

Table 9-4: IRR under Basic Scenario

Project IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JPY

Year	Tipping fee	Power Selling	Carbon Offset or Subsidy	Initital Investment	Corporate Tax	O/M Expenses	Financial Cost	Financial cashflow	Accumulated Cash Balance
-2	0	0	2,500	3,000	0	14	514	-514	-514
-1	0	0	0	2,000	0	19	2,019	-2,019	-2,533
0	0	0	0	1,300	0	29	1,329	-1,329	-3,862
1	775	332		0	0	196	196	911	-2,950
2	775	332		0	0	196	196	911	-2,039
3	775	332		0	0	196	196	911	-1,128
4	775	332		0	0	196	196	911	-216
5	775	332		0	16	196	211	896	680
6	775	332		0	12	297	309	798	1,478
7	775	332		0	9	374	383	724	2,201
8	775	332		0	8	419	427	680	2,881
9	775	332		0	12	371	383	724	3,606
10	775	332		0	22	418	440	667	4,273
11	775	332		0	40	264	304	803	5,076
12	775	332		0	33	357	390	717	5,793
13	775	332		0	42	299	340	767	6,560
14	775	332		0	36	382	417	690	7,250
15	775	332		0	10	663	673	434	7,683
16	775	332		0	48	311	359	748	8,431
17	775	332		0	49	299	349	758	9,190
18	775	332		0	52	269	321	786	9,975
19	775	332		0	54	249	303	804	10,779
20	775	332		0	38	412	450	657	11,436
TOTAL	15,500	6,640	0	1,300		6,390	8,171	13,969	

Project IRR= **18.13%** (Inc. Corporate Tax)

Equity IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JPY

Year	Tipping fee	Power Selling	Equity Contribution	Corporate Tax	O/M Expenses	Total Cashflow	Interest Payment	Loan Repayment	Cashflow to Equity Holder
-2	0	0	550	0	0	0	0	0	-550
-1	0	0	571	0	0	0	0	0	-571
0	0	0	440	0	0	0	0	0	-440
1	775	332		0	196	911	390	200	321
2	775	332		0	196	911	364	200	347
3	775	332		0	196	911	338	200	373
4	775	332		0	196	911	312	200	399
5	775	332		16	196	896	286	200	410
6	775	332		12	297	798	260	200	338
7	775	332		9	374	724	234	200	290
8	775	332		8	419	680	208	200	272
9	775	332		12	371	724	182	200	342
10	775	332		22	418	667	156	200	311
11	775	332		40	264	803	130	200	473
12	775	332		33	357	717	104	200	413
13	775	332		42	299	767	78	200	489
14	775	332		36	382	690	52	200	438
15	775	332		10	663	434	26	200	208
16	775	332		48	311	748	0	0	748
17	775	332		49	299	758	0	0	758
18	775	332		52	269	786	0	0	786
19	775	332		54	249	804	0	0	804
20	775	332		38	412	657	0	0	657
TOTAL	15,500	6,640	440		6,361	15,298	3,120	19,020	7,617

Equity IRR= 19.028%

Table 9-5: Cash Flow under 5% Inflation Scenario

Project Cashflow Unit: k JPY

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	TOTAL
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Cash in	**3,014,220**	**2,239,820**	**1,718,540**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**23,858,374**
Equity	514,220	539,820	418,540																					1,472,580
Long-term loan		1,700,000	1,300,000																					1,300,000
Subsidy	2,500,000																							0
Tipping fee		0	0	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	15,500,000
Electricity Sales		0	0	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	6,639,834
Cash out (excl. Repayment)	3,014,220	2,239,820	1,718,540	585,660	569,443	625,198	614,548	613,661	738,360	735,792	733,343	731,018	732,149	730,201	728,389	726,721	725,203	723,844	722,651	726,311	730,155	734,191	5,912,994	20,858,374
Initial Investment	3,000,000	2,000,000	1,300,000																					6,300,000
Project Preparation	14,220	18,820	28,540																					
O/M cost	0	0	0	195,660	205,443	215,715	226,501	237,826	249,717	262,203	275,313	289,079	303,533	318,710	334,645	351,377	368,946	387,393	406,763	427,101	448,456	470,879	494,423	6,469,685
Interest Payment	0	221,000	390,000	390,000	364,000	338,000	312,000	286,000	260,000	234,000	208,000	182,000	156,000	130,000	104,000	78,000	52,000	26,000	0	0	0	0	0	3,510,000
Depreciation	0	0	0	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	6,300,000
Profit Before Tax	0	0	0	206,332	222,549	238,277	253,491	268,166	282,274	295,789	308,678	320,913	332,459	343,282	353,347	362,614	371,046	378,598	385,229	364,890	343,535	321,113	297,569	6,250,149
Corporate Income Tax	0	0	0	0	0	0	0	13,408	14,114	14,789	15,434	16,046	33,246	34,328	35,335	36,261	37,105	37,860	38,523	36,489	34,354	32,111	29,757	459,159
Profit After Tax	0	0	0	206,332	222,549	238,277	253,491	254,757	268,161	280,999	293,245	304,867	299,213	308,954	318,012	326,353	333,941	340,738	346,706	328,401	309,182	289,001	267,812	5,790,990
Dividend	0	0	0	0	0	71,483	76,047	76,427	214,529	224,799	234,596	243,894	239,370	247,163	254,410	261,082	267,153	272,591	277,365	262,721	247,345	231,201	5,388,814	9,090,990
Single Year CashFlow	0	0	0	321,332	337,549	281,794	292,444	293,330	168,632	171,200	173,649	175,973	174,843	176,791	178,602	180,271	181,788	183,148	384,341	380,680	376,836	372,800	-4,806,002	0
Loan Repayment	0	0	0	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000						3,000,000
Remaining Loan	0	1,700,000	3,000,000	2,800,000	2,600,000	2,400,000	2,200,000	2,000,000	1,800,000	1,600,000	1,400,000	1,200,000	1,000,000	800,000	600,000	400,000	200,000	0	0	0	0	0	0	
Balance Brought Forward	0	0	0	321,332	658,880	940,674	1,233,118	1,526,448	1,695,080	1,866,280	2,039,929	2,215,902	2,390,745	2,567,535	2,746,138	2,926,408	3,108,197	3,291,344	3,675,686	4,056,366	4,433,202	4,806,002	0	

Table 9-6: IRR under 5% Inflation Scenario

Project IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JPY

Year	Tipping fee	Power Selling	Carbon Offset or Subsidy	Initital Investment	Corporate Tax	O/M Expenses	Financial Cost	Financial cashflow	Accumulated Cash Balance
-2	0	0	2,500	3,000	0	14	514	-514	-514
-1	0	0	0	2,000	0	19	2,019	-2,019	-2,533
0	0	0	0	1,300	0	29	1,329	-1,329	-3,862
1	775	332		0	0	170	170	937	-2,925
2	775	332		0	0	179	179	928	-1,996
3	775	332		0	0	188	188	919	-1,077
4	775	332		0	0	197	197	910	-167
5	775	332		0	15	207	222	885	719
6	775	332		0	16	217	233	874	1,593
7	775	332		0	17	228	244	863	2,455
8	775	332		0	17	239	257	850	3,306
9	775	332		0	18	251	269	838	4,143
10	775	332		0	37	264	301	806	4,949
11	775	332		0	38	277	316	791	5,741
12	775	332		0	40	291	331	776	6,517
13	775	332		0	41	305	346	761	7,278
14	775	332		0	42	321	363	744	8,022
15	775	332		0	43	337	380	727	8,749
16	775	332		0	44	354	397	710	9,459
17	775	332		0	42	371	413	694	10,152
18	775	332		0	40	390	430	677	10,829
19	775	332		0	38	409	448	659	11,489
20	775	332		0	36	430	466	641	12,130
TOTAL	15,500	6,640	0	1,300		5,653	7,477	14,663	

19.04% (Inc. Corporate Tax)

Equity IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JPY

Year	Tipping fee	Power Selling	Equity Contribution	Corporate Tax	O/M Expenses	Total Cashflow	Interest Payment	Loan Repayment	Cashflow to Equity Holder
-2	0	0	514	0	0	0	0	0	-514
-1	0	0	540	0	0	0	0	0	-540
0	0	0	419	0	0	0	0	0	-419
1	775	332		0	170	937	390	200	347
2	775	332		0	179	928	364	200	364
3	775	332		0	188	919	338	200	381
4	775	332		0	197	910	312	200	398
5	775	332		15	207	885	286	200	399
6	775	332		16	217	874	260	200	414
7	775	332		17	228	863	234	200	429
8	775	332		17	239	850	208	200	442
9	775	332		18	251	838	182	200	456
10	775	332		37	264	806	156	200	450
11	775	332		38	277	791	130	200	461
12	775	332		40	291	776	104	200	472
13	775	332		41	305	761	78	200	483
14	775	332		42	321	744	52	200	492
15	775	332		43	337	727	26	200	501
16	775	332		44	354	710	0	0	710
17	775	332		42	371	694	0	0	694
18	775	332		40	390	677	0	0	677
19	775	332		38	409	659	0	0	659
20	775	332		36	430	641	0	0	641
TOTAL	15,500	6,640	419		5,625	15,991	3,120	19,020	8,399

Equity IRR 21.72%

Table 9-7: Cash Flow under 10% Inflation Scenario

Project Cashflow Unit: k JPY

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	TOTAL
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Cash in	**3,014,220**	**2,239,820**	**1,718,540**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**1,106,992**	**23,858,374**
Equity	514,220	539,820	418,540																					1,472,580
Long-term loan		1,700,000	1,300,000																					1,300,000
Subsidy	2,500,000																							0
Tipping fee		0	0	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	775,000	15,500,000
Electricity Sales		0	0	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	331,992	6,639,834
Cash out (excl. Repayment)	3,014,220	2,239,820	1,718,540	585,660	579,226	639,922	638,294	646,007	750,785	751,832	753,478	755,782	760,557	764,182	768,637	774,005	780,378	787,857	817,320	899,052	988,958	1,087,853	4,610,051	20,858,374
Initial Investment	3,000,000	2,000,000	1,300,000																					6,300,000
Project Preparation	14,220	18,820	28,540																					
O/M cost	0	0	0	195,660	215,226	236,749	260,423	286,466	315,112	346,624	381,286	419,415	461,356	507,492	558,241	614,065	675,471	743,019	817,320	899,052	988,958	1,087,853	1,196,639	11,206,426
Interest Payment	0	221,000	390,000	390,000	364,000	338,000	312,000	286,000	260,000	234,000	208,000	182,000	156,000	130,000	104,000	78,000	52,000	26,000	0	0	0	0	0	3,510,000
Depreciation	0	0	0	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	6,300,000
Profit Before Tax	0	0	0	206,332	212,766	217,243	219,568	219,526	216,879	211,368	202,706	190,577	174,636	154,500	129,751	99,927	64,520	22,973	-25,329	-107,061	-196,966	-295,862	-404,647	1,513,408
Corporate Income Tax	0	0	0	0	0	0	0	10,976	10,844	10,568	10,135	9,529	17,464	15,450	12,975	9,993	6,452	2,297	0	0	0	0	0	116,683
Profit After Tax	0	0	0	206,332	212,766	217,243	219,568	208,550	206,035	200,800	192,570	181,048	157,172	139,050	116,776	89,934	58,068	20,676	-25,329	-107,061	-196,966	-295,862	-404,647	1,396,724
Dividend	0	0	0	0	0	65,173	65,870	62,565	164,828	160,640	154,056	144,839	125,738	111,240	93,421	71,947	46,455	16,541	0	0	0	0	3,413,412	4,696,724
Single Year CashFlow	0	0	0	321,332	327,766	267,070	268,698	260,985	156,207	155,160	153,514	151,210	146,434	142,810	138,355	132,987	126,614	119,135	289,671	207,939	118,034	19,138	-3,503,059	0
Loan Repayment	0	0	0	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000						3,000,000
Remaining Loan	0	1,700,000	3,000,000	2,800,000	2,600,000	2,400,000	2,200,000	2,000,000	1,800,000	1,600,000	1,400,000	1,200,000	1,000,000	800,000	600,000	400,000	200,000	0	0	0	0	0	0	
Balance Brought Forward	0	0	0	321,332	649,097	916,168	1,184,865	1,445,850	1,602,057	1,757,217	1,910,731	2,061,941	2,208,375	2,351,185	2,489,540	2,622,527	2,749,141	2,868,276	3,157,947	3,365,887	3,483,921	3,503,059	0	

Table 9-8: IRR under 10% Inflation Scenario

Project IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JPY

Year	Tipping fee	Power Selling	Carbon Offset or Subsidy	Initital Investment	Corporate Tax	O/M Expenses	Financial Cost	Financial cashflow	Accumulated Cash Balance
-2	0	0	2,500	3,000	0	14	514	-514	-514
-1	0	0	0	2,000	0	19	2,019	-2,019	-2,533
0	0	0	0	1,300	0	29	1,329	-1,329	-3,862
1	775	332		0	0	170	170	937	-2,925
2	775	332		0	0	187	187	920	-2,005
3	775	332		0	0	206	206	901	-1,104
4	775	332		0	0	226	226	881	-223
5	775	332		0	13	249	262	845	622
6	775	332		0	13	274	287	820	1,442
7	775	332		0	13	301	314	793	2,235
8	775	332		0	13	331	344	763	2,998
9	775	332		0	12	365	377	730	3,728
10	775	332		0	23	401	425	682	4,410
11	775	332		0	22	441	463	644	5,054
12	775	332		0	20	485	506	601	5,656
13	775	332		0	18	534	552	555	6,211
14	775	332		0	15	587	603	504	6,715
15	775	332		0	12	646	658	449	7,164
16	775	332		0	8	711	719	388	7,552
17	775	332		0	1	782	783	324	7,877
18	775	332		0	0	860	860	247	8,124
19	775	332		0	0	946	946	161	8,285
20	775	332		0	0	1,040	1,040	67	8,352
TOTAL	15,500	6,640	0	1,300		9,771	11,255	10,885	

17.33% (Inc. Corporate Tax)

Equity IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JPY

Year	Tipping fee	Power Selling	Equity Contribution	Corporate Tax	O/M Expenses	Total Cashflow	Interest Payment	Loan Repayment	Cashflow to Equity Holder
-2	0	0	514	0	0	0	0	0	-514
-1	0	0	540	0	0	0	0	0	-540
0	0	0	419	0	0	0	0	0	-419
1	775	332		0	170	937	390	200	347
2	775	332		0	187	920	364	200	356
3	775	332		0	206	901	338	200	363
4	775	332		0	226	881	312	200	369
5	775	332		13	249	845	286	200	359
6	775	332		13	274	820	260	200	360
7	775	332		13	301	793	234	200	359
8	775	332		13	331	763	208	200	355
9	775	332		12	365	730	182	200	348
10	775	332		23	401	682	156	200	326
11	775	332		22	441	644	130	200	314
12	775	332		20	485	601	104	200	297
13	775	332		18	534	555	78	200	277
14	775	332		15	587	504	52	200	252
15	775	332		12	646	449	26	200	223
16	775	332		8	711	388	0	0	388
17	775	332		1	782	324	0	0	324
18	775	332		0	860	247	0	0	247
19	775	332		0	946	161	0	0	161
20	775	332		0	1,040	67	0	0	67
TOTAL	15,500	6,640	419		9,742	12,214	3,120	19,020	4,621

Equity IRR 18.64%

Table 9-9 Cash Flow under 1% VND Depreciation Scenario

Project Cashflow Unit: k JPY

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	TOTAL
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Cash in	**3,014,220**	**2,239,820**	**1,718,540**	**1,106,992**	**1,095,922**	**1,074,113**	**1,042,211**	**1,001,143**	**952,077**	**896,362**	**835,468**	**770,924**	**704,252**	**636,913**	**570,253**	**505,463**	**443,555**	**385,336**	**331,412**	**282,183**	**237,864**	**198,501**	**163,995**	**14,953,478**
Equity	514,220	539,820	418,540																					1,472,580
Long-term loan		1,700,000	1,300,000																					1,300,000
Subsidy	2,500,000																							0
Tipping fee		0	0	775,000	767,250	751,982	729,647	700,896	666,545	627,539	584,907	539,720	493,044	445,900	399,231	353,873	310,531	269,772	232,020	197,555	166,528	138,970	114,812	9,265,722
Electricity Sales		0	0	331,992	328,672	322,131	312,564	300,247	285,532	268,823	250,561	231,203	211,208	191,013	171,021	151,591	133,024	115,564	99,392	84,628	71,337	59,531	49,183	3,969,216
Cash out (excl. Repayment)	3,014,220	2,239,820	1,718,540	585,660	557,703	598,570	569,457	545,035	600,786	550,363	495,749	438,182	379,440	319,220	279,182	251,430	223,696	195,979	168,279	166,596	164,930	163,281	2,981,400	11,953,478
Initial Investment	3,000,000	2,000,000	1,300,000																					6,300,000
Project Preparation	14,220	18,820	28,540																					
O/M cost	0	0	0	195,660	193,703	191,766	189,849	187,950	186,071	184,210	182,368	180,544	178,739	176,951	175,182	173,430	171,696	169,979	168,279	166,596	164,930	163,281	161,648	3,562,833
Interest Payment	0	221,000	390,000	390,000	364,000	338,000	312,000	286,000	260,000	234,000	208,000	182,000	156,000	130,000	104,000	78,000	52,000	26,000	0	0	0	0	0	3,510,000
Depreciation	0	0	0	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	6,300,000
Profit Before Tax	0	0	0	206,332	223,218	229,347	225,362	212,193	191,007	163,152	130,100	93,379	54,513	14,962	-23,929	-60,967	-95,141	-125,643	-151,867	-199,413	-242,066	-279,780	-312,653	252,105
Corporate Income Tax	0	0	0	0	0	0	0	10,610	9,550	8,158	6,505	4,669	5,451	1,496	0	0	0	0	0	0	0	0	0	46,439
Profit After Tax	0	0	0	206,332	223,218	229,347	225,362	201,584	181,456	154,994	123,595	88,710	49,062	13,465	-23,929	-60,967	-95,141	-125,643	-151,867	-199,413	-242,066	-279,780	-312,653	205,666
Dividend	0	0	0	0	0	68,804	67,609	60,475	145,165	123,996	98,876	70,968	39,250	10,772	0	0	0	0	0	0	0	0	2,819,752	3,505,666
Single Year CashFlow	0	0	0	321,332	338,218	275,543	272,753	256,109	151,291	145,999	139,719	132,742	124,812	117,693	91,071	54,033	19,859	-10,643	163,133	115,587	72,934	35,220	-2,817,405	0
Loan Repayment	0	0	0	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000						3,000,000
Remaining Loan	0	1,700,000	3,000,000	2,800,000	2,600,000	2,400,000	2,200,000	2,000,000	1,800,000	1,600,000	1,400,000	1,200,000	1,000,000	800,000	600,000	400,000	200,000	0	0	0	0	0	0	
Balance Brought Forward	0	0	0	321,332	659,550	935,093	1,207,846	1,463,955	1,615,246	1,761,245	1,900,964	2,033,706	2,158,518	2,276,211	2,367,282	2,421,315	2,441,174	2,430,531	2,593,664	2,709,251	2,782,185	2,817,405	0	

Table 9-10: IRR under 1% VND Depreciation Scenario

Project IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JPY

Year	Tipping fee	Power Selling	Carbon Offset or Subsidy	Initital Investment	Corporate Tax	O/M Expenses	Financial Cost	Financial cashflow	Accumulated Cash Balance
-2	0	0	2,500	3,000	0	14	514	-514	-514
-1	0	0	0	2,000	0	19	2,019	-2,019	-2,533
0	0	0	0	1,300	0	29	1,329	-1,329	-3,862
1	775	332		0	0	170	170	937	-2,925
2	767	329		0	0	168	168	928	-1,997
3	752	322		0	0	167	167	907	-1,090
4	730	313		0	0	165	165	877	-213
5	701	300		0	12	163	175	826	613
6	667	286		0	11	162	173	780	1,393
7	628	269		0	9	160	170	727	2,120
8	585	251		0	8	159	166	669	2,789
9	540	231		0	6	157	163	608	3,397
10	493	211		0	8	155	163	541	3,938
11	446	191		0	4	154	158	479	4,417
12	399	171		0	0	152	152	418	4,835
13	354	152		0	0	151	151	355	5,190
14	311	133		0	0	149	149	294	5,484
15	270	116		0	0	148	148	238	5,722
16	232	99		0	0	146	146	185	5,907
17	198	85		0	0	145	145	137	6,044
18	167	71		0	0	143	143	94	6,139
19	139	60		0	0	142	142	57	6,195
20	115	49		0	0	141	141	23	6,219
TOTAL	9,266	3,969	0	1,300		3,126	4,483	8,752	

15.88% (Inc. Corporate Tax)

Equity IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JPY

Year	Tipping fee	Power Selling	Equity Contribution	Corporate Tax	O/M Expenses	Total Cashflow	Interest Payment	Loan Repayment	Cashflow to Equity Holder
-2	0	0	514	0	0	0	0	0	-514
-1	0	0	540	0	0	0	0	0	-540
0	0	0	419	0	0	0	0	0	-419
1	775	332		0	170	937	390	200	347
2	767	329		0	168	928	364	200	364
3	752	322		0	167	907	338	200	369
4	730	313		0	165	877	312	200	365
5	701	300		12	163	826	286	200	340
6	667	286		11	162	780	260	200	320
7	628	269		9	160	727	234	200	293
8	585	251		8	159	669	208	200	261
9	540	231		6	157	608	182	200	226
10	493	211		8	155	541	156	200	185
11	446	191		4	154	479	130	200	149
12	399	171		0	152	418	104	200	114
13	354	152		0	151	355	78	200	77
14	311	133		0	149	294	52	200	42
15	270	116		0	148	238	26	200	12
16	232	99		0	146	185	0	0	185
17	198	85		0	145	137	0	0	137
18	167	71		0	143	94	0	0	94
19	139	60		0	142	57	0	0	57
20	115	49		0	141	23	0	0	23
TOTAL	9,266	3,969	419		3,097	10,080	3,120	10,115	2,488

