

**PREPARATORY SURVEY  
ON  
JICA PROGRAM FOR IMPROVEMENT OF  
MEDICAL WASTE WATER AND SOLID WASTE  
TREATMENT SYSTEM  
IN  
THE SOCIALIST REPUBLIC OF VIET NAM  
FINAL REPORT**

**JANUARY 2011**

**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

**YACHIYO ENGINEERING CO.,LTD.  
SYSTEM SCIENCE CONSULTANTS INC.**

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### Exchange rates

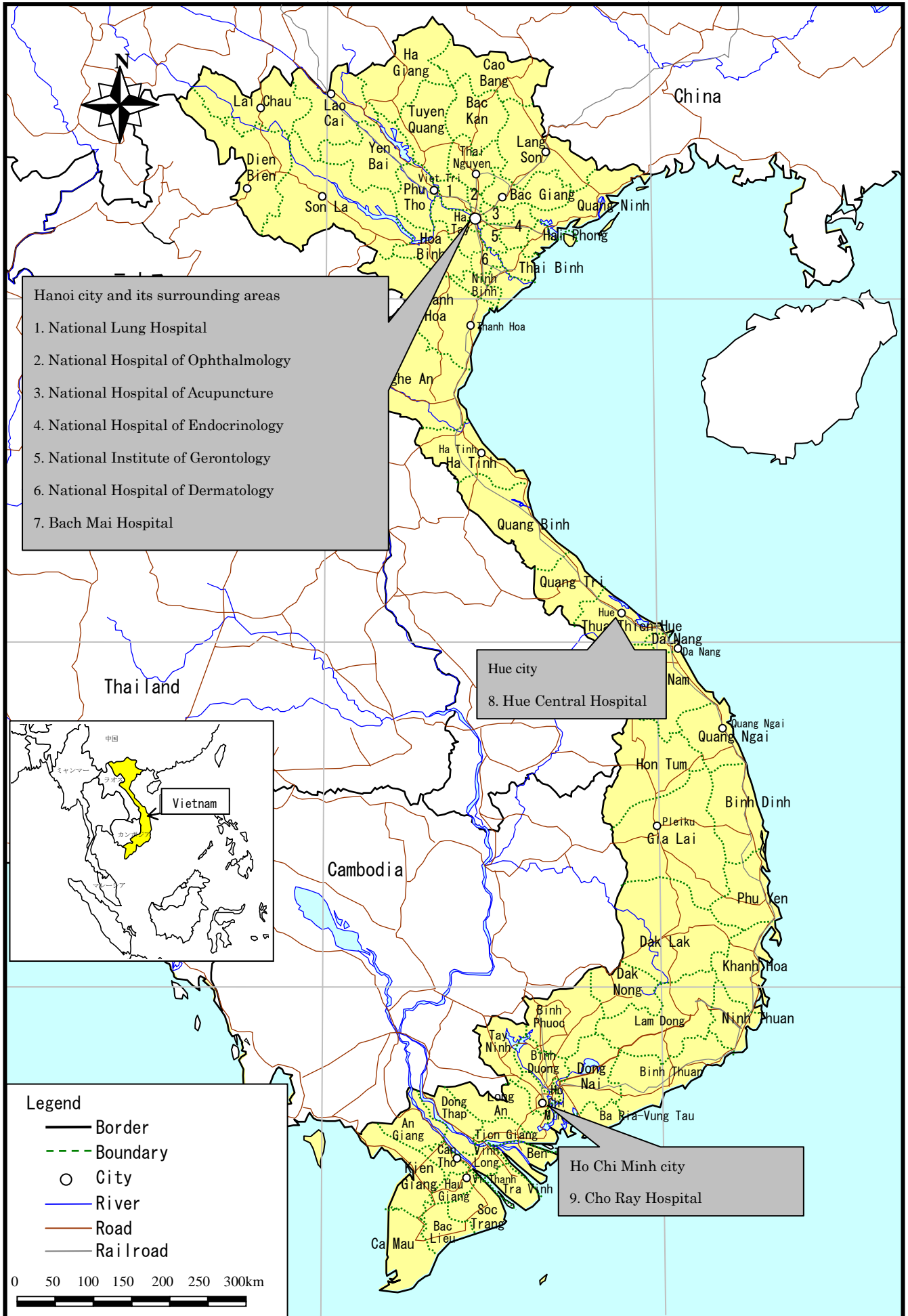
Exchange rates of US dollar -VND and VND- Japanese Yen in this study are set below,

(1) US dollar vs. Vietnamese Dong (VND) (As of January 2011)

US dollar 1= VND 18,982

(2) VND vs. Japanese Yen (As of January 2011)

VND 1 = Japanese Yen 0.00438



LOCATION MAP (VIETNAM)

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LOCATION MAP (VIETNAM)

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## **ABBREVIATION**

ADB	: Asian Development Bank
CITENCO	: City Environment Company
DOC	: Department of Construction
DOF	: Department of Finance
DOH	: Department of Health
DONRE	: Department of Natural Resources and Environment
EIA	: Environmental Impact Assessment
GEF	: Global Environment Facility
IC	: Infection Control
ICC	: Infection Control Committee
ICD	: Infection Control Department
ICN	: Infection Control Network
MOC	: Ministry of Construction
MOF	: Ministry of Finance
MOH	: Ministry of Health
MONRE	: Ministry of Natural Resources and Environment
MOST	: Ministry of Science and Technology
MOT	: Ministry of Transportation
MPI	: Ministry of Planning and Investment
MSA	: Medical Examination and Treatment Management Agency
MWWSWM	: medical wastewater and solid waste management
JICA	: Japan International Cooperation Agency
ODA	: Official Development Assistance
POPs	: Persistent Organic Pollutants
PPC	: Provincial People's Committees
RI	: Radio Isotope
UNDP	: United Nation Development Program
URENCO	: Urban Environmental Company
VEA	: Vietnam Environmental Protection Agency
VIHEMA	: Health Environment Management Agency
WB	: World Bank
WHO	: World Health Organization

## **CHAPTER 1 INTRODUCTION**

In the Country Assistance Program for Vietnam, formulated in 2009 by the Government of Japan.(GoJ) “Environment” was added to “Economy” and “Society” as a new pillar of the plan. GoJ expressed its willingness to extend comprehensive assistance, centering on 4 areas (a. Promotion of economic growth and strengthening of international competitiveness, b. Improvements in living and social conditions and corrections of disparities, c. Environmental conservation, d. Strengthening of governance (forming the foundation of the 3 pillars mentioned above)). Japan will continue to deeply respect the ownership of the Vietnamese government, positively evaluate its development policy and its high-level goals, and furnish assistance enabling continuation of the process of “reducing poverty through growth” achieved heretofore by Vietnam.

Improvement of medical wastewater/solid waste (MWWSW) treatment system is consistent with Japan’s assistance policy, that contribute to solution of the critical issues such as achievement of the proper handling medical waste to minimize the risk of diseases infection and improvement of the quality of urban sewage. For instance, when MWWSW containing pathogens and antibiotics is discharged to the environment without appropriate treatment, it may cause outbreak of infectious diseases or change the characteristics of bacteria to have resistance to several antibiotics. In particular, if untreated MWWSW outflows during flooding caused by torrential rains, such risk will be heighten and widely spread.

From these perspectives, the Vietnamese government recognizes that MWWSW is an important issue that fields such as health or the environment are cross-sectional. In Decision No.64/2003/QD-TTg by the Prime Minister, it is noted that healthcare facilities, although listed as generators of toxic or hazardous wastewater/solid waste, are essential facilities for public so that it is not easy to close instantly but needs urgent countermeasures to improve MWWSW management systems like other industrial sources.

In particular, the risk of infection by improper management of MWWSW has been increasing in Hanoi where 644 million populations are concentrated. Therefore measures for appropriate management of MWWSW become imperative. The Ministry of Health (MOH) in Vietnam has requested grant aid to Japanese government for development of medical wastewater treatment system at some central hospitals. However, in order to promote appropriate treatment of medical wastewater, prompt actions are required for a wide range of issues such as policy development, administrative capacity building, human resources development, procurement of equipment, and designing proper system and formulation of management system. Therefore both Vietnamese and Japanese sides agreed to conduct a preparatory survey for formulation of a cooperation program in order to develop an understanding of the whole picture and then to discuss solutions for specific issues.

This study is to understand the situation about a wide range of issues related to MWWSW management including identification of issues that may hamper a proper MWWSW management and proposing the necessary measures to reduce MWWSW generation and to enhance proper treatment. Results of the study are finally compiled as a model system and a road map for improvement and a new development. Findings and proposals in this study will be utilized as recommendations for JICA to design future cooperation strategy in this sector with considering JICA’s policy, direction and effectiveness of the cooperation program.

In this study, 5 Japanese experts were dispatched and the work in Vietnam was composed of 2 periods. During the 1st study period from September 14<sup>th</sup> to October 24<sup>th</sup> 2010, current conditions on MWWSW management was clarified through the fact-finding survey by questionnaire and site survey etc., and issues and measures have also been identified. On October 19<sup>th</sup> 2010, a workshop was held in Hanoi and issues and measures identified by the study were discussed among Vietnamese stakeholders, i.e. MOH, the Ministry of Natural Resources and Environment (MONRE), the Department of Health (DOH), surveyed hospitals in Hanoi, Hue and Ho Chi

Minh City, etc. and common perception was shared among the workshop participants. During the 2nd study period from January 6<sup>th</sup> to 26<sup>th</sup> 2011, the Draft Final Report (DFR), was prepared by updating the Interim Report and adding the roadmap on MWWSW management, proposed possible JICA's assistance program and model system for MWWSW management. DFR was basically approved by MOH at the Stakeholder Meeting on January 13<sup>th</sup> 2011. On January 20<sup>th</sup> 2011, Seminar on the Improvement of MWWSW Management System in Vietnam was held in Hanoi with the participation of variety of stakeholders, i.e. MOH, MONRE, DOH, surveyed hospitals, the World Bank, the Asian Development Bank (ADB), the World Health Organization (WHO) and other related agencies.

In this Final Report, Introduction (Chapter 1), MWWSW management in Vietnam (Chapter 2), Current conditions and practices of MWWSW management (Chapter 3), Issues and challenges on MWWSW management (Chapter 4) and Road map and JICA's assistance program on MWWSW management in Vietnam (Chapter 5) are described.

## **CHAPTER 2 MWWSW MANAGEMENT IN VIETNAM**

### **2.1 Administrative and Legislative Frame**

As a leading administrative body of health-related services and systems MOH is a central agency to manage and control of MWWSW generated at healthcare and health-related facilities<sup>1</sup>. Besides MOH, MONRE, the Ministry of Construction (MOC), and others have direct or indirect responsibility and duties for MWWSW management. The Ministry of Planning and Investment (MPI) and the Ministry of Finance (MOF) have also influential roles for MWWSW management with respect to establishing overall policy and strategy or allocation and arrangement of budget for investment in MWWSW management projects.

Under administrative bodies of the central ministries, corresponding departments at provincial and district levels have their own roles and responsibilities for MWWSW management at healthcare and health-related facilities in their regions. Because of involvement of a wide range of agencies and a nature of complexity for appropriate MWWSW management, the Office of Government (OOG) has issued official letters in past years requesting MOH to actively collaborate with related ministries and sectors in developing a nation-wide master plan for medical waste management<sup>2</sup>.

#### **2.1.1 National agencies**

##### **(1) Ministry of Health (MOH)**

MOH is responsible for: (i) monitoring MWWSW management activities of healthcare and health-related facilities to ensure the completion of functioning provisions, (ii) developing MWWSW management plan, capital investment for construction, selection of treatment technologies and equipment in coordination with the Ministry of Science and Technology (MOST) and MOC, and (iii) monitoring the implementation of these policies and provisions. Figure 2.1 shows the organization structure of MOH in which several departments or agencies have role or responsibility for MWWSW management directly or indirectly. Amongst these departments and agencies, the Health Environment Management Agency (VIHEMA) and the Department of Medical Equipment, Facilities and Construction have vital roles to plan, select and evaluate MWWSW management systems at central level healthcare facilities in general, and monitor the systems. VIHEMA is also responsible for health and environmental issues of healthcare facilities with giving training to staffs at healthcare facilities.

##### Health Environment Management Agency (VIHEMA)

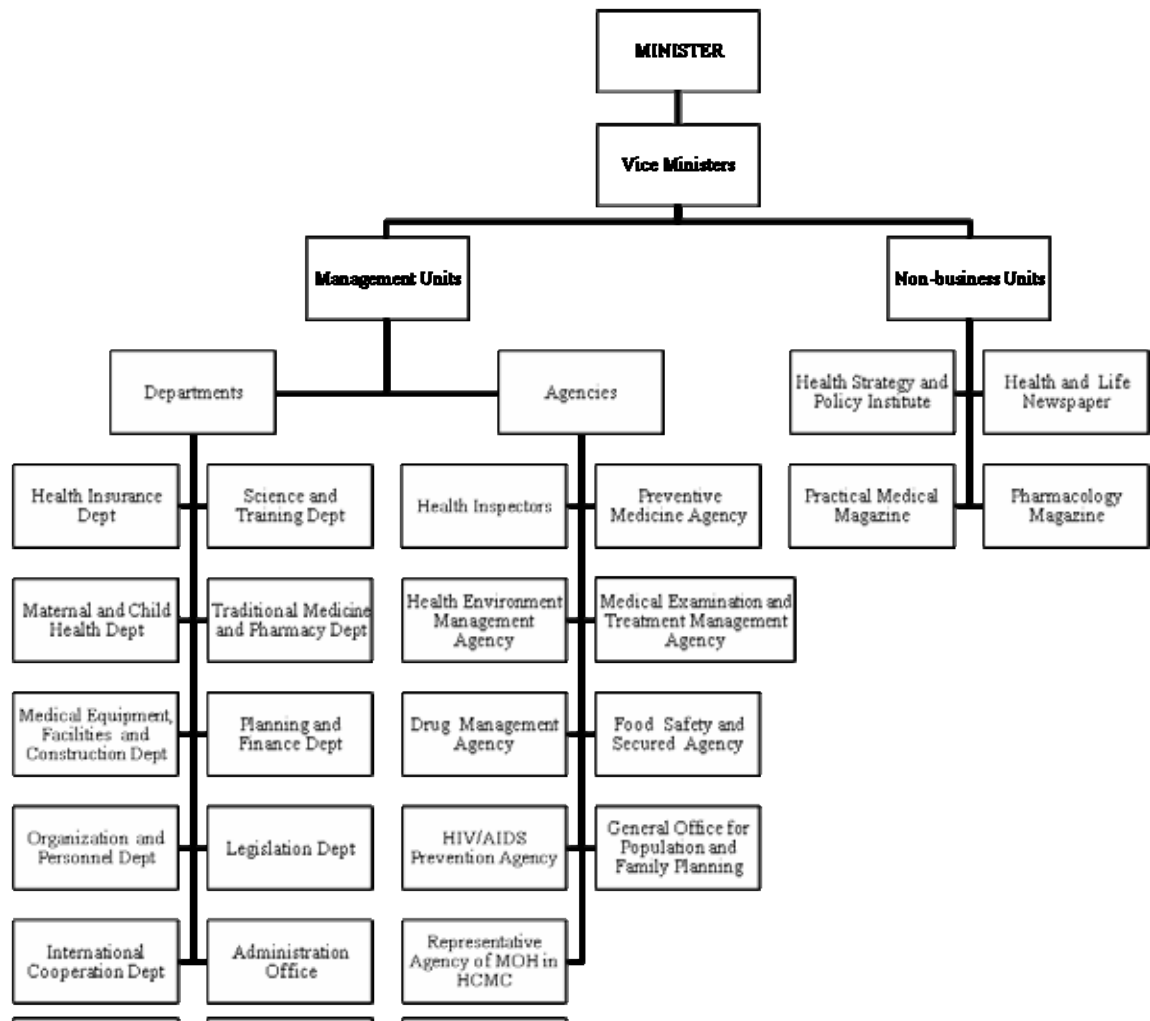
VIHEMA is commissioned to advise to the Minister of Health to perform functions of MOH related to health environment issues such as:

- environmental protection of healthcare and health-related facilities and burial activities and environmental health,
- hygiene and occupational health and diseases and safety control, health impact control due to a climate change,
- management of chemicals, disinfectants, insecticide for domestic and medical use, and
- other tasks related to health environment.

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<sup>1</sup> Healthcare facilities are places where medicine is practiced, including hospitals, clinics, dental offices, out-patient surgery centers, birthing centers and nursing homes, while health-related facilities include medical school, research institutes, and pharmaceutical industries and so on in this report.

<sup>2</sup> Official Letter 1153/VPCP-KG dated on March 22, 1999 and Letter 1069 dated on October 11, 1999.



**Figure 2.1 Organization Structure of the Ministry of Health (MOH)**

(Based on Decision No. 1874/QĐ-TTg dated on 12th November 2009 and Decree No. 22/2010/NĐ-CP dated on 09th March 2010)

a. MWSSW management and environmental protection

In connection with MWSSW management, VIHEMA presides over in setting up strategy, scheme, and plan for environment protection in the health sector. VIHEMA also drafts and submits legal documents on environmental protection for healthcare and health related-facilities including technical standards on environmental health, etc. Furthermore VIHEMA (i) organizes and evaluates the environmental impact of MOH projects with warning on environment activities in the field of health, (ii) prevents and responses to environmental incidents, (iii) overcomes pollution and restores health environment, and (iv) proposes solutions for conservation and sustainable development in the field of health.

b. Research and information collection

Other roles remitted are:

- to manage and allocate budget and funds for environmental protection,
- to guide the conduct, transfer, application of findings from scientific and technological research on health environmental protection,

- to exchange information and documents on scientific environmental within the country or with other countries, and
- to compile and publish data and information regarding health environment.

c. Guide and direction

VIHEMA directs and guides technical activities in the assigned field to health facilities below provincial level under management of other ministries. VIHEMA, in collaboration with relevant agencies and units, inspects, detects, recommends and impose penalties violation of law units in terms of environment protection, environmental health, occupational hygiene and health, etc. according to the Agency's competence.

Department of Medical Equipment, Facilities and Construction

The Department of Medical Equipment, Facility and Construction is the specialized department of MOH. The Department has the function to offer consultation and support the minister to manage the investment of medical equipment and facilities including ones for MWWSW treatment. It formulates legal documents for instruction of: (i) purchases, management, usage, maintenance and checkup of medical equipment, (ii) production, selling and technical services about medical equipment.

The Department formulates a list of standard medical equipment for medical facilities in accordance with the technical levels set by MOH, national standards about medical equipment. The Department also evaluates the list, specifications, technical standards of the medical equipment of the investment projects using state budget and submits bidding plans, invitation for bidding, bidding results of medical equipment purchase by the organizations under MOH to the minister for approval of using developing investment budget.

The Department organizes a consultancy committee for medical equipment and formulates programs, contents and plans for training of technical and management staffs regarding medical equipment. In addition the Department organizes monitoring and evaluation of purchasing, management and usage of medical equipment in the healthcare facilities. In collaboration with the Planning and Finance Department, the Department plans allocation of developing investment budget every year and evaluates the usage of investment and construction budget.

(2) Ministry of Natural Resources and Environment (MONRE)

MONRE is a central agency in charge of environmental management and protection in Vietnam. Its major roles in waste management include:

- to issue guidelines, regulations, and standards for waste management in coordination with other ministries,
- to compile annual and long-term waste management plans and formulate policies and strategies,
- to plan and allocate budgets for research and development,
- to appraise and approve Environmental Impact Assessment (EIA) reports for waste management projects,
- to inspect and supervise waste management activities, and
- to raise public awareness and approve recycling and treatment technologies.

As for hazardous waste management, MONRE, as directed by Decision 155/1999/QD-TTg, has the following functions:

- to manage hazardous waste and guide the implementation of hazardous waste management,
- to work out policies, strategies, legislation on environmental protection and submit to the Government;

- to develop standards, technical qualifications of hazardous waste containers, technologies for hazardous waste treatment,
- to work out environment fees for hazardous waste management together with MOF,
- to approve the EIA report for the listed projects,
- to monitor environmental protection and coordinate enforcement of hazardous waste management, and
- to conduct training, awareness raising for hazardous waste management and provisions on hazardous waste control.