Equity IRR 15.46%

Table 9-11: Cash Flow: 2% VND Depreciation Scenario

Project Cashflow Unit: k JPY

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	TOTAL
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Cash in	**3,014,220**	**2,239,820**	**1,718,540**	**1,106,992**	**1,084,852**	**1,041,892**	**980,620**	**904,493**	**817,590**	**724,256**	**628,745**	**534,913**	**445,982**	**364,400**	**291,787**	**228,970**	**176,083**	**132,703**	**98,011**	**70,940**	**50,319**	**39,262**	**35,366**	**11,476,715**
Equity	514,220	539,820	418,540																					1,472,580
Long-term loan		1,700,000	1,300,000																					1,300,000
Subsidy	2,500,000																							0
Tipping fee		0	0	775,000	759,500	729,424	686,528	633,231	572,391	507,048	440,182	374,490	312,230	255,115	204,279	160,301	123,275	92,905	68,617	49,665	35,228	27,487	23,592	6,830,487
Electricity Sales		0	0	331,992	325,352	312,468	294,092	271,261	245,199	217,207	188,563	160,423	133,752	109,285	87,508	68,669	52,808	39,798	29,394	21,275	15,091	11,775	11,775	2,927,688
Cash out (excl. Repayment)	3,014,220	2,239,820	1,718,540	585,660	555,747	586,206	546,994	507,683	490,101	408,889	377,857	348,460	319,131	289,868	260,671	231,538	202,467	173,458	144,508	141,618	138,786	152,664	295,868	8,476,715
Initial Investment	3,000,000	2,000,000	1,300,000																					6,300,000
Project Preparation	14,220	18,820	28,540																					
O/M cost	0	0	0	195,660	191,747	187,912	184,154	180,471	176,861	173,324	169,857	166,460	163,131	159,868	156,671	153,538	150,467	147,458	144,508	141,618	138,786	152,664	167,931	3,303,086
Interest Payment	0	221,000	390,000	390,000	364,000	338,000	312,000	286,000	260,000	234,000	208,000	182,000	156,000	130,000	104,000	78,000	52,000	26,000	0	0	0	0	0	3,510,000
Depreciation	0	0	0	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	6,300,000
Profit Before Tax	0	0	0	206,332	214,105	200,980	169,467	123,022	65,729	1,932	-64,113	-128,547	-188,149	-240,468	-283,884	-317,568	-341,384	-355,754	-361,498	-385,678	-403,467	-428,403	-447,565	-2,964,911
Corporate Income Tax	0	0	0	0	0	0	0	6,151	3,286	97	0	0	0	0	0	0	0	0	0	0	0	0	0	9,534
Profit After Tax	0	0	0	206,332	214,105	200,980	169,467	116,871	62,442	1,835	-64,113	-128,547	-188,149	-240,468	-283,884	-317,568	-341,384	-355,754	-361,498	-385,678	-403,467	-428,403	-447,565	-2,974,446
Dividend	0	0	0	0	0	60,294	50,840	35,061	49,954	1,468	0	0	0	0	0	0	0	0	0	0	0	0	127,937	325,554
Single Year CashFlow	0	0	0	321,332	329,105	255,686	233,627	196,810	127,488	115,367	50,887	-13,547	-73,149	-125,468	-168,884	-202,568	-226,384	-240,754	-46,498	-70,678	-88,467	-113,403	-260,502	0
Loan Repayment	0	0	0	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000						3,000,000
Remaining Loan	0	1,700,000	3,000,000	2,800,000	2,600,000	2,400,000	2,200,000	2,000,000	1,800,000	1,600,000	1,400,000	1,200,000	1,000,000	800,000	600,000	400,000	200,000	0	0	0	0	0	0	
Balance Brought Forward	0	0	0	321,332	650,437	906,123	1,139,749	1,336,559	1,464,048	1,579,415	1,630,302	1,616,755	1,543,606	1,418,138	1,249,253	1,046,685	820,301	579,547	533,050	462,371	373,905	260,502	0	

Table 9-12: Cash Flow: 2% VND Depreciation Scenario

Project IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JP

Year	Tipping fee	Power Selling	Carbon Offset or Subsidy	Initital Investment	Corporate Tax	O/M Expenses	Financial Cost	Financial cashflow	Accumulated Cas Balance
-2	0	0	2,500	3,000	0	14	514	-514	-51
-1	0	0	0	2,000	0	19	2,019	-2,019	-2,53
0	0	0	0	1,300	0	29	1,329	-1,329	-3,86
1	775	332		0	0	170	170	937	-2,92
2	760	325		0	0	167	167	918	-2,00
3	729	312		0	0	163	163	879	-1,12
4	687	294		0	0	160	160	821	-30
5	633	271		0	7	157	164	740	43
6	572	245		0	4	154	158	659	1,09
7	507	217		0	1	151	152	572	1,66
8	440	189		0	0	148	148	481	2,14
9	374	160		0	0	145	145	390	2,53
10	312	134		0	0	142	142	304	2,84
11	255	109		0	0	139	139	225	3,06
12	204	88		0	0	136	136	156	3,22
13	160	69		0	0	133	133	95	3,31
14	123	53		0	0	131	131	45	3,36
15	93	40		0	0	128	128	5	3,36
16	69	29		0	0	126	126	-28	3,33
17	50	21		0	1	123	124	-53	3,28
18	35	15		0	0	121	121	-70	3,21
19	27	12		0	0	133	133	-93	3,12
20	24	12		0	0	146	146	-111	3,01
TOTAL	6,830	2,928	0	1,300		2,900	4,214	5,544	

12.11% (Inc. Corporate Tax)

Equity IRR

Case 2: Waste-to-Energy T/F= 2,500 FIT= 10.1 CAPEX= 6,300,000 unit: Million JP

Year	Tipping fee	Power Selling	Equity Contribution	Corporate Tax	O/M Expenses	Total Cashflow	Interest Payment	Loan Repayment	Cashflow to Equity Holder
-2	0	0	514	0	0	0	0	0	-51
-1	0	0	540	0	0	0	0	0	-54
0	0	0	419	0	0	0	0	0	-41
1	775	332		0	170	937	390	200	34
2	760	325		0	167	918	364	200	35
3	729	312		0	163	879	338	200	34
4	687	294		0	160	821	312	200	30
5	633	271		7	157	740	286	200	25
6	572	245		4	154	659	260	200	19
7	507	217		1	151	572	234	200	13
8	440	189		0	148	481	208	200	7
9	374	160		0	145	390	182	200	
10	312	134		0	142	304	156	200	-5
11	255	109		0	139	225	130	200	-10
12	204	88		0	136	156	104	200	-14
13	160	69		0	133	95	78	200	-18
14	123	53		0	131	45	52	200	-20
15	93	40		0	128	5	26	200	-22
16	69	29		0	126	-28	0	0	-2
17	50	21		1	123	-53	0	0	-5
18	35	15		0	121	-70	0	0	-7
19	27	12		0	133	-93	0	0	-9
20	24	12		0	146	-111	0	0	-11
TOTAL	6,830	2,928	419		2,872	6,873	3,120	6,638	-72

Equity IRR #NUM!

9.2 Necessity of the Project and its Impact

Based on the current remaining capacity of Khan Son Landfill (2,535,521 cubic meter) at the time of October 2012 and the result of estimation on future waste generation and treatment above, the Study estimated the remaining years of Khan Son Landfill as shown in the table below. As a result, the Khan Son Landfill is estimated to be full by 2019 if all the wastes collected are landfilled without any treatment for volume reduction.

Table 9-13: Projected Trend of Waste Disposal at Khan Son Landfill

Year	Amount of solid waste (ton/year)	Amount of sludge (ton/year)	Amount of cover soil (t/year)	Amount of waste disposal at landfill (ton/year)	Volume of waste disposal at landfill (m^3/year)	Remaining capacity of landfill (m^3)
2012	-	-	-	-	-	2,535,521
2013	268,597	2,920	16,291	287,808	287,808	2,247,713
2014	286,890	2,999	17,393	307,282	307,282	1,940,431
2015	297,475	3,078	18,033	318,586	318,586	1,621,844
2016	308,904	3,168	18,724	330,796	330,796	1,291,048
2017	318,280	3,244	19,291	340,815	340,815	950,233
2018	328,500	3,329	19,910	351,739	351,739	598,494
2019	338,355	3,416	20,506	362,277	362,277	236,217
2020	348,798	3,514	21,139	373,451	373,451	-137,234

Remark: Average specific gravity of waste is assumed at 0.8 ton/m^3 based on the result of waste amount and composition survey conducted in the Study.

However, based on the experience of constructing the current Khanh Son disposal site, it is highly difficult if not impossible to construct new disposal sites in the surrounding areas. Thus, Da Nang City should extend the lifetime of the current Khanh Son Landfill as much as possible, and in order to achieve this objective, introduction of intermediate treatment facilities could be highly effective as they would drastically reduce the volume of wastes to be landfilled.

In this Survey, it was found that although the effect would be different depending on the chosen option, introduction of the intermediate treatment facility would reduce the amount of wastes by 40 to 70% (if it is assumed that direct landfill would reduce the wastes by 0%).

9.3 Challenges and Countermeasures regarding Project Implementation

Option 3 which will introduce MRF with waste incineration and power generation facility (treatment capacity of 1,000 ton/day), the tipping fee would be from 25 to 30 USD/ton under the most favorable conditions[11] (in order to use the JCM grant, Da Nang City must handover to SPC free of charge the

[11] Conditions such as "electric power sales price would be USD 0.1/kWh", "USD 46million would be financed by the JCM Program of the Ministry of the Environment, Japan"

carbon credit that will be generated through the project).

Meanwhile, the current cost for municipal solid waste management (collection, transport, treatment, and disposal) is 233,000 VND (approximately 11 USD)/ton. Within this cost, the cost for treatment and disposal is 24,611 VND (approximately 1.1 USD)/ton.

In order to realize this project, it is essential that the conditions listed in Table 7-4 are met. As obtaining the guarantee by the central government would be especially difficult with only the efforts by the Japanese private companies, efforts will be made in collaboration with Da Nang city.

Annex 1
Report on Wastewater Management in Da Nang City

The information explained in the report of wastewater management is not authorized by Da Nang City because there was no official meeting with Da Nang City on wastewater. On December 19th, JICA and Da Nang people's Committee agreed with taking the survey on wastewater management from the scope of work. Therefore, the report of wastewater management is prepared based on the data which JICA survey team had collected until December 2012.

Chapter 1 Current Condition and Future Plan of Wastewater Management in Da Nang

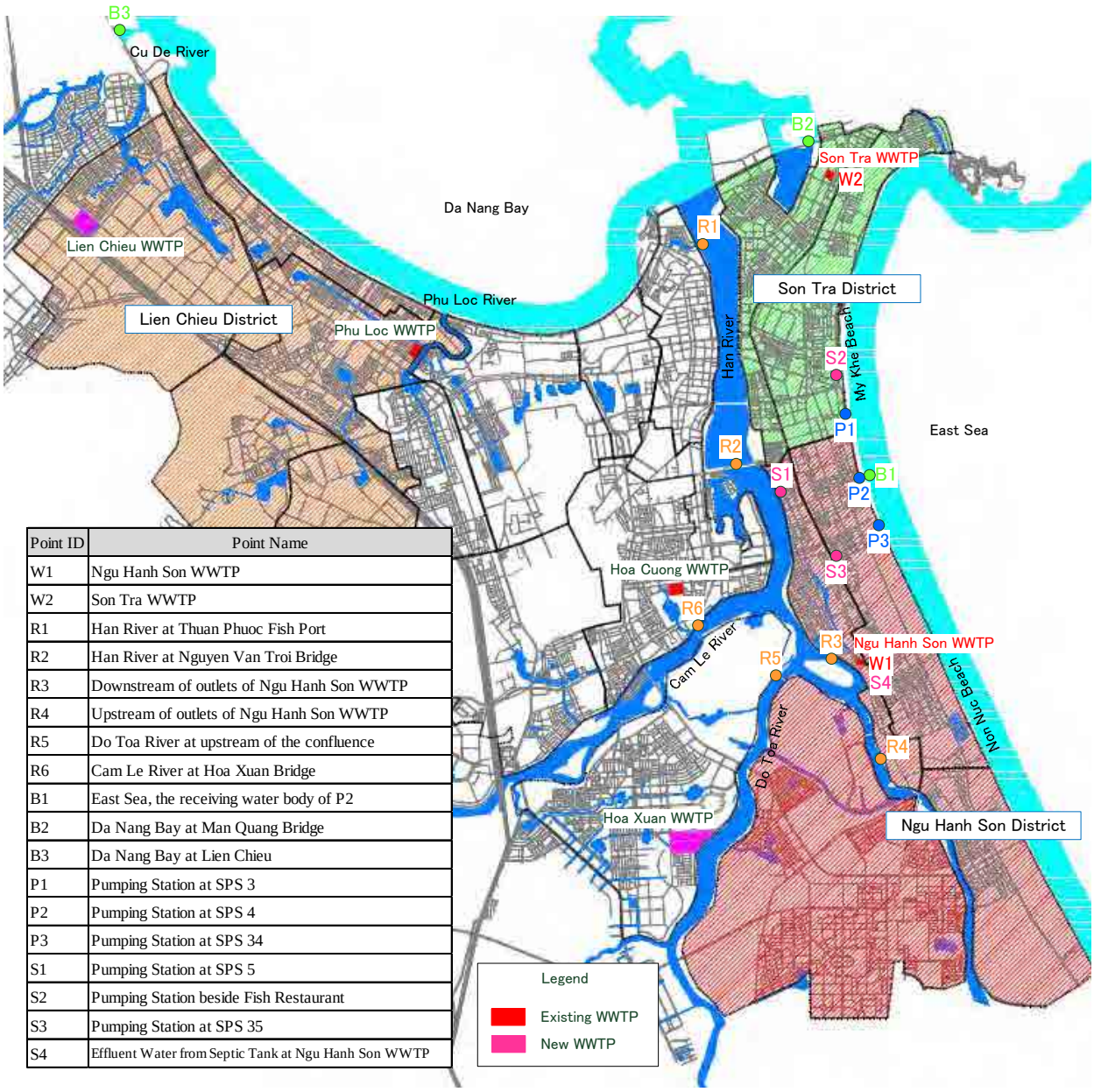
1.1 Current Conditions and Future Plan of Wastewater Management of Vietnam

The National Policy on Sewage and Drainage in Viet Nam is described in the "Decision on Ratifying the Orientation for the Development of Urban Drainage in Viet Nam up to the year 2020" (Decision No.35/1999/QD-TTg of March 5). The decision establishes that a city should have its own wastewater treatment system and should provide wastewater treatment and drainage services for 90-100% of its population by 2020.

1.2 Current Conditions and Future Plan of Wastewater Management of Da Nang

1.2.1 Current Water Quality of Da Nang

The water quality survey was conducted in July, 2012 by the Survey Team to figure out the current water quality in Da Nang City. The map of sampling points is shown in Figure 1-2-1. The feature of water quality in the existing wastewater treatment plants and the receiving water bodies in Da Nang City is described in this chapter.



Point ID	Point Name
W1	Ngu Hanh Son WWTP
W2	Son Tra WWTP
R1	Han River at Thuan Phuoc Fish Port
R2	Han River at Nguyen Van Troi Bridge
R3	Downstream of outlets of Ngu Hanh Son WWTP
R4	Upstream of outlets of Ngu Hanh Son WWTP
R5	Do Toa River at upstream of the confluence
R6	Cam Le River at Hoa Xuan Bridge
B1	East Sea, the receiving water body of P2
B2	Da Nang Bay at Man Quang Bridge
B3	Da Nang Bay at Lien Chieu
P1	Pumping Station at SPS 3
P2	Pumping Station at SPS 4
P3	Pumping Station at SPS 34
S1	Pumping Station at SPS 5
S2	Pumping Station beside Fish Restaurant
S3	Pumping Station at SPS 35
S4	Effluent Water from Septic Tank at Ngu Hanh Son WWTP

Figure 1-2-1 Map of Sampling Points in Water Quality Survey

a) Existing wastewater treatment plants

The water quality data of influent and effluent in Ngu Hanh Son and Son Tra WWTPs is shown in Table 1-2-1 based on the results of water quality survey conducted by the Survey Team.

BOD and COD of the effluent in Ngu Hanh Son and Son Tra WWTPs do not meet the required standards for class B domestic or industrial wastewater as shown in Table 1-2-1. The treatment efficiency of BOD is 32% in Ngu Hanh Son WWTP and 39% in Son Tra WWTP. Other water quality parameters of the effluent in both WWTPs meet the required

standards for class B, but the concentrations of them are relatively high. In comparison with the results of water quality survey reported in "Study on Wastewater Management Strategy in Da Nang City" in 2009, the results of water quality survey conducted by the Survey Team are relatively high.

Table 1-2-1 Water Quality in Existing WWTPs

No.	Parameters	Unit	Ngu Hanh Son WWTP		Son Tra WWTP		QCVN 14:2008/ BTNMT, Class B	QCVN 24:2009/ BTNMT, Class B
			W1-I	W1-E	W2-I	W2-E		
	Situation	-	Influent	Effluent	Influent	Effluent	-	-
	Date	-	25/7/2012		25/7/2012		-	-
1	pH	-	6.65	6.82	6.68	6.90	5 - 9	5.5 – 9
2	TSS	mg/l	210	62	240	80	100	100
3	TDS	mg/l	3610	664	3748	736	1000	-
4	BOD_5 (20 ^{o}C)	mg/l	120.5	81.6	157.6	96.3	50	50
5	COD	mg/l	289	123	342	152	-	100
6	NH_4-N	mg/l	12.9	7.8	16.4	9.8	10	10
7	T-N	mg/l	36.5	12.6	42.5	28.8	-	30
8	T-P	mg/l	15.9	3.6	18.5	5.6	-	6
9	H_2S	mg/l	2.2	0.8	5.0	1.4	4	-
10	Oil & grease	mg/l	12.1	5.1	16.7	6.9	20	20
11	Surfactants	mg/l	6.9	3.8	7.3	5.3	10	-

Remarks:
QCVN 14:2008/BTNMT: Vietnamese National Technical Regulation on Domestic Wastewater
- Class A: apply for discharge into the resource which is used to Water treatment plant
- Class B: apply for discharge into the resource which isn't used to Water treatment plant

QCVN 24:2009/BTNMT: Vietnamese National Technical Regulation on Industrial Wastewater
- Class A: discharge into water bodies used for domestic purpose
- Class B: discharge into other water bodies without Class A

b) Receiving water bodies

The water quality data in Han River which is the receiving water body from Ngu Hanh Son WWTP is shown in Table 1-2-2 based on the results of water quality survey conducted by the Survey Team.

The water quality at R1 located in the mouth of Han River meets the required standards for class B2 surface water quality except for NH4-N and oil & grease in high tide. The water quality at R2 located in the downstream of Han River meets the required standards for class B2 surface water quality except for NH4-N in high tide. The survey results show that the water quality in the downstream of Han River is more polluted in high tide than in low tide due to the reverse flow of pollutants from the sea.

On the other hand, the water quality at R3 located in the downstream of outlet in Ngu Hanh Son WWTP is more affected by the effluent from WWTP than by the reverse flow of pollutants from the downstream. The water quality at R3 meets the required standards for class B2 surface water quality.

Table 1-2-2 Water Quality in Han River

No.	Parameters	Unit	R1		R2		R3		QCVN 08:2008/BTNMT, Class B2
			R1-H	R1-L	R2-H	R2-L	R3-H	R3-L	
	Tide	-	High	Low	High	Low	High	Low	-
	Date	-	27/7/2012		27/7/2012		30/7/2012		-
1	pH	-	6.85	6.56	6.63	6.82	6.28	6.47	5.5 - 9
2	EC	µS/cm	27300	15625	13939	11277	12548	9020	-
3	DO	mg/l	6.46	5.68	6.95	6.50	6.72	5.95	≥2
4	TSS	mg/l	30.0	24.0	18.0	19.0	16.0	24.0	100
5	BOD_5 (20 °C)	mg/l	20.8	7.2	5.6	4.8	6.8	8.9	25
6	COD	mg/l	38	16	12	10	15	18	50
7	NH_4-N	mg/l	1.08	0.55	1.21	0.70	0.21	0.47	1
8	Oil & grease	mg/l	1.26	0.95	0.16	0.14	0.08	0.12	0.3
9	Surfactants	mg/l	0.36	0.24	0.21	0.15	0.30	0.33	0.5
10	E.coli	MPN/100 ml	20	60	24	30	30	40	200

Remarks:
QCVN 08:2008/BTNMT: Vietnamese National Technical Regulation on Surface Water Quality
- Class A1: it is used for domestic water supply and others like A2, B1 and B2.
- Class A2: it is used for domestic water supply but it must be applied the suitable treatment technologies; to preserve aquatic animals and plants or other purposes like B1 and B2.
- Class B1: it is used for irrigation or other purposes requiring similar water quality or other purposes like B2.
- Class B2: it is used for sea traffic and other purposes with the requirement of low quality water.

The water quality data in coastal areas which is the receiving water body from WWTPs is shown in Table 1-2-3 based on the results of water quality survey conducted by the Survey Team.

The water quality on the sunny day at B1 located in the beach along East Sea meets the required standards for class I coastal water quality. However, since there is a discharge of sewage from the pumping station at SPS 4 on a rainy day, it is assumed that the water quality in the beach would deteriorate on a rainy day due to discharged pollutants from pumping stations. Discharged pollutants in rainfall period from Pumping Station SPS 3 to the beach are shown in Photo 1-2-1.

The water quality at B2 located in the downstream of outlet in Son Tra WWTP meets the required standards for class III coastal water quality.

The water quality at B3 located in the mouth of Cu De River meets the required standards for class B2 surface water quality. If the new WWTP is constructed in Lien Chieu District in the future, it is assumed that the water quality in Cu De River will be affected by the effluent of it.

Table 1-2-3 Water Quality in Coastal Areas

No.	Parameters	Unit	B1	B2	B3	QCVN 10:2008/ BTNMT, Class I	QCVN 10:2008/ BTNMT, Class III	QCVN 08:2008/ BTNMT, Class B2
	Date	-	25/7/2012		27/7/2012	-	-	-
1	pH	-	7.12	7.50	6.95	6.5 – 8.5	6.5 – 8.5	5.5 - 9
2	EC	µS/cm	52200	44500	37900	-	-	-
3	DO	mg/l	6.75	7.08	6.56	≥4	-	≥2
4	TSS	mg/l	15.0	18.0	20.0	50	-	100
5	BOD_5 (20 °C)	mg/l	1.6	8.5	4.2	-	-	25
6	COD	mg/l	4	18	9	4	-	50
7	NH_4-N	mg/l	0.052	0.064	0.009	0.5	0.5	1
8	Oil & grease	mg/l	ND	0.06	0.08	0.1	0.2	0.3
9	Surfactants	mg/l	0.34	0.56	0.48	-	-	0.5
10	E.coli	MPN/100 ml	ND	3	2	1000	1000	200

Remarks:
QCVN 10:2008/BTNMT: Vietnamese National Technical Regulation on Coastal Water Quality
- Class I: it is used for beaches.
- Class II: it is used for aquaculture areas.
- Class III: it is used for other places.

QCVN 08:2008/BTNMT: Vietnamese National Technical Regulation on Surface Water Quality
- Class A1: it is used for domestic water supply and others like A2, B1 and B2.
- Class A2: it is used for domestic water supply but it must be applied the suitable treatment technologies; to preserve aquatic animals and plants or other purposes like B1 and B2.
- Class B1: it is used for irrigation or other purposes requiring similar water quality or other purposes like B2.
- Class B2: it is used for sea traffic and other purposes with the requirement of low quality water.

Overflow Water from Pumping Station

Discharge to Beach

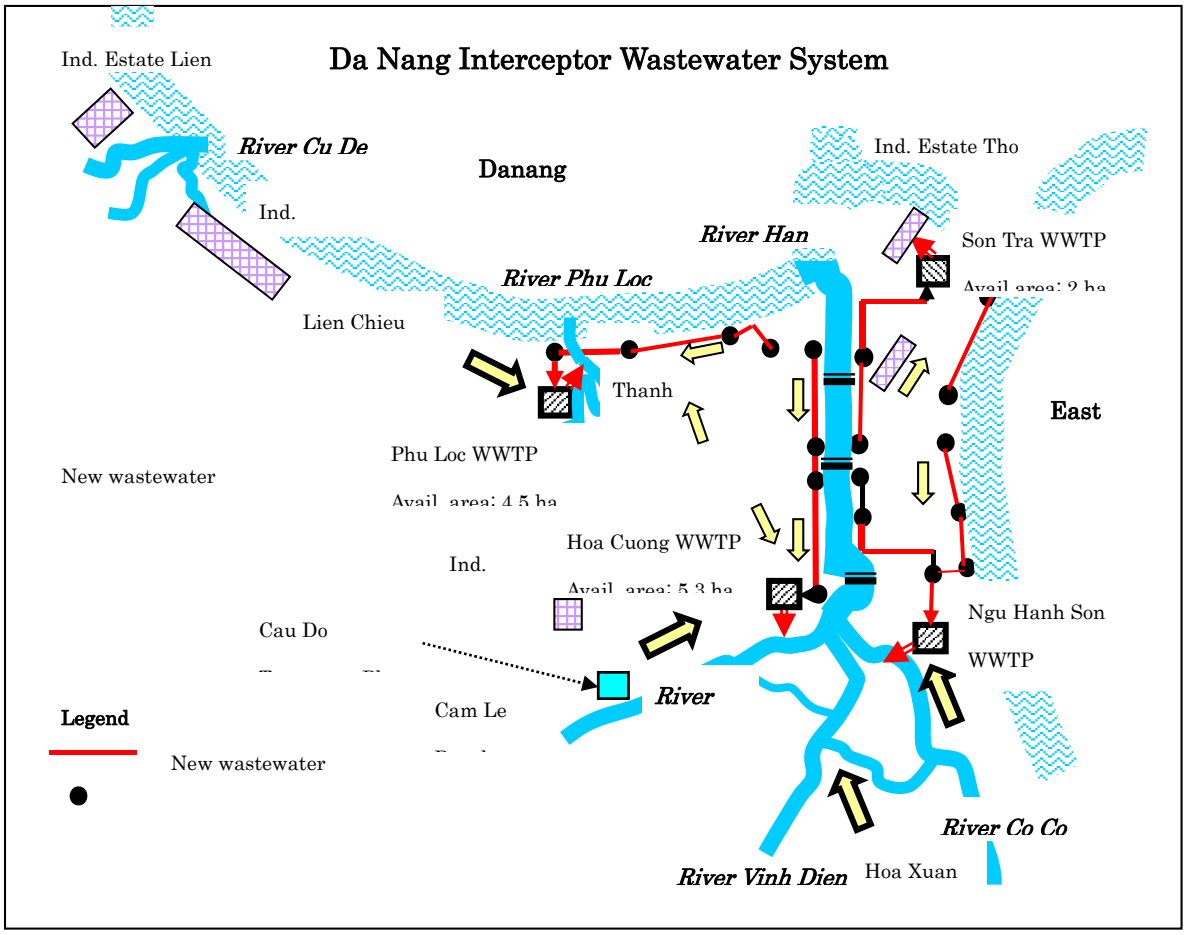
Photo 1-2-1 Overflow from Pumping Station SPS3 (in rainfall period on July 21)

1.2.2 Existing Wastewater System of Da Nang

a) Sewage

The current sewerage system in Da Nang City is basically a combined system. This means that wastewater, normally effluent from septic tanks and storm water, are collected and conveyed in the same pipe. The majority of the households have septic tanks or similar on-site sanitation facilities but only a small percentage of the septic tanks appear to be connected to the sewerage system.

Based on "Study on Wastewater Management Strategy in Da Nang City" in 2009, the The main features of the new wastewater (Interceptor) system are illustrated in Figure 1-2-2.



Source: Study on Wastewater Management Strategy in Da Nang, 2009

Figure 1-2-2 The Interceptor Wastewater System in Da Nang

The Interceptor wastewater system includes the following main infrastructure:

- 15.7 km of gravity pipes,
- 19.4 km of pumping mains,
- 60 diversion chambers, and

- 18 pumping stations.

The collected wastewater is treated at 4 anaerobic wastewater treatment plants (WWTPs) located at 4 different locations in Da Nang City. Management and operation of the wastewater system is the responsibility of the Da Nang Transportation Management and Drainage Company (TMDC).

Table 1-2-4 Capacity of Wastewater Treatment Plants

Name of WWTP	Capacity (m^3/day)
Hua Cuong	30,000
Ngu Hang Son	10,000
Phu Loc	8,000
Son Tra	16,000
Hoa Xuan	Under Tendering

Source: JICA Survey Team updated information on "JICA Study, The Study on Integrated Development Strategy for Danang City and Its Neighboring Area in the Socialist Republic of Vietnam (DaCRISS), December 2010"

As for sludge of septic tank, only a limited amount of night soil from septic tanks is collected by night soil trucks operated by private companies. Treatment is done at night soil aerobic treatment facilities at the Khanh Son landfill site.

b) Drainage

Da Nang has land elevations which range from 3m to 7m above mean sea level. Most of the city drains either directly to the sea in Da Nang Bay and My Khe Beach, a popular tourist area, or indirectly via the Hanh River, which bisects the city. Flooding occurs during the wet season with flood depths of as much as 0.70m persisting for up to 48 hours in some areas of the city.

Until recently the drainage system was limited to the center of the city and comprised around 122km of covered rectangular curbside drains of stone, brick or concrete. Many of these drains were built in an ad-hoc fashion without due regard to hydraulic design and their overall interaction as a network. System capacity was further hampered by undersized connections under roads and the railway, water pipes and other utility services crossing the drains, siltation and garbage dumping.

Wastewater is discharged to storm water drains. An interceptor sewer system was completed in 2006 under the World Bank's "IDA Three Cities Sanitation Project". The project focused on the central and eastern parts of the city, where development is most dense and returns on investment highest. Works included rehabilitation of existing drains and provision of new large drain culverts, wastewater interceptor sewers and sewage

pumping stations, together with four new wastewater treatment plants employing the anaerobic stabilization process.

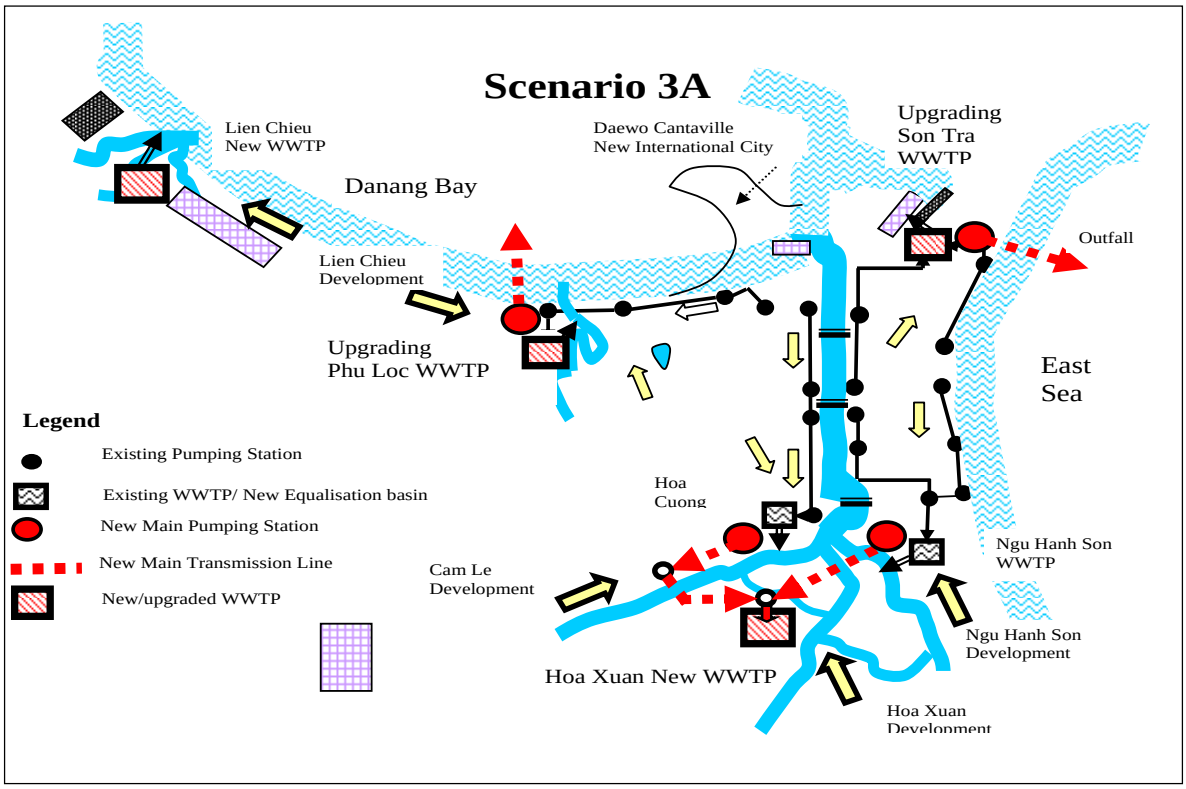
Based on the drainage simulation (See Appendix A Drainage Simulation on Ngu Hanh Son District) on Ngu Hanh Son District by using US Environmental Protection Agency SWMM model, after interceptor sewers built in the world bank's project, it is anticipated that peak surcharging and minor flooding occurs 3 hours after the start of the storm when the peak rainfall intensity coincides with the high tide. Surcharging and flooding do not last long and flows subside quickly as the peak rainfall intensity passes.

1.2.3 Future Plan for Wastewater Management of Da Nang

The wastewater treatment master plan of Da Nang was formulated by the World Bank in April 2009. In 2010, Da Nang city made the target in which 100 % of collected wastewater is treatment up to 2020 in the master plan (No 1866/QD-TT, October, 2010).

Objectives of the master plan in 2009 are 1) to assist local government for choice of comprehensive medium and long term strategies, 2) to recommend options for optimizing the performance of existing wastewater treatment plants, 3) to identify the specific investment required to implement the recommend; and 4) to provide firm recommendations on the optimum wastewater treatment methods for existing and proposed waste water treatment plants.

Based on careful assessment of existing condition and data, four different wastewater management scenarios were analyzed with regard to overall feasibility. The most feasible management option proposed in the project is shown in Figure 1-2-3.



Source: Study on Wastewater Management Strategy in Da Nang, 2009

Figure 1-2-3 Proposed Wastewater System in Danang City (Scenario 3A)

The preferred Scenario divides Da Nang City into two logical catchments areas on a hydrologic basis. The two hydrological areas are Northern Da Nang and Southern Da Nang.

It is recommended that three WWTP (Waste Water Treatment Plant) (Son Tra, Pgu Loc, and Lien Chieu) are used to treat wastewater in Northern Da Nang, while only one central WWTP at Hoa Xuan is used in Southern Da Nang.

Based on the master plan, on May 30, 2012, Da Nang City decided the increase of Capacity of Hoa Xuan WWTP, the construction of Lien Chieu WWTP, and the improvement of treatment process and increase of Capacity of Son Tra WWTP by World Bank fund (the letter of No. 3736/UBND-QLDTu, Unifying the list of investment projects).

Chapter 2 Facility Plan

2.1 Wastewater Management

There are three potential PPP project areas such as Lien Chieu district, Son Tra district and Ngu Hanh Son district based on the master plan and Minutes of meeting between Da Nang city and JICA (Minutes of meetings on the mission for the preparatory survey on wastewater management and solid waste management for Da Nang city in the Socialist Republic of Vietnam, 28 December 2011). One PPP project area is selected among three districts after analysis and design parameter of facilities in selected project area is determined.

2.1.1 Areas and Populations for potential PPP project

a) Potential PPP Project Areas

Target area is selected among three districts, Lien Chieu district, Son Tra district, and Ngu Hanh Son district (see Figure 2-1-1, Photo 2-1-1) for the wastewater management. The selection of one suitable area is carried out based on the data from literature reviews and site surveys by JICA Survey Team.

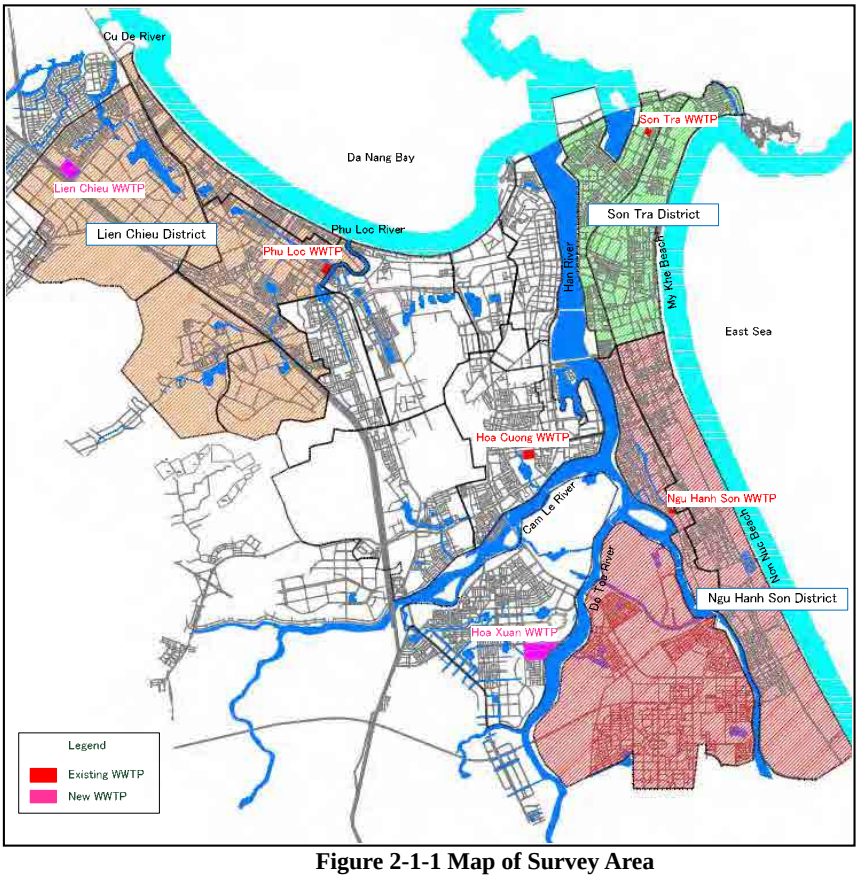


Figure 2-1-1 Map of Survey Area

Lien Chieu District

Planned Site of Lien Chieu WWTP

Residential Area in Lien Chieu District

Son Tra District

Son Tra WWTP (Anaerobic Lagoon)

Residential Area in Son Tra District

Ngu Hanh Son District

Ngu Hanh Son WWTP (Anaerobic Lagoon)

Residential Area in Ngu Hanh Son District

Photo 2-1-1 WWTP and Residential Area of Each District

b) Populations

The forecast for the population growth up to year 2030 Population is calculated according to the general formula: Pn = Po x (1 +GR) ^ n where:

Pn : population in year n

Po : population in reference year

GR: population growth rate

n : number of years since reference year.

The population growth rate for three districts is 4.17 based on DPI data, and that for all Da Nang city comes from Master Plan on Da Nang city Socio-Economical Development up to 2020. The results are shown in Table 2-1-1.

Table 2-1-1 Population Projection

District	2008	2010	2015		2020		2030	
	Population	Population	GR, %	Population	GR, %	Population	GR, %	Population
Lien Chieu[1)]	100,051	136,737	4.17	167,725	4.17	205,737	4.17	309,556
Son Tra[1)]	122,571	132,944	4.17	163,073	4.17	200,030	4.17	300,969
Ngu Han Son[1)]	55,124	68,270	4.17	83,741	4.17	102,720	4.17	154,555
Da Nang City[2)]		910,000	3.44	1,077,665	4.90	1,368,867	3.30	1,893,932

Source: 1) DPI data
2) Master Plan on Da Nang city Socio-Economical Development up to 2020

c) Wastewater Volume

Wastewater volume takes account of wastewater from residents and tourists. Industrial wastewater is not included in wastewater volume because industrial wastewater is treated in wastewater treatment plants (e.g. Tho Quang WWTP) for industrial wastewater.

Wastewater volume is calculated by wastewater production rate and population.

Population of tourist for each district is estimated by allocating tourist population in Da Nang City to each district based on the population of each district. Table 2-1-2 shows the population of tourist in each district.

Table 2-1-2 Population of Tourist in Each District

Items	Unit	2010 [1)]	2015 [1)]	2020 [1)]	2030 [2)]
Yearly No of Tourist	Person/ year	1,770,000	3,500,000	8,100,000	9,873,855
Length of Stay	day	2	2.2	2.4	2.3
Daily of Tourist	Person/ day	9,699	21,096	53,260	62,219
Daily number of Tourist in	Person/ day	1,457	3,283	8,005	10,169

Lien Chieu		(=9,699x136,737/910,000)	(=21,096x167,725/1,077,665)	(=53,260x205,737/1,368,867)	(=62,219x309,556/1,893,932)
Daily number of Tourist in Son Tra	Person/ day	1,417 (=9,699x132,944/910,000)	3,192 (=21,096x163,073/1,077,665)	7,783 (=53,260x200,030/1,368,867)	9,887 (=62,219x300,969/1,893,932)
Daily number of Tourist in Ngu Han Son	Person/ day	727 (=9,699x68,270/910,000)	1,639 (=21,096x83,741/1,077,665)	3,997 (=53,260x102,720/1,368,867)	5,077 (=62,219x154,555/1,893,932)

Source: 1) Master Plan on Da Nang city Socio-Economical Development up to 2020
2) Number of tourist per year in 2030 and 2040 is estimated based on a tourist population growth rate of 2%.

Wastewater production per capita is shown in Table 2-1-3. The figures for Wastewater production of resident are based on Study on Wastewater Management Strategy in Da Nang, 2009. Wastewater of tourist is estimated based on the assumption that water consumption for tourist is same as that for household.

Table 2-1-3 Wastewater Production per Capita

Items	Unit	2010		2020		2030	
		Resident[1])	Tourist[2])	Resident[1])	Tourist[2])	Resident[1])	Tourist[2])
Water consumption for household	l/capita/ d	125	125	144	144	162	162
Small industries	l/capita/ d	15	0	15	0	15	0
Water used for institutions	l/capita/ d	15	0	15	0	15	0
Water used for commercial	l/capita/ d	10	0	10	0	10	0
Unaccounted water consumption	l/capita/ d	1	0	1	0	1	0
Total Water Consumption	l/capita/ d	166	125	185	144	203	162
Rate of water discharge	%	80	80	80	80	80	80
Infiltration Rate	%	23	23	17	17	11	11
Total wastewater production per capita	l/capita/ d	163	120	173	135	180	140

Source: 1) Study on Wastewater Management Strategy in Da Nang, 2009
2) JICA Survey Team

Based on the population and wastewater per capita, wastewater productions as daily average flow are presented in Table 2-1-4. Wastewater production in 2015 is calculating based on the assumption that wastewater per capita in 2015 is same as that in 2020.

Table 2-1-4 Wastewater Productions as Daily Average Flow (DAF)

Items	2010			2015			2020			2030		
	Resident	Tourist	Total	Resident	Tourist	Total	Resident	Tourist	Total	Resident	Tourist	Total
Wastewater Per Capita, l/capita/d	163	120		173	135		173	135		180	140	
DAF in Lien Chieu, m^3/day	22,261	175	22,246	29,016	443	29,460	35,593	1,057	36,649	55,720	1,424	57,144
DAF in Son Tra, m^3/day	21,643	170	21,813	28,212	431	28,643	34,605	1,027	35,633	54,174	1,384	55,559
DAF in Ngu Hanh Son, m^3/day	11,114	87	11,202	14,487	221	14,708	17,771	528	18,298	27,820	711	28,531

Maximum daily flows (MDF) are presented in Table 2-1-5. 1.2 of peak factor is used as a conversion factor mentioned in Water Supply - Distribution System and Facilities - Design Standard (TCXD 33-2006).

Table 2-1-5 Maximum Daily Flows (MDF)

District	2010		2015		2020		2030	
	DAF, m^3/day	MDF, m^3/day	DAF, m^3/day	MDF, m^3/day	DAF, m^3/day	MDF, m^3/day	DAF, m^3/day	MDF, m^3/day
Lien hieu,	22,246	26,900	29,460	35,400	36,649	44,000	57,144	68,600
Son Tra	21,813	26,200	28,643	34,400	35,633	42,800	55,559	66,700
Ngu Hanh Son	11,202	13,400	14,708	17,700	18,298	22,000	28,531	34,200

d) Evaluation factors

Evaluations are conducted by four aspects which are relevance, necessity, effectiveness, and projects by other donors.

In the aspect of relevance, it is investigated on whether investment of wastewater management complies with policy and plan of government.

In the aspect of necessity, it is investigated on the extent of potential needs on wastewater treatment in terms of the present population and present wastewater volume.

In the aspect of effectiveness, it is investigated on the extent of effective investment and effectiveness on improving water environment in terms of the present population density, the future population, the future reduction of pollution loads.

In the aspect of projects by other donors, it is investigated to avoid duplications of investments.

From the viewpoints of above four aspects, the selection is carried out.

e) Evaluations

Table 2-1-6 shows the evaluations of each area in terms of four aspects.