### Vietnam Environmental Administration (VEA)

VEA under MONRE is the body specifically assigned to the mandate of the environmental protection. The organization of VEA is shown in Figure 2.2. VEA has mission to develop and submit laws and regulations, policies, strategies, plans, national targets, programs and projects on the environment. VEA organizes implementation of preventive measures in order to prevent, mitigate and respond to environmental contamination caused by environmental accidents. Assessment and appraisal of the reports of strategic environmental assessment, EIA, integrated EIA, and environmental protection commitment is another role of VEA together with a provision of guidance to examine, evaluate and appraise equipment and treatment facilities prior to operation. Waste management, promotion of environment quality, protection of the environment in river basins and coastal zones and handling environmental pollution at the hot spots are also included in the duty of VEA.

#### (3) Ministry of Construction (MOC)

MOC is a line ministry with the highest authority in municipal solid waste and wastewater and urban drainage management, primarily in terms of technical oversight of these sectors. Its responsibilities and jurisdiction in waste and wastewater management are as follows: (i) formulating policy and legislation, planning and construction of solid waste treatment facilities, and (ii) developing and managing plans for the construction of waste and wastewater management infrastructure nationally and provincially. Recently MOC updated National Solid Waste Management Strategy<sup>3</sup> and issued the Decision for integrated solid waste management<sup>4</sup> in collaboration with MONRE. This Decision enhances a role of the state in integrated solid waste management by means of socialization, mobilizing its resources, and strengthening investment in line with economic and social development plan and other plans. In addition, MOC is reported to be in preparation of a master plan for national hazardous waste management<sup>5</sup> in which hazardous medical waste management plan is likely included as well.

#### (4) Ministry of Planning and Investment (MPI) and Ministry of Finance (MOF)

MPI has great influence in policy making at the ministerial level, managing state budget for investment financed by the Government Treasury, credits or ODA loans and grants. In this regard, MPI manages the demands of finance for investment with taking into account of relevant development plan and strategy, and reviews and formulates policies and mechanisms to mobilize domestic and foreign financing for investment. Coordination of ODA funded projects is done by MPI.

MOF manages and provides state fund and other financial sources to ministries and agencies, provincial governments to implement the projects. All major investment plans must be approved by MPI. Furthermore, MPI in coordination with MOF also issues economic incentives to facilitate environmental protection activities including waste and wastewater management<sup>6</sup>. MOF

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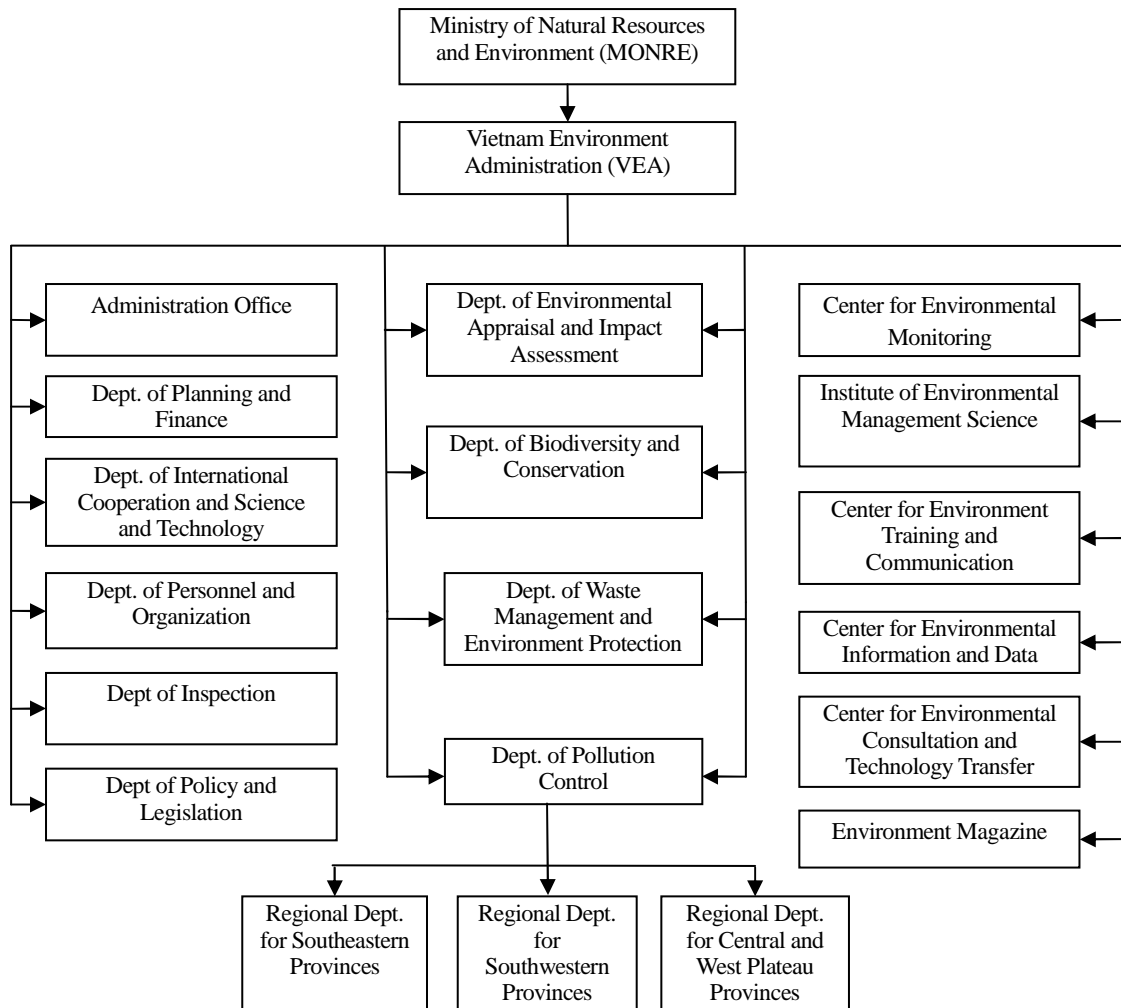
<sup>3</sup> Decision 152/1999/QĐ-TTg dated on 10/7/1999 of the Prime Minister approving *Strategy of Waste Control in Urban Sector and Industrial Zones by the Year 2020*.

<sup>4</sup> Decision 2149/2009/QĐ-TTg dated on 17/12/2009 approving *National Strategy for Integrated Management of Solid Waste up to 2015 with a Vision to 2050*.

<sup>5</sup> *Master Plan on Hazardous Solid Waste Treatment up to 2025 (795/QĐ-BXD)* (in progress)

<sup>6</sup> Decree No: 4/2009/NĐ-CP dated on 14/1/2009, *Incentives and Supports for Environment Protection Activities*.

in coordination with MPI allocates budgets for waste and wastewater management activities, focusing more specifically on financial and pricing issues.



**Figure 2.2 Organization of the Vietnam Environmental Administration (VEA)**

### 2.1.2 Local agencies

Provincial People's Committee (PPC) is an executive unit of local administration, while the Provincial People's Council is a representative of provincial government. PPC has several departments mirroring to the national level ministries. PPC is responsible to oversee local level administration and their responsibilities in waste and wastewater management are as follows:

- To implement regulations on environmental protection, direct their agencies in organizing, coordinating with the respective central agencies to work out annual and long-term management plans,
- To make approval of relevant projects based on the conditions of each locality,
- To mobilize investment capital from various sources for the projects and work out mechanisms to encourage private participation in the sectors,
- To direct the Department of Natural Resources and Environment (DONRE) and the Department of Construction (DOC) in carrying out the projects in terms of design, construction, monitoring, EIA, etc.



DOC supervises the implementation of urban development plans of the province or city, organizing the designing and construction of the waste and wastewater treatment facilities, supporting PPC in making decisions on the projects, and reporting to PPC for approval in coordination with DONRE.

DONRE plays important roles in the waste and wastewater management: monitoring of environmental quality; managing and implementing policies and regulations issued by MONRE and PPC; appraising EIA for the projects; and coordinating with DOC and the Urban Environmental Company (URENCO) in selecting landfill sites, all of which are then proposed to get approval by PPC.

DOH supervises the implementation of MWWSW management plan in healthcare and health-related facilities. Monitoring of environmental protection in these facilities is also included in their roles in coordination with DONRE. Investment plan for MWWSW management proposed by healthcare and health-related facilities is assessed in collaboration with relevant local authorities, and then proposed to PPC to get approval.

URENCO collects municipal solid waste and treats or disposes of at landfill site. They may also collect and dispose of some industrial and hazardous waste generated from industries and healthcare facilities as a contract basis.

In November 2006, the government established the Environmental Police Department in the Ministry of Public Security<sup>7</sup>. This watchdog agency has tasks of detecting, preventing and fighting against environmental offenders. Divisions of the environmental police are also established in the Departments of Police of provinces.

## **2.2 Policy and Strategy on MWWSW Management in Vietnam**

Policy and strategy for MWWSW management is found in several legal documents that include the plan and strategy for: (i) environmental and waste management, (ii) MWWSW management, and (iii) development for healthcare services and infection control.

### **2.2.1 Plan and strategy for environmental and waste management**

***Decision No.256/2003/QĐ-TTg dated on 2/12/2003 by the Prime Minister on National Strategy on Environmental Protection up to Year 2010 and Vision to 2020.***

The National Strategy for Environmental Protection has 3 comprehensive objectives:

- Preventing and controlling pollution.
- Protecting, conserving and sustainably using natural resources.
- Nature and biodiversity conservation

This strategy targets that 40% of urban centers, 70% of industrial parks and export-processing zones should be provided with collected waste treatment systems that meet environmental standards; 90% of domestic, industrial and commercial wastes should be collected; and 60% of collected hazardous wastes and 100% of collected hazardous medical wastes should be treated until 2010.

***Decision No. 153/2004/QĐ-TTg dated on 17/8/2004 of the Prime Minister approving Strategic Orientation for Sustainable Development (Vietnam Agenda 21)***

Vietnam's sustainable development program (Agenda 21) sets goals of sustainable development by properly exploiting and saving natural resources. Agenda 21 issues principle that environmental protection and improvement in environment quality are an integral part of development process. The Agenda 21 gives high priority to medical waste management.

***Order 23/2005/CT-TTg dated on 21/6/2005 of the Prime Minister accelerating Solid Waste***

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<sup>7</sup> Decision No.1899/2006/QĐ-BCA dated on 29/11/2006 on *Established Environmental Police Agency under Public Security Agency.*

### ***Management in Cities and Industrial Areas.***

This order instructs ministries and local governments to strengthen their monitoring and guiding functions for solid waste management. This order sets the goal to treat 100% of hazardous medical waste and over 60% of hazardous industrial waste by 2010 using appropriate technologies.

### ***Decision 2149/2009/QĐ-TTg dated on 17/12/2009 approving the National Strategy for Integrated Solid Waste Management up to 2015 with a Vision to 2050.***

This national strategy is considered particularly essential in order to overcome the shortcomings and strengthen the efficiency of solid waste management in the process of modernization and urbanization in Vietnam. The strategy examines the status of solid waste management in Vietnam: (i) to generate the general and comprehensive directions, objectives, tasks and the measures; (ii) to support for formulating the investment program and development policy of solid waste management and the foundation of solid waste management planning in local level.

The strategy sets specific goals for a treatment of medical wastes: (i) 85% of total non-hazardous medical waste and 70% of hazardous medical wastes will be collected in healthcare facilities and totally treated by 2015; (ii) 100% of total non-hazardous and hazardous medical waste will be collected in healthcare facilities and totally treated by 2020. MOH is responsible for enhancing the examination and monitoring of the healthcare facilities to implement the regulations on waste management.

#### **2.2.2 Plan or strategy of MWWSW management**

### ***Decision No.1873/2009/QĐ-BYT: Plan of Environmental Protection in Health Sector in Period from 2009 to 2015.***

In order to protect public health and occupational health and minimize negative impacts on environmental quality caused by the health facilities, this decision was issued on May 28, 2009 (No.1873/2009/QĐ-BYT). This decision has specific objectives including: (i) to improve legal documents on environmental protection in health sector; (ii) to ensure to install medical waste treatment system; (iii) to strengthen inspection, supervision and assessment of environmental impacts and health impacts of healthcare facilities; (iv) to develop capacity of those who are responsible for environmental management in healthcare facilities; and (v) to improve awareness of environmental protection among health staff, local authority and community.

This plan targets following goals with respect to MWWSW management in hospitals by 2015:

- 100% of central hospitals and private hospitals, 70% provincial hospitals, 50% of district hospitals treat medical waste in the way to comply with the environmental standards,
- 100% of healthcare facilities have staffs in charge of environmental works who are trained on medical waste management and environmental monitoring,
- 100% of health staffs receive training on regulations of medical waste, communication of environmental protection in health sector, and
- 100% of healthcare facilities provide health staffs, patients and their relatives with communication of environmental protection in health sector.

### ***Official letter 7164/BYT- KCB dated 20/10/2008, issued by the Minister of Health on Reinforcing healthcare waste treatment and management***

This official letter by MOH indicates a straightforward direction for medical waste management in terms of both technology and system, promoting to make a plan of hazardous medical waste management for DOH-managed health facilities in the provinces so that until 2010, 100% of hazardous medical waste is treated in comply with the regulations.

In the planning and integration of waste management projects, the following issues should be taken into account: (i) model of hazardous medical waste management system, (ii) technology for hazardous medical waste treatment, and (iii) technology for medical wastewater treatment.

(1) Model of hazardous medical waste management system

- A centralized model for hazardous medical waste treatment, in which a key waste treatment facility in the city may treat all hazardous medical waste generated in the city in order to save investment and operation cost, would be suitable for government-managed cities, where density of hospitals and healthcare facilities is high, and traffic system is well developed.
- A cluster model for hazardous medical waste treatment, in which core healthcare facilities in the province may also treat hazardous medical waste generated at other healthcare facilities, would be suitable for healthcare facilities located near core healthcare facilities (within 30 km).
- For the centralized and cluster models for hazardous medical waste treatment, DOH cooperates with relevant departments and sectors to develop mechanism and invests in waste transportation vehicles and treatment equipment.
- On-site treatment would be suitable for healthcare facilities located in a remote area, employing suitable technologies.

(2) Technology for hazardous medical waste treatment

- Provinces, cities, and hospitals that are equipped with incinerators may continue to use them, but must conduct analysis of flue gas quality according to existing regulations.
- Provinces, cities, hospitals that do not have waste treatment facilities or have malfunctioning incinerators should apply new environmentally sound technologies such as disinfection, microwave technologies. For hospital operating incinerators, devices of air pollution abatement should be equipped.
- The district hospitals locating far from the city center can apply temporarily a burial pit while they wait for investment for medical waste treatment.

(3) Technology for medical wastewater treatment

- Each hospital must have a drainage system of wastewater for a treatment. In case that several hospitals are located closely, they can share one treatment system, however, system capacity and effluent quality must be ensured to meet environmental standards.
- Hospitals built in the past without wastewater treatment system must supplement a complete wastewater treatment system.
- Hospitals with a damaged/ineffective treatment system must upgrade or renovate the system to meet environmental standards.
- Hospitals to be built must have wastewater treatment system approved by competent authority.
- Technology of wastewater treatment shall meet environmental standards, be appropriate to geographic conditions, investment capital, operational and maintenance expenses.
- It is necessary to inspect treatment system and wastewater quality and to keep the record.

### **2.2.3 Hospital development and infection control plan**

***Decision No.30/2008/QĐ-TTg dated on 22/2/2008 on approving the Master Plan of Healthcare Network Development until 2010 with a Vision to 2020***

This Decision provides directions for the construction and development of the network systems of healthcare facilities to go along with the socio-economic development level of Vietnam and to improve the quality of health to the level of advanced countries in the region. This decision targets that 80% of hospitals by 2010 and 100% of hospitals by 2020 should have their own waste treatment system meeting with the standards of MOH.

The quantitative indicators of the development goals of MWWSW management system committed by these strategies or plans are summarized in Table 2.1. Some of the goals, mostly set in the earlier years, have not been obviously achieved.

**Table 2.1 Numerical indicators of the development goal of MWSSW management system in Vietnam**

Plan or Strategy	Year of issuance	Goal	Target year
National Strategy on Environmental Protection up to Year 2010 and Vision to 2020 (Decision No.256/2003/QĐ- TTg)	2003	100% of collected hazardous medical waste is treated.	2010
Accelerating Solid Waste Management in Cities and Industrial Areas (Order 23/2005/CT-TTg)	2005	100% of hazardous medical waste is treated with appropriate technologies.	2010
Approving the Master Plan of Healthcare Network Development until 2010 with a Vision to 2020 (Decision No.30/2008/QĐ -TTg)	2008	80% of hospitals should have their own waste treatment system meeting with the standards of MOH.	2010
		100% of hospitals should have their own waste treatment system meeting with the standards of MOH.	2020
Reinforcing Healthcare Waste Treatment and Management (Official letter 7164/BYT-KCB)	2008	100% of hazardous medical waste is treated in comply with the regulations at DOH-managed hospitals.	2010
Approving the National Strategy for Integrated Solid Waste Management up to 2015 with a Vision to 2050 (Decision 2149/2009/QĐ-TTg)	2009	85% of non-hazardous medical waste and 70% of hazardous medical waste are collected and treated.	2015
		100% of both non-hazardous and hazardous medical wastes are treated.	2020
Plan of Environmental Protection in Health Sector in Period from 2009 to 2015 (Decision No.1873/2009/QĐ- BYT)	2009	100% of central hospitals and private hospitals, 70% provincial hospitals, 50% of district hospitals treat medical waste complying with the environmental standards.	2015
		100% of health facilities have staff trained on medical waste management and environmental monitoring	2015
		100% of health staff receive training on regulations of medical waste, communication of environmental protection in health sector.	2015
		100% of health facilities provide health staff, patients and their relatives with communication of environmental protection in health sector	2015

## 2.3 Regulations and Standards

### 2.3.1 Laws, decree, decision and circular

Legal frameworks for MWSSW management and other solid and hazardous wastes management have been gradually improved as the waste yield grows and the risk of negative impact to the environment and health caused by inappropriate waste management becomes rampant. Especially the Prime Minister's Decision No.64/2003/QĐ-TTg dated on April 22, 2003 is an impressive decision that listed facilities causing severe environmental deterioration and showed a government's strong commitment toward environmental protection. The Decision No.64/2003/QĐ-TTg listed 84 healthcare facilities, 6 central level and 78 provincial or district level facilities. Before and even after promulgation of the Decision No.64/2003/QĐ-TTg a series of legal documents regarding MWSSW management have been promulgated including environmental standards and technical criteria or guidelines. Major documents related to MWSSW management issued since the late 1990s are summarized in Appendix 1.

Among these legal documents followings are considered the most essential laws and regulations for MWSSW management.

- Decision 1895/1997/BYT-QĐ dated on 19/09/1997 promulgating Regulation on Hospital Management,
- Decision 155/1999/QĐ-TTg dated on 16/7/1999 of Prime Minister promulgating Regulation on Hazardous Waste Management,
- Law 52/2005/QH11 dated on 29/11/2005 on Environmental Protection
- Decree 59/2007/NĐ-CP dated on 9/4/2007 on Solid Waste Management,
- Decision 43/2007/QĐ-BYT dated on 30/11/2007 of Ministry of Health promulgating Regulation on Health Care Waste Management.

The Regulation on Hospital Management prescribes responsibility of administration section and medical workers for MWSSW management in hospitals. Fundamental requirements and

essential measures for a treatment of solid, liquid or gaseous wastes including hazardous medical wastes are prescribed in Article 12 REGULATION ON WASTE TREATMENT WORK in PART IV REGULATION ON PROFESSION. For instance, solid waste must be segregated, collected and kept in a certain place. Solid waste must be segregated into 4 categories, put in separate nylon bags or bins and taken to disposal sites twice a day. Hospitals must have incinerators complying with the technical standards and operational requirements. Contracted waste management companies may transport wastes to certain places for disposal. This regulation prohibits hospitals to dispose untreated liquid waste to public waters. All hospitals must treat liquid waste before discharging.