Table 2-1-6 Evaluations of Each Area

Area	Lien Chieu	Son Tra	Ngu Hanh Son
Relevance	Development and Upgrade of wastewater management system complies with 1) "Decision on Ratifying the Orientation for the Development of Urban Drainage in Viet Nam up to the year 2020" (Decision No.35/1999/QD-TTg of March 5), 2) Master Plan on Social Economic development in Da Nang City (No 1866/QD-TT, October,2010).		
Necessity Present Population*1	About 137,000	About 133,000	About 68,000
Present Wastewater Flow*2	About 22,000 m^3/d (Estimated)	16,000 m^3/d (Field Survey Data)	10,000 - 11,000 m^3/d (Field Survey Data)
Capacity Utilization Rate of WWTP	No WWTP	100% (Capacity of WWTP 16,000m^3/d)	66% -73% (Capacity of WWTP 15,000m^3/d)
Effectiveness Population Density on 2010	17.3 persons/ha	22.4.3 persons/ha	17.7 persons/ha
Population in 2030	About 310,000 persons (estimated)	About 301,000 persons (estimated)	About 155,000 persons (estimated)
Pollution Load Reduction Rate in 2030*3.	90% of reduction	90% of reduction	90% of reduction
Projects by Other Donors	Construction of WWTP is decided by World Bank Fund*4	Improvement of technology and Upgrade of Capacity of WWTP is decided by World Bank Fund*4.	Not planned.
Evaluation	Not Suitable for feasibility study	Not Suitable for feasibility study	Suitable for feasibility study

Source: *1 Statistic data 2010

*2 Present wastewater flow of Lien Chieu district is estimated under the assumption of 100 % house connection. Date of Son Tra and Ngu Hanh Son districts are based on field surveys.

*3 175 mg/l of inflow in 3030 is expected. Industrial wastewater in Lien Chieu is not included because industrial wastewater is treated in industrial zone.

*4 Da Nang PC Decision, "Unifying the list of investment projects under the Component 1 – Project of Sustainable Development of Da Nang City" (No. 3736/UBND-QLDTu', 30 May 2012).

Investments on wastewater management were confirmed to comply with the national and Da Nang City plans. In "Decision on Ratifying the Orientation for the Development of

Urban Drainage in Viet Nam up to the year 2020" (Decision No.35/1999/QD-TTg of March 5), the decision establishes that a city should have its own wastewater treatment system and should provide wastewater treatment and drainage services for 90-100% of its population by 2020. In the master plan (No 1866/QD-TT, October, 2010), Da Nang city made the target in which 100 % of collected wastewater is treatment up to 2020. Based on these two facts, the investments on three areas have relevance to the national and Da Nang City plans.

On necessity, three districts were faced with the urgent necessity of constructing a wastewater treatment plant (WWTP) and expanding the capacity of WWTP in terms of the capacity utilization rate. Especially Lien Chieu district does not have a WWTP. Every day about 20,000 m3/d of sewage is discharged directly to receiving water body. Necessity of investment to Lien Chieu seems to be high.

On effectiveness, at present Son Tra district has high investment efficiency including sewer investment because of high population density. On the future effectiveness on improving water quality, three districts have high pollution reduction rate in 2030 because mechanical treatment processes are planned to be built. The effectiveness on improving water quality seems to be high.

On projects by other donors, on May 30, 2012, Da Nang PC decided the investments of WWTPs in Lien Chieu and Son Tra districts which will be carried out by the fund of World Bank. At present there is no plan of the investment on the WWTP of Ngu Hanh Son district. From the viewpoints of avoiding the duplications of projects by other donors, Ngu Han Son district is a most suitable area for the feasibility study.

f) PPP project Area Selected

Ngu Hanh Son district is the most suitable area for the feasibility study of wastewater management because of complying with national and city plans, having necessity and effectiveness on investment of wastewater management. Especially this district does not have any investment plans of wastewater treatment plant by other donors. There is no duplication of investment.

Based on these reasons, Ngu Hanh Son district is selected for the feasibility study for PPP project of wastewater management.

2.1.2 Planning Parameter of Wastewater System

1) Population and Wastewater volume

Population and wastewater volume of Ngu Hanh Son district is presented in Table 2-1-7.

Table 2-1-7 Population and Wastewater Volume of Ngu Hanh Son

Item	Unit	2010	2015	2020	2030
Resident[1)]	person	68,270	83,741	102,720	154,555
Tourist[2)]	person	727	1,639	3,997	5,077
DAF (Daily Average Flow)[3)]	m^3/day	11,202	14,708	18,298	28,531
MDF (Maximum Daily Flow)[3)]	m^3/day	13,400	17,700	22,000	34,200

Source: 1) From Table 2-1-1.
2) From Table 2-1-2.
3) From Table 2-1-5.

2) Pollution Load

Unit Pollution Loading factors in other countries are presented in Table 2-1-8. Unit loading factors depend to a great extent on water supply and life style.

Table 2-1-8 Unit Pollution Loading Factors in Other Countries

Country/ City	Unit	BOD_5	SS	TN	TP
Ho Chi Minh, Viet Nam[1)]	g/capita/d	55	55	-	-
Japan[2)]	g/capita/d	58	45	11	1.3
Malaysia[3)]	g/capita/d	56	68	11	2.0
India[4)]	g/capita/d	50 (45 – 54)	108 (70 – 145)	9 (6 – 12)	2.4 (0.8 – 4.0)
Sri Lanka[5)]	g/capita/d	50 (45 – 54)	108 (70 – 145)	9 (6 – 12)	2.6 (0.6 – 4.5)
Abu Dhabi[6)]	g/capita/d	80	90	-	-
Turkey[7)]	g/capita/d	77 (27 – 50)	55 (41 – 68)	11 (8 – 14)	1.2 (0.4 – 2)
USA[7)]	g/capita/d	85	95	21	3.0
China[8)]	g/capita/d	38 (25 – 50)	53 (40 – 65)	8 (5 – 11)	1.1 (0.7 – 1.4)

Source: 1) Ho Chi Minh City Water Environment Improvement Project Phase II
2) Japan Sewerage Design Standards, 2001
3) Malaysia Sewerage Industry Guidelines, Volume IV, 2009
4) Indian Ministry of Urban Development, Manual on Sewerage and Sewage Treatment (Second Edition), 1993
5) Sri Lanka National Water Supply &Drainage Board, Design Manual 07, 2012
6) Abu Dhabi Municipality, Design Standards Manual, 2004
7) Metcalf & Eddy, Wastewater Engineering, 4th Ed., 2003
8) Chinese Ministry of Housing and Urban-Rural Development (MOHURD), Code for Design of Outdoor Wastewater Engineering (GB 50014), 2006

Taking into the account of Ho Chi Minh, unit pollution loading factors of Da Nang are estimated on those of Malaysia because BOD5 unit pollution load of Ho Chi Minh is close to that of Malaysia.

Also, septic tank is used as a treatment unit in Da Nang. Unit pollution load takes in consideration of the treatment effect of septic tank. It is assumed that the septic tank in houses which has already connected to sewer system will be gradually removed. Therefore, it is expected that the effect of septic tank will varies from 50% reduction rate in 2010 to 30% reduction rate in 2030.

Raw sewage quality is presented in Table 2-1-9.

Table 2-1-9 Raw Sewage Quality of Ngu Hanh Son

Item	Unit	2010	2015	2020	2030
BOD_5 Unit pollution load	g/capita/d	56	56	56	56
Treatment effect of septic tank (reduction rate)	%	50	45	40	30
Total wastewater production per capita	l/capita/d	163	173	173	180
BOD_5 of raw sewage	mg/l	172	178	194	217
Measured BOD_5 in 2012[1)]	mg/l	120	-	-	-
SS Unit pollution load	g/capita/d	68	68	68	68
Treatment effect of septic tank	%	50	45	40	30
Total wastewater production per capita	l/capita/d	163	173	173	180
SS of raw sewage	mg/l	209	216	236	264
Measured SS in 2012[1)]	mg/l	210	-	-	-
TN Unit pollution load	g/capita/d	11	11	11	11
Treatment effect of septic tank	%	50	45	40	30
Total wastewater production per capita	l/capita/d	163	173	173	180
TN of raw sewage	mg/l	34	35	38	43
Measured TN in 2012[1)]	mg/l	37	-	-	-
TP Unit pollution load	g/capita/d	2.0	2.0	2.0	2.0
Treatment effect of septic tank	%	50	45	40	30
Total wastewater production per capita	l/capita/d	163	173	173	180
TP of raw sewage	mg/l	6.1	6.4	6.9	7.8
Measured TP in 2012[1)]	mg/l	16	-	-	-

Source: 1) Raw sewage at Ngu Hanh Son WWTP was measured by JICA Survey Team.

The raw sewage quality calculated in 2010 is almost same as that of actual raw sewage measured in 2012. Based on those raw sewage qualities, the following design sewage qualities for each year are adopted.

Table 2-1-10 Design Sewage Quality of Ngu Hanh Son

Item	Unit	2010	2015	2020	2030
BOD_5	mg/l	170	170	190	210
SS	mg/l	200	210	230	260
TN	mg/l	34	35	38	43
TP	mg/l	6.1	6.4	6.9	7.8

3) Target treated water quality

There are several effluent discharge standards in effect in Vietnam, to be used for different purposes. The following standards are considered in the design of target treated water quality for the domestic wastewater management in Da Nang City.

a) Standard TCVN 7222: 2002 General Environmental Requirements for Central Domestic (Municipal) Wastewater Treatment Plans.

The standard is only applied for central wastewater treatment plants in order to initially monitor environmental aspects related during construction, operation, environmental

monitoring to prevent and minimize negative impacts from operation of the treatment plant on environment and public health.

It should be noted that in Section 5.4.1 of the Standard, treatment method of Treatment Plant must be able to eliminate at least 85% BOD and SS in the raw domestic wastewater. The parameter of main pollutants, which included in the raw domestic wastewater, must reach the minimum quality at the level 2 or above after treatment, for example in the Table 2-1-11.

Table 2-1-11 Quality of the typical parameters in the treated domestic wastewater

Parameter	Preliminarily treated wastewater - Level 1	**Treated wastewater - Level 2**	Treated wastewater - Level 3
(1)	(2)	**(3)**	(4)
pH	6 to 9	**6 to 9**	6 to 9
BOD (mg/l)	100 to 200	**10 to 30**	5 to below 10
Total SS (mg/l)	100 to 150	**10 to 30**	5 to below 10
Total N (mg/l)	20 to 40	**15 to 30**	3 to 5
Total phosphor (mg/l)	7 to 15	**5 to 12**	1 to 2
Note: Quality level of the Treated wastewater - Level 3 in the column 4 is the result of advance, complex treatment process. Encourage investment and apply this technology.			

Source: TCVN 7222:2002

b) Standard QCVN 24:2009/BTNMT National Technical Regulations on Industrial Wastewater.

There are many national technical regulations for wastewater discharge to vary depending on the intended use. The main technical regulations for wastewater discharge are indicated as follows.

- QCVN 11: 2008/BTNMT, National technical regulation on the effluent of aquatic products processing industry.
- QCVN 12: 2008/BTNMT, National technical regulation on the effluent of pulp and paper mills.
- QCVN 13: 2008/BTNMT, National technical regulation on the effluents from textile industry.
- QCVN 14: 2008/BTNMT, National technical regulation on domestic wastewater.
- QCVN 24: 2009/BTNMT, National technical regulations on industrial wastewater.
- QCVN 25: 2009/BTNMT, National technical regulations on wastewater of the solid waste land fill sites.

For the treatment plant for centralized domestic wastewater, QCVN 24:2009/BTNMT is applied primarily. Others are applied as the occasion demands.

This regulation regulates the allowable maximum value of polluted parameters in industrial wastewater when discharging into the environment. The standard is applied the organizations or individuals related to industrial wastewater discharge into water bodies.

Industrial wastewater is defined "the wastewater discharged from production, processing bases, services and manufacturing business into water bodies".

Maximum polluted parameter value of industrial wastewater is identified as followed:

$$Cmax = C \times Kq \times Kf$$

In which:

- Cmax is the maximum allowable concentration of polluted parameter in industrial wastewater before discharging into rivers/pools, mg/l;
- C is the concentration value of polluted parameter regulated in Table 2-1-12.
- Kq is coefficient of the flow or environmental capacity of water bodies. In this project, the effluents discharged into coastal waters using for waters sports and recreation. Therefore coefficient Kq is selected the value of 1.0 in accordance with the section 2.4.3 of QCVN 24.
- Kf is coefficient of the flow of treated wastewater discharge. In this project, the flow rate of effluent is more than 5,000m^3/day therefore Kf is selected the value of 0.9 in accordance with the section 2.5 of QCVN 24. However coefficient of Kp for waters sports and recreation on coastal waters is not selected to relating with the size of water bodies. Formally, the decision of Kf is required the confirmation of DPI and approved EIA however the coefficient of Kf is selected the value of 1.0 in this report.

Table 2-1-12 Quality of the typical parameters in the treated domestic wastewater

No.	Substance	Limit Value	
		A	**B**
1	Temperature (^{0}C)	**40**	40
2	pH	**6.0-9.0**	5.5-9.0
3	Odor	**Acceptable**	Acceptable
4	Color, Co-Pt at pH=7	**20**	70
5	BOD_5 (20^{0}C)	**30**	50
6	COD (mg/l)	**50**	100

No.	Substance	Limit Value	
		A	**B**
7	SS (mg/l)	**50**	100
8	Arsenic (mg/l)	**0.05**	0.1
9	Hg (mg/l)	**0.005**	0.01
10	Lead (mg/l)	**0.1**	0.5
11	Cd (mg/l)	**0.005**	0.01
12	Cr (VI) (mg/l)	**0.05**	0.1
13	Cr (III) (mg/l)	**0.2**	1
14	Copper (mg/l)	**2**	2
15	Zinc (mg/l)	**3**	3
16	Nickel (mg/l)	**0.2**	0.5
17	Manganese (mg/l)	**0.5**	1
18	Fe (mg/l)	**1**	5
19	Tin (mg/l)	**0.2**	1
20	Cyanide (mg/l)	**0.07**	0.1
21	Phenol (mg/l)	**0.1**	0.5
22	Mineral oil (mg/l)	**5**	5
23	Animal and plant oil (mg/l)	**10**	20
24	Residual Chlorine (mg/l)	**1**	2
25	PCBs (mg/l)	**0.003**	0.01
26	Plant protection chemicals: Organic phosphorous (mg/l)	**0.3**	1
27	Plant protection chemicals: Organic chloride (mg/l)	**0.1**	0.1
28	Sulfur (mg/l)	**0.2**	0.5
29	Fluoride (mg/l)	**5**	10
30	Chloride (mg/l)	**500**	600
31	Ammonia (basing on Nitrogen) (mg/l)	**5**	10
32	Total nitrogen (mg/l)	**15**	30
33	Total phosphorous (mg/l)	**4**	6
34	Coliform (MPN/100 ml)	**3000**	5000
35	α radiation (Bq/l)	**0.1**	0.1
36	β radiation (Bq/l)	**1.0**	1.0

Source: QCVN 24:2009

Industrial wastewater with the values of the parameters and concentration of the pollutants equivalent with the values in the Column A is allowed to be discharged into water bodies used for domestic purpose. Column B is allowed to be discharged into water bodies used for other purpose.

In this project, the WWTP doesn't discharge into river to use for drinking however the river water pours into coastal waters using for waters sports. This purpose is as similar as domestic use. On the other hand, Da Nang DPI desired in the meeting to apply the values in Column A due to the environmental improvement of coastal waters. Therefore the values of the parameter and concentration of the pollutants from WWTP applies to the values in Column A on this project.

c) Target quality

The target quality of treated water from WWTP should be satisfied the both regulations as TCVN 7222 and QCVN 24. The main parameters of these regulations and target quality for management of WWTP are indicated in Table 2-1-13.

Table 2-1-13 Target quality of the typical parameters

Parameter	TCVN 7222 - Level 2	QCVN 24 - Column A	**Target quality**
pH	6 to 9	5 to 9	**6 to 9**
BOD (mg/l)	10 to 30	30	**30**
Total SS (mg/l)	10 to 30	50	**30**
Total N (mg/l)	15 to 30	15	**15**
Total phosphor (mg/l)	5 to 12	4	**4**

Source: TCVN 7222:2002, QCVN 24:2009

4) Treatment process

a) Precondition for comparison of treatment process

a-1) Required removal efficiency

The required removal efficiency of WWTP is calculated from design sewage quality and target treated water quality as in Table 2-1-14. The design sewage quality of WWTP is added 10% of raw sewage quality with consideration for process return flow.

Table 2-1-14 Required removal efficiency

	Design Sewage Quality (mg/L)			Target Quality	**Required Removal Efficiency**		
	2015	2020	2030	(mg/L)	2015	2020	**2030**
BOD	187 (170)	209 (190)	231 (210)	30	84.0%	85.6%	**87.0%**
Total SS	231 (210)	253 (230)	286 (260)	30	87.0%	88.1%	**89.5%**
Total N	39 (35)	42 (38)	47 (43)	15	61.5%	64.3%	**68.1%**
Total P	7.0 (6.4)	7.6 (6.9)	8.6 (7.8)	4	42.9%	47.4%	**53.5%**

Note: The value in ( ) means the raw sewage quality.

a-2) Buffer zone

The size of the buffer zone around the WWTP is determined by QCVN 07 2010 /BXD (Vietnam Building Code Urban Engineering Infrastructures). The regulations are shown in Table 2-1-15.

Table 2-1-15 Buffer Zone of QCVN 07 2010/BXD

No.	Items	Buffer zone (m) base on capacity (×1000m^3/day)			
		< 0.2	0.2 – 5	5 – 50	>50
1.	Pumping Station	15	20	25	30
2.	Sewage treatment plant				
a.	Physical treatment (combine with Sludge drying bed)	100	200	300	400
b.	Biological treatment (combine with Sludge drying bed)	100	150	300	400
c.	Biological treatment without Sludge drying bed (combine with Sludge drying equipment, Sludge treated equipment)	10	15	30	40
d.	Underground sewage filter yard	100	150	300	500
e.	Sewage farming	50	200	400	1,000
f.	Biological pond	50	200		
g.	Sewage Oxidation channel	50	150		

Source: QCVN-07:2010/BXD

The capacity of WWTP is about 35,000 m^3/day, the treatment process does not have a sludge drying bed therefore the required buffer zone is 30m.

b) Treatment Methods for WWTP

Treatment methods in use and identified in planning studies in Viet Nam are identified in Table 2-1-16.

Table 2-1-16 Existing and Planned STP in Viet Nam

No.	STP Name	Location	a. Treatment Methods	Capacity (m^3/day)	Donor	Conditions
1	Truc Bach STP	Hanoi	Anaerobic-anoxic-oxic Activated Sludge	3,000 m^3/day	JBIC	Operation
2	Kim Lien STP	Hanoi	Anaerobic-anoxic-oxic Activated Sludge	3,700 m^3/day	JBIC	Operation
3	Van Tri STP	Hanoi	Conventional Activated Sludge	50,000 m^3/day	GOV	Operation
4	Ha Long STP	Ha Long City	Sequencing Batch Reactor	3,500 m^3/day	WB	Operation
5	Hua Cuong	Da Nang City	Anaerobic Pond with cover	30,000 m^3/day	WB	Operation
6	Ngu Hang Son	Da Nang City	Anaerobic Pond with cover	10,000 m^3/day	WB	Operation
7	Phu Loc	Da Nang City	Anaerobic Pond with cover	8,000 m^3/day	WB	Operation
8	Son Tra	Da Nang City	Anaerobic Pond with cover	16,000 m^3/day	WB	Operation
9	Lien Chieu STP	Da Nang City	Conventional Activated Sludge	62,900 m^3/day	METI (Japan)	Before detailed design
10	Hoa Xuan	Da Nang City	Oxidation Ditch	160,000 m^3/day	WB	Construction Tender
11	Hoa Lac Hi-Tech Industrial Zone STP	Ha Tay province	Conventional Activated Sludge	6,500 m^3/day	GOV	Finished Construction
12	Vinh Yen Town STP	Vinh Phuc Province	Conventional Activated Sludge	5,000 m^3/day	JBIC	Construction Tender
13	Binh Hung STP	Ho Chi Minh City	Conventional Activated Sludge	141,000 m^3/day	JBIC	Operation
14	Thu Dau Mot STP	Binh Duong Province	Sequencing Batch Reactor	17,650 m^3/day	JBIC	Under Construction
15	Bay Mau STP	Hanoi	Conventional Activated Sludge	13,300 m^3/day	JBIC	Under Construction
16	Vinh Niem STP	Hai Phong Province	Conventional Activated Sludge	36,000 m^3/day	JBIC	Under Construction
17	North Thang Long STP	Hanoi	Conventional Activated Sludge	42,000 m^3/day	JBIC	Operation
18	Thuy An STP	Hue City	Conventional Activated Sludge	20,000 m^3/day	JBIC	Before detailed design

In other tropical countries, the upflow anaerobic sludge blanket (UASB) process is often used because it requires less energy and has a smaller footprint. However, UASB effluent has BOD_5 above the normally acceptable limit of 30 mg/l and is anoxic. UASB is usually combined with a trickling filter or polishing pond to achieve good quality effluent.

The treatment process of high class applies to oxidation ditch, conventional activated sludge and sequencing batch reactor due to need the high nitrogen removal rate.

The following 5 types of treatment processes are evaluated by the Study Team:

- Waste Stabilization Ponds (Anaerobic Pond and Aerated Lagoon)
- Advanced Oxidation Ditch
- Step-feed Anoxic/Aerobic Process (Improved method of Conventional Activated Sludge)
- Sequencing Batch Reactor (High class operation)
- UASB +trickling filter

c) Comparison of Treatment Methods

The five treatment methods are evaluated qualitatively using a design flow of 35,000 m^3/day. The results are summarized in Table 2-1-17. The sample drawing of WWTP layout plan for Step-feed Anoxic /Aerobic Process is shown in Figure 2-1-2.

Based on the evaluation, Step-feed Anoxic/Aerobic Process is selected for the following reasons.

- This method has highest removal efficiency in five methods.
- The required site area is smallest in five methods.
- This method is stable to the flow fluctuation in the rain.
- The operation and maintenance of this method requires relatively high technique. But the operation and maintenance can be conducted because there are a similar know-how of operation and maintenance in Hanoi or Ho Chi Minh City.

Treatment Method	1. Waste Stabilization Ponds	2. Advaced Oxidation Ditch	3. Step-feed Anoxic / Aerobic Process	4. Sequencing Batch Reactor (High Class Opration)	5. UASB + Trickling Filter (T.F.)
Composition of Sewage treatmet Process	→ R.T.(1) → R.T.(2) →	→ R.T. → S.S.T. → Sludge Treatment Facility	→ P.S.T. → R.T. → S.S.T. → Sludge Treatment Facility	→ F.E.T. → R.T. → Sludge Treatment Facility	→ UASB → T.F. → S.S.T → Sludge Treatment Facility
Theory of Reaction in Reactor Tank	Sewage is purified by oxidation of aerobic bacteria activated by oxygen supply through algae or anaerobic bacteria.	Sewage is circulated together with activated sludge and contained organic substance is absorbed and assimilated by activated sludge. Nitorgen is removed to denitrify under the anoxic condition.	Sewage flows down to 3 step reactor with activated sludge and contained organic substance is absorbed and assimilated by activated sludge. Nitorgen is removed to denitrify in the anoxic tank.	The four processes of (1) Inflow, (2) Aeration, (3) Sedimentation, (4) Effluent and sludge draining are occurred in the one tank. Nitorgen is removed to denitrify under the anoxic condition.	Solids of sewage settles and it is anaerobic digested in UASB (Upflow Anaerobic Sludge Blanket) tank, and nitrificated and purified in Trickling Filter.
Water Quality (removal efficiency)	**BOD : 70%**	BOD : 90-95%	BOD : 90-95%	BOD : 90-95%	BOD : 85-95%
	SS : 70%	SS : 90-95%	SS : 90-95%	SS : 90-95%	**SS : 70-90%**
	T-N : 40-50%	T-N : 70% over	T-N : 75-85%	T-N : 70% over	**T-N : 30-40%**
	T-P : 20-30%	T-P : 40% over	T-P : 30-50%	T-P : 30-50%	**T-P : 30%**
	It is unsatisfactory about all.	It is satisfactory about all items.	It is satisfactory about all items.	It is satisfactory about all items.	It is unsatisfactory without BOD.
	Not satisfied	Satisfied	Satisfied	Satisfied	**Not satisfied**
Required Site Area (without buffer zone)	**11.0 ha**	**5.2 ha**	2.6 ha	3.1 ha	2.8 ha
	Big Area	**Big Area**	Small Area	Medium Area	Medium Area
Stability of Flow Fluctuation (rain)	Very Stable	Very Stable	Stable	Not Stable	Not Stable
Operation and maintenance (O&M)	O&M is easy since there is simple equipment. Sludge treatment facility in not needed.	Operationl technique is easier than that of CAS method. Ganerated sludge volume is small.	Relatively high O&M technique is required because large blowers are installed. The system has an relatively stableoperation when rain go into STP because primary sedimentation tank works as a buffer tank for fluctuation of flow.	High O&M technique is required because large blowers, many monitoring devices and automatic valves are installed. The system without large equalization tanks has very unstable when rain go into STP.	Relatively high O&M technique is required because anaerobic process. Ganerated sludge volume is small. The system without large equalization tanks has very unstable when flow is changed.
	Very Simple	Simple	Not simple	Not simple	Not Simple
Evaluation	×	×	◎	○	×

Legend : P.S.T. : Primary Sedimentation Tank R.T. : Reactor Tank S.S.T : Secondary Sedimentation Tank F.E.T : Flow Equalization Tank
Source : JICA Study Team

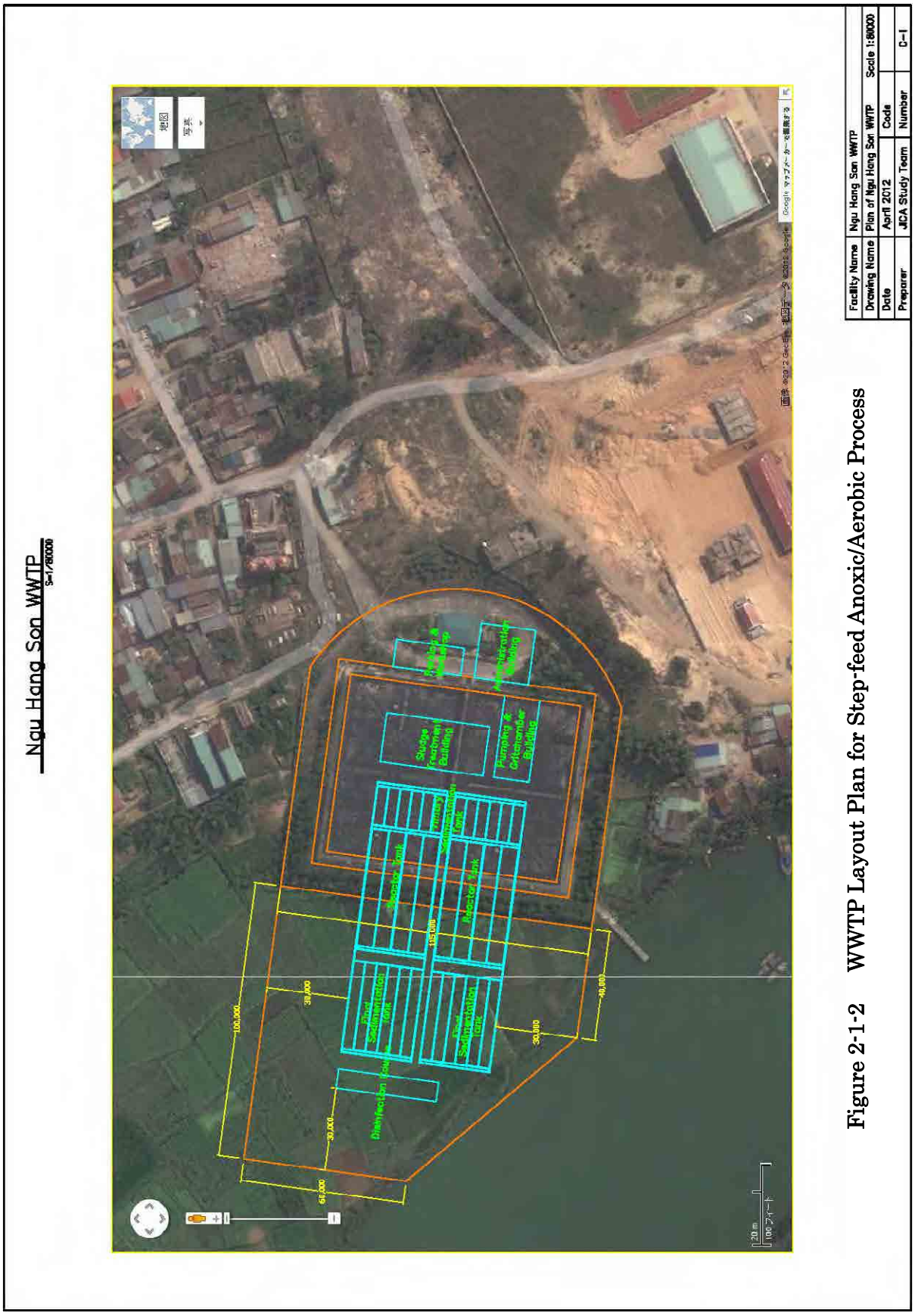


Figure 2-1-2 WWTP Layout Plan for Step-feed Anoxic/Aerobic Process

Annex 2

Da Nang Drainage System

Da Nang Drainage System

1. Purpose

Existing drainage system in Ngu Hang Son district and water quality impacts is examined to improve the existing combined system. In this study, existing conditions on drainage system is presented because of taking the survey on wastewater management from the scope of work on December 19th.

1.1 Approach/Methodology

In this study, the popular US Environmental Protection Agency SWMM model is used to simulate rainfall-runoff for the Ngu Han Son district. The main aim of this work is to examine the hydraulic performance of the existing drainage system and water quality impacts of proposed improvements to the existing combined sewer system.

1.2 Work Carried Out During The First Assignment

- Study area: Ngu Hanh Son
- Obtained drawing and operating manuals for the existing and planned drainage systems
- Obtained rainfall data, intensity duration frequency curves and developed design storm hyetographs
- Used SWMM to assess the hydraulic capacity of the major drainage network and identify problem areas if any.
- Used SWMM to analyse the volume of overflows from the combined sewer system
- Estimated the pollutant load from urban runoff and from combined sewer overflows (CSO)

1.3 Source Of Data

The following information was made available to the study team by the Da Nang Drainage Company

- AutoCAD drawings showing main drains (existing and planned) with invert elevations and ground elevations as well as conduit sizes.
- Inventory datasheets for the interceptor sewer system (in spreadsheet format) providing information on pipe sizes, pump sizes and pump start and stop levels
- An operations manual produced by the World Bank Three Cities Project describing the interceptor sewer system and pump operations “Da Nang Wastewater Systems - An Introduction Manual, April 2006.
- AutoCAD drawings of the pump stations and diversion structures.

2 Existing Drainage System

2.1 Description

Da Nang has land elevations which range from 3m to 7m above mean sea level. Most of the city drains either directly to the sea in Da Nang Bay and My Khe Beach, a popular tourist area, or indirectly via the Hanh River, which bisects the city. Flooding occurs during the wet season with flood depths of as much as 0.70m persisting for up to 48 hours in some areas of the city.

Until recently the drainage system was limited to the center of the city and comprised around 122km of covered rectangular curbside drains of stone, brick or concrete. Many of these drains were built in an ad-hoc fashion without due regard to hydraulic design and their overall interaction as a network. System capacity was further hampered by undersized connections under roads and the railway, water pipes and other utility services crossing the drains, siltation and garbage dumping.

Wastewater is discharged to storm water drains. An interceptor sewer system was completed in 2006 under the World Bank's "IDA Three Cities Sanitation Project". The project focused on the central and eastern parts of the city, where development is most dense and returns on investment highest. Works included rehabilitation of existing drains and provision of new large drain culverts, wastewater interceptor sewers and sewage pumping stations, together with four new wastewater treatment plants employing the anaerobic stabilization process.

2.2 Drainage System In The Ngu Hanh Son District (Study Area)

The drainage design identified in a drawing provided by the Da Nang Drainage Company is presented in Figure 2.1 and 2.2. The interceptor sewer system constructed under the World Bank project is shown in red (solid lines= gravity sewer, dashed lines = pressure mains) and solid green lines along the river indicate local gravity interceptor sewers (gravity). Existing drainage is shown in blue. Drainage improvements constructed or proposed under the World Bank project are shown in purple. Drainage identified for planning purposes is shown in dashed green.

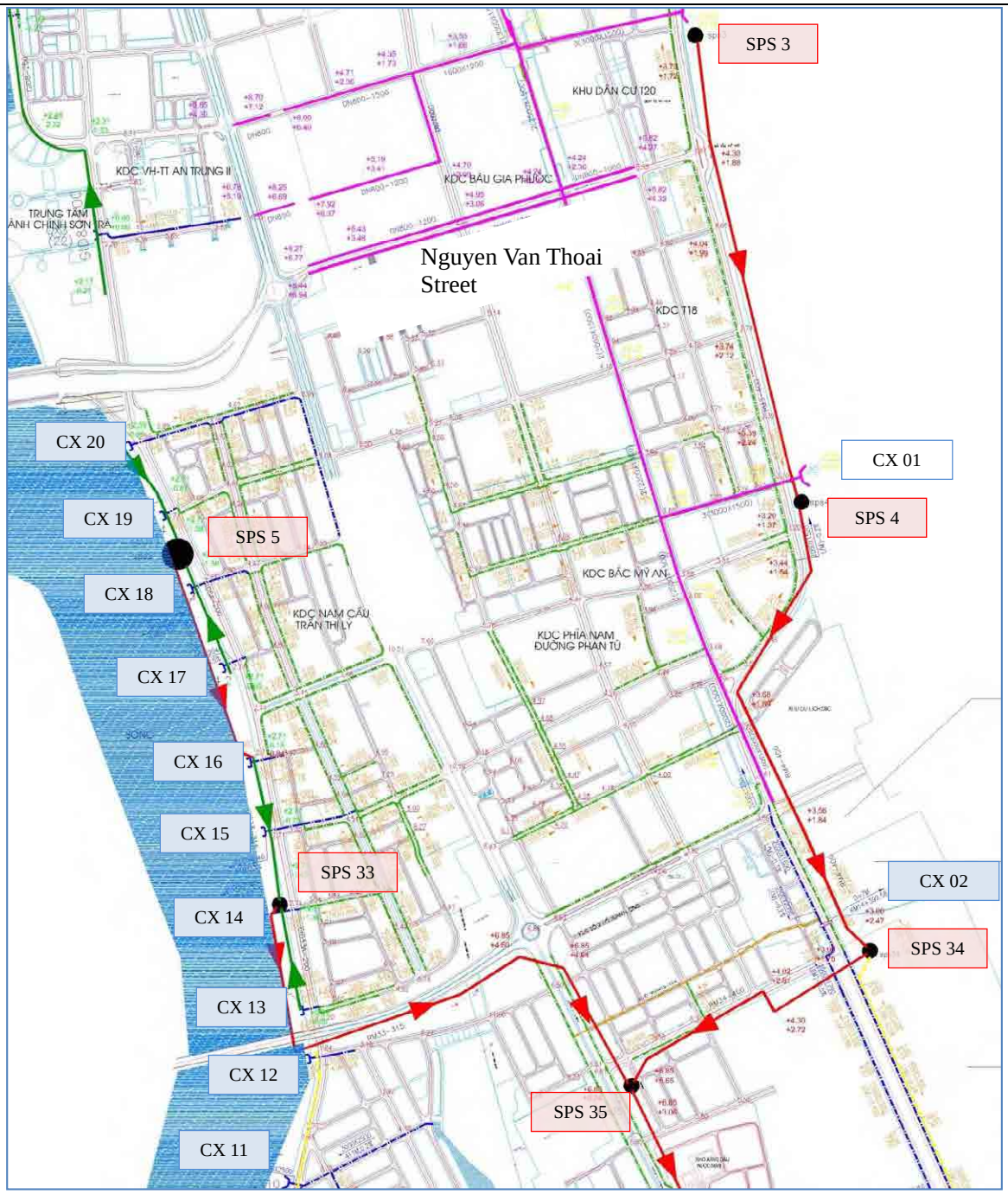


Figure 2.1 Location of Combined Sewer Outfalls and Interceptor (North Half)

Figure 2.2 Location of Combined Sewer Outfalls and Interceptor (South Half)

The boundaries of the Ngu Hanh Son drainage catchment are:

- Nguyen Van Thoai street and Hoa Hai precinct to the south
- Marble mountain (Lang Da Non Nuoc) to the north
- Truong Sa street to the east
- Hanh River to the west.
- The drainage area is divided into 2 subcatchments: east (565 ha) and west (231 ha). The two areas are separated by a ridge that runs from north to south along Ngu Hanh Son street and Le Van Hien street. From this ridge water drains east to the beaches along the Eastern Sea and west to into the Hanh Son river.

There are 20 drainage outfalls, 6 which discharge to the beaches along the Eastern Sea(CX01 –CX06). The other outfalls discharge to the Hanh Son river.

The following outfalls have diversion structures to intercept dry weather flow

- Outlet CX01 at SPS-4 (east side), also called the My An outlet (CX04 in the World Bank project)
- Outlet CX02 at SPS-34 (east side)

- Outlet CX13-16 at SPS-33 (west side south of Ho Xuang Huong Bridge)
- Outlet CX17-20 at SPS-5 (west side north of Ho Xuang Huong Bridge)

Outfall CX01 at SPS4 is equipped with a tide flap gate to prevent back flooding during high tides. Other outfalls are equipped with an overflow weir that diverts sewage to the interceptor system during dry weather.There are no diversion structures on the other drainage outfalls at this time

Figure 2.3 Combined Sewer Outfall CX01

Table 2.1

Outlet ID	Diversion structure ID	Channel Invert(2) (m)	Channel Depth	Crest(1) Elevation (m)	Weir Height(3) (m)
	SPS3	0.79	1.50	0.99	0.20
CX01	SPS4	0.72	1.50	0.92	0.20
CX02	SPS34	1.05	2.05	1.25	0.20
CX14	(SPS33/3)	0.30	2.04	0.60	0.30
CX17	(SPS5/2)	0.30	2.04	0.60	0.30
CX20	(SPS5/1)	0.30	1.00	0.60	0.30
CX18	(SPS5/1A)	0.30	1.00	0.60	0.30
CX19	(SPS5/2A)	0.30	1.00	0.60	0.30
CX16	(SPS33/1)	0.30	2.04	0.60	0.30
CX15	(SPS33/2)	0.30	2.04	0.60	0.30
CX13	(SPS33/1A)	0.30	1.35	0.60	0.30

(1) Data obtained from DDC Operational Manual for Wastewater Systems
(2) Invert levels taken from drawings
(3) Weir heights assumed. To be confirmed by DDC through field survey.

Diversion structures that have an invert level at or below 0.6 meters, have an overflow weir with a crest elevation of +0.60 meters above mean sea level.

The overflow weir is set higher at SPS-3 located along My Ke beach and CX01 and CX02 located at My Anh beaches where channel invert levels are higher.

2.3 Dry Weather Flows

Dry weather wastewater flows, used for calculating volumes and pollutant, are estimated on the basis of population and per unit flows identified in other studies.

Table 2.2 Estimated Wastewater Flow From Ngu Han Son District

Item	2010	2020	2030
Population	68,270	90,002	135,419
Total water consumption (lpcd)	166	185	221
Discharge of water to the sewerage system (lpcd)	133	148	177
Infiltration (lpcd)	30	25	9
Total wastewater flow (lpcd)	163	173	186
Total wastewater flow (m3)	11,128	15,570	25,188

Source: Study on wastewater management strategy in Da Nang City

Population by ward and information on population densities were not available to the study team. The total wastewater flow is divided and distributed to specific drainage outfalls on the basis of catchment area and assumed population densities.

Table 2.3 Estimated Dry Weather Flow By Drainage Outfall (2010).

Outlet	Interceptor pump stn.	Catchment Area (ha)	Population density(1) (pers./ha)	Population	Unit wastewater load (lpcd)	Flow m3/d	Flow m3/s
CX01	SPS4	161	100	16067	163	2619	0.030
CX02	SPS34	41	100	4100	163	668	0.008
CX02	SPS35	41	100	4100	163	668	0.008
CX03		59	100	5851	163	954	0.011
CX04		111	80	8893	163	1450	0.017
CX05		132	80	10594	163	1727	0.020
CX06		21	80	1671	163	272	0.003
CX07		9	80	749	163	122	0.001
CX08		24	80	1909	163	311	0.004
CX09		34	80	2726	163	444	0.005
CX10		25	80	2037	163	332	0.004
CX11		51	80	4049	163	660	0.008
CX12		9	80	718	163	117	0.001
CX13	SPS33	5	80	410	163	67	0.001
CX14	SPS33	12	80	974	163	159	0.002
CX15	SPS33	19	80	1484	163	242	0.003
CX16	SPS33	6	80	482	163	79	0.001
CX17	SPS5	3	80	217	163	35	0.0004
CX18	SPS5	11	80	854	163	139	0.002
CX19	SPS5	3	80	242	163	39	0.0005
CX20	SPS5	20	80	1594	163	260	0.003
Total		**796**		**69,717**		**11,364**	**0.132**
Diverted to interceptor		**321**				**4,975**	
Dry weather overflows		**475**				**6,389**	

Note: (1) Estimated by study team from field survey

About 40% of the Ngu Han Son district (321 ha) is covered by the interceptor system which captures about 45% (4,975) of the total wastewater generated during dry weather periods. Approximately 55% of the sewage is not intercepted.

Table 2.4 Estimated dry weather flow to interceptor pump stations

SPS	Catchment Area (ha)	Population density 2010 (Per/ha)	Wastewater load (lpcd)	Flow m^3/d	Flow m^3/s
SPS3	230	100	163	3749	0.043
SPS4	161	100	163	2619	0.030
SPS34	41	100	163	668	0.008
SPS5	36	80	163	474	0.005
SPS33	42	80	163	546	0.006
SPS35	41	100	163	668	0.008
Total	551			8724	0.146

Note SPS3 is located outside the Ngu Han Son catchment. It is collecting wastewater from Son Tra District and pumping it to SPS4.

2.4 Interceptor Sewer Design Philosophy

The newly constructed wastewater system (also referred to as the Interceptor System shown in red) has been deliberately designed as a “dry weather” system only and has a very limited capacity to deal with any additional wet weather flows

The design concept for the interceptor system aimed to provide maximum benefit against minimal costs. This was mainly due to budget limitations, but also important was the view that it would be better to provide small systems for all important urban settlements in Danang, rather than a perfect system for only a limited area.

A number of key design parameters were selected to reduce the cost of the interceptor system at the start of the project:

- The interceptor system was designed using flow estimates for the year 2010.
- Wastewater flows have no allowance for groundwater infiltration into the large drains
- A peak factor of only 1.2 was selected to size interceptor pipes and pumps. The low peak factor assumes that the drains will buffer the diurnal peaks in wastewater flow.
- Pump station civil works are based on flow estimates for the year 2020 and should be able to accommodate larger sized pumps and internal piping. In several cases, it will also be possible to fully integrate the standby pump in the operation cycle, thus increasing the capacity.
- Treatment plant effluent pipes are designed using average flow. Peak flows must be regulated by changing water levels in the anaerobic lagoons.

All of the design parameters listed above point in the same direction: They provide an inexpensive system with extremely limited capacity.

In a city where not much was known about wastewater flows and especially how they would develop in the future, it made sense not to immediately install a very expensive system. The present system was designed as a first step, to give Danang a chance to experience a wastewater system and to get a feel for where the larger wastewater flows would come from.

2.5 Interceptor Sewer Operation

During dry weather, all wastewater is directed to the drainage system and flows into the diversion chambers located at the end of the drains. From the diversion chambers, the wastewater is pumped to the new wastewater interceptor system and conveyed to the wastewater treatment plants.

The overflow weir provides two functions:

- it diverts the flow of wastewater during dry weather into the pumping station and
- it prevents the sea or river from flowing back into the drainage system during periods of high water levels.

When the tide (or river water level) is higher than the crest of the overflow weir, the water enters the diversion chambers and the pumping stations are automatically switched off to prevent pumping large amounts of diluted wastewater to the treatment plants and to protect the biological process from salt water.

During wet weather, the mixture of storm water and wastewater is conveyed by the drains to the diversion chambers. The mixed flow is diverted to the interceptor and conveyed to the treatment plant as long as the amount does not exceed the capacity of the interceptor system . If the rainfall is significant the mixed flow in the drain will eventually overflow the diversion weir and the pumping station will shut down automatically. These “combined sewer overflows” (CSO) have a negative impact on water quality and aesthetics along the beaches.

2.6 Combined Sewer Overflows Observed During the First Field Assignment

A short duration rainfall was observed by the study team on July 20, 2012. Records obtained from the Da Nang airport meteorological station show that 4.5mm of rain fell in 48 minutes (5mm/hr). The event was a typical July thunderstorm.

An overflow of combined sewage was observed from the diversion structure at SPS 3 (My Khe beach) as well as other locations along Da Nang bay. The fact that such a low intensity short duration storm resulted in a CSO event indicates that the interceptor system really has very little capacity to absorb any wet weather flow.