The Regulation on Hazardous Waste Management is essential regulation to manage hazardous waste in general. This regulation covers hazardous medical wastes such as infectious, chemical, and radioactive wastes as well as pressurized containers. It provides the responsibilities of organizations and individuals in sorting out, collecting and transporting hazardous waste, the duty of relevant ministries. Especially Article 24 specifies clearly the responsibilities of MOH for medical waste management as follows: controlling, monitoring and encouraging healthcare facilities to implement rules of hazardous medical waste as provided by this decision. The Regulation, originally issued in 1999, is being replaced by the Guiding Practical Conditions and Procedures to Document, Registry, License, Practice, Code of Hazardous Waste Management (Circular No 12/2006/TT-BTNMT) and List of Hazardous Waste (Decision No 23/2006/QĐ-BTNMT). This circular specifies the responsibility of hazardous waste generators as follows:

- Segregation and isolation of hazardous waste,
- Safe storage of hazardous waste, and
- Safe packing or containerization of hazardous waste to meet technical requirement ensuring not to leak and spill away into the environment.

The Law on Environmental Protection 2005 is, as a title indicated, a comprehensive law to protect the environment. Article 39 of Chapter V describes fundamental directions and measures for management of medical waste including normal, hazardous waste and wastewater as well as radioactive waste generated at healthcare facilities. In Chapter VIII of the law are included general requirements for waste management of normal, hazardous wastes as well as wastewater. In the detailing and guiding documents of the Environmental Protection Law (Decree 80/2006/ND-CP dated on 9/8/2006 and Decree 21/2008/ND-CP dated on 28/2/2008) the procedure for EIA and the environmental protection commitments are prescribed. A construction of hospital with more than 50 beds or wastewater treatment facility with more than 1,000 m<sup>3</sup>/day capacity is those listed projects subject to EIA.

The Decree on Solid Waste Management provides for a comprehensive guide and explanation of both solid and hazardous wastes management. It covers definition of solid waste, planning of solid waste management, investment provisions, responsibility of waste generator, collector/transporter and treatment/disposal facility. It also emphasizes waste separation at source, treatment/disposal technologies, waste management charge/expense and inspection, examination and handling of violation in solid waste management. MOC, MONRE and concerned ministries and branches shall guide and organize the implementation of this Decree.

The Regulation on Health Care Waste Management is a pivotal legal document to manage healthcare waste. This covers all types of healthcare waste generated from not only hospitals but also other health-related facilities. This regulation prescribes responsibility of waste generators, requirements for waste handling, and implementation of healthcare waste management both on-site and off-site. However, this regulation does not mention about punishment or sanction for violators against this regulation. The sanctions for the violator may be covered by the Regulation on Hazardous Waste Management, the Environmental Protection Law or the Decree of Solid Waste Management.

### **2.3.2 Standards, criteria, and codes**

Besides these laws and regulations mentioned in the previous section followings are standards, criteria or codes linked to MWWSW management.

- TCVN 5939-1999: Air quality-Emission standards for healthcare solid waste incinerator: Allowable limits (This standard became legally binding standards in QCVN 02: 2008/BTNMT)
- TCVN 6707-2000: Prevention and warning signs for hazardous waste
- TCVN 6705-2000: Non-hazardous solid wastes - Classification
- TCVN 6706-2000: Hazardous solid wastes - Classification
- TCVN 6696-2000: Requirements for environmental protection for sanitary landfills
- TCXDVN 261-2001: Landfill - Standard for designing
- TCVN 7241-2003: Health care solid waste incinerators - Determination of dusts concentration in flue gas
- TCXDVN 320-2004: Hazardous waste Landfill - Standard for designing
- TCVN 7382-2004: Hospital wastewater-Effluent standards (This standard became legally binding standards in QCVN 28:2010/BTNMT)
- TCVN 7380-2004: Healthcare solid waste incinerators- Specifications
- TCVN 7381-2004: Healthcare solid waste incinerator- Assessment and appraisal methods
- TCVN 5945-2005: Industrial wastewater-Effluent standards (This standard became legally binding standards in QCVN 24:2009/BTNMT)
- TCXDVIN 365-2007: General hospital design guideline
- QCVN 02: 2008/BTNMT: National technical regulation on the emission of healthcare solid waste incinerators
- QCXDVN 01: 2008/BXD: Vietnam Building Code-Regional and urban planning and rural residential planning
- QCVN 24:2009/BTNMT: National technical regulation on industrial wastewater
- QCVN 28:2010/BTNMT: National Technical Regulation on Health Care Wastewater

Technical criteria required for medical waste incinerators and assessment or appraisal criteria are prescribed in TCVN 7380-2004 and TCVN 7381-2004. Emission standards of medical waste incinerators were regulated in TCVN 5939-1999 as allowable limits. This standard was replaced by QCVN 02; 2008/BTNMT after reviews and assessments of the limiting values, becoming more stringent and enforced standards. Effluents standards from healthcare facilities are regulated by both TCVN 7382-2004 and TCVN 5945-2005. But, recently both were consolidated to become national technical regulation of QCVN 28:2010/BTNMT, giving legally binding limiting values for hospital effluents. The later was also replaced by QCVN 24:2009/BTNMT. QCVN 02: 2008/BTNMT and QCVN 28:2010/BTNMT are attached in Appendix 2 and 3, respectively. In TCXDVIN 365-2007 and QCXDVN 01; 2008/BXD, medical waste incinerator and wastewater treatment facility are described as a necessary facilities for healthcare facilities.

## **CHAPTER 3 CURRENT CONDITION & PRACTICES OF MWWSW MANAGEMENT**

### **3.1 Current MWWSW Management in Vietnam**

#### **3.1.1 Status of MWWSW management**

At the end of 2008, there were 13,506 health facilities with more than 221,695 beds<sup>8</sup> in the country. Besides, there were 14 institutes of preventive medicine; 190 provincial preventive centers (63 preventive medicine centers, 59 centers for HIV/AIDS, 28 malaria prevention and control center, 23 disease prevention centers, 11 international medical quarantines, 6 center for occupational health and environment); 686 district health centers; nearly 100 research and training facilities; and 181 drug manufacturing and related industries<sup>9</sup>. Both healthcare facilities and beds are increased in number from the previous year.

In Vietnam, the amount of hazardous medical wastes is increasing. In 2005, the total amount of solid waste arising from healthcare facilities was around 300 tons per day, of which 40 tons was hazardous medical wastes and poorly treated<sup>10</sup>. The amount of waste generation depends on the number of bed, the extent and kinds of medical services and accessibility for people to health services. In 2010, the amount of medical waste is expected to be 380 tons per day, of which about 45 tons is hazardous solid waste. It is expected to grow to approximately 600 tons in 2015 and over 800 tons in 2020.

According to the survey conducted in 2006 by the Institute of Occupational Health and Environmental Sanitation, MOH hospital wastes were collected in accordance with the requirements prescribed in the Regulation on Health Care Waste Management at about 50% of total hospitals. Although more than 500 incinerators had been installed to handle medical waste, more than 33% of them did not work at the time of survey because of high operation and maintenance cost as well as lower performance. In addition, many incinerators were polluting the surrounding environment due to a lack of flue gas treatment and poor operation and maintenance. Moreover standards and technical criteria of incinerators were not enforced, making hospitals difficult to operate incinerators and implement environmental protection programs.

In the same survey, 63% of the total hospitals had no wastewater treatment systems and 70% of the wastewater treatment system had not achieved a requirement of effluents standards. The recent study conducted by JICA at 5 big cities, i.e. Hai Phong, Hanoi, Hue (Province), Da Nang, Ho Chi Minh City, showed 82 out of 166 surveyed hospitals had wastewater treatment system (49%), but system was not operated at 17 (21%) hospitals out of 82 by various reasons.<sup>11</sup>

Although details of the former survey is not explained in terms of survey methodology, sample number and respondent number, kinds and levels of hospital, etc., it is not so difficult to image a poor and unsatisfactory management of medical wastewater in Vietnam. Even at central level hospitals wastewater system is not installed completely. Even the hospitals that have wastewater treatment system cannot operate it meeting with effluent standards by various reasons of both inherent and external factors. Situation of medical waste management at hospitals is also far below the satisfactory level. Only half of the central level hospital surveyed segregates and collects in accordance with the requirement prescribed in the Regulation. If referred to provincial, district level hospitals and lower level healthcare facilities, situation of medical wastewater management may be far from the international levels and thus likely pose a negative impact on the environment and public health as well.

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<sup>8</sup> Ministry of Health: Statistical Year Book 2008.

<sup>9</sup> Ibid.

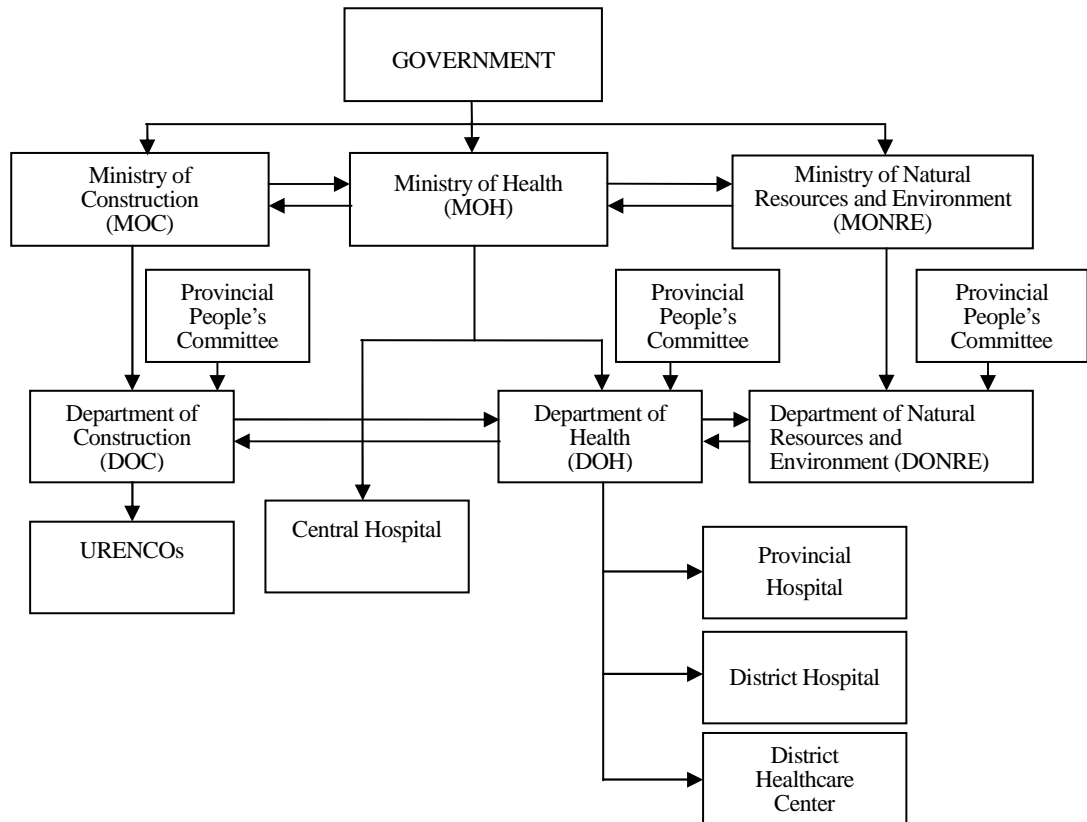
<sup>10</sup> Decision 1873-QD-BYT dated on 2009 on *Plan for Environmental Protection in Health Sector from 2009 to 2015*.

<sup>11</sup> JICA: The Study on Urban Environmental Management in Vietnam, Progress Report, August 2010.

### 3.1.2 Administrative structure for MWWSW management

As mentioned in Chapter 2, besides for MOH as a responsible ministry for MWWSW management, MONRE and MOC have a role for MWWSW management. Especially MONRE is a responsible ministry for the environmental monitoring and EIA on MWWSW management. On the other hand MOC has a responsibility for planning and development of infrastructure for MWWSW management, especially for off-site management of MWWSW. Currently MOC is reportedly preparing for issuing the master plan for hazardous solid waste treatment. These three ministries are collaborating for MWWSW management. MOH is authorized to directly control MWWSW management only in the central level healthcare facilities. Similar management structure is seen at provincial levels as shown in Figure 3.1. In this case, the role and functions of DOH, DONRE, and DOC correspond to those of MOC, MONRE and MOC in the central level in this order.

Although MWWSW management system in the healthcare facilities is not standardized, infection control department or infection control board (committee) together with administration department may have responsibility for MWWSW management. Under these organizations, each department assigns a chief staff in charge of MWWSW management. Waste collection workers or workers at waste storage point are managed by the administration department, irrespective of their affiliations such as healthcare facility or outsourced companies.



**Figure 3.1 Administrative structures of MWWSW management at central and provincial levels.**

Mandates of these major ministries and agencies for implementation of MWWSW management are illustrated in Figure 3.2. In addition to MOH/DOH, MONRE/DONRE and MOC/DOC, the mandates of the Ministry of Transportation (MOT) and MOST are shown in Figure 3.2



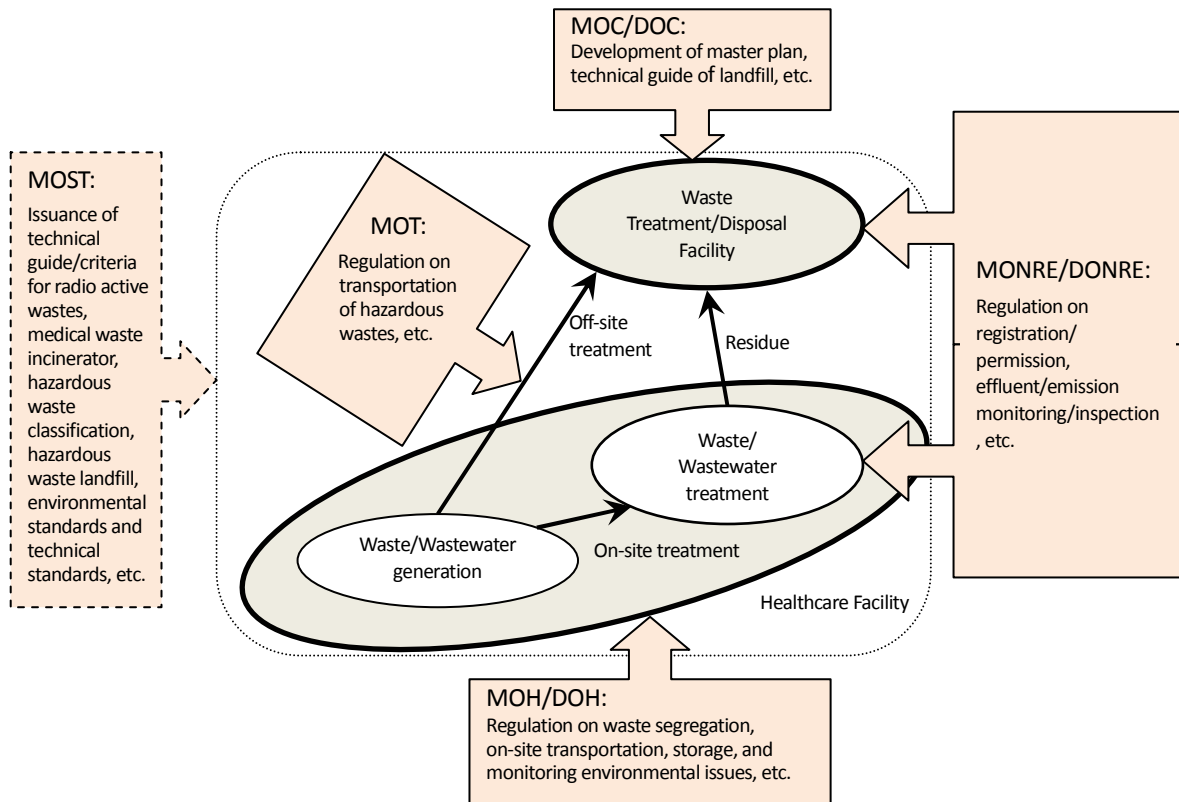


Figure 3.2 Major mandate of ministries on MWWSW management

### 3.1.3 Budget for MWWSW management

Major budget sources for MWWSW management for MOH-managed healthcare facilities are state budget, Environmental Career budget, donors' assistance, loan from the Vietnam Environmental Protection Fund, and other loans from credit organizations. The Environmental Career budget is a new mechanism recently established providing 1% of state budget for environmental protection projects of non-business sectors. So far there is no healthcare facilities applied for the Environmental Protection Fund for investment of MWWSW management<sup>12</sup>.

Table 3.1 shows MOH's planned budget in FY2009. The total budget in FY2009 was 4,622.5 billion VND of which 994.4 billion VND was a budget for investment including 335 billion VND from ODA source and 659 billion VND from domestic source. 7.4 billion VND out of 994.4 billion VND of the investment budget and 40.6 billion VND of the Environmental Career budget were for environment related investment and recurrent expenditures. The FY2009's environment-related budget was provided for Thong Nhat hospital (Ho Chi Minh City), Viet Duc hospital and K hospital (Hanoi) for improvement of their wastewater treatment facilities. About 20 billion VND out of 40.6 billion VND of the Environmental Career budget were used for construction or improvement of MWWSW management system at 6 central hospitals, i.e., C Hospital (Da Nang), E Hospital (Hanoi), Central Lung Hospital (Hanoi), Central Otorhinolaryngology Hospital (Hanoi), National Leprosy Dermatology Hospital (Quy Hoa), and K Hospital (Hanoi)<sup>13</sup>. Detail plan of expenditure for 40.6 billion VND is attached in Appendix 4.

<sup>12</sup> Hearing from VEA, MONRE in September, 2010.

<sup>13</sup> Decision No. 1624/QĐ-BYT dated May 13, 2009 on Allocation Environmental Career Budget in 2009.

**Table 3.1 MOH Budget (plan) in FY 2009**

Items		Expenditure (Million VND)
Development investment expenditure	Domestic sources	659,400
	Foreign sources	335,000
Recurrent expenditure	Education and training	328,310
	Health, population and family planning	1,979,630
	Science and technology	72,440
	Economic development	4,650
	Environmental protection	40,641
	Public administration, party, unions	46,170
	Good price subsidies under state regulations	120
National target programs, Program 135, 5 million hectare reforestation project expenditure	National target programs	1,156,208
Total expenditure (including borrowings and grants)		4,622,569

Source: Adapted from the Web site of MOF

The budget for environmental protection at healthcare facilities including operation and maintenance costs for MWWSW management is not separately accounted in the budget of healthcare facilities. These costs are generally included in the budget of infection control as a lump sum. There seem to be various ideas how to cover the recurrent cost of MWWSW management including the state budget, increment of fee for healthcare service and so on. The decree regulating the “cost of service” is now negotiated at the central level<sup>14</sup>.

### **3.1.4 Environmental inspection and monitoring for healthcare facility**

Environmental inspection and monitoring for healthcare facilities are a part of mandate of MONRE/DONRE. The target healthcare facilities for the administrative inspection are those that have submitted EIA and the environmental protection commitment for construction or operation of healthcare facilities. The administrative violations subject to penalty in the domain of environmental protection and possibly related to healthcare facilities are as follows<sup>15</sup>:

- Violation of regulation requiring to prepare EIA reports (EIA or environmental protection commitment)
- Pollution activity
- Violation of (health care) waste management regulation

Inspection results are summarized in terms of operation status and compliance status of legislations for environmental protection, violation statistics and sanctions. The results are sent to inspected facilities as well as a head of administrative agencies that deployed inspection groups and managed inspected facilities.

Violators are sanctioned by several kinds of sanctions depending on the seriousness of violation such as warning, fines, and temporal and indefinite deprivation of the use of right or certificate related to the environmental protection and confiscation of the evidence and vehicles testified administrative violations. In addition, violators are also subject to a forced remediation of the environmental pollution. Competence of administrative sanction for environmental violation is prescribed depending on the level of inspectors such as chairpersons of People’s Committee (commune level, district level, provincial level), heads of public security forces (environmental police on duty, commune level public security force, district level environmental police division, environmental police department), and chiefs of inspectors (specialized inspector, chief inspectors of MONRE and DONRE)<sup>16</sup>.

<sup>14</sup> Hearing from the World Bank.

<sup>15</sup> Decree No. 117/2009/ND-CP dated on 31/12/2009 on *Handling of Law Violations in the Domain of Environmental Protection*.

<sup>16</sup> Ibid.

The environmental police prosecute or investigate only when the environmental violation is suspected to any criminal involvement or when violators do not obey the administrative sanctions. This means the operation of the environmental police is different from those of environmental inspection conducted by MONRE/DONRE. Environmental inspection has to identify who, what, when to inspect and to whom it shall inform in advance. But the operation of the environmental police is limited to identify the violation, violator and date of violation, and they do not have to inform inspection targets in advance.

Beside those inspection done by MONRE/DONRE or the environmental police, MOH/DOH have their own programs for monitoring healthcare facilities<sup>17</sup>. One of them is a self-inspection system by healthcare facilities guided by Medical Examination and Treatment Management Agency (MSA), MOH to assess: (1) the status of infrastructure, equipment and personnel in healthcare facility; (2) the quality and effectiveness of medical examination and treatment, implementation of regulation on healthcare facilities and other relevant provisions of government in the examination and treatment; and (3) the status to meet excellent score set by MSA. This checklist therefore includes various items concerning with the assessment of healthcare facility of which items concerning MWWSW management are as follows:

- Regarding infrastructure status,
  - Availability, operational condition and performance of wastewater treatment system
  - Solid waste management system complied with the Regulation regarding discharging, storage, and treatment (on-site or off-site) of wastes
- Regarding infection control,
  - Implementation status of the Circular 18/2009/TT-BYT<sup>18</sup> about implementation of infection control in healthcare facilities
  - Segregation, on-site collecting, and treatment of hazardous medical wastes in comply with the Regulation.

Besides this self-inspection program, VIHEMA, MOH, in a collaboration with relevant agencies and units, inspects, detects and recommends penalties or penalizes by themselves according to the Agency's competence, law violated units in terms of environment protection, environmental health, occupational hygiene and health, etc. The checking items regarding MWWSW management related activities at hospitals are as follows:

- Registration as a hazardous waste generator
- Internal training for all staffs on the Regulation on Health Care Waste Management
- Amounts of medical waste, hazardous waste and recyclable
- Consumables supply (waste bag, container, etc) and waste storage room
- Source separation
- On-site waste transportation
- On-site waste treatment (operational condition, operational data, emission gas data, etc)
- Off-site waste treatment (contract documents, etc)
- Wastewater treatment system (operational condition, operational data, effluents data, etc)

### **3.1.5 On-going JICA's project related to MWWSW management**

Currently the JICA has 2 on-going projects related to MWWSW management: (i) Project for Enhancing Capacity of Vietnamese Academy of Science and Technology in Water Environment Protection (2007.12~2011.11), and (ii) the Study on Urban Environmental Management in Vietnam (2010.3~2011.9). The former includes analysis of pH, COD, SS, T-N, Total Coliform, Fecal Coliform, and Hg in effluents of wastewater treatment facilities of the selected 5 hospitals.

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<sup>17</sup> Official document No. 869/KCB-NV dated on 14/9/2010 on *Guidelines for Checking Hospitals in 2010*.

<sup>18</sup> Circular No.18/2009/TT-BYT dated on 14/11/2009 on *Guiding Implementation of Infection Control Activities in the Healthcare Facilities*.

In this project a technical manual for medical wastewater management is being developed. This manual includes not only technological issues but also management issues for medical wastewater treatment at healthcare facilities, reflecting the Vietnamese situation. The tentative contents of this manual are shown in Table 3.2.

**Table 3.2 Tentative contents of the manual of medical wastewater management**

Section	Contents
1	Hospital wastewater treatment
1.1	Infection control regulation
1.2	Hospital wastewater treatment
2	The current situation in Vietnam
3	The current situation in Japan
4	Hospital wastewater treatment system
4.1	The disinfection / sterilization methods
4.2	Heating (Steam) System
4.3	Laboratory liquid waste
4.4	Hemodialysis liquid waste
4.5	Infectious liquid waste
4.6	Radio Isotope (RI) liquid waste
4.7	Gray water
5	Proper wastewater treatment system
5.1	Improvement of wastewater treatment system
5.2	Proper treatment system in the near future
6	Management of hospital wastewater treatment facility

The later project is to review and summarize the situation of MWWSW management at hospitals in 5 cities such as Hai Phong, Hanoi, Hue (Province), Da Nang, and Ho Chi Minh City. Questionnaire survey and interview at the selected hospitals and relevant government organizations are carried out to collect information. In the questionnaire survey, 166 hospitals of public (central, provincial, and district levels) and private hospitals with more than 200 beds were selected. The survey includes status of MWWSW management, from generation to final treatment, as well as management issues at hospitals. The study result is expected to serve a basic information to formulate the future JICA's assistance program in the environmental sector of Vietnam.

### **3.1.6 Donor's programs in MWWSW management sector**

Several studies and projects have been implemented in this sector especially after 2000. These include capacity development of MWWSW management sectors at both central and provincial level hospitals and administrative organizations, development of master plan, procurement and installation of equipment and facilities for MWWSW treatment in some regions and provinces. Some of them are summarized in Table 3.3. Especially recent activities conducted or being conducted by the WHO, the UNDP and the World Bank are notable as described below.

**The WHO** supported development of action plan<sup>19</sup> of medical waste management. In this action plan, although not approved by the Government yet, a centralized waste management system is proposed. Some core hospitals having medical waste treatment facility (mostly incinerator) with

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<sup>19</sup> Proposed National Action Plan for Healthcare Waste Management-Vietnam, World Health Organization-Vietnam Country Office & Western Pacific Regional Office, January 26, 2009.

surplus capacity can treat wastes from other hospitals located within an economical waste hauling distance. Model plan of this system is introduced in this action plan. In addition the WHO supports making technical manuals for non-burning waste treatment technologies, which is underway at the time of making this report. Also, the WHO supports the study on how to improve cost efficiency of medical waste incineration system.

**The UNDP**, in a program of their Global Environmental Facility (GEF), has promoted non-burning technologies for medical waste treatment with intention to avoid toxic chemicals including mercury and POPs released into the environment. Vietnam is selected as one of pilot study sites for non-burning medical waste treatment. Other selected countries include Argentina, India, Latvia, Lebanon, Philippines, Senegal, and Kingdom of Tanzania. They are planning to introduce a large-scale autoclaving system (200 kg/load, 2 units) in URENCO, Hanoi, exclusively used for medical waste treatment and other technologies at several hospitals in the surrounding provinces such as Nim Binh province. However, this project has not been implemented at the time of making this report.

**The World Bank**, contrary to the WHO and the UNDP, has project focusing on medical wastewater management under the operation of Vietnam Poverty Reduction Support Credit program. Project includes assistance for a procurement and improvement of wastewater treatment systems in several provincial, district and central hospitals as well as support for a development and improvement of legal frameworks on MWWSW management and training programs to strengthen capacity development of the sector. For this 5-year project, the Bank pledges total budget of about \$150 million, for strengthening policy foundations (\$50 million), strengthening institutional capacity for MWWSW management (\$9 million), funding facility improvement (\$90 million), and for program implementation support and coordination (\$1 million).

The Bank expects around 200~250 hospitals will be covered by this project. It is said currently nearly 30 provinces show intention to join this project. These provinces have to prepare their master plan for MWWSW management in their provinces. Each candidate hospitals must submit necessary documents according to the Bank's template. Based on these documents and a field survey, hospitals and investment are selected. To satisfy the criteria of selection hospitals should have more than 200 beds and no support from other donors. Technologies are selected from the Bank's menu with a consultation of the Department of Medical Equipment, Facilities and Construction and other relevant Department of MOH. Because of a safeguard policy the Bank does not support incinerators in this project but a waste transportation vehicle for a clustering medical waste treatment system. The size of budget for medical wastewater treatment system for each provincial hospital is estimated between \$300,000 and \$800,000. For the first stage of project implementation, the Bank will also support 50% of recurrent cost of the system.

**Table 3.3 Donors' assistance programs on MWWSW management**

Name of project	Financial source	Contents related to MWWSW management	Time and project location	Area*	Agency
Healthcare solid waste treatment	Australia ODA	Procurement of 25 HOVAL incinerators	2000-2004 (25 central general hospitals and provincial hospitals)	SW	MOH
Master plan on solid waste management	French ODA	Building up master plan on solid waste management for Vietnam	2001-2003 (MOH and 6 demonstration sites)	SW	MOH
Healthcare support for 5 Middle Land provinces	ADB	(i) Procurement and installation of waste and wastewater treatment facilities; (ii) Building up EIA and EMP; (iii) Training	2005-2010 (Implemented at several hospitals at provincial and district levels of 5 Middle Land provinces)	SW, WW	MOH
Healthcare support for South Coastal Region	ADB	(i) Procurement and installation of medical equipment, waste and wastewater treatment facilities; (ii) Building up EIA and EMP; (iii) Training.	2008-2010 (Implemented at several hospitals at provincial and district level of 8 South Coastal Region)	SW, WW	MOH
Healthcare support for Mekong Delta River	World Bank	Building up master plan for the regional healthcare waste management	2006-2012 (Implemented at 13 Mekong Delta River region)	SW	MOH
Healthcare support for 7 North Upland Provinces	World Bank	(i) Procurement and installation of waste and wastewater treatment facilities; (ii) Building up EIA and EMP; (iii) Training.	2008-2012 (Implemented at hospitals at provincial and district level of 7 North Upland provinces)	SW, WW	MOH
Healthcare support for 6 North Central Provinces	World Bank	(i) Procurement and installation of waste and wastewater treatment facilities; (ii) Building up EIA and EMP; (iii) Training.	2010-2016 (Implemented at hospitals at provincial and district level of 6 North Central)	SW, WW	MOH
Healthcare support for provincial hospitals (phase 1,2)	KfW German and State budget	(i) Consultancy activities on making plan; (ii) Training, procurement and installation of wastewater and medical waste treatment facilities.	2001-2010 (9 provincial hospitals)	SW, WW	MOH, PPC
Healthcare support for provincial medical system	KfW German and State budget	(i) Consultancy activities on making plan; (ii) Training, procurement and installation of wastewater and medical waste treatment facilities.	2008-2012 (Several provincial and district hospitals in Yen Bai, Thanh Hoa, Phu Yen)	SW, WW	MOH, PPC
Healthcare waste management	WHO	(i) Building up action plan on healthcare waste management; (ii) Guiding document on healthcare waste water management; (iii) Introduction of medical waste treatment by non-burning technology; (iv) Building up model on healthcare waste treatment of commune health station by sanitary landfill.	2009-2011	SW	MOH
Best practices on HCW reduction in order to avoid emission of dioxin and mercury to the environment	UNDP	(i) Building up medical waste treatment model at some pilot sites; (ii) Implementation and evaluation of non-burning technology; (iii) Introduction of non-mercury at pilot sites; (iv) Training and capacity building in HCWN, (v) Review related issues and legal frameworks.	2009-2014	SW	MONRE

(\*Note: SW; medical solid waste, WW; medical wastewater)

## 3.2 MWWSW Management in Surveyed Hospitals

### 3.2.1 Outline of surveyed hospitals/institutes

The hospitals/institutes surveyed in this study are 8 central hospitals and 1 institute; National Lung Hospitals, National Hospital of Ophthalmology, National Hospital of Acupuncture, National Hospital of Endocrinology, National Institute of Gerontology, National Hospital of Dermatology, Bach Mai Hospital, Hue Central Hospital and Cho Ray Hospital. 7 of them are located in Hanoi, while remaining 2 are in Hue and Ho Chi Minh City, respectively. Outline of these hospitals is summarized in Table 3.4 based on MOH's statistical information in 2008 and location of surveyed hospitals in Hanoi is shown in Figure 3.3.

**Table 3.4 Basic information of surveyed hospitals/institutes as of FY2008**

	Lung Hospital	Ophthalmology Hospital	Acupuncture Hospital	Endocrinology Hospital	Institute of Gerontology	Dermatology Hospital	Bach Mai Hospital	Hue Central Hospital	Cho Ray Hospital
Type	Specialty	Specialty	Specialty	Specialty	Specialty	Specialty	General	General	General
<b>Bed number</b>									
Planned bed	400	320	290	150	150	100	1,500	1,100	1,400
Actual bed	448	320	440	277	165	100	1,500	2,006	1,644
No. of departments	0	0	17	0	11	6	36	44	52
No. of clinical department	0	0	12	0	8	4	28	33	40
No. of paramedical department	0	0	2	0	3	2	8	11	12
No. of examination	33,499	251,519	12,500	170,716	17,097	161,995	535,986	257,358	930,705
Total death case	81	0	0	1	31	0	460	228	3,110
No. of operation	409	34,959	200	2,928	0	1,432	9,855	18,341	35,952
No. of medical procedure	23,011	10,984	600	14,519	5,025	2,361	212,464	42,766	221,598
Total delivery case	0	0	0	0	0	0	5,969	6,738	32
<b>No. of medical test</b>									
Biochemical	329,923	77,747	11,105	1,401,995	12,508	35,070	3,233,65	628,983	6,147,830
Hematology	855,262	96,280	9,936	295,943	4,008	8,406	1,434,11	337,999	7,806,096
Microbiology	72,814	15,814	0	608	0	31,088	609,646	42,369	383,248
Pathology	28,034	3,282	0	14,087	0	3,959	43,759	43,653	37,640
X-ray	65,921	9,306	5,639	16,434	13,512	0	203,848	133,522	552,223
Ultrasound	11,538	33,080	2,506	55,403	24,113	0	152,386	90,352	192,368
<b>Budget (unit = million VND)</b>									
Revenue	67,007	58,342	—	135,116	37,500	36,406	789,569	374,073	1,157,831
Expenditure	84,679	48,463	18,703	114,536	37,840	39,054	792,000	293,231	1,147,759
<b>No. of staff</b>									
Medical	114	90	236	63	48	44	415	369	628
Pharmaceutical	17	30	8	5	9	17	42	62	77
Nurse	161	141	127	65	49	39	733	576	1,388
Technician	49	17	15	16	7	9	111	146	314
Orderly	55	59	15	13	9	20	187	541	111
Others	100	85	66	42	20	44	343	177	575
Total	496	422	340	204	142	173	1,847	2,016	3,095

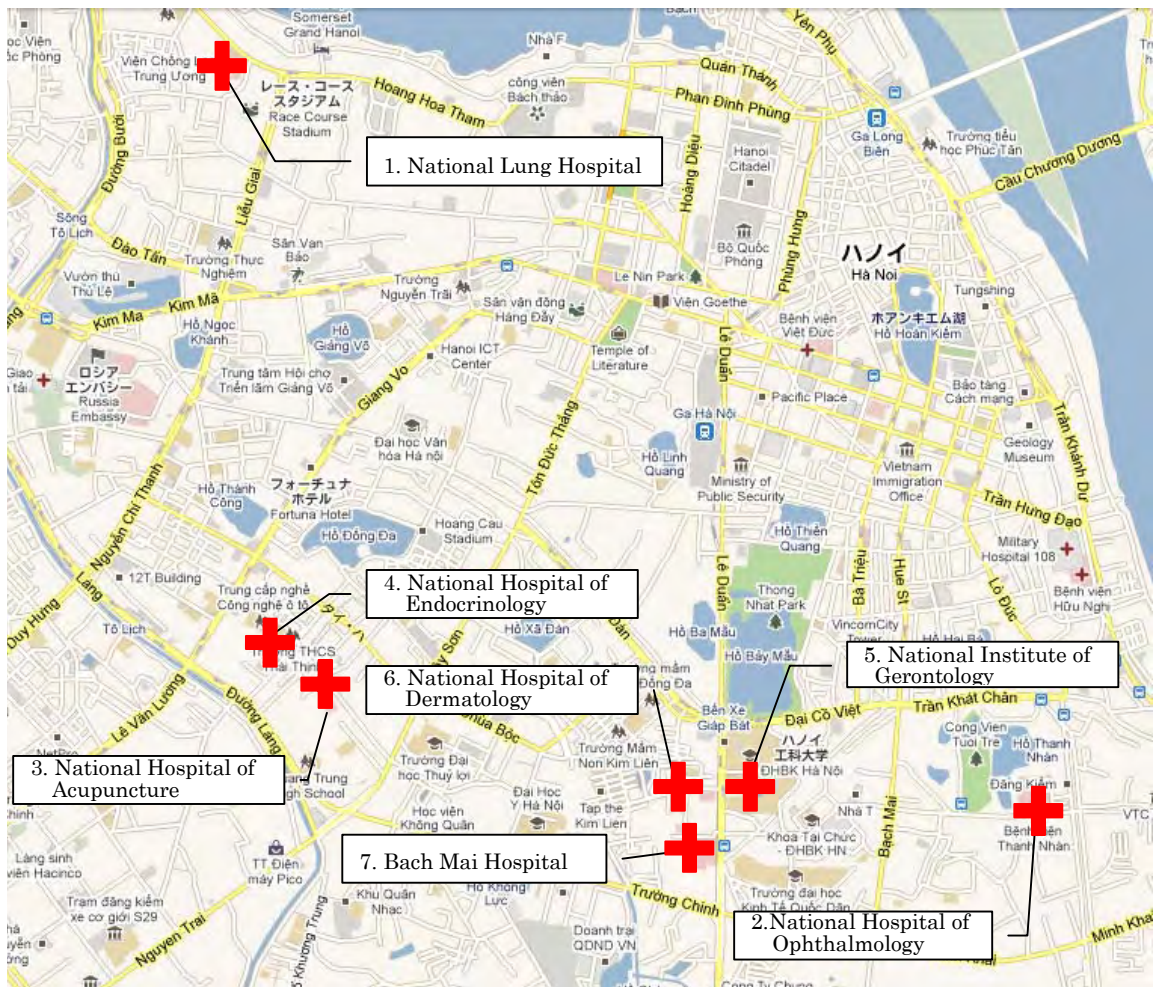


Figure 3.3 Location of the surveyed hospitals/institutes in Hanoi

### National Lung Hospital

National Lung Hospital, former National Hospital of Tuberculosis and Respiratory Diseases, has been positioned as tertiary specialized hospital for infection control, mainly focusing on tuberculosis treatment. After 50 years of its establishment, the hospital widely expanded its role to provide not only drug therapy to treat thorax but also surgical treatment. As hospital has now multiple functions it has various types of waste and wastewater as any other general hospital, but since it specializes in infectious diseases the hospital concerns the MWWSW more than other hospitals generally do, especially for blood-borne infection. Also, restriction of hospital visit by patient's families to prevent air-borne infection proved to reduce general waste.

The hospital focuses on long-term in-patient care rather than out-patient treatment. Respectively it has fewer out-patients and conducts more diagnostic examinations (especially microbiology test and X-ray diagnosis) in comparison with other similar-specialized hospitals.

It has 29 departments and a center, including 13 clinical departments, 9 paramedical departments, training & direction center, and 6 functional departments (planning, human resources, financial, equipment & material, nursing, administration).



### **National Hospital of Ophthalmology**

Ophthalmologic clinic was established in Hanoi by French in 1917. Since then, it has been providing tertiary specialized services and leading doctors to be specialists as a teaching hospital. In 1957, the hospital changed its name to become National Hospital of Ophthalmology with 5 departments and 300 beds. Nowadays, the hospital has officially 350 beds (actually 367 beds) with 90 medical staff. Mainly treated diseases in that hospital are conjunctivitis, myopia, cataract, external injuries and retinal hemorrhage resulting from diabetic complications. Major operations performed in the hospital are cataract-related and number of operation per year is around 60,000. This number is particularly high when compared to other specialized hospitals, which means a lot of in-patients. In fact, the number of in-patients is double that of out-patients.

The hospital has 6 clinical departments (pediatric ophthalmology, eye trauma, retina & uveitis, cornea & external diseases, glaucoma, and out-patient department (OPD)) and 16 paramedical departments (operation theater, ICU, laboratories, in-patient department (IPD), Imaging diagnosis, etc.).

### **National Hospital of Acupuncture**

National Hospital of Acupuncture was established in 1982. Currently, the hospital employs 388 medical staff in 20 departments with 400 beds. It mainly provides pain treatment through acupuncture; however it also adopts and integrates acupuncture method into western medicine. For instance, instead of anesthesia it uses acupuncture when a patient has anesthetic anaphylaxis. The hospital treats all generations from infant who has congenital cerebral disorder to elderly who has backache and arthritis. It mainly treats diseases such as dysphasia, post-operational rehabilitation and numbness (many patients come or are referred because other hospital couldn't cure them by usual procedures). Therefore, the hospital has almost same functions as general hospital, such as an operation theater, laboratories and imaging diagnosis, and total 91 medical doctors with different specialties.