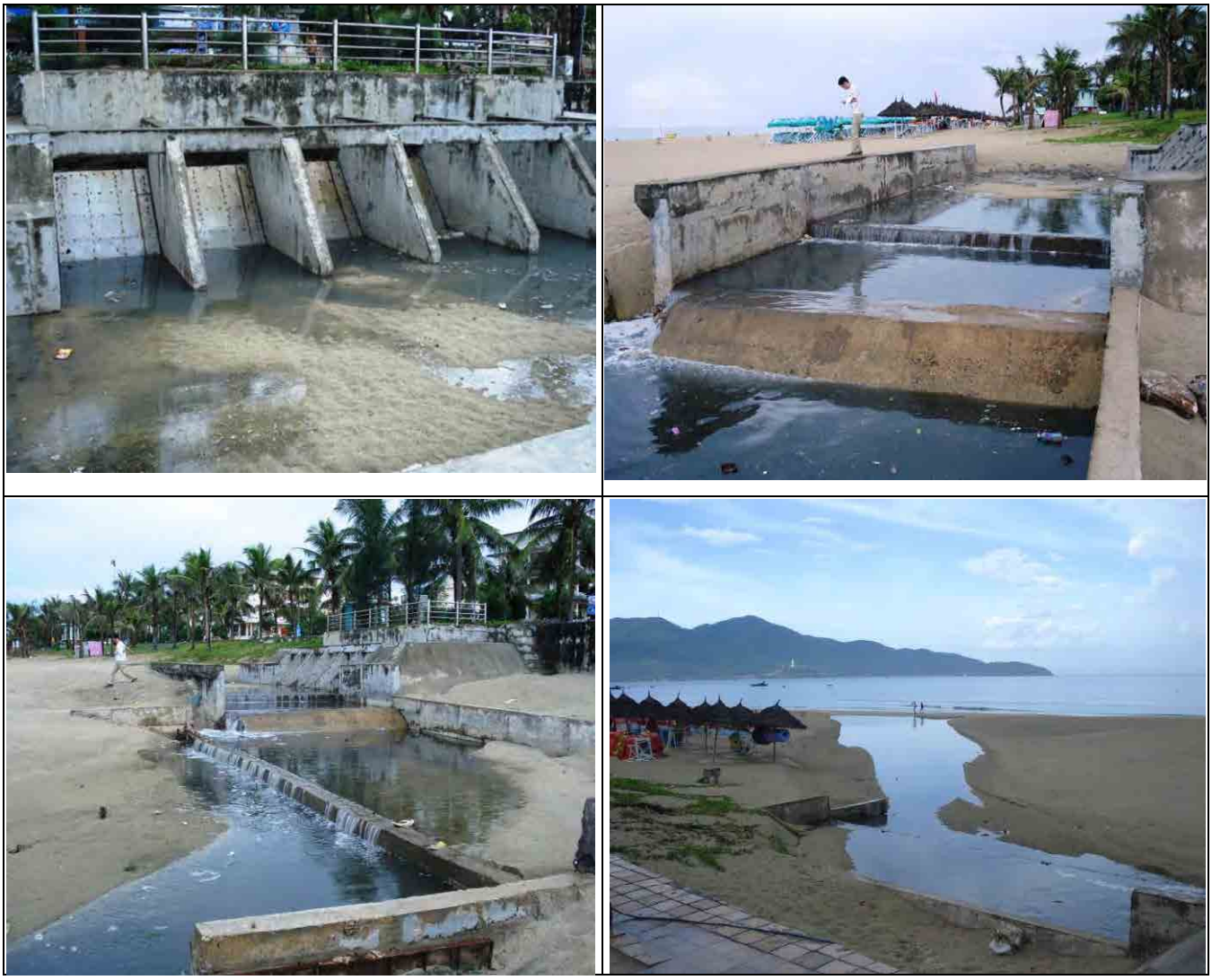


Figure 2.4 Combined Sewer Outfall at SPS-3 (My Khe Beach July 20, 2012)

3 Drainage design

3.1 Precipitation

The average annual rainfall in Da Nang is 2561 mm (for the 30 year period 1976-2006), distributed unevenly through the year. Approximately 75 percent of the rainfall occurs during the main rainy season from September to December.

The wettest month is October with an average total rainfall of 654 mm. The driest month is March with an average total rainfall of 22 mm.

Table 3.1 Summary of Daily Rainfall Data for 1976-2006

Month	Mean Total Rainfall (mm)	Mean no. of wet days
January	73	18
February	25	11
March	22	12
April	35	12
May	99	13
June	104	12
July	82	12
August	147	16
September	335	18
October	654	24
November	465	24
December	220	24
Total	2,561	196

Source World Bank Policy Research Working Paper No. 5491, December 2010. The daily rainfall data are obtained from Vietnam's Hydro Meteorological Data Center

The study team obtained hourly rainfall records for the period 2007-2011 in digital format from the Da Nang Airport Meteorological Station (Station ID. No. 48855).

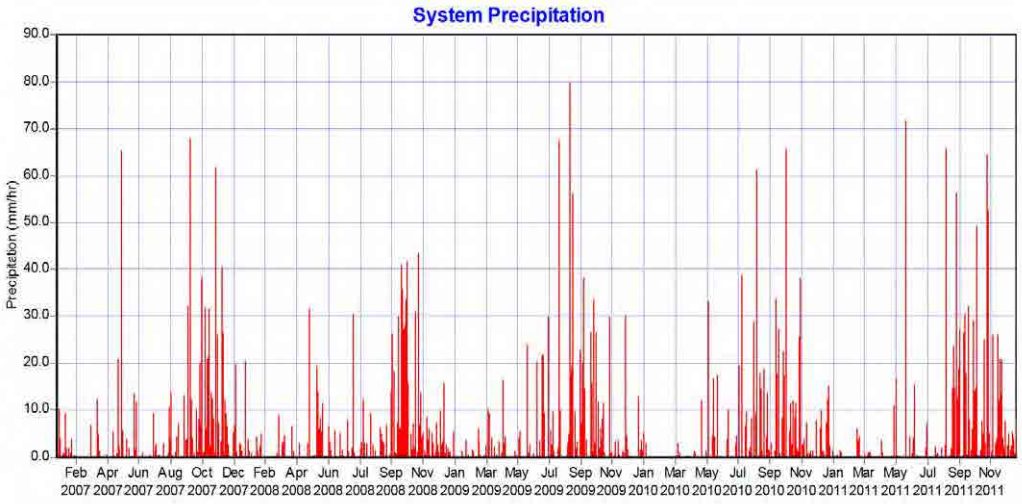


Figure 3.1 Rainfall Record for Da Nang 2007-2011
(Station 48855 Vietnamese Hydro Meteorological Service)

Table 3.2 provides a breakdown of the total annual rainfall for the 2007-2011 record period. The year 2008 generated a total that is close to the average for the 30 year record.

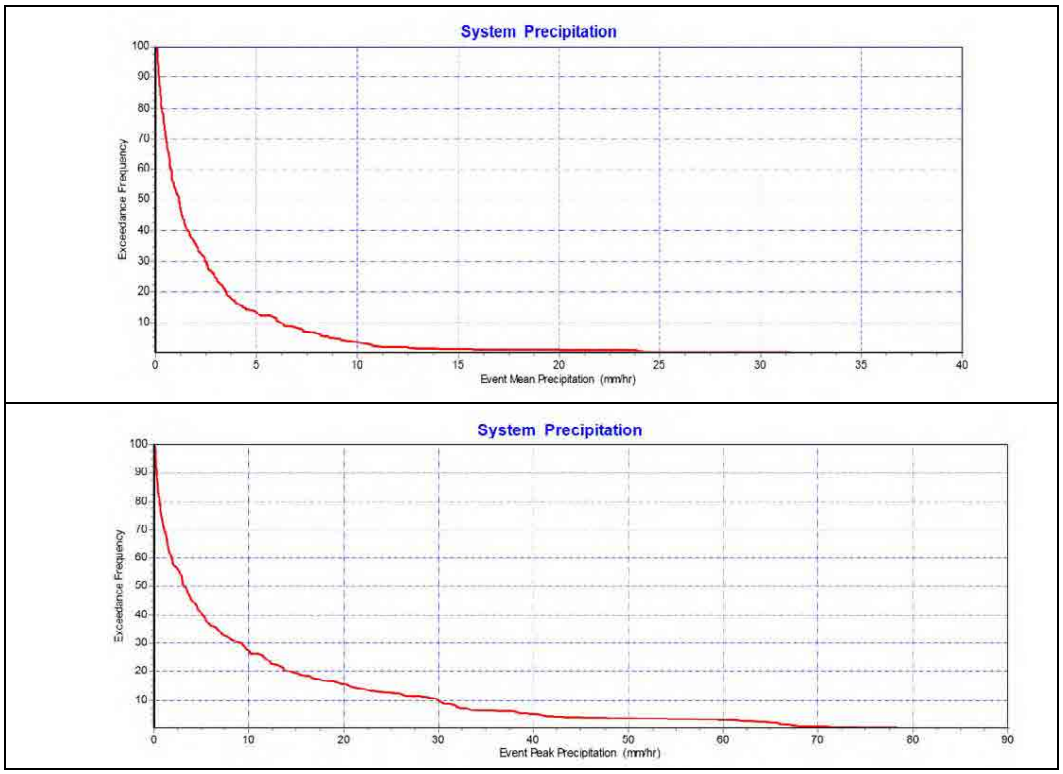
Table 3.2 Summary of Total Rainfall for 2007-2011

Year	Total rainfall (mm)	Total duration (hours)
2007	3107	993
2008	2551	1124
2009	3041	938
2010	2268	789
2011	3716	1110

The hourly rainfall record was analyzed using the statistical reporting tools in the EPA SWMM model. An average inter-event separation time of 24 hours was selected to separate rainfall into discrete events.

A total of 322 rainfall events occurred over the 5 year period. Plots of exceedance frequencies for various parameters, presented in Figure 3.2, indicate that most rainfall events are low intensity, low volume and of longer duration.

- Average rainfall: 90 % ≤ 6 mm/hr.
- Total rainfall: 90% ≤ 60 mm or less and 80 % ≤18mm.
- Peak intensity: 90% ≤ 30 mm/hr.
- Duration: 90 % ≤ 100 hours and 80% ≤ 50 hours



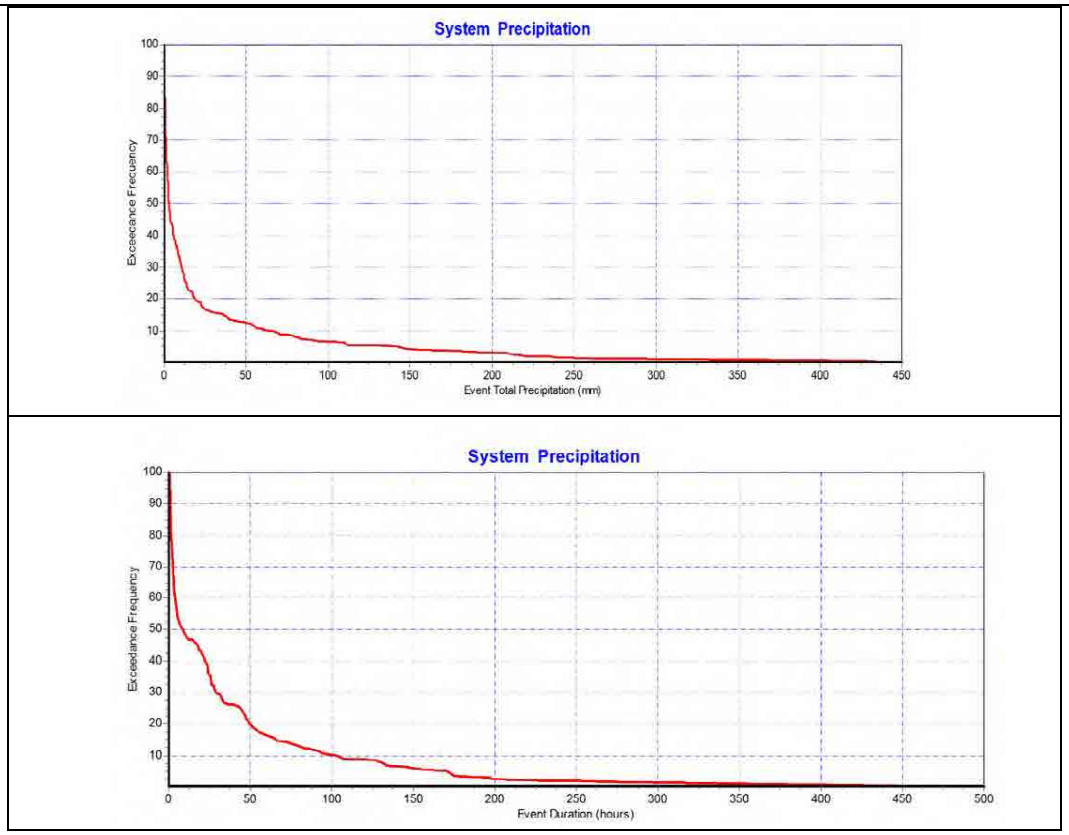


Figure 3.2 Exceedance Frequencies for rainfall events (source: JICA Study Team)

3.2 Rainfall Intensity Duration Curves

Vietnamese Standard (TCVN 7957-2008) provides the following equation for rainfall intensity:

$$q = \frac{A\,(1 + C \lg P)}{(t+b)^n}$$

In which :

- q - rainfall intensity (l/s.ha)
- t - rainfall duration (min)
- P – calculated rain recurrence interval (years)

A, C, b, n are coefficients that are based on historical rainfall records and vary for each locality . The standard specifies the following coefficients for DaNang city:

- A = 2170
- C = 0.52
- b = 10
- n = 0.65

The formula generates rainfall intensities for different durations and return periods which are used to create rainfall-intensity-duration (IDF) curves. The IDF curves are used to design drainage infrastructure using the rational method.

For a large city like Da Nang the Vietnamese design standard (TCVN 7957-2008) recommends the following return periods for drainage works:

- minor drains: 2 years
- major drains: 5 years
- major canals: 10 years

Table 3.3 Rainfall Intensity (mm/hr)

Time (hours)	Return period P			
	2	5	10	25
0.25	111.5	131.5	146.6	166.5
0.5	82.2	96.8	108.0	122.7
1	57.1	67.3	75.0	85.3
2	38.2	45.0	50.2	57.0
3	29.8	35.2	39.2	44.6
4	25.0	29.4	32.8	37.3
6	19.4	22.8	25.4	28.9
12	12.4	14.7	16.4	18.6
24	8.0	9.4	10.5	12.0

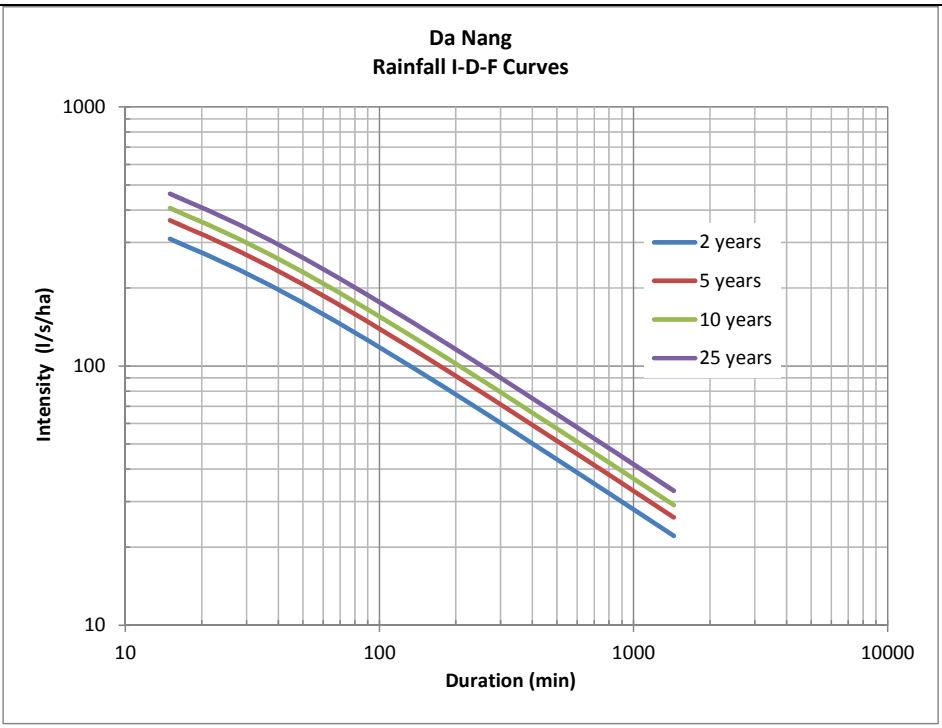


Figure 3.3 Rainfall Intensity Duration Frequency Curves for Da Nang

3.3 Design Storm

A synthetic design storm hyetograph is derived from the rainfall IDF curves by using the alternating block method with an advancement coefficient of 0,5 (i.e. the peak occurs at the middle of the storm).

The selection of a suitable duration for the design storm depends on the size of the urban area and on the typical rainfall experienced in the area. For the design of drainage conveyance systems in Vietnam the recommended duration of the design storm varies between 3 and 6 hours.

Analysis of hydraulic performance using the SWMM model is based on a 6 hour design storm with 30 minute intervals and a 5 year return period. The precipitation hyetograph has a peak intensity of 108 mm/hr (54mm in 30 minutes). The total depth of the storm is 136 mm and is equal to the area under the hyetograph.

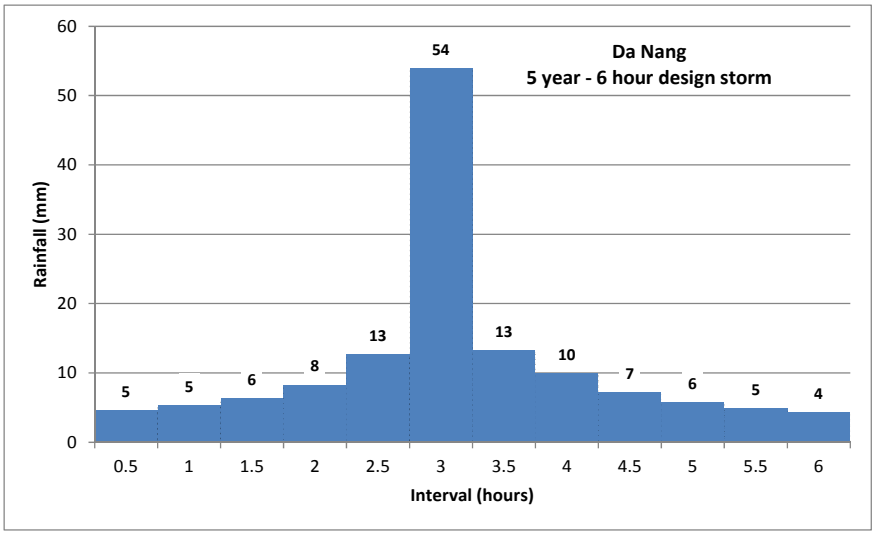


Figure 3.4 - 6 hour-5 year Design Rainfall Hyetograph for Da Nang

3.4 Tides and River Water Level

Tidal influences have an adverse impact on drainage and the operation of the interceptor sewer system.

Da Nang has two high tides each day with different heights (and two low tides also of different heights); this pattern is called a mixed semi-diurnal tide. Each month the highest tide occurs on full moon day and the lowest tide occurs when the moon reaches first quarter.

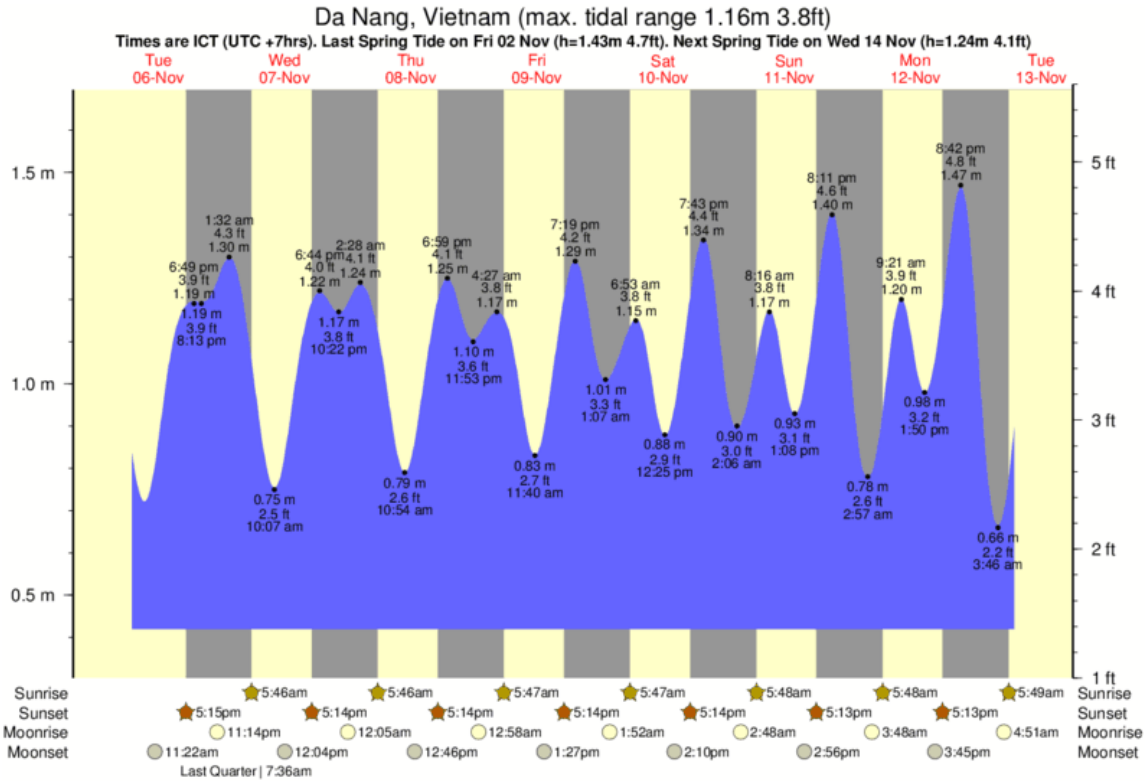


Figure 3.5 Semi-diurnal tide pattern

Every year the highest sea levels occur during the wettest months of October and November.