The hospital has key clinical departments; pediatric, surgery/operation, internal medicine, ICU, comprehensive treatment, and drug user rehabilitation.

### **National Hospital of Endocrinology**

National Hospital of Endocrinology was established in 1969. From the beginning, its functions have been linked to the national prevention program. However, from 2000 the hospital's functions have been expanded to also deal with endocrinology and metabolism disorders (especially diabetes): it now has 350 beds. Major treatments performed in the hospital are for thyroid disease, oncology prevention and diabetes. It also has unique departments such as thyroid surgery and foot care department.

Its chronic out-patients regularly visit a doctor and regularly receive laboratory tests, this explains the largest number of biochemistry tests performed in specialized hospitals and, as a matter of fact, has 20 times more out-patients than in-patients. There are very few endocrinologists who can perform a surgery in Vietnam. This is another reason why patients rush into this hospital.

The hospital specializes and provides several medical services such as: general treatment, medical research, training, and specialized care method direction for its national network in 64 provinces. It even specialized in endocrinology, which has various functions from internal medicine to surgical fields, and supportive areas such as an operation theater, imaging diagnosis and laboratories. As a whole, the hospital is made up 8 clinical departments and 17 paramedical departments. In 2011, the hospital is planning to move to a new location with 200 planned beds.

### **National Institute of Gerontology**

National Institute of Gerontology has been independent from Bach Mai Hospital since 2006. Its mandates are: research, patient care, training and promotion, and provision of guidance on gerontological topics. Main care methods in the hospital are pharmacotherapy and observation that mainly focuses on elderly patients who have diseases such as arthritis, osteoporosis,

hypometabolism, diabetes (especially chronic and complex illness by aging), and cardiac diseases: most of the elderly patients are over 50 years old. Therefore, the hospital does not have an operation theater and ICU except from emergency room. However, when necessary, the hospital may refer to Bach Mai Hospital for assistance. As the hospital has 150 beds and no operation theatre, medical and hazardous waste are rare.

The hospital has 5 clinical departments: cardio-vascular, psycho-neurology, endocrinology, emergency room, and laser application. It also keeps functional diagnostic rehabilitation department as paramedical and administrative areas.

### **National Hospitals of Dermatology**

National Hospital Dermatology has been separated from Bach Mai Hospital since 2006. It now has 150 beds. Its mandates are: research, patient care, training and provision of guidance, and international cooperation on dermatology and leprosy.

Main diseases of out-patients are: allergy, lupus, psoriasis, acnes, sexual transmitted infection (STI), and leprosy. As for in-patients they are mainly: leprosy, STI, atopic dermatitis, and autoimmunity disease. Major operations include: plastic surgery, reconstructive surgery, and skin cancer abscission.

The hospital has 7 functional departments, including 4 major clinical departments; out-patient, leprosy treatment and laser-operation, women and children dermatology, and men's dermatology. In addition it has 2 paramedical departments, pharmacy and laboratory, the latter includes microbiology & fungus, pathology, serum, biochemical-hematology, and immunology.

### **Bach Mai Hospital**

Bach Mai Hospital was established in 1911 in Hanoi during the French colonial rule. The hospital is a tertiary general hospital but also specializes in internal medicine. It serves as a big center of cadres training and scientific research in Vietnam. It has 1,500 beds, 415 medical staff, 28 clinical departments and 8 paramedical departments, which sums up as 36 departments in total.

As a general hospital, it treats over 90,000 in-patients and 670,000 out-patients per year, meaning that about 2,500 patients and their family members stay at the hospital per day. Because of the high volume of patients the hospital discharges large amount of various medical waste. In fact, according to our studies the top 3 central hospitals (Bach Mai, Hue Central, and Cho Ray Hospitals) discharge 10 times more various medical waste than other smaller specialized hospitals.

### **Hue Central Hospital**

The Hue Central Hospital was established in 1894 as the first occidental hospital in Vietnam. The hospital has around 2,000 beds, and is one of the three largest in the country along with Bach Mai Hospital in Hanoi and Cho Ray Hospital in Ho Chi Minh City. It is a central medical institution for the population of 15.3 million in Central Vietnam; respectively, it is positioned as a top referral hospital. It also serves as the primary training facility for the Hue Medical College. Currently the hospital plans to expand and build Ophthalmology Department, along with training center that are funded by Atlantic Philanthropies. It recently announced a new project to build Tumor Center that will provide 300 beds.

The hospital consists of 2,016 medical personal and 2,500 students of the Hue Medical College and other 300 doctors and interns continuing their professional development at the hospital. On annual basis it provides around 250,000~300,000 of medical examinations, 60,000~70,000 in-patient treatments, and 20,000 surgeries. In 2005, it served 51,911 in-patients, with an above-norm occupancy rate of 137%, and provided care for 5,060 births. Patients from minority groups and the poor can be fully or partially exempted from medical fees.

The hospital is divided into 52 clinics and para-clinic departments, notably the Cardiovascular Center (co-funded by Atlantic Philanthropies and East Meets West Foundation), Blood Transfusion Center (co-funded by World Bank and the WHO), and Training Center.

### **Cho Ray Hospital**

Cho Ray Hospital is the largest general hospital in Ho Chi Minh City, founded in 1900 during the French colonial rule as Hôpital Municipal de Cholon. Over the years, it was also known as Hôpital Indigène de Cochinchine (1919), Hôpital Lolung Bonnoires (1938), and Hôpital 415 (1945), until it was ultimately renamed Cho Ray in 1957.

Currently, the hospital has 35 clinical, 11 subclinical and 8 functional departments. It organizes practice and postgraduate training for more than 2,500 medical students and 600 doctors each year. The hospital has 1,200 beds, employs 2,270 health workers including 500 medical doctors and pharmacists, and provides treatment for about 457,000 out-patients and 67,000 in-patients per year.

#### **3.2.2 Preliminary questionnaire survey on MWWSW management**

In Table 3.5, the results of questionnaire survey are summarized. This survey was conducted in September 2010 to obtain overall information regarding MWWSW management at these hospitals; practices of source separation, on-site transportation, and storage of medical wastes, amount of wastes and wastewater generation, treatment and disposal methods and on-site systems, cost and man power of MWWSW management, and activity for awareness raising or capacity development of staffs and workers. There are several discrepant data in general information on hospitals between Table 3.4 and Table 3.5 because of a different survey year. Several data are missing in Table 3.5 presumably because of a data lacking at hospitals or some difficulty to answer due to uncertainty of the question. Questionnaire sheet of this survey is attached in Appendix 5-1.

Major findings of the survey are as follows:

##### **a. General information**

- The number of planned bed and actual bed are different especially in the general hospitals. The actual bed number at Bach Mai Hospital and Hue Central Hospital is significantly more than those of planned.
- Ophthalmology Hospital, Dermatology Hospital and Cho Ray Hospital have experienced a flooding in the hospitals premises in the last 10 years.

##### **b. Waste generation, segregation, storage and treatment**

- Infectious waste generation rates (kg/bed/day) are grouped into 3 ranges: less than 0.1 kg/bed/day, 0.1~0.2 kg/bed/day and more than 0.2 kg/bed/day. Only Cho Ray Hospital reports higher amount of infectious waste generation rate, 0.84 kg/bed/day. In general waste generation rate at the general hospitals (more than 0.2 kg/bed/day) are more than at the specialty hospitals (less than 0.2 kg/bed/day) with exception of Institute of Gerontology (0.31 kg/bed/day) and Cho Ray Hospital (0.93 kg/bed/day).
- Generation rates of normal waste are grouped in 3 ranges, less than 1.0 kg/bed/day, 1.0~2.0 kg/bed/day and more than 2.0 kg/bed/day. 3 hospitals report the amount of waste in cubic meter, and thus these are not included in these groups. 2 general hospitals (Bach Mai Hospital and Cho Ray Hospital) report waste generation rate less than 1.0 kg/bed/day while 2 specialty hospitals (Lung Hospital and Dermatology Hospital) more than 2.0 kg/bed/day.
- Waste segregation at sources is well organized and conducted at most hospitals using colored bags, especially for sharps, other hazardous medical wastes and normal waste. Segregation for recyclables is not clear at Acupuncture Hospital, Dermatology Hospital and Bach Mai Hospital.
- There are not storage facilities for hazardous medical wastes at Institute of Gerontology and Dermatology Hospital. Only Cho Ray Hospital has a storage room with air conditioning or ventilation system. Others have storage rooms without air conditioning or ventilation system.
- Only Hue Central Hospital (incinerator) and Ophthalmology Hospital (autoclave) have their own waste treatment facilities and treat some kinds of waste by themselves. However, other hospitals contract out waste treatment to the URENCO mostly. Normal waste is treated by the URENCO at all facilities.

- Treatment cost (charge) of hazardous medical waste is ranged 8.98~9.878 million VND/ton, while non-hazardous waste is 160,000 VND/m<sup>3</sup> or 157,000~437,000 VND/ton.
  - Annual expenditure for waste discharge and storage is ranged 160,000~480,000 VND/actual bed (information from Bach Mai Hospital and Cho Ray Hospital is lacking). Only exception is the expenditure of Dermatology Hospital, 1.167 million VND/actual bed/year. Annual expenditure for off-site waste treatment is ranged from 200,000 to 900,000 VND/actual bed (information from Endocrinology Hospital and Hue Central Hospital is lacking).
- c. Wastewater treatment
- Lung Hospital, Acupuncture Hospital and 3 general hospitals have their own wastewater treatment facility. Dermatology Hospital and Institute of Gerontology send their wastewater to the wastewater treatment facility of Bach Mai Hospital. All the wastewater treatment systems were installed before 2000 and updated recently except for the system of Lung Hospitals of which system was installed in 1997.
  - The amount of wastewater, however, exceeds the capacity of the wastewater treatment facility except at Lung Hospital and Hue Central Hospital. The amounts of wastewater at Acupuncture Hospital and Cho Ray Hospital are 6 times more than the nominal capacity of the wastewater treatment facility, while in Bach Mai Hospital 18 times more than the nominal capacity presumably because Bach Mai Hospital accepts wastewater from Dermatology Hospital and Institute of Gerontology.
  - Annual operation and maintenance expenditure of wastewater treatment facilities is around 300,000VND/actual capacity (m<sup>3</sup>/day) on average. Exceptions are at Bach Mai Hospital and Hue Central Hospital where operation and maintenance costs are 55,000 VND/actual capacity (m<sup>3</sup>/day) and 165,000 VND/actual capacity (m<sup>3</sup>/day), respectively.
  - Only Bach Mai Hospital and Hue Central Hospital have a separate wastewater treatment system for some sorts of medical liquid waste. However, it is not clear which technologies are employed and what kinds of liquid wastes are separately treated.
- d. Awareness raising and capacity development
- For awareness raising program for medical staff on MWWSW management, holding seminar or workshop on-site or participation in the seminar or workshop sponsored by other organizations, and having own training/educational program are the common means at surveyed hospitals.
  - For capacity development program of non-medical staffs working for MWWSW management, periodical training of occupational safety, participation workshop/seminar outside hospital are most frequently used measures among surveyed hospitals.

**Table 3.5 Results of preliminary questionnaire survey on MWWSW management at 9 central hospitals/institutes**

Items	National Lung Hospital	National Hospital of Ophthalmology	National Hospital of Acupuncture	National Hospital of Endocrinology	National Institute of Gerontology	National Hospital of Dermatology	Bach Mai Hospital	Hue Central Hospital	Cho Ray Hospital	
<b>1. General Information on the Hospital</b>										
<b>No of the bed</b>										
Planned	400	350	450	500	165	150	1,900	1,500	1,800	
Actual	445	367	380	NA	180 - 200	120	3,160	2,239	1,620	
<b>No of the staff (full time)</b>										
Administration	39	91	42	NA	22	21	NA	170	200	
Physician	112	117	4	63	50	51	NA	410	1,091	
Nurse	155	154	113	71	63	45	799	947	1,357	
Medical technician	51	15	11	17	12	11	134	164	332	
Others	138	89	123	70	41	67	145	602	243	
Total	494	446	293	-	188	195	-	2,293	3,223	
<b>Average number of patients and operation (year)</b>										
In-patients	11,241	21,041	2,400	8,500	4,822	43,200	93,758	75,250	918,843	
Out-patients	2,815	12,148	3,000	156,250	34,566	21600 - 28800	672,033	338,000	985,800	
Number of minor operation	24,506	24,225	7,200	11,700	0	6,836	226,242	62,218	NA	
Number of operation	855	35,629	2,400	2,600	0	1,435	9,545	20,244	37,409	
Number of testing	1,530,523	222,180	261,636	1,850,000	35,755	111,244	6,819,353	1,367,384	15,037,267	
<b>Inundation experience around the hospital in the last 10 years</b>	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	
<b>2. Medical Waste Management</b>										
<b>Average amounts of solid waste</b>										
Hazardous waste (kg/day)	Infectious waste	60.5	30.2	27.7	37 - 37.5	51	20	527	300 - 350	1,513
	Chemicals	NA*	NA	Very few cytotoxic	0.004 (m <sup>3</sup> /day)	Very little	NA	28	1 - 1.4	Solid: 1.6, Liquid: 1.5 (m <sup>3</sup> /day)
	Radioactive waste	NA	NA	NA	NA	NA	NA	0.76	0.2 - 0.3	166.6 (m <sup>3</sup> /day)

Items		National Lung Hospital	National Hospital of Ophthalmology	National Hospital of Acupuncture	National Hospital of Endocrinology	National Institute of Gerontology	National Hospital of Dermatology	Bach Mai Hospital	Hue Central Hospital	Cho Ray Hospital
	Pressurized container	NA	NA	NA	NA	NA	NA	NA	NA	NA
Non-hazardous healthcare waste (unit/day)		910kg	1.75m <sup>3</sup>	210kg	0.34m <sup>3</sup>	300kg	400kg	576kg	7m <sup>3</sup>	550kg
<b>Waste segregation at source, on-site transportation and storage</b>										
Container for sharp items		Specialized plastic box	Regulated carton boxes	Regulated carton boxes	Regulated carton boxes	Plastic bottle	Specialized plastic container	PE container	Regulated carton boxes, Bottles/Plastic bins/Metal canes	PET bottles/Plastic bins/Metal canes
Color code bags for waste segregation	Infectious waste	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
	Other hazardous waste	Black	Yellow	Yellow	Black	Black	Black	NA	Black	Black (radioactive)
	Normal waste	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	Recyclables	White	White	NA	White	White	NA	NA	White	White
Tools for on-site transportation (units)	Handcart	5	0	Yes	0	0	1	Yes	Yes	Yes
	Wheeled bin	5	6	Yes	2	10	10	Yes	Yes	55
Temporal waste storage for medical waste		Storage room without air conditioning or ventilation	Storage room without air conditioning or ventilation	Storage room without air conditioning or ventilation	Storage room without air conditioning or ventilation	No storage room	No storage room	Storage room without air conditioning or ventilation	Storage room without air conditioning or ventilation	Storage room with air conditioning or ventilation
<b>Methods of treatment/disposal</b>										
Sharps (Category A)		Contract out	Contract out	Contract out	Contract out	Contract out	Contract out	Contract out	Incinerator/Needle destruction	Contract out
Non-sharps (Category B)		Contract out	Contract out	Contract out	Contract out	Contract out	Contract out	Contract out	Incinerator	Contract out
Highly infectious (Category C)		Contract out	Autoclave	Contract out	Contract out	NA	NA	Contract out	Incinerator	Contract out
Anatomical (Category D)		Contract out	Autoclave	Contract out	Contract out	NA	NA	Contract out	Incinerator/ Autoclave/ Chemical disinfection	Contract out
Pharmaceutical		Contract out	Contract out	NA	NA	Contract out	Contract out	Contract out	Incinerator /Neutralization	Return to suppliers
Hazardous chemicals		Contract out	Contract out	NA	Contract out	Contract out	NA	Contract out	Incinerator Neutralization	Contract out
Cytotoxic waste		NA	NA	NA	NA	NA	NA	Contract out	Incinerator	Contract out
Heavy metal		NA	NA	NA	NA	NA	NA	Contract out	NA	Contract out
Radioactive waste		NA	NA	Contract out	NA	NA	NA	Contract out	Others	Contract out

Items	National Lung Hospital	National Hospital of Ophthalmology	National Hospital of Acupuncture	National Hospital of Endocrinology	National Institute of Gerontology	National Hospital of Dermatology	Bach Mai Hospital	Hue Central Hospital	Cho Ray Hospital	
Pressurized container	Returned to suppliers	NA	Return to supplier	NA	NA	NA	Return to supplier	Returned to suppliers	Return to suppliers	
Normal waste	Contract out	Contract out	Contract out	Contract out	Contract out	Contract out	Contract out	Contract out	Contract out	
<b>Fee for treatment (contract out)</b>										
Hazardous medical waste (VND/ton)	8,980,000	8,980,000	NA	8,980,000	8,980,000	8,694,000	9,878,000	NA	NA	
Non-hazardous medical waste	160,000 VND/m <sup>3</sup>	160,000 VND/m <sup>3</sup>	157,000 VND/m <sup>3</sup>	160,000 VND/m <sup>3</sup>	380,000 VND/ton	437,000 VND/ton	418,000 VND/ton	NA	157,000 VND/ton	
Treatment residue	NA	NA	NA	NA	NA	NA	NA	NA	NA	
<b>Number of waste management workers and staffs</b>										
Manager	3	2	79	NA	3	2	4	5	NA	
Waste collection	5	22	13	NA	30	6	121	NA	NA	
Waste treatment	5	0	0	NA	0	0	0	6	NA	
<b>Annual expenditure of waste management (1,000 VND/year)</b>										
Discharge and storage	165,800	60,000	95,533	240,000	88,041	140,000	NA	612,000	NA	
On-site treatment	5,000	NA	13,000	NA	NA	20,000	NA	433,000	156,000	
Off-site treatment	327,162	165,484	80,494	NA	166,966	100,000	2,660,798	NA	372,776	
<b>3. Wastewater Management</b>										
<b>Existence of wastewater treatment system</b>	Yes	No	Yes	No	No	Shared with Bach Mai	Yes	Yes	Yes	
Year of installation	1997	-	1975	-	-	NA	1996	1987 (old ) 2006 (new)	1975	
Upgrade or expansion	No	-	2010	-	-	No	2000	2010	2010	
<b>Technology of current wastewater treatment system</b>										
Technology	Microbial	-	Sedimentation	-	-	NA	Anaerobic	Aeration treatment	Sedimentation	
Capacity (m <sup>3</sup> /day)	Amount of wastewater	250	-	3,000	-	-	NA	15,000	900 - 1000	3,000
	Nominal	300	-	500	-	-	NA	800	1100 - 1250	500
	Actual	250	-	250	-	-	NA	15,000	1,000	500

Items	National Lung Hospital	National Hospital of Ophthalmology	National Hospital of Acupuncture	National Hospital of Endocrinology	National Institute of Gerontology	National Hospital of Dermatology	Bach Mai Hospital	Hue Central Hospital	Cho Ray Hospital	
Initial investment cost	800,000,000 VND	-	NA(donated)	-	-	NA	NA	425,000 USD	NA(donated)	
Operation and maintenance cost (1000 VND/year)	76,000	-	156,000	-	-	NA	831,720	165,000	156,000	
Sludge withdrawal	Frequency (time/year)	2	-	NA	-	-	NA	0.5	1	NA
	Average amount/time (m <sup>3</sup> )	10-May	-	NA	-	-	NA	53	20	NA
	Treatment method	off-site	-	NA	-	-	NA	off-site	off-site	NA
No of wastewater treatment workers and staffs	6	-	NA	-	-	NA	NA	3	NA	
Effluent analysis	Yes	-	Yes	-	-	No	NA	Yes	Yes	
Frequency of effluent analysis (time/year)	2	-	2	-	-	NA	NA	2	2	
	Fee for effluent analysis (1000 VND/time)	NA	-	4,000	-	-	NA	10,000	4,000	
<b>Separate treatment system for the following liquid wastes /Technology</b>	No	No	No	No	Shared with Bach Mai Hos.	Shared with Bach Mai Hos.	Yes	Yes	No	
Acid or Alkali	-	-	-	-	-	-	NA	Neutralization	-	
Organic solvent	-	-	-	-	-	-	NA	NA	-	
Heavy metals containing liquid	-	-	-	-	-	-	NA	NA	-	
Photochemical	-	-	-	-	-	-	NA	NA	-	
Disinfectants/Formalin	-	-	-	-	-	-	NA	NA	-	
Radioactive/isotope	-	-	-	-	-	-	NA	Treatment system that meets standards	-	
Others	-	-	-	-	-	-	JAVEN solution	NA	-	
<b>Training and awareness raising activities</b>										
a. Activities carried out to raising awareness for hospital staffs										
Leaflet or poster for waste segregation					Yes	Yes		Yes	Yes	
Periodical campaign for a proper waste and wastewater management		Yes	Yes	Yes				Yes	Yes	
Holding workshop or seminar on waste and wastewater management	Yes		Yes	Yes	Yes	Yes		Yes	Yes	
Participation on workshop or seminar outside hospital	Yes	Yes	Yes	Yes	Yes			Yes	Yes	
Task force or committee formation to enhance			Yes		Yes			Yes	Yes	



Items	National Lung Hospital	National Hospital of Ophthalmology	National Hospital of Acupuncture	National Hospital of Endocrinology	National Institute of Gerontology	National Hospital of Dermatology	Bach Mai Hospital	Hue Central Hospital	Cho Ray Hospital
proper waste and wastewater management									
Having own training/educational program	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes
b. Activities carried out to improve capability for waste and wastewater management workers									
Periodical training/education for occupational safety and measures for incidents	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Periodical training for waste or wastewater handling method	Yes		Yes	Yes				Yes	Yes
Participation on workshop or seminar outside hospital	Yes		Yes	Yes	Yes	Yes		Yes	Yes
Manual preparation for safe waste and wastewater handling	Yes		Yes						Yes

\*: NA means “not available”.