A review of daily tide data for 2011 obtained from Saigon Port website provides the following information:

- maximum high tide+1.7m, minimum high tide+0.7m
- maximum low tide+1.3m, minimum low tide+0.2m
- average for October (wettest month): high tide +1.3m, low tide +0.7m
- average for March (driest month): high tide +1.1m, low tide +0.6m

Tide data for 2011 indicates that there are several days per year where the low tide remains above the crest of the overflow weir in the diversion structures:

- 172 days low tide > 0.60m (affecting SPS-5 and SPS-33 along Han River)
- 017 days low tide > +0.92m (affecting operation of SPS 4 at My Anh beach)

The interceptor pumping system is frequently shut-down by the semi diurnal high tides:

- 295 days high tide >0.60m (affecting SPS-5 and SPS-33 along Han River)
- 323 days high tide >0.92m (affecting operation of SPS 4 at My Anh beach)
- 236 days high tide >1.00m (affecting operation of SPS 3 at My Khe beach)
- 063 days high tide >1.20m ((affecting operation of SPS 34 at Furano resort)

Tidal influence is simulated in the SWMM model for the analysis of hydraulic performance using a single rainfall event. The following average tide patterns are used for evaluating the hydraulic performance of the drainage outfalls located along the Eastern Sea:

Table 3.4 Tidal Patterns

Tide 1: wet season	1	2	3	4
Stage (m)	1.3	0.7	1.2	1.1
Time	2:30	11.15	20:00	22.30
Tide 2: dry season	1	2	3	4
Stage (m)	0.6	1.1	0.6	1.1
Time	2:30	9:00	15:15	21:30

Water levels in Han river fluctuate with tides but can also be affected by heavy rainfall and storm surges brought on by typhoons.

The design high water level for the Hanh River adopted by the World Bank Project for drainage improvements in the Ngu Hanh Son district is +1.75m above MSL which is +0.4m above the design high tide of 1.35m thereby indicating a backwater effect.

The following tide patterns are used for evaluating the hydraulic performance of the drainage outfalls located along the Hanh River:

Table 3.5 River Stage Patterns

Tide 3: wet season	1	2	3	4
Stage (m)	1.7	1.1	1.6	1.5
Time	2:30	11.15	20:00	22.30
Tide 4: dry season	1	2	3	4
Stage (m)	1.0	1.5	1.0	1.5
Time	2:30	9:00	15:15	21:30

4 Assessment of hydraulic performance

4.1 Model Set-up

4.1.1 Network

Single event analysis using the SWMM model is carried out to test the hydraulic capacity of the drainage system to a single 6 hour storm with a 5 year return period. Dry weather flows are excluded from the analysis of hydraulic performance because they are relatively insignificant (hydraulically) compared to the amount of storm water.

The drainage network model is based on an AutoCAD drawing provided by Da Nang Drainage Company. Sizes, shapes, invert elevations and ground elevations are taken off the drawing.

Only the major drains leading to the outfalls along the sea have been modeled for hydraulic capacity. These are CX01, CX02, CX03 CX04 and CX05.

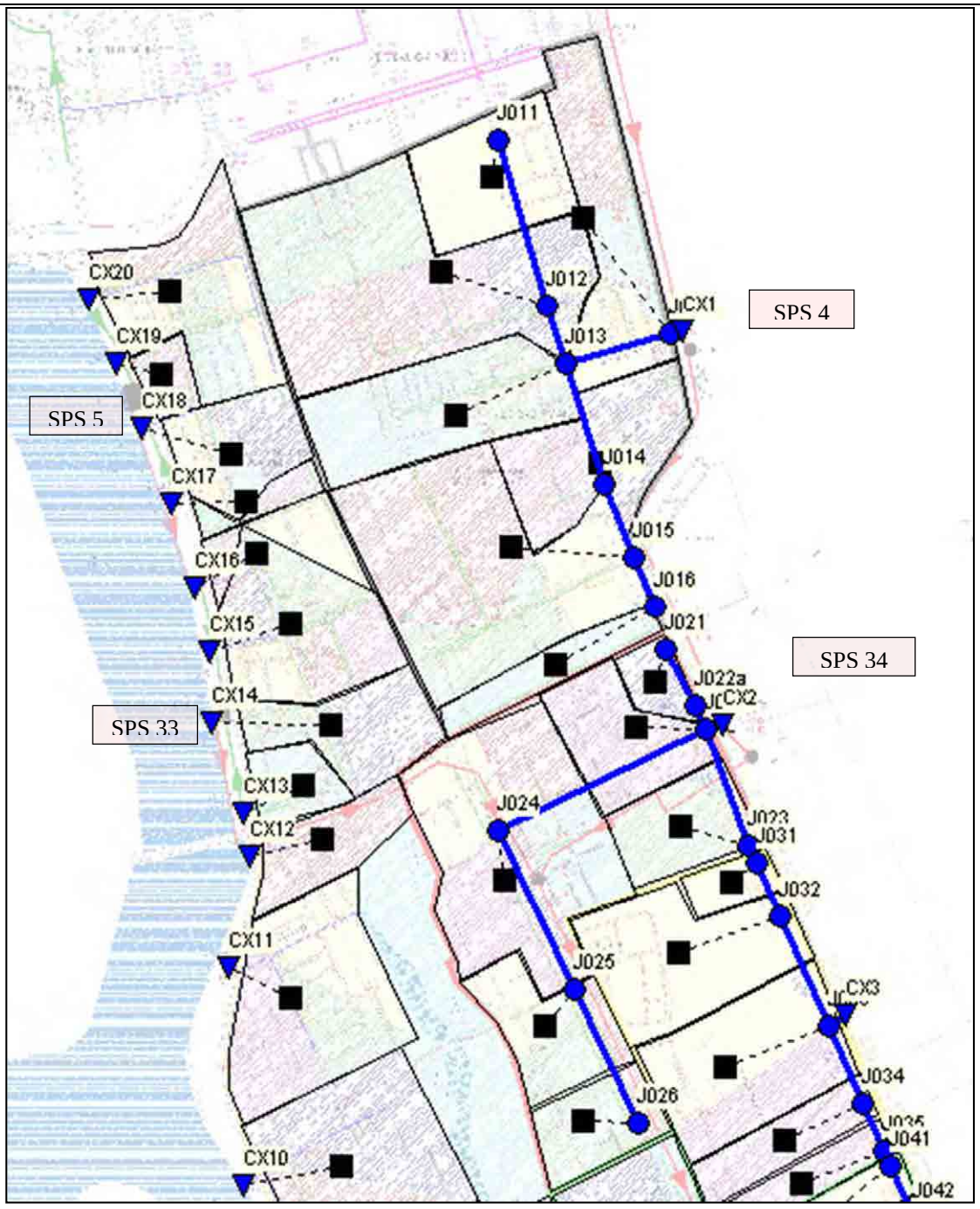


Figure 4.1 Drainage Network in Ngu Han Son (North Half)

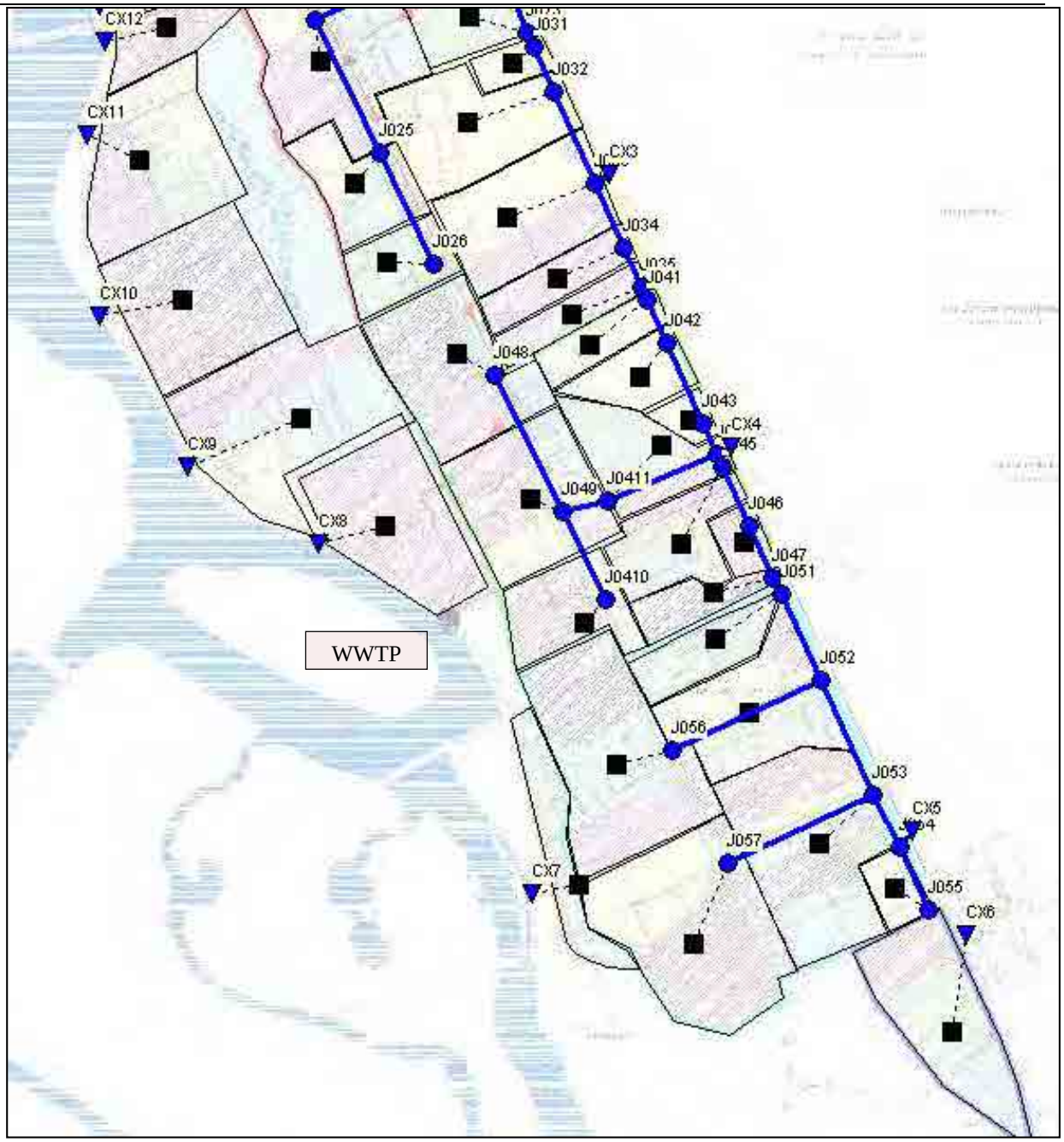


Figure 4.2 Drainage Network in Ngu Han Son (South Half)

4.1.2 Sub-catchments

The study area is divided into 20 sub-catchments that correspond to the 20 drainage outfalls identified in Figure 4.1 and 4.2. Catchment boundaries are based on topography and the physical location of the drains tributary to each outlet.

Table 4.1 Sub-Catchment Properties For SWMM Model

Property	Value	Property	Value
Area	Determined from AutoCAD drawing	Depression storage impervious areas	2 mm
Width	calculated by measuring the average overland flow path	Depression storage pervious areas	5 mm
Slope	area weighted average based on topographic contours and spot elevation	% of impervious area without depression storage	25 %
Imperviousness	60%	Horton maximum infiltration rate	assuming sandy clay fully drained but not dry 25 mm/hr.
Roughness coefficient, impervious areas	0.012	Horton minimum infiltration rate	1.3 mm/hr.
Roughness coefficient, pervious areas	0.13	Infiltration decay coefficient	2 hr^{-1}

4.1.3 Land Use

Proposed land use, zoning and target densities were not available to the study team therefore the following future land use mix was assumed for each sub-catchment:

- Residential: 15%
- Mixed residential: 30%
- Commercial: 15%
- Mixed commercial: 15%

Table 4.2 Percent Imperviousness By Land Use

Land use	Code	% of Total Area	% Imperviousness*
Residential	R1	15%	40%
Mixed Residential	MR	30%	50%
Commercial	C1	15%	85%
Mixed Commercial	MC	15%	75%
	Total	75%	60%**

* estimated by field survey of built up areas in Da Nang
** weighted average

Land use designations correspond to those used in the National Surface Water Quality Database (USA) and are chosen to provide a reference point for setting of pollutant concentrations.

4.1.4 Tide

The hydraulic performance of the system is carried out assuming average tide conditions during the wet season:

- Tide 1on Eastern sea and
- Tide 3 water levels for Han River

4.1.5 Rainfall

The drainage system is tested with the design storm (6 hour 5 year return period). The rainfall starts at 18:30 to have the peak rainfall coincide with the high tide to create a worst case scenario.

4.1.6 Flow routing

Dynamic wave calculations are used to route the runoff through the conveyance system. This method can simulate all gradually-varied flow conditions observed in urban drainage systems such as backwater, surcharged flow and flooding.

4.2 Hydraulic Analysis Summary

The SWMM model was used to simulate a 6 hour rainfall event identifies flooding and surcharge conditions in the drainage conveyance system. Flooding refers to all water that overflows a node unto the surface. Surcharging occurs in closed conduits and junction nodes when water rises above the top of the highest conduit.

Table 4.3 Node Flooding Summary

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
J015	0.20	2.055	0 19:59	0.712	2.00
J016	0.20	1.841	0 19:48	0.339	1.79
J051	0.01	0.663	0 19:48	0.015	1.89
J052	0.30	7.257	0 19:59	5.474	2.07
J056	0.01	1.430	0 19:49	0.015	3.06

Table 4.4 Node Surcharging Summary

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
J012	JUNCTION	0.17	0.482	0.348
J013	JUNCTION	0.33	0.383	0.737
J014	JUNCTION	0.27	0.575	0.145
J015	JUNCTION	0.27	0.500	0.000
J016	JUNCTION	0.23	0.290	0.000
J051	JUNCTION	0.20	0.370	0.000
J052	JUNCTION	0.34	0.220	0.000
J056	JUNCTION	0.23	1.560	0.000
J048	JUNCTION	0.07	0.087	0.563
J024	JUNCTION	0.13	0.123	1.987

Table 4.5 Conduit Surcharging Summary

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C011	0.01	0.01	0.01	0.03	0.01
C012	0.17	0.17	0.18	0.61	0.02
C013	0.01	0.01	0.01	1.83	0.01
C014	0.01	0.01	0.01	7.45	0.01
C015	0.23	0.23	0.23	0.01	0.01
C016	0.27	0.27	0.27	0.73	0.26
C017	0.27	0.27	0.27	0.76	0.26
C021	0.01	0.01	0.01	2.51	0.01
C024	0.01	0.01	0.01	0.20	0.01
C025	0.01	0.01	0.01	0.39	0.01
C045	0.01	0.01	0.01	0.65	0.01
C0410	0.01	0.01	0.01	0.08	0.01
C052	0.20	0.20	0.20	0.01	0.01
C057	0.23	0.23	0.24	0.01	0.01
C053	0.34	0.34	0.34	0.01	0.01
C054	0.01	0.01	0.01	0.71	0.01
C046	0.01	0.01	0.01	0.51	0.01

4.2.1 Drains Connected to Outfall CX01

Surcharging occurs in all conduits (C011 to C017). Surcharge conditions last for a maximum of about 16 minutes Surcharging occurs at nodes J013, J014, J015 and J016. Flooding occurs at node J15 and J16 for 12 minutes.

Table 4.5 Details of Major Drains Connected To Outfall CX01

Link	Node U/S	Node D/S	Shape	Depth m	Width m	No. of barrels	Manning's n
C011	J011	J012	Rect_Closed	1.5	2.0	2.0	0.013
C012	J012	J013	Rect_Closed	1.5	2.2	2.0	0.013
C013	J013	J017	Rect_Closed	1.5	3.0	3.0	0.013
C014	J017	CX01	Rect_Closed	1.5	3.0	3.0	0.013
C015	J016	J015	Rect_Closed	1.5	2.0	2.0	0.013
C016	J015	J014	Rect_Closed	1.5	2.0	2.0	0.013
C017	J014	J013	Rect_Closed	1.5	2.5	2.0	0.013

Table 4.6 Details of Junction Nodes For Drains Connected To Outfall CX01

Node	Invert (m)	Ground (m)	Max Depth (m)
J011	2.27	4.50	2.23
J012	1.56	3.89	2.33
J013	1.06	3.68	2.62
J014	1.46	3.68	2.22
J015	1.68	3.68	2.00
J016	1.90	3.69	1.79
J017	0.73	3.28	2.55

4.2.2 Drains Connected to Outfall CX02

A small amount of surcharging occurs in conduits C021, C024 and C025 but it has no significant impact on capacity. Surcharging occurs at node J024 but only for a very short period of 8 minutes. There is no flooding.

Table 4.7 Details of Major Drains Connected To Outfall CX02

Link	Node U/S	Node D/S	Shape	Depth m	Width m	No. of barrels	Manning's n
C021	J022	CX02	Rect_Open	2.05	7.0	1	0.013
C022	J021	J022a	Rect_Closed	1.6	2.0	1	0.013
C022a	J22a	J22	Rect_Closed	2.05	3.5	1	0.013
C023	J023	J022	Rect_Closed	1.3	1.3	1	0.013
C024	J024	J022	Rect_Open	1.5	3.6	1	0.013
C025	J024	J025	Rect_Open	1.5	2.0*	1 on each side of the road	0.013
C026	J025	J026	Rect_Open	1.0	1.5*	1 on each side of the road	0.013

Note: *indicates that value is assumed because the size is not indicated on drawings

Table 4.8 Details of Junction Nodes for Drains Connected To Outfall CX02

Node	Invert (m)	Ground (m)	Max Depth (m)
J021	1.79	3.60	1.81
J022	2.06	3.83	1.77
J022a	1.20	3.40	2.20
J023	4.57	6.00	1.43
J024	2.90	6.51	3.61
J025	3.90	6.73	2.83
J026	4.80	6.90	2.10

4.2.3 Drains Connected to Outfall CX03

There is no surcharging or flooding reported for this portion of the network.

Table 4.9 Details of Major Drains Connected To Outfall CX03

Link	Node U/S	Node D/S	Shape	Depth	Width	No. of barrels	Manning's n
C031	J033	CX03	Rect_Open	2.0	4.0	1.0	0.013
C032	J031	J032	Rect_Closed	1.3	1.5	1.0	0.013
C033	J032	J033	Rect_Closed	1.8	2.0	1.0	0.013
C034	J034	J035	Rect_Closed	1.6	1.5	1.0	0.013
C035	J033	J034	Rect_Closed	2.0	2.0	1.0	0.013

Table 4.10 Details Of Junction Nodes For Drains Connected To Outfall CX03

Node	Invert (m)	Ground (m)	Max Depth (m)
J031	4.57	6.00	1.43
J032	3.84	5.64	1.80
J033	2.50	4.97	2.47
J034	3.30	5.30	2.00
J035	3.45	5.47	2.02

4.2.4 Drains Connected to Outfall CX04

A small amount of surcharging occurs in conduit C045, C046 and C0410 but it has no significant impact on capacity. Minor surcharging occurs at node J048 but there is no flooding.

Table 4.11 Details of Major Drains Connected To Outfall CX04

Link	Node U/S	Node D/S	Shape	Depth m	Width m	No. of barrels	Manning's n
C041	J044	CX04	Rect_Open	2.13	5.0	1	0.013
C042	J041	J042	Rect_Closed	1.5	1.5	1	0.013
C043	J042	J043	Rect_Closed	1.65	2.0	1	0.013
C044	J043	J044	Rect_Closed	2.13	2.0	1	0.013
C045	J048	J049	Rect_Open	1.2*	1.2*	2	0.013
C046	J044	J0411	Rect_Open	2.0*	1.8*	3	0.013
C047	J046	J047	Rect_Closed	1.56	1.5	1	0.013
C048	J045	J046	Rect_Closed	1.81	2.0	1	0.013
C049	J044	J045	Rect_Closed	2.17	2.0	1	0.013
C0410	J049	J0410	Rect_Open	1.0*	0.8*	2	0.013
C0411	J0411	J049	Trapezoid*	1.5*	2.0*	1	0.013

Note: *indicates that value is assumed because the size is not indicated on drawings

Table 4.12 Details Of Junction Nodes For Drains Connected To Outfall CX04

Node	Invert (m)	Ground (m)	Max Depth (m)
J041	3.45	5.47	2.02
J042	3.35	5.07	1.72
J043	2.55	4.68	2.13
J044	1.98	4.43	2.45
J045	2.49	4.69	2.20
J046	2.83	4.70	1.87
J047	3.15	5.00	1.85
J048	4.71	6.56	1.85
J049	3.67	6.61	2.94
J0410	4.34	7.86	3.52
J0411	3.19	5.19	2.00

4.2.5 Drains Connected to Outfall CX05

Surcharging occurs in conduit C052, C053, C054 and C057 but it has no significant impact on capacity.

Surcharging is occurs at node J051, J052 and J056 for a maximum of 20 minutes. Flooding only occurs at node J051 but only for 13 minutes.

Table 4.13 Details of Major Drains Connected to Outfall CX05

Link	Node U/S	Node D/S	Shape	Depth m	Width m	No. of barrels	Manning's n
C051	J054	CX05	Rect_Open	2.30	3.0	1	0.013
C052	J051	J052	Rect_Closed	1.52	2.0	1	0.013
C053	J052	J053	Rect_Closed	1.85	2.5	1	0.013
C054	J053	J054	Rect_Closed	2.04	3.0	1	0.013
C055	J054	J055	Rect_Closed	2.37	2.5	1	0.013
C056	J057	J053	Rect_Closed	2.50	2.5	1	0.013
C057	J056	J052	Rect_Closed	1.50	2.9*	1	0.013

Note: *indicates equivalent size of one conduit to replace two parallel conduits of different widths

Table 4.14 Details Of Junction Nodes For Drains Connected To Outfall CX05

Node	Invert (m)	Ground (m)	Max Depth (m)
J051	2.94	4.83	1.89
J052	2.30	4.37	2.07
J053	1.89	4.71	2.82
J054	1.04	3.82	2.78
J055	3.20	5.23	2.03
J056	3.36	6.42	3.06
J057	4.00	6.48	2.48

4.3 Conclusion for Hydraulic Analysis

It can be concluded that the drainage system performs well even under the worst case scenario where the peak of the storm coincides with the high tide.

Peak surcharging and minor flooding occurs 3 hours after the start of the storm when the peak rainfall intensity coincides with the high tide. Surcharging and flooding do not last long and flows subside quickly as the peak rainfall intensity passes.

5 Continuous Simulations For Assessing Pollutant Loads

Continuous simulations were carried out in order to evaluate the potential benefits of a separate sewer system in the reduction of pollutant loads.

The simulation uses a digital hourly rainfall record for the year 2008 (366 days). This year was selected because it provides a total rainfall that is close to the average.