### **3.2.3 In-depth survey on MWWSW management and the environmental issues at hospitals**

Together with the overview survey on MWWSW management at hospitals, in-depth survey concerning MWWSW management was also conducted including waste handling at the waste generation points, solid and liquid waste treatment, awareness of medical staff and non-medical staff, awareness of residents nearby the hospitals, analyses of water quality of wastewater treatment facility and soil in the premise of the hospitals.

#### **Waste management and awareness survey of medical and non-medical staff**

Waste management system regarding waste segregation and handling of sorted wastes, training/education on MWWSW management for medical and non-medical staffs are surveyed by field survey and interview as well as questionnaire survey at 9 hospitals. Awareness survey of 20 medical and non-medical staffs at each hospital is also included in the survey item. Questionnaire sheets of this survey are attached in Appendix 5.2 and 5.3, and the results are summarized in Appendix 6. Hazardous medical waste and liquid waste treatment systems at 9 hospitals are clarified by a field survey and interviews with staffs in charge. Management of exhaust gases from a bio-safety chamber is also referred although gaseous waste is out of scope of this study.

#### **Environment survey in the hospitals and their vicinity**

Water quality of the wastewater treatment system in 6 hospitals in Hanoi was analyzed to assess the effluents quality. Water quality of unit processes comprising wastewater treatment facility was also analyzed to evaluate performance of wastewater treatment facility at 2 hospitals (National Lung Hospital and Bach Mai Hospital) where water samples were obtainable. The samples were analyzed for 14 parameters of TCVN7382-2004 and 22 parameters of QCVN24:2009/BTNMT. Soil samples in the premises of 6 hospitals in Hanoi were analyzed together with back ground samples for 5 parameters regulated by TCVN 5297:1995-Soils Quality, Sampling, and General Requirements. Analytical methods of wastewater and soil including sampling and storage methods are summarized in Appendix 7. Analytical results of wastewater and soil are summarized in Appendix 8.

#### **Awareness survey of residents living nearby the hospitals**

About 50 residents living within 100m from each hospital were randomly selected for questionnaire survey on awareness with respect to living environmental and impact from hospitals. Questionnaire sheets for this survey are attached in Appendix 5.4.

Table 3.6 shows survey items by hospitals and survey results are explained as follows. Especially the results of in-depth survey for Bach Mai Hospital, Hue Central Hospital and Cho Ray Hospital are compared in Appendix 9.

**Table 3.6 Survey items by hospitals**

Hospitals	Awareness of staff	Waste and waste liquid treatment	Water quality	Soil quality	Awareness of resident	Remarks
National Lung Hospital	○	○	○*	○	○	*Water samples of unit processes were analyzed.
National Hospital of Ophthalmology	○	○	○	○	○	
National Hospital of Acupuncture	○	○	-	-	○**	**One awareness survey of residence for National Hospital of Acupuncture and National Hospital of Endocrinology.
National Hospital of Endocrinology	○	○	○	○	○**	
National Institute of Gerontology	○	○	○	○	○***	***One awareness survey of residence for National Institute of Gerontology, National Hospital of Dermatology and Bach Mai Hospital.
National Hospital of Dermatology	○	○	○	○	○***	
Bach Mai Hospital	○	○	○*	○	○***	* Water samples of unit processes were analyzed.
Hue Central Hospital	○	○	-	-	○	
Cho Ray Hospital	○	○	-	-	○	

### **A. National Lung Hospital**

#### (1) Management issues of MWWSW

##### Waste management body

##### a. Organization

Under the Infection Control Committee (ICC), which has 12 Constituents, the Infection Control Department (ICD) and the Nurse Department are the main implementation bodies. Deputy director is the chair and the rest of 11 members are from ICU, operation theater (2 persons are in charge), microbiology, pharmacy, internal medicine, administration, Planning Department, Facility and Equipment Department, Infection Control Department, and Nurse Department. Nurse Department is in charge for monitoring of infection control including waste management through Infection Control Network.

##### b. Budget and expenditure

All surveyed hospitals are located in Hanoi City. These hospitals temporary keep general solid and medical wastes at their premises, but later, wastes are transported to the processing plant by contracted transport companies, which are subsidiaries of URENCO. Therefore, to maintain efficiency budgeting is the key to properly treat generated wastes inside the hospital and bring it out timely for the later transportation.

The hospital pays contract fee for waste-disposal services and manpower supply companies for cleaning. Contract fee is based on a fixed amount per quantities (hazardous medical waste is 8.98 million VND/ton and non-hazardous medical waste is 160,000 VND/m<sup>3</sup>). This hospital spends 497.962 million VND/year and this accounts for 0.6% of total hospital expenditure (adopting total hospital expenditure 85 billion VND in 2008).

##### Medical waste management

##### a. Separate discharge system and pre-treatment

The 4-kind segregation bag system is highly observed with no contamination at a first glance. Staff knows about segregation rules in the hospital and the hospital seems providing basic instruction for its new employees within a year from the day of the start. Departments that

discharge infectious waste, such as laboratories and operation theater introduced the heat-sterilized method (autoclave, dry heat sterilizer and boiling disinfection). Most departments have a detached building, and the department tries to complete the medical waste cycle/flow independently not depending on other departments to ask disinfection of medical waste. It means that the department has disinfecting equipment such as autoclave and the department carries medical waste out for pre-treatment. However, when the department does not have such function, it asks outside specialized disposal collecting company to pick up and dispose the waste.

Medical wastewater is also well managed at laboratories, as chlorine disinfectant tablet is put into waste tank in advance or chlorinated solvent with adequate concentration value. After this primary treatment, the wastewater is released into general sink.

#### b. Instruction and training

Training curriculum is planned and provided by the Infection Control Department. Source of information comes from MOH. Also Association of Nurses and Hanoi School of Public Health collaborate to be lecturers. Training plan is basically included into annual plan of the hospital. In each workplace, the issue of infection control is frequently discussed according to the specialty of the hospital. The interest of the medical waste management is relatively high, and necessary basic manuals are recognized by the staff.

#### c. Monitoring and feedback

Monitoring is performed daily by nurses in charge. Monitoring method is determined by MOH, and contents of check list are mainly categorized in 3 parts; medical procedure (how correctly medical workers work at each workplace, such as bandages, drainage tube change and equipment usage), waste segregation (correct separation of medical waste, especially sharps and needles), and hygiene actions (such as hand washing). Monitoring process is completed in one month for all hospital.

Result of monitoring is reported to each workplace and reflected to staff's reward and punishment. This hospital is quite strict for worker's behavior on infection control according to the hospital's characteristic specialty and management leadership. Also, special environment with less emergency cases and out-patients, and complex buildings with expansive grounds contribute management board to control hospital workers loosely on hygiene issues.

#### Staff awareness

According to the questionnaire survey, it seems that most of the hospital workers recognize what is dangerous and what causes problems clearly, and what to do in case of accident. At least they do not think their knowledge is enough and seem welcoming more in-service training as well. The occupational accidents are mainly needle stick, cut by sharps, and touch dangerous medical substances. In this hospital, normal medical wastes could be hazardous, so that staffs are aware of they are surrounded by the infectious risk.

However, even the hospital provides high quality in-service trainings already, 50% of interviewees saw the mixed waste disposal, 60% remembers their mistakes, and 70% saw other types of contamination. Hospital can consider why still there is contamination of waste disposal, how they can find disposal contamination by monitoring, and what kind of approach is effective in training.

#### (2) Technical issues of MWWSW management

This hospital does not have a waste treatment facility such as incinerator. Treatment of solid waste generated at the hospital is mostly contracted out to URENCO, waste management company. Medical solid waste is separated into hazardous and non-hazardous solid waste at hospital and hazardous solid waste is stored in temporal waste storage until contracting out.

This hospital has a central wastewater treatment system which was installed in 1997. Wastewater treatment technology is a biological treatment and the system is composed of storage tank, sedimentation tank and aeration tank. Nominal capacity of the system is 300 m<sup>3</sup>/day but actual

wastewater generation is 250 m<sup>3</sup>/day. All liquid wastes are discharged into this wastewater treatment system after treatment with a special solution by the hospital themselves if necessary.

**Table 3.7 Summary of liquid and solid waste treatment system (National Lung Hospital)**

Liquid waste	Treatment method	Solid waste	Treatment method
Liquid waste from operating theater (OT)	Correcting and transporting by cleaner belonging to departments after treatment with special solution at OT	Solid waste	Separating at each departments/rooms, then transporting to storage.  Note: MOH has instructed new technology for solid waste treatment as trial at this hospital together with C Da Nang Hospital.
Liquid waste from laboratories	Correcting and transporting by cleaner belonging to each laboratory after treatment with special solution at each laboratories		
X-ray film development solution	Since using digital X-ray film processor, no waste liquid is discharged		

Main focus points of this study are wastewater and solid waste management. However, exhaust air from bio-safety cabinet at microbiology laboratory is one of the most important matters for a protection of nosocomial infection. This hospital has many bio-safety cabinets at microbiology laboratory. And hospital has a contract with equipment supplier for maintenance of the cabinets including changing HEPA filter every 6 to 8 months.

(3) Environmental issues of MWWSW management

a. Environmental impact by MWWSW treatment facility

Effluent, noise, vibration and odor could be considered as factors of environmental impact on the surrounding area related to MWWSW treatment facility. But with regard to noise and vibration, driving machine of aeration and sludge withdrawal of medical wastewater treatment facility are the only source. The levels of noise and vibration are very low so that it does not make serious environmental impact on the surrounding area. Also, with regard to odor, wastewater holding tank and sludge tank are the main sources of odor, however these facilities are installed in the basement of the facility and are sealed in the ground. Therefore odor is not an environmental impact factor.

b. Water quality of wastewater treatment facility and soil analysis

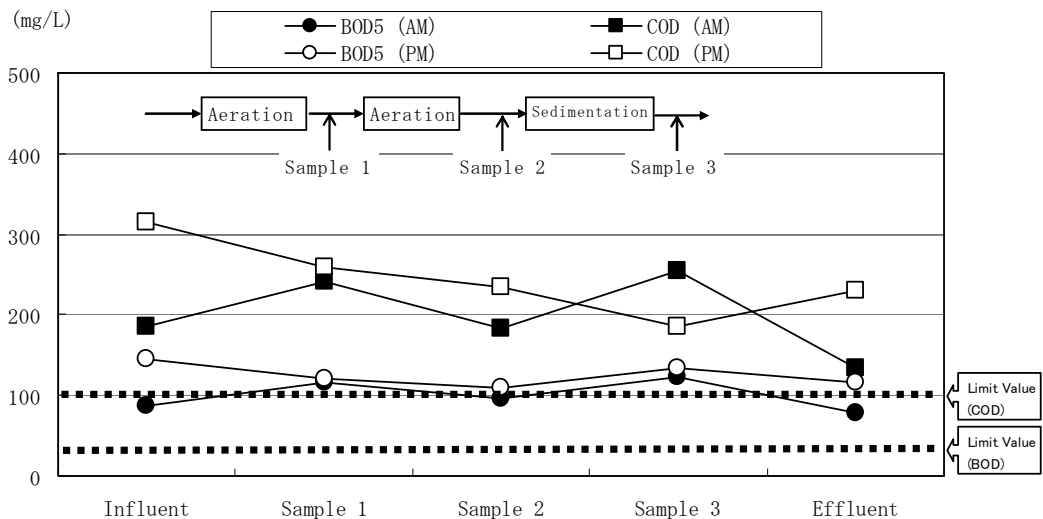
The survey was carried out on 28<sup>th</sup> September, and effluent and wastewater of each unit processes such as storage tank, sedimentation tank and aeration tank were sampled twice in the morning and afternoon. In the parameters of TCVN7382-2004, 4 parameters in effluent such as BOD, S<sup>2-</sup>, PO<sub>4</sub><sup>3-</sup> and Total coliforms exceeded limit values and *Shigella* was detected. With regard to QCVN24:2009/BTNMT, 2 parameters such as COD and CN<sup>-</sup> exceeded limit values but heavy metal such as Cd, Cu, Pb, Zn met respective limit values. Result of wastewater quality analysis is shown in Table 3.8 in which all the parameters of TCVN7382-2004 and 5 parameters of QCVN24:2009/BTNMT apt to exceed limit values are selectively shown.

Figure 3.4 shows the variation of BOD and COD by each unit of wastewater treatment facility. BOD and COD keep nearly constant values which indicate unit processes and thus entire wastewater treatment facility of this hospital did not work well.

4 samples of soil in hospital premise were sampled on 28<sup>th</sup> September and analyzed for Pb, Zn, Cd, As and Cu of QCVN03:2008/BTNMT. All of parameters met limit value and comparable to background level.

**Table 3.8 Result of wastewater quality analysis (National Lung Hospital)**

Parameters	Unit	Wastewater (Effluent)		Limit Value	Remark
		AM	PM		
pH	-	7.4	7.6	6.5 - 8.5	TCVN 7382
SS	mg/L	15	26	100	ditto
BOD <sub>5</sub>	mg/L	78	117	30	ditto
S <sup>2-</sup> (H <sub>2</sub> S)	mg/L	3.6	3.2	1	ditto
NH <sub>4</sub> <sup>+</sup> (N)	mg/L	4.4	7.8	10	ditto
NO <sub>3</sub> <sup>-</sup> (N)	mg/L	0.3	<0.1	30	ditto
Floral and faunal fat	mg/L	1.0	0.7	10	ditto
PO <sub>4</sub> <sup>3-</sup>	mg/L	4.3	9.8	6	ditto
Total Coliform	MPN/100mL	3.9E+06	9.7E+07	5,000	ditto
Samonella	-	ND	ND	ND	ditto
Shigella	-	++	++	ND	ditto
Vibrio cholera	-	ND	ND	ND	ditto
Total Alpha radian activity	Bq/L	0.03	0.02	0.1	ditto
Total Beta radian activity	Bq/L	0.49	0.35	1	ditto
Odor	-	bad	bad	uncomfortable	QCVN24:2009/BTNMT
Color	-	37	66	70	ditto
COD	mg/L	135	229	100	ditto
CN <sup>-</sup>	mg/L	0.70	0.18	0.1	ditto
T-N	mg/L	6.9	8.9	30	ditto



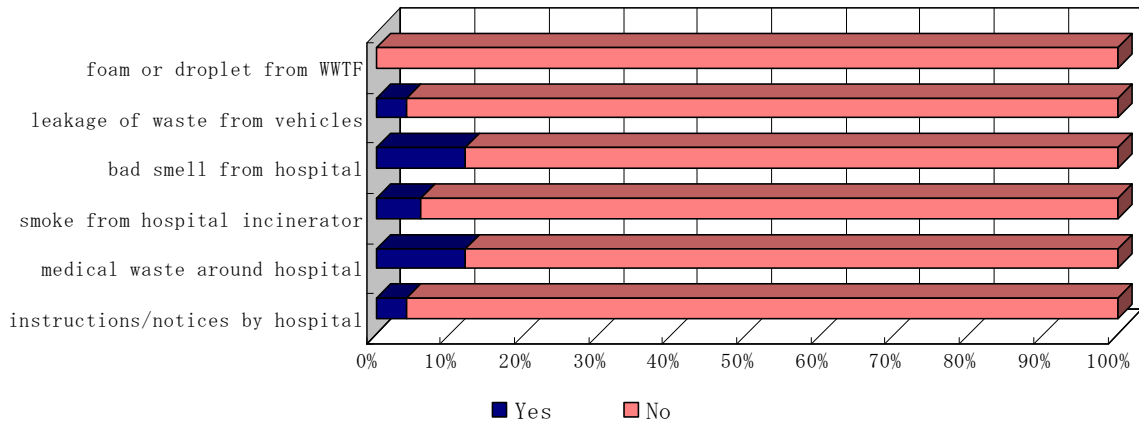
**Figure 3.4 Variation of BOD<sub>5</sub> and COD by unit processes (National Lung Hospital)**

c. Result of questionnaire survey on resident awareness

About 36% of respondents (18 out of 50 samples) have experienced inundation around their houses and 4 out of 18 respondents answered the highest level is above knee. Around 12% of respondents have seen scattered medical waste around hospital and suffered from a bad smell from hospital. Around 6% of respondents have seen smoke generated from hospitals incinerator<sup>20</sup>.

<sup>20</sup> Currently this hospital has no incinerator.

Around 4% of respondents have seen drops or leakage of waste from waste collection vehicles. Only 4% of respondents have received the instructions/notices by the hospital on the prevention of epidemical spread after disasters such as floods and/or during construction work of hospital. The survey results are shown in Figure 3.5. The answer of “Yes” with less than 10% respondents is questionable.



**Figure 3.5 Result of resident awareness survey (National Lung Hospital)**

d. Environmental impact at the time of flood and disaster

The hospital is located in the urban area, surrounded by housing and commercial facilities. The wastewater treatment facility is away from the main road and surrounded by a wall of about 2 m height. The sedimentation tank and aeration tank of wastewater treatment facility is about 3 m high on the ground. The storage tank and sludge tank are installed in the basement. When floods occur, there is a possibility of outflow of wastewater out of the storage tank and sludge tank. Therefore environmental risk at the time of flood and disaster could become higher than that of existing states.

Medical solid waste is temporally stored in the storage room which, however, does not have equipment for preventing ingress of water. Therefore there is a possibility for outflow of wastes out of the storage room when water level exceeds the floor level of the storage during floods.

**B. National Hospital of Ophthalmology**

(1) Management issues of MWWSW

Waste management body

a. Organization

ICC is composed by 17 members from related departments where ICD and Nurse Department are the key with Infection Control Network. ICD has 4 divisions and full-time staffs are assigned; waste management (1 doctor, 1 nurse and 1 engineer), central sterilization, laundry and consumable supply. It seems that ICD is established well and organized effectively.

b. Budget and expenditure

The hospital contracts 2 companies for discharge waste and temporary cleaning service in hospital. Total cost for waste management is 225.484 million VND/year and this makes up 0.5% of total expenditure.

Medical waste management

a. Separate discharge system and pre-treatment

According to ophthalmological treatment, discharged anatomic and blood wastes are less than in the other general hospitals. Major chemical waste and wastewater come from laboratories, and blood waste is discharged from an operation theater and inpatient wards. There is no radioactive waste due to digital processor for X-ray films development, so that no developing solution.

The 4-kind segregation bag system is highly obeyed. The hospital seems that the Infection Control Network by Department of Nurses works well provided human resources are sufficient. Disposals in each room are carried out by contracted cleaners twice a day. However, some hospital staff does not know the importance of proper waste separation and disposal. Hence, staff knowledge of medical waste management in the hospital is weak and the importance of segregation must be stressed and explained comprehensively.

#### b. Instruction and training

Instruction and in-service training seem to be adequate in each department. The hospital does not regulate particular instruction about medical waste for students and trainees. However, it tries to communicate the segregation system by writing signs on disposal box. There is no evidence of correlation between the lack of training for new comers and the reporting of mixed waste disposal. However, many interviewees see the mixed disposal and colleague's wrong action. Hence, effectiveness of training of the hospital remains a matter of further research.

#### c. Monitoring and feedback

Through Infection Control network, systematic and regular monitoring method is well established, including feedback to each department. Due to the limited waste storage area and the hospital location near center of downtown, the hospital seems to take measure of frequent disposal collection. Also because of the popularity of eye surgeries, it seems that hospital can receive fee-for-service reimbursement. This makes hospital financially stable and affordable to pay attention for waste management. Such advantage and hospital leadership has potential to provide enough quantity and adequate materials for disposal containers reflecting post-monitoring feedback. These should lead to the reduction of the current occupational accidents.

#### Staff awareness

According to the infection control training and monitoring for medical procedure, hospital staff has basic knowledge of infection risks during emergency cases, most probably due to the hospital's specialty. The surface of the eye is armed with mechanical and immunologic functions to defend itself against a hostile environment; however, as it is too delicate when interacted with external hard and sharp objects the chance of infection is much higher than for the other parts of the body. The defense mechanisms of an eye are native and acquired, both generalized and specific. It is obvious that exposed parts of an eye have a remarkable defense against microorganisms. To breach this defense, any trauma in some form is usually sufficed.

Even though staff is generally knowledgeable of waste segregation, some observed that waste was not properly segregated. To address the problem and reduce incorrect disposal of the waste, the hospital can demonstrate the evidence-based monitoring and linking it with scientific achievement. It will be also helpful if the hospital educates its medical staff about the whole process of the waste flow disposal. This total understanding is able to make staff realize which part of that process is their responsibility. Moreover, it will help staff to spot wrongful waste disposal and report such incidents so appropriate preventive actions can be implemented immediately.

#### (2) Technical issues of MWWSW management

This hospital does not have on-site waste treatment facility such as incinerator. Waste generated at the hospital is mostly contracted out to URENCO. Solid wastes are separated into hazardous and non-hazardous solid waste at hospital and hazardous wastes are stored in a temporal storage until contracting out. Anatomical wastes are sterilized by ICD, and handed over to URENCO for



final disposal. Wastes generated at microbiology laboratory are also sterilized by autoclave at ICD.

The hospital does not have a central wastewater treatment facility. Therefore liquid wastes are treated individually and discharged into public sewer as shown in Table 3.9.

Hospital has a safety bio cabinet at microbiology. But HEPA filter of the cabinet has not been changed for 3 years.

**Table 3.9 Summary of liquid and solid waste treatment system  
(National Hospital of Ophthalmology)**

Liquid waste	Treatment method	Solid waste	Treatment method
Liquid waste from operating theater (OT)	Transportation to Infection control department (ICD) by cleaner belonging to OT without any treatment	Anatomical waste from OT	Transportation to pathology after treatment with special solution
Liquid waste from laboratories	Correcting and transportation by cleaner belonging to laboratories after treatment with special solution at each laboratories	Anatomical waste from pathology	Transportation to ICD
Blood waste from hematology laboratory	Collecting by cleaner belonging to ICD, and handing over to URENCO after sterilizing	All solid waste collected from each department to ICD	Sterilizing at ICD and handing over to URENCO
Waste urine from hematology	Discharging into general wastewater line without treatment		
X-ray film development solution	Collecting and transportation to ICD by cleaner belonging to department		

### (3) Environmental issues of MWWSW management

#### a. Environmental impact by MWWSW treatment facility

Effluent and odor could be considered as factors of environmental impact on the surrounding area. But with regard to odor, drainage facilities such as pipes and tanks are installed in the basement and are sealed underground. Therefore odor is not a environmental impact factor.

#### b. Water quality of wastewater treatment facility and soil analysis

The survey was carried out on 28<sup>th</sup> September, and effluent was sampled twice in the morning and afternoon. 2 samples showed slightly alkaline and pH of 1 water sample exceeded limit values. 5 parameters of TCVN7382-2004 such as BOD, S<sup>2-</sup>, NH<sub>4</sub><sup>+</sup>, PO<sub>4</sub><sup>3-</sup> and Total coliforms exceeded limit values and *Shigella* was also detected. 2 parameters of QCVN24:2009/BTNMT, such as COD and T-N exceeded limit values but heavy metal such as Cd, Cu, Pb, Zn met limit values. Result of wastewater quality analysis is shown in Table 3.10 in which all the parameters of TCVN7382-2004 and 5 parameters of QCVN24:2009/BTNMT apt to exceed limit values are selectively shown.

2 samples of soil in the hospital premise were analyzed for Pb, Zn, Cd, As and Cu of QCVN03:2008/BTNMT. Arsenic (As) of 1 sample exceeded limit value. But other parameters met limit values and comparable with back ground level.

**Table 3.10 Result of wastewater quality analysis (National Hospital of Ophthalmology)**

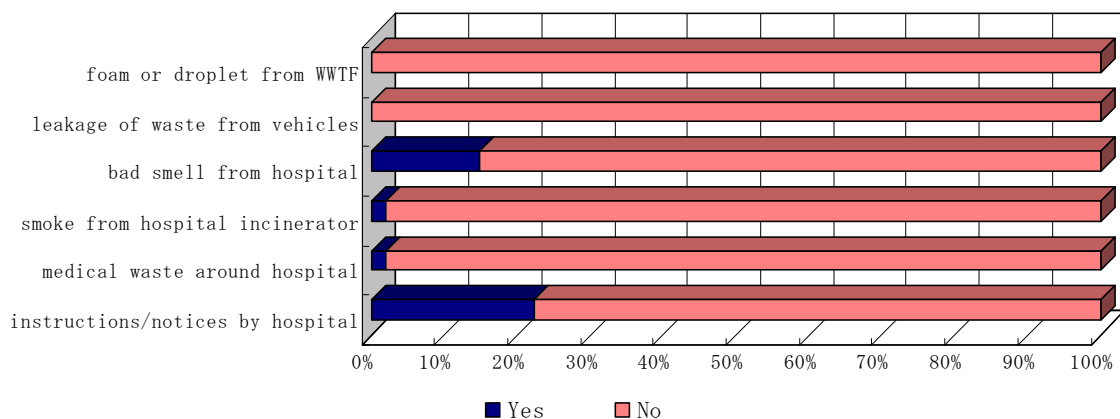
Parameters	Unit	Wastewater (Effluent)		Limit Value	Remark
		AM	PM		
pH	-	8.6	8.2	6.5 - 8.5	TCVN 7382
SS	mg/L	34	39	100	ditto
BOD <sub>5</sub>	mg/L	76	180	30	ditto
S <sup>2-</sup> (H <sub>2</sub> S)	mg/L	3.0	8.8	1	ditto
NH <sub>4</sub> <sup>+</sup> (N)	mg/L	32.6	30.8	10	ditto
NO <sub>3</sub> <sup>-</sup> (N)	mg/L	<0.1	<0.1	30	ditto
Floral and faunal fat	mg/L	2.0	0.5	10	ditto
PO <sub>4</sub> <sup>3-</sup>	mg/L	6.4	11.8	6	ditto
Total Coliform	MPN/100mL	2.4E+06	1.5E+07	5,000	ditto
Samonella	-	ND	ND	ND	ditto
Shigella	-	++	+	ND	ditto
Vibrio cholera	-	ND	ND	ND	ditto
Total Alpha radian activity	Bq/L	0.04	0.04	0.1	ditto
Total Beta radian activity	Bq/L	0.78	0.62	1	ditto
Odor	-	bad	bad	uncomfortable	QCVN24:2009/BTNMT
Color	-	63	41	70	ditto
COD	mg/L	113	267	100	ditto
CN <sup>-</sup>	mg/L	<0.01	0.08	0.1	ditto
T-N	mg/L	35.6	33.2	30	ditto

c. Result of questionnaire survey on resident awareness

22 residents out of 54 have experienced inundation around their house and 13 out of 22 respondents answered the highest level of water was above knee.

Only 1 out of 54 residents has seen scattered medical waste around hospital and smoke generated from hospitals incinerator. Around 15% of respondents have suffered from a bad smell from hospital. None of residents have seen drops or leakage of waste from waste collection vehicles and flying foam or droplet from wastewater treatment facility at hospital.

Around 22% of respondents have received the instructions/notices by the hospital on the prevention of epidemical spread after disasters such as floods and/or during construction work of hospital. The survey results are shown in Figure 3.6. The answer of “Yes” with less than 10% respondents is questionable.



**Figure 3.6 Result of resident awareness survey (National Hospital of Ophthalmology)**

d. Environmental impact at the time of flood and disaster

The hospital is located in the urban area, surrounded by housing and commercial facilities. The hospital does not have a central wastewater treatment system. Therefore environmental burden is not much difference between existing states and the time of flood and disaster. It means there is not strong possibility of additional environmental burden on the surrounding area at the time of flood and disaster. But environmental risk at the time of flood and disaster could become higher than that of existing states. Because wastewater overflowed from drainage could be spread into everywhere.

Medical solid waste is temporally stored in the storage which does not have equipment to prevent water ingress. Therefore there is a possibility of waste outflow of the storage room when water level exceeds floor level of the storage during a flood.

**C. National Hospital of Acupuncture**

(1) Management issues of MWWSW

Waste management body

a. Organization

Under ICC, ICD and Nurse Department are main body as MOH's regulation. ICC is composed of 14 members. ICD does not employ full-time medical workers; therefore its main task is coordination such as waste management planning, arrangement of in-service training, and contract with industrial waste disposers. In addition, Nurse Department deals with infection control through Infection Control Network (IC Network), particularly monitoring and hygiene.

b. Budget and expenditure

The hospital contracts 2 companies for waste disposal and cleaning service in some departments, which are understaffed or in which there is necessity to keep sanitary levels i.e. operation theater. Total cost of waste management is 189.027 million VND/year. Total expenditure is unknown; hence we can not calculate the ratio of total hospital's expenditure to waste management cost. If we assume that the costs are comparable to a similar-sized and function of hospital, the cost allocation to waste management against the total expenditure should be around 0.5%.

Medical waste management

a. Separate discharge system and pre-treatment

Though no data exists, we assume that the hospital uses more needles and sharp medical instruments in comparison to other comparable hospitals. Indeed, four-kind segregation bag system is introduced, however recycle bag is not often seen in place.

b. Instruction and training

Even with no full-time staff, ICD plans regular in-service trainings at least once a year, plus additional short courses on quarterly basis. For a proper execution of training activities, ICD needs three additional personnel i.e. training instructor and monitoring staff. It must be noted that Nurse Department conducts monitoring following the instruction by MOH, and they plan to introduce reward and punishment system in the future to promote open feedback.

c. Monitoring and feedback

Monitoring system is well-established through Infection Control network, including feedback to each department. It is notable that the hospital encourages staff to give honest positive feedback. It implies that not only punishment but also promotion are introduced, in which the latter contributes to a higher motivation that in turn can serve as a model to other hospitals.

Also, to lift staff's motivation to follow correct waste segregation, the hospital pays attention to cleanliness and tidiness. For example, almost 90% of the interviewees feel the hospital is messy and has been injured by needle sticks. To protect everyone in the hospital from such accidental

injures, tidiness and all-employees involvement is a key. For examples, if needle is found on the floor, staff, regardless of the rank, should pick it up immediately for everyone's safety.

Staff awareness

The most accidents cases caused by needles injury is observed among staff that performs acupuncture treatment. From our all interviewees everyone had needle injury accidents, even though they strongly aware that their jobs involve such occupational risk. Half of the interviewees admit contaminating the wastes, and over 60% of them saw the contamination caused by their colleagues. When materials are missing they do not check the disposal box knowing it is full of needles, hence, the risk goes beyond the hospital boundaries to the transporters and waste traders. The hospital should be responsible for the waste they produce and its safe disposal.

Within the hospital, staff has high self-interest in protecting themselves from infectious risks. All interviewees had hand gloves and washed their hands, but such protection and disinfection is not sufficient in case of the needle injury, which happens often. The best protection is to establish proper procedures and make sure that medical staff observes them. It will also be beneficial to analyze the current number of accidents and set the goal and method to reduce them.

(2) Technical issues of MWWSW management

The hospital does have on-site waste treatment facility such as incinerator. Waste generated at the hospital is mostly contracted out to URENCO. Medical wastes are separated into hazardous and non-hazardous wastes at hospital and hazardous wastes are stored in temporal storage by the time of contracting out.

This hospital does not have a central wastewater treatment system. The hospital has already applied to MOH to construct wastewater treatment system, but not yet approved. All liquid wastes are collected by the cleaners from a contracted cleansing service company.

**Table 3.11 Summary of liquid and solid waste treatment system  
(National Hospital of Acupuncture)**

Liquid waste	Treatment method	Solid waste	Treatment method
All liquid waste	Collecting and transportation to storage by the cleaners from specialized private company	Solid waste from OT	Separating at OT and collecting and transportation to storage by cleaners
		Solid waste from laboratories	Separating at each laboratories and collecting and transportation to storage by cleaners

(3) Environmental issues of MWWSW management

a. Environmental impact by MWWSW treatment facility

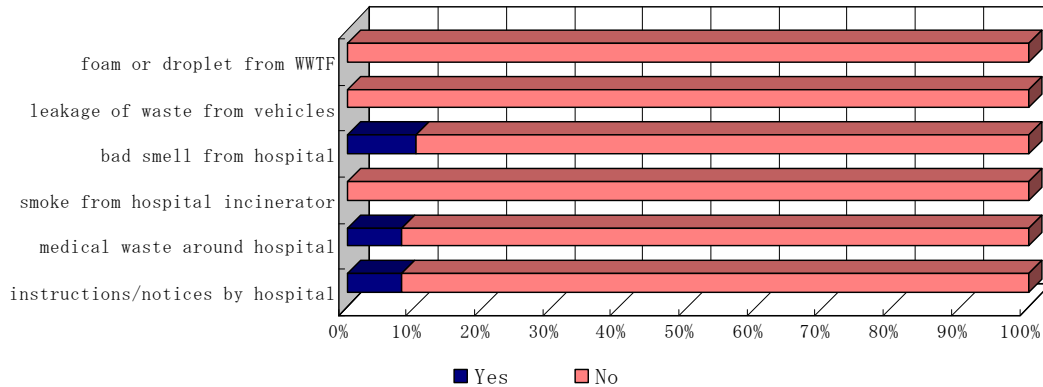
Water quality and odor could be considered as factors of environmental impact on the surrounding area. But with regard to odor, drainage facilities such as pipes and tanks are installed in the basement and have been sealed in the ground. Therefore odor is not an environmental impact factor.

b. Result of questionnaire survey on resident awareness

The survey was carried out near hospital and 50 residents replied to the questionnaire. All of residents have experienced inundation around their house and 35 out of 50 residents answered the highest depth is above knee.

Around 8% of respondents have seen scattered medical waste around hospital. Around 10% of respondents have suffered from a bad smell from hospital. None of residents have seen smoke generated from hospital's incinerator and drops or leakage of waste from waste collection vehicles and flying foam or droplet from wastewater treatment facility at hospital.

Only 8% of respondents have received the instructions/notices by the hospital on the prevention of epidemical spread after disasters such as floods and/or during construction work of hospital. The survey results are shown in Figure 3.7. The answer of “Yes” with less than 10% respondents is questionable.



**Figure 3.7 Result of resident awareness survey (National Hospital of Acupuncture)**

c. Environmental impact at the time of flood and disaster

The hospital is located in the urban area, surrounded by housing and commercial facilities. The hospital does not have a central wastewater treatment system. Therefore environmental burden is not much difference between existing states and the time of flood and disaster. It means there is not strong possibility of additional environmental burden on the surrounding area at the time of flood and disaster. But environmental risk at the time of flood and disaster could become higher than that of existing states. Because wastewater overflowed from drainage could be spread into everywhere.

Medical solid waste is temporally stored in the storage room which does not have equipment to prevent water intrusion. Therefore there is a possibility of waste outflow out of the storage room when water level exceeds the floor level during a flood.

**D. National Hospital of Endocrinology**

(1) Management issues of MWWSW

Waste management body

a. Organization

As well as other hospital, ICC, ICD, Nurse Department and IC Network are established and play their roles. ICD does not have full-time staff, and coordination and planning is main role for ICD.

b. Budget and expenditure

The hospital contracts a company to bring out waste to off-site transportation. Total cost for waste management is 240 million VND/year. The hospital’s total expenditure in 2008 was 115 billion VND and 0.2% of that was spent of waste management, which makes it 240 million VND/year.

Medical waste management

a. Separate discharge system and pre-treatment

The 4-kind segregation bag system is adopted, and industrial waste disposer comes to pick up the waste twice a day. Wastewater and Blood waste are chlorinated at each department, especially at laboratories, and then disposed from general sink or latrine. Fluids resulted from X-ray room is directly discharged into sink. Anatomic waste is collected into black vinyl bag, but in discharged

area, such as operation room, medical staff does not know how this waste will be disposed after it is collected.

Hospital cleaner in each department seems not clearly understood the meaning between blue and yellow bags, or yellow container for needles/sharps and yellow vinyl bag for infectious waste. It was observed that a collector reshuffles contents, and contamination of disposal bags.

**b. Instruction and training**

In-service training for staff is carried out by the hospital, as in other hospitals. 2 ICD representatives manage short-course training. However, according to the questionnaire, half of interviewees are not received training in a year. It is clear that the training is not planned regularly or not well-communicate to the staff.

**c. Monitoring and feedback**

Even though, monitoring activity is carried out, overloaded hospital OPD services and decrepit buildings may be a source of staff's low motivation for infection control and waste management. To tackle that, ICD gives feedback and communicates the score to department and remind them of the problem. Generally, after the feedback, staff's attitude to infection control and waste management is improved until next monitoring. However, 3-4 months later staff's awareness and attention declines to a lower level. Hence, the hospital has a potential to consider and improve more effective feedback system.

**Staff awareness**

Most of the staff seems understanding importance of waste management system, what infectious materials are and how to avoid the accidental injures. However, disposal boxes are observed as contaminated in the reality. Also many interviewees mentioned that guideline is not described clearly how to take action for infection control. The hospital can propose sustainable promotion activities. Also the needle sticks seems the main problem in the workplace. Because of the specialty of this hospital, medical intervention is mainly treatment with medication for chronic in-patients. Therefore the hospital needs to link staff's awareness to correct procedure with medical waste management.

**(2) Technical issues of MWWSW management**

This hospital does not have waste treatment facility such as incinerator. Wastes generated at the hospital are mostly contracted out to URENCO. Medical waste is separated into hazardous and non-hazardous wastes at hospital and hazardous wastes are stored in temporal waste storage until contracting out. Instruction and training for medical staffs by hospital seem to be not satisfactory. Incorrect segregation was found during the survey.

The hospital does not have a central wastewater treatment system. Therefore liquid wastes are discharged into public drainage system after treatment by special solution.

**Table 3.12 Summary of liquid and solid waste treatment system  
(National Hospital of Endocrinology)**

Liquid waste	Treatment method	Solid waste	Treatment method
All liquid waste	Discharging into general wastewater line after treatment with special solution	All solid waste	Separating at each department and/or room, and transportation to storage by cleaner (Instruction and training by hospital are not thoroughgoing)

**(3) Environmental issues of MWWSW management**

**a. Environmental impact by MWWSW treatment facility**

Water quality and odor could be considered as factors of environmental impact on the surrounding area. But with regard to odor, drainage facilities such as pipes and tanks are installed in the basement and have been sealed in the ground. Therefore odor is not an environmental impact factor.

b. Water quality of wastewater treatment facility and soil analysis

The survey was carried out on 28<sup>th</sup> September, and effluent was sampled twice in the morning and afternoon. 1 sample showed slightly alkaline and pH of 1 water sample exceeded limit values. 5 parameters of TCVN7382-2004 such as BOD, S<sup>2-</sup>, NH<sub>4</sub><sup>+</sup>, PO<sub>4</sub><sup>3-</sup> and Total coliforms exceeded limit values and *Shigella* was also detected. 4 parameters of QCVN24:2009/BTNMT, such as Color, COD CN<sup>-</sup> and T-N exceeded limit values but heavy metal such as Cd, Cu, Pb, Zn met limit values. Result of wastewater quality analysis is shown in Table 3.13 in which all the parameters of TCVN7382-2004 and 5 parameters of QCVN24:2009/BTNMT apt to exceed limit values are selectively shown.