- Total rainfall: 2503 mm
- Total number of rainfall events: 73
- Event separation time: 24 hrs
- Maximum rainfall intensity: 43.6 mm/hr
- Mean rainfall intensity 6.74 mm

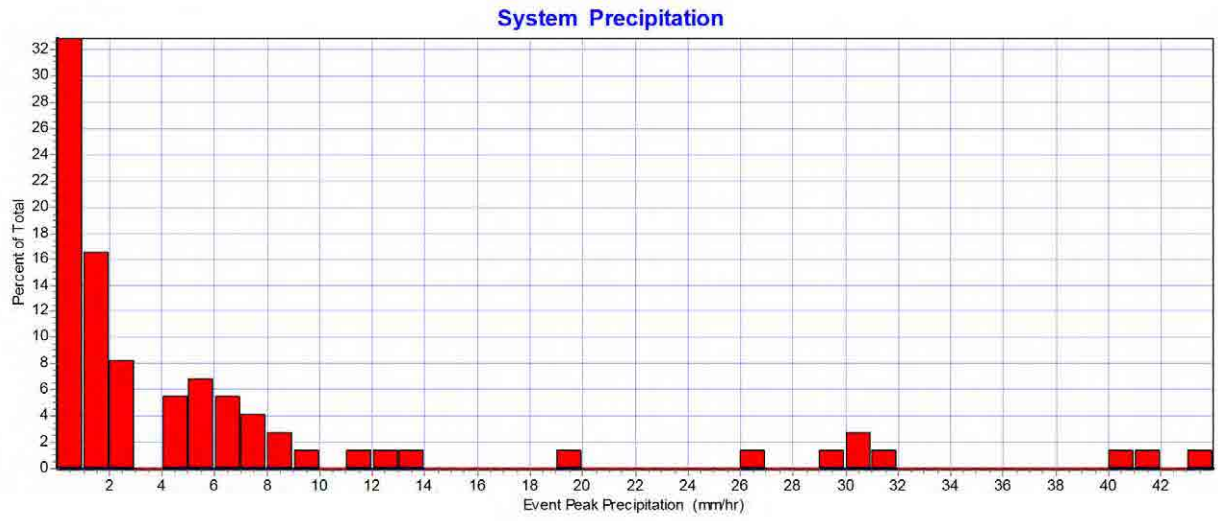


Figure 5.1

5.2 Separate Drainage System

The separate sewer system is the same drainage system modeled under the single event and depicted in Figure 4.1 and 4.2. The analysis assumes that all wastewater flow would be discharged to a separate wastewater collection system.

Tidal effects are ignored for this analysis of pollutant loads since they have no impact on the operation of sewage pump stations in a completely separate system.

A total of five pollutants are selected with different values for each type of land use category. Event mean concentrations (EMC) are used because there is insufficient data to estimate exponential curves for the decay of pollutants over the duration of the event (e.g. first flush). The use of EMC values assumes that each pollutant has a constant runoff concentration throughout the simulation

Table 5.1 Event Mean Concentrations for Selected Storm water Quality Parameters

Land Use	TSS mg/l	BOD mg/l	COD mg/l	TKN mg/l	TP mg/l
R1	49	9	55	1.5	0.31
MR	66	7.8	43	1.4	0.28
C1	43	11	58	1.5	0.22
MC	55	9	60	1.4	0.26

Source: Summary of Available Storm Water Data Included in NSQD, version 1.

Pollutant loads generated by the treatment plant effluent are added to the load generated by storm water outfalls to get a total annual loading. Wastewater flows (dry weather) and treatment plant effluent are given per unit pollutant loads shown in Table 5.2 . Pollutant loads in the treated effluent are based on criteria specified in Vietnamese Standard TCVN 7222:2002 class II assuming advanced wastewater treatment systems. Total inflow to the treatment plant is based on wastewater estimates for 2010

Table 5.2 Unit Pollutant Loads

	TSS mg/l	BOD mg/l	Total N mg/l	Total P mg/l	Total Coliform MPN/100ml
Raw sewage (1)	230	200	35	8	10^7
Surface runoff(2)	56	9	1.4	0.3	26×10^3
Treated sewage(3)	20	20	22	8	10^3

Note 1: Study on wastewater management strategy in Da Nang City

Note 2: Weighted average based on event mean concentrations assumed for land use

Note 3: Standard TCVN 7222:2002 class II. Assumes upgrading from anaerobic lagoons to advanced treatment process with disinfection

The continuous simulation produces storm water pollutant loadings for each outfall as presented in Table 5.3. The total annual runoff volume for the selected rainfall series is about 15,416, 870 m^3

Table 5.3 Annual Outfall Pollutant Loads For Separate Storm Water System.

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CMS	Max. Flow CMS	Total Volume 10^6 ltr	Total TSS kg	Total BOD kg	Total COD kg	Total TKN kg	Total TP kg	Total FC LogN
CX1	40.75	1.054	17.792	2994.931	124246.671	19861.654	115340.099	3206.366	601.194	14.244
CX2	99.99	0.267	10.969	1964.329	76391.972	12211.763	70915.845	1971.406	369.639	14.033
CX3	77.42	0.264	8.360	1505.414	62414.066	9977.302	57939.939	1610.686	302.004	13.945
CX4	75.73	0.394	12.388	2124.736	88307.668	14116.566	81977.370	2278.908	427.295	14.096
CX5	71.54	0.493	15.244	2468.154	102766.364	16427.885	95399.600	2652.035	497.257	14.162
CX6	62.18	0.089	2.299	400.831	16636.676	2659.483	15444.083	429.334	80.500	13.371
CX7	55.69	0.045	1.046	181.346	7528.642	1203.503	6988.955	194.288	36.429	13.027
CX8	53.77	0.123	2.801	465.163	19346.680	3092.695	17959.821	499.269	93.613	13.437
CX9	64.62	0.142	3.804	658.143	27325.403	4368.147	25366.593	705.172	132.220	13.587
CX10	64.00	0.106	2.811	491.194	20385.106	3258.694	18923.808	526.067	98.638	13.459
CX11	53.96	0.122	2.795	464.471	19317.289	3087.997	17932.537	498.511	93.471	13.436
CX12	48.70	0.051	1.054	175.349	7292.472	1165.750	6769.714	188.193	35.286	13.013
CX13	43.20	0.033	0.605	99.767	4151.650	663.670	3854.048	107.140	20.089	12.768
CX14	52.09	0.064	1.414	237.146	9860.420	1576.253	9153.579	254.462	47.712	13.144
CX15	54.31	0.094	2.161	361.717	15041.350	2404.460	13963.117	388.164	72.781	13.327
CX16	47.67	0.035	0.698	116.704	4853.059	775.794	4505.169	125.240	23.483	12.836
CX17	41.00	0.018	0.320	52.781	2196.103	351.062	2038.676	56.674	10.626	12.492
CX18	49.41	0.060	1.254	208.536	8672.928	1386.425	8051.212	223.817	41.966	13.088
CX19	42.52	0.020	0.353	58.525	2434.323	389.143	2259.820	62.821	11.779	12.536
CX20	53.39	0.103	2.328	387.634	16120.614	2576.987	14965.015	416.016	78.003	13.357
System	57.60	3.577	90.358	15416.870	635289.464	101555.233	589749.001	16394.567	3073.981	14.953

Table 5.4 Total Annual Pollutant Loads for Separate Drainage System

	TSS	BOD	Total N	Total P	Volume
Source of pollutant	kg	kg	kg	kg	m^3 x10^3
Treatment Plant Outfall	108,602	81,234	89,358	32,494	5,531(1)
Storm water Outfalls	635,289	101,555	16,395	3,074	15,417
Total	743,891	182,789	105,753	35,568	20,948

Note (1): (11,364 m3/d from Ngu Han Son District + 3,749 m3/d from SPS3) x 366 days/year for 2008 rainfall series..

5.3 Combined Sewer and Drainage System

The model for the combined sewage collection system is created by adding the interceptor sewer system components (shown in Figure 2.1 and 2.2 in red) to the separate drainage system model.

The interceptor sewer system model includes the following components: dry weather sewage inflow at interception points, diversion weirs at the drainage outfalls, interceptor pump stations, rising mains, gravity interceptor sewers and an advanced wastewater treatment plant. The treatment plant outfall is identified as node CX021.

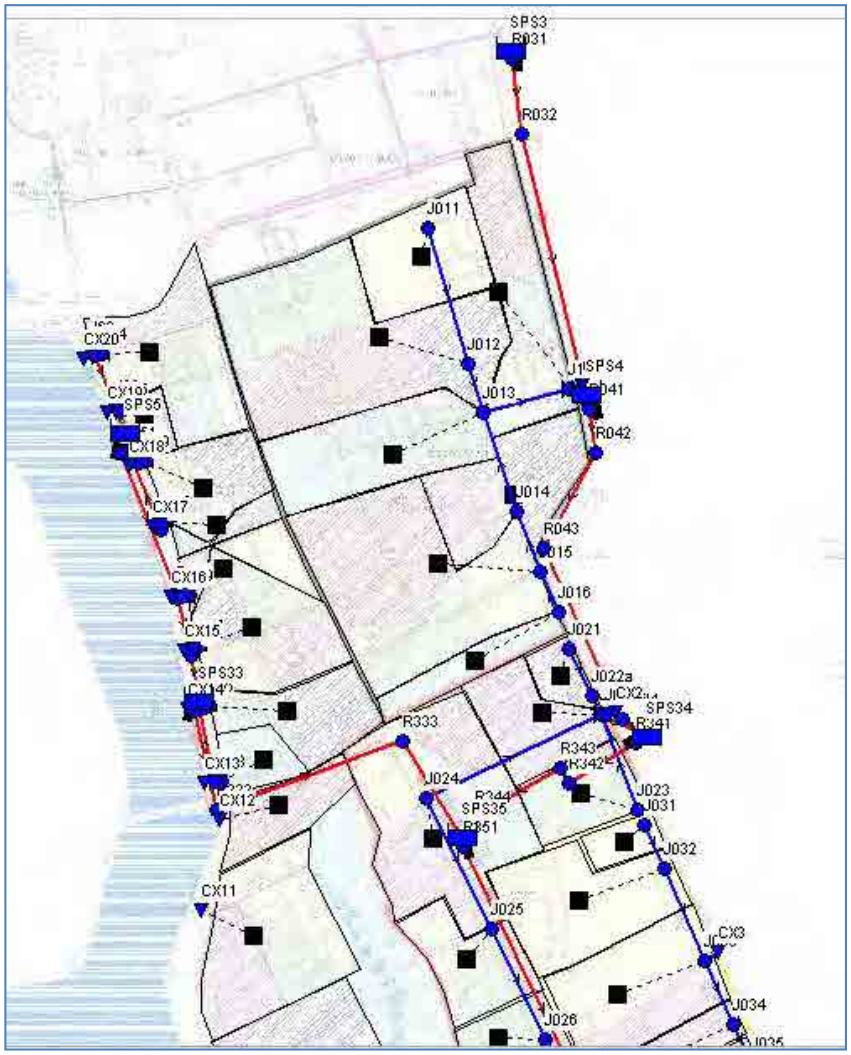


Figure 5.2 Combined Sewer System Network in Ngu Han Son (North Half)

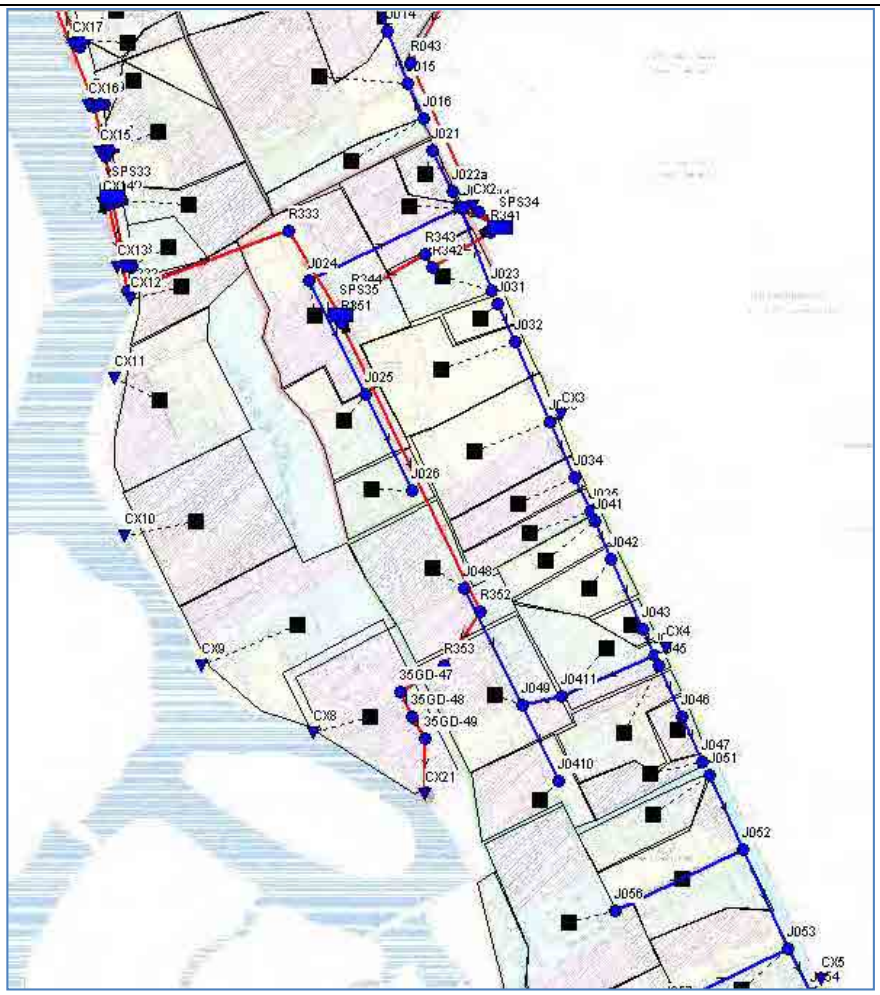


Figure 5.3 Combined Sewer System Network in Ngu Han Son (South Half)

Pump station operation controls the amount of wastewater and wet weather flow that gets intercepted. Pumps are controlled automatically by a local control panel. Primary control of the pumps is based on water levels in the wet wells as show in Table 5.5.

Table 5.5 Pump Station Primary Controls

Pump station	Pump no.	Elevations (m)			
		Invert	Start	Stop	Overflow
SPS3	1 duty	-1.50	-0.26	-1.14	3.21
	2 standby	-1.50	-0.16	-1.04	3.21
SPS4	1 duty	-1.76	-0.33	-1.20	2.50
	2 standby	-1.76	-0.23	-1.10	2.50
SPS34	1 duty	-1.56	0.10	-1.22	2.98
	2 duty	-1.56	0.20	-1.12	2.98
	3 standby	-1.56	0.30	-1.02	2.98
SPS5	1 duty	-2.63	-1.55	-2.26	2.07
	2 standby	-2.63	-1.45	-2.16	2.07
SPS33	1 duty	-2.78	-1.41	-2.44	1.99
	2 standby	-2.78	-1.31	-2.34	1.99
SPS35	1 duty	0.99	5.00	1.42	6.00
	2 duty	0.99	5.10	1.52	6.00
	3 standby	0.99	5.20	1.62	6.00

Note: The standby pump is turned on when wastewater flows exceed the capacity of the duty pump.

During wet weather and high tides the gravity interceptor sewers and the pump stations are flooded and pumps are shut down automatically by the secondary ("wet weather") pump control.

The secondary pump control system gets its signals from water level sensors installed at the weir of the diversion structures. Pumps are stopped when water levels are100mm above the crest of the diversion weir. Primary control resumes once the flooding has subsided. Upstream pumps are shutdown when downstream pump stations are turned off by the secondary control. The continuous simulation includes on and off control of the pumps according to operating rules that match specified start and stop levels.

Dry weather wastewater flows are estimated on the basis of population and per unit flows identified in previous studies. Dry weather flows are subjected to a diurnal time pattern to simulate peaks.

Table 5.6 Dry Weather Flow Diurnal Pattern

Time	0:00	1:00	2:00	3:00	4:00	5:00
Peak Coefficient	1	1	0.7	0.7	0.7	0.8
Time	6:00	7:00	8:00	9:00	10:00	11:00
Peak Coefficient	1	1	1	1	1	1
Time	12:00	13:00	14:00	15:00	16:00	17:00
Peak Coefficient	1	1	1	1	1	1
Time	18:00	19:00	20:00	21:00	22:00	23:00
Peak Coefficient	1.3	1.3	1.3	1.2	1	1

Table 5.7 Wastewater Quantity to Ngu Han Son Treatment Plant

Source of wastewater	Volume	Unit
Flow from pump stations. in Ngu Han Son	4,975	m3/d
Flow from pump stations. in Son Tra	3,749	m3/d
Total sewage flow to Ngu Han Son (1)	8,724	m3/d
Annual flow to Ngu Han Son WWTP(2)	3,192,980	m3/yr

(1) Based on 2010 dry weather flows

(2) Based on 366 days for analysis using the 2008 rainfall series.

The continuous simulation was initially carried out with a daily time series of high and low tide data for a complete year. However the model ran into difficulties because pumps continued to operate for a short time when the station was flooded by high water levels. This had the effect of increasing the amount of water conveyed to the treatment plant by a significantly large amount. The problem could be caused by incorrect start/stop levels or incorrect weir crest elevations which were obtained from drawings and documents. The only way to resolve the problem is to carry out a detailed field survey to confirm actual conditions on site.

The simulation was run without tidal influence in order to generate correct effluent volumes and pollutant loadings for comparison to the separate system,. Results are presented in Table 5.8

Table 5.8 Annual Outfall Pollutant Loads For Combined Sewage System.

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CMS	Max. Flow CMS	Total Volume 10^6 ltr	Total TSS kg	Total BOD kg	Total COD kg	Total TKN kg	Total TP kg
CX1	100.00	0.727	9.743	3503.272	312413.368	194760.457	100618.110	33847.591	7621.489
CX2	100.00	0.419	9.087	1804.237	120537.811	58926.582	60039.719	10171.633	2256.262
CX3	100.00	0.394	8.371	1855.332	142181.287	79366.049	57921.396	13753.498	3077.397
CX4	100.00	0.575	12.401	2667.436	211632.628	121358.129	81995.936	21045.767	4716.661
CX5	100.00	0.683	15.531	3107.921	247877.361	142598.929	95441.226	24731.440	5543.719
CX6	100.00	0.108	2.302	496.415	38391.433	21583.586	15439.131	3740.993	837.422
CX7	100.00	0.049	1.047	213.346	14779.901	7512.054	6986.746	1298.258	288.752
CX8	100.00	0.130	2.804	593.030	48353.633	28324.116	17954.151	4914.700	1102.821
CX9	100.00	0.178	3.809	817.525	63584.536	35908.396	25359.510	6224.617	1393.759
CX10	100.00	0.132	2.815	618.509	49391.236	28490.282	18917.240	4941.525	1107.851
CX11	100.00	0.134	2.803	718.457	77334.635	53545.829	17926.882	9328.564	2111.735
CX12	100.00	0.049	1.055	207.526	14544.022	7474.280	6767.806	1292.159	287.609
CX14	100.00	0.057	1.369	366.106	28778.964	19030.301	7843.535	3311.945	748.043
CX15	100.00	0.093	2.090	685.687	53810.047	37160.820	12600.302	6473.653	1465.278
CX16	100.00	0.037	0.911	190.912	13687.717	8170.524	4882.629	1418.414	318.623
CX17	100.00	0.016	0.338	77.984	5414.668	3062.650	2153.260	530.924	118.891
CX18	100.00	0.051	1.216	242.280	20071.158	12163.764	6920.521	2112.462	474.932
CX19	100.00	0.015	0.366	83.209	6207.645	3807.032	2081.513	661.359	148.787
CX20	100.00	0.106	3.543	767.262	58813.391	40247.170	14254.584	7009.893	1585.955
CX21	99.99	0.189	0.700	2469.085	23171.046	18843.110	17082.430	20419.987	7508.564
CX13	100.00	0.027	0.617	176.072	13778.054	9147.162	3707.603	1592.076	359.662
System	100.00	4.170	80.499	21661.604	1564754.543	931481.222	576894.231	178821.458	43074.211

Table 5.9 Total Annual Pollutant Load for Combined Sewer System

Pollutant	TSS	BOD	Total N	Total P	Volume
Unit	kg	kg	kg	kg	m^3 x10^3
Treatment Plant Outfall	23,171	18,843	20,420	7,509	2,469
Storm water Outfalls	1,541,584	912,638	158,401	35,565	19,193
Total	1,564,755	931,481	178,821	43,074	21,662

The amount of wastewater generated within the collection system's catchment area is 3,193 x 10^3 m^3 (refer to Table 5.7 however only 77% of this amount (2,469 x 10^3 m^3)is received at the treatment plant. The rest is lost to CSO's caused by the frequent and prolonged shut down of pump stations during wet weather in response to limited capacity of the interceptor system.

Table 5.10 Comparison of Annual Pollutant Loads for Separate and Combined Sewer Options

Pollutant	TSS	BOD	Total N	Total P
Unit	kg	kg	kg	kg
Separate system	743,891	182,789	105,753	35,568
Combined system	1,564,755	931,481	178,821	43,074

As expected the combined sewer system generates significantly higher quantities of suspended solids and BOD.

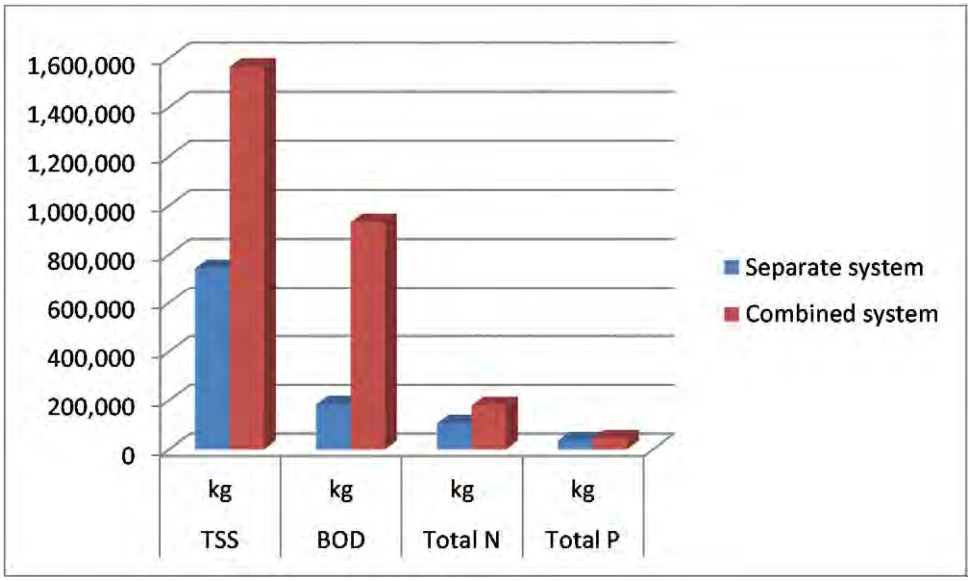


Figure 5.4 Comparison of Annual Pollutant Loads