**Table 3.13 Result of wastewater quality analysis (National Hospital of Endocrinology)**

Parameters	Unit	Wastewater (Effluent)		Limit Value	Remark
		AM	PM		
pH	-	7.5	8.9	6.5 - 8.5	TCVN 7382
SS	mg/L	62	48	100	ditto
BOD <sub>5</sub>	mg/L	210	594	30	ditto
S <sup>2-</sup> (H <sub>2</sub> S)	mg/L	6.4	53.7	1	ditto
NH <sub>4</sub> <sup>+</sup> (N)	mg/L	34.5	38.9	10	ditto
NO <sub>3</sub> <sup>-</sup> (N)	mg/L	<0.1	0.7	30	ditto
Floral and faunal fat	mg/L	1.1	0.8	10	ditto
PO <sub>4</sub> <sup>3-</sup>	mg/L	19.7	34.6	6	ditto
Total Coliform	MPN/100mL	2.4E+09	1.7E+09	5,000	ditto
Samonella	-	ND	ND	ND	ditto
Shigella	-	++	+++	ND	ditto
Vibrio cholera	-	ND	ND	ND	ditto
Total Alpha radian activity	Bq/L	0.02	0.03	0.1	ditto
Total Beta radian activity	Bq/L	0.84	0.61	1	ditto
Odor	-	bad	bad	uncomfortable	QCVN24:2009/BTNMT
Color	-	332	456	70	ditto
COD	mg/L	315	891	100	ditto
CN <sup>-</sup>	mg/L	0.43	3.90	0.1	ditto
T-N	mg/L	37.1	42.0	30	ditto

2 samples of soil in the hospital premise were analyzed for Pb, Zn, Cd, As and Cu of QCVN03:2008/BTNMT. Arsenic (As) of 1 sample exceeded a limit value. But other parameters met limit values and comparable with back ground levels.

c. Result of questionnaire survey on resident awareness

The survey results are included in the result described in C. National Hospital of Acupuncture because these hospitals are located close and survey was carried out for the same residents.

d. Environmental impact at the time of flood and disaster

The hospital is located in the urban area, surrounded by housing and commercial facilities. The hospital does not have a central wastewater treatment system. Therefore environmental burden is not much difference between existing states and the time of flood and disaster. It means there is not strong possibility of additional environmental burden on the surrounding area at the time of flood and disaster. But environmental risk at the time of flood and disaster could become higher

than that of existing states. Because wastewater overflowed from drainage could be spread into everywhere.

Medical solid waste is temporally stored in the storage room which does not have equipment to prevent water intrusion. Therefore there is a possibility of waste outflow out of the storage room when water level exceeds the floor level during a flood.

## **E. National Institute of Gerontology**

### (1) Management issues of MWWSW

#### Waste management body

##### a. Organization

Only this hospital does not have ICD, however, Department of Administration plays that role, under ICC with Department of Nurses. Monitoring is in charge of nurses through IC Network, so that Department of Administration is in charge of waste management and hygiene, especially outsourcing contract issues. ICC in this hospital is composed of planning board, management board, emergency unit, Nurse Department and functional diagnostic and rehabilitation department.

##### b. Budget and expenditure

The hospital pays 255 million VND/year for consumables and contract fee with industrial waste disposers. This accounts for 0.7% of total expenditure (37.84 billion VND in 2008). However, this expenditure seems not represent all costs of waste management, excluding cleaning personnel, drainage cost and maintenance fee. Those costs are included in other categories as personnel, heating and lighting expenses. It is hard to clarify the pure waste management expenditure under this financial statement.

#### Medical waste management

##### a. Separate discharge system and pre-treatment

The hospital has been collaborating with ICD in Bach Mai Hospital. It is notable to say that Director of ICD of Bach Mai Hospital gives adequate advices. Wastewater drainage is physically linked to main pipe of Bach Mai Hospital. Laundry and disinfection services are also contracted out to Bach Mai Hospital. The 4-kind segregation bag system is adopted, and industrial waste disposer comes to pick up the waste twice a day.

##### b. Instruction and training

Nurse Department carries out in-service training only for medical staff through IC Network. The content is mainly about occupational safety regarding waste management, MOH instruction is by and large covered comprehensively.

Training is taken very seriously. However, because of lack of budget and not constant assignment of new staff every year, the hospital does not plan to hold in-service training regularly every year. Instead, when in-service training is necessary, staff of ICD in Bach Mai Hospital will visit to conduct the training.

##### c. Monitoring and feedback

Nurse Department is also in charge of monitoring that carries out daily checking and monthly monitoring. The monthly monitoring supervises only some department, such as functional diagnostic and rehabilitation department on the point of hygiene and sterilization issues.

#### Staff awareness

Because the hospital provides care for vulnerable elderly patients, it practices holistic medicine, rehabilitation, nutrition control and sterilization. In this sense, infection control including medical waste is relevant to this hospital.



Nevertheless, staff is aware of disposal contamination and careless behaviors, therefore hospital can consider launching a cost-effective and sustainable promotion activity or in-service training.

(2) Technical issues of MWWSW management

This hospital does not have waste treatment facility such as incinerator. Wastes generated at the hospital are mostly contracted out to URENCO, a waste the management company. Medical waste is separated into hazardous and non-hazardous wastes at hospital and hazardous wastes are stored in temporal waste storage until contracting out. Instruction and training for medical staffs by hospital seem to be not satisfactory. Incorrect segregation was found while the survey.

The hospital does not have a central wastewater treatment system. Therefore liquid wastes are discharged into public drainage system after treatment by special solution.

**Table 3.14 Summary of liquid and solid waste treatment system  
(National Institute of Gerontology)**

Liquid waste	Treatment method	Solid waste	Treatment method
All liquid waste	Discharging into public swage line after first treatment with special solution by the hospital.	All solid waste	Separating at OT and collecting and transportation to storage by cleaner of cleansing service company

(3) Environmental issues of MWWSW management

a. Environmental impact by MWWSW treatment facility

Water quality and odor could be considered as factors of environmental impact on the surrounding area. But with regard to odor, drainage facilities such as pipes and tanks are installed in the basement and have been sealed in the ground. Therefore odor is not a environmental impact factor.

b. Water quality of wastewater treatment facility and soil analysis

The survey was carried out on 27<sup>th</sup> September, and effluent was sampled twice in the morning and afternoon. 1 sample showed slightly alkaline. 5 parameters of TCVN7382-2004 such as BOD, S<sup>2-</sup>, NH<sub>4</sub><sup>+</sup>, PO<sub>4</sub><sup>3-</sup> and Total coliforms exceeded limit values and *Shigella* was also detected. 4 parameters of QCVN24:2009/BTNMT such as Color, COD CN and T-N exceeded limit values but heavy metal such as Cd, Cu, Pb, Zn met limit values. Result of wastewater quality analysis is shown in Table 3.15 in which all the parameters of TCVN7382-2004 and 5 parameters of QCVN24:2009/BTNMT apt to exceed limit values are selectively shown.

2 samples of soil in the hospital premise were analyzed for Pb, Zn, Cd, As and Cu of QCVN03:2008/BTNMT. Arsenic (As) of 2 samples exceeded a limit value. But other parameters met limit values and comparable with back ground levels.

**Table 3.15 Result of wastewater quality analysis (National Institute of Gerontology)**

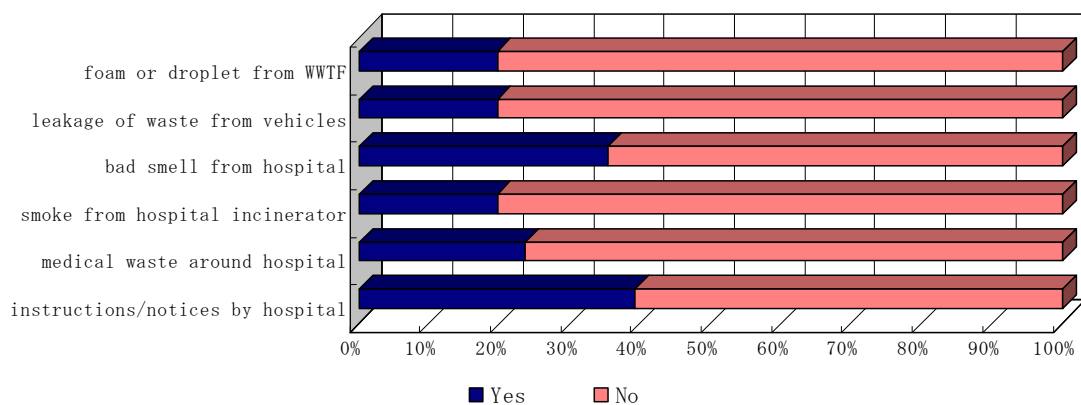
Parameters	Unit	Wastewater (Effluent)		Limit Value	Remark
		AM	PM		
pH	-	7.8	8.1	6.5 - 8.5	TCVN 7382
SS	mg/L	56	57	100	ditto
BOD <sub>5</sub>	mg/L	86	190	30	ditto
S <sup>2-</sup> (H <sub>2</sub> S)	mg/L	3.4	5.0	1	ditto
NH <sub>4</sub> <sup>+</sup> (N)	mg/L	53.2	78.4	10	ditto
NO <sub>3</sub> <sup>-</sup> (N)	mg/L	<0.1	1.5	30	ditto
Floral and faunal fat	mg/L	1.5	0.4	10	ditto
PO <sub>4</sub> <sup>3-</sup>	mg/L	22.6	26.8	6	ditto
Total Coliform	MPN/100mL	4.3E+06	2.5E+06	5,000	ditto
Samonella	-	ND	ND	ND	ditto
Shigella	-	+++	+	ND	ditto
Vibrio cholera	-	ND	ND	ND	ditto
Total Alpha radian activity	Bq/L	0.05	0.04	0.1	ditto
Total Beta radian activity	Bq/L	0.68	0.52	1	ditto
Odor	-	bad	bad	uncomfortable	QCVN24:2009/BTNMT
Color	-	347	388	70	ditto
COD	mg/L	129	287	100	ditto
CN <sup>-</sup>	mg/L	2.70	2.22	0.1	ditto
T-N	mg/L	56.4	98.7	30	ditto

c. Result of questionnaire survey on resident awareness

The survey was carried out near hospital and 51 residents replied to the questionnaire. 21 out of 51 residents have experienced inundation around their house and 3 out of 21 respondents answered the highest depth is above knee.

Around 24% of respondents have seen scattered medical waste around hospital. Around 35% of respondents have suffered from a bad smell from hospital. Around 20% of respondents have seen smoke generated from hospitals incinerator and drops or leakage of waste from waste collection vehicles and flying foam or droplet from wastewater treatment facility at hospital.

Around 39% of respondents have received the instructions/notices by the hospital on the prevention of epidemical spread after disasters such as floods and/or during construction work of hospital. The survey results are shown in Figure 3.8.



**Figure 3.8 Result of resident awareness survey (National Institute of Gerontology)**

d. Environmental impact at the time of flood and disaster

The hospital is located in the urban area, surrounded by housing and commercial facilities. The hospital does not have a central wastewater treatment system. Therefore environmental burden is not much difference between existing states and the time of flood and disaster. It means there is not strong possibility of additional environmental burden on the surrounding area at the time of flood and disaster. But environmental risk at the time of flood and disaster could become higher than that of existing states. Because wastewater overflowed from drainage could be spread into everywhere.

Medical solid waste is temporally stored in the storage room which does not have equipment to prevent water intrusion. Therefore there is a possibility of waste outflow out of the storage room when water level exceeds the floor level during a flood.

**F. National Hospital of Dermatology**

(1) Management issues of MWWSW

Waste management body

a. Organization

Instead of ICC, the hospital has Infection Control Council. Infection Control Council is composed of director, deputy director, secretary, and 7-8 heads of related departments. ICD is not established yet, but it will be authorized with 4-8 full-time members.

b. Budget and expenditure

The hospital pays 260 million VND/year and this accounts for 0.7% of total expenditure (39 billion VND in 2008) for consumables and contract fee with industrial waste disposers, as the same pattern with National Institute of Gerontology.

Medical waste management

a. Separate discharge system and pre-treatment

The 4-kind segregation bag system is adopted, and industrial waste disposer comes to pick up the waste twice a day. Similar to National Institute of Gerontology, the hospital still shares the drainage system with Bach Mai hospital. Due to the nature of dermatologic treatment, which mainly is topical cream and drug treatment, amount of hazardous and medical waste is the smallest among target hospitals.

b. Instruction and training

The hospital is on the way to develop infection control management structure, so that the hospital hardly holds in-service training.

c. Monitoring and feedback

Monitoring is conducted by Nurse Department through IC Network; however, their performance seems more limited than other target hospital.

Staff awareness

Hospital staff seems having basic knowledge of waste management. According to the specialty of this hospital, which does not require invading body deeply in general, staff may feel less necessary of infection control on clinical duty. And yet, staff has interest and look with favor on acquisition of updated information to prevent risks.

(2) Technical issues of MWWAWM

This hospital does not have waste treatment facility such as incinerator. Solid waste generated at the hospital is mostly contracted out to URENCO. Medical wastes are separated into hazardous and non-hazardous wastes at hospital but the hospital does not have a storage room for hazardous waste.

This hospital does not have a central wastewater treatment system. But some pipes from building are still connected to a wastewater treatment system of Bach Mai Hospital. Therefore wastewater is partly treated by this facility. Liquid wastes are discharged into wastewater line of Bach Mai Hospital after pre-treatment with special chemicals by the hospital.

Hospital has a bio-safety cabinet at microbiology laboratory. But HEPA filter of a cabinet has not been changed for long time, generally cleaned every 6 months.

**Table 3.16 Summary of liquid and solid waste treatment system  
(National Hospital of Dermatology)**

Liquid waste	Treatment method	Solid waste	Treatment method
All liquid waste	Discharging into wastewater line of Bach Mai Hospital after first treatment with special solution by the hospital.	All solid waste	Separating at OT and collecting and transportation to storage by cleaner of cleansing service company

(3) Environmental issues of MWWSW management

a. Environmental impact by MWWSW treatment facility

Water quality and odor could be considered as factors of environmental impact on the surrounding area. But with regard to odor, drainage facilities such as pipes and tanks are installed in the basement and have been sealed in the ground. Therefore odor is not an environmental impact factor.

b. Water quality of wastewater treatment facility and soil analysis

The survey was carried out on 27<sup>th</sup> September, and effluent was sampled twice in the morning and afternoon. 1 sample showed slightly alkaline. 7 parameters of TCVN7382-2004 such as SS, BOD, S<sup>2-</sup>, NH<sub>4</sub><sup>+</sup>, PO<sub>4</sub><sup>3-</sup>, Total coliforms and Total beta radiation activity exceeded limit values and *Shigella* was also detected. 3 parameters of QCVN24:2009/BTNMT such as Color, COD and T-N exceeded limit values but heavy metal such as Cd, Cu, Pb, Zn met limit values. Result of wastewater quality analysis is shown in Table 3.17 in which all the parameters of TCVN7382-2004 and 5 parameters of QCVN24:2009/BTNMT apt to exceed limit values are selectively shown.

2 samples of soil in the hospital premise were analyzed for Pb, Zn, Cd, As and Cu of QCVN03:2008/BTNMT. Arsenic (As) of 2 samples exceeded a limit value. But other parameters met limit values and comparable with background levels.

**Table 3.17 Result of wastewater quality analysis (National Hospital of Dermatology)**

Parameters	Unit	Wastewater (Effluent)		Limit Value	Remark
		AM	PM		
pH	-	7.8	8.0	6.5 - 8.5	TCVN 7382
SS	mg/L	129	68	100	ditto
BOD <sub>5</sub>	mg/L	155	146	30	ditto
S <sup>2-</sup> (H <sub>2</sub> S)	mg/L	2.7	1.7	1	ditto
NH <sub>4</sub> <sup>+</sup> (N)	mg/L	4.9	45.8	10	ditto
NO <sub>3</sub> <sup>-</sup> (N)	mg/L	<0.1	<0.1	30	ditto
Floral and faunal fat	mg/L	0.9	0.7	10	ditto
PO <sub>4</sub> <sup>3-</sup>	mg/L	20.4	25.7	6	ditto
Total Coliform	MPN/100mL	7.5E+08	9.3E+07	5,000	ditto
Samonella	-	ND	ND	ND	ditto
Shigella	-	+	+	ND	ditto
Vibrio cholera	-	ND	ND	ND	ditto
Total Alpha radian activity	Bq/L	0.03	0.04	0.1	ditto
Total Beta radian activity	Bq/L	1.05	1.12	1	ditto
Odor	-	bad	bad	uncomfortable	QCVN24:2009/BTNMT
Color	-	315	211	70	ditto
COD	mg/L	232	219	100	ditto
CN <sup>-</sup>	mg/L	<0.01	<0.01	0.1	ditto
T-N	mg/L	5.6	54.8	30	ditto

c. Result of questionnaire survey on resident awareness

The survey results are included in the result described in E. National Institute of Gerontology because these hospitals are located close and survey was carried out for the same residents.

d. Environmental impact at the time of flood and disaster

The hospital is located in the urban area, surrounded by housing and commercial facilities. The hospital does not have a central wastewater treatment system. Therefore environmental burden is not much difference between existing states and the time of flood and disaster. It means there is not strong possibility of additional environmental burden on the surrounding area at the time of flood and disaster. But environmental risk at the time of flood and disaster could become higher than that of existing states. Because wastewater overflowed from drainage could be spread into everywhere.

Medical solid waste is temporally stored in the storage room which does not have equipment to prevent water intrusion. Therefore there is a possibility of waste outflow out of the storage room when water level exceeds the floor level during a flood.

**G. Bach Mai Hospital**

(1) Management issues of MWWSW

Waste management body

a. Organization

Under ICC, ICD and IC Network work for infection control and waste management, ICD is responsible for laundry, sterilization of equipment, facility hygiene control, annual planning for infection control and management, coordination with other departments and outsourcing contracts. ICD has 55 medical personal and 9 non-medical full-time staff. Nurse Department is

mainly responsible for behavior management on infection control and general medical procedures.

b. Budget and expenditure

Hospital's total expenditures in 2008 were 792 billion VND, expenses for medical waste accounted for 2,660.798 million VND, which is 0.3 % from the total. However, this expenditure does not represent all costs and the actual costs will lift with the contract fee for industrial waste disposers.

Medical waste management

a. Separate discharge system and pre-treatment

Solid waste is collected following instruction of MOH and WHO and gathered into the storage area. Large numbers of patients, their families and hospital workers stays in hospital and daily general waste generated is 6 tons whereas medical waste is 600 kg. Waste disposal is a heavy financial burden to the hospital, ICD seeks for a solution to recycle and reduce solid waste. Chemical waste is a small comparing to other wastes. Radioactive and chemical wastes handed to the specialized contractor and general waste is carried over by URENCO. In each department, the 4-kind segregation bag system is adopted.

Generally, primary pretreatment for hazardous waste and wastewater in each department is chlorination.

b. Instruction and training

ICD plans short-training course for new comers, students and trainees. However, it is hard to control patients and their family to ask proper separation of trash. Also disposal bag/box is easily becoming full and cleaner should do more cleaning rounds as well as replacing disposal bags.

c. Monitoring and feedback

Monitoring of all departments is conducted daily, by 7 nurses who are selected from IC Network. They go in shifts i.e. 2 departments per week. Such rotation makes it possible to cover whole hospital in a month after which chief nurse reports monthly result to ICC. Monitoring checklist has 36 subjects, and the results are communicated to each head nurse of the department. Such direct feedback has a positive impact on the personnel assessment. Also, to standardize and maintain the quality of 7 monitors, Nurse Department trains personnel using case-study approach.

In addition, ICD monitors sanitation facilities and waste management protocol semi-annually. This is not a frequent check, because it is hard for ICD to control all departments on time. Nurse Department and ICD supervise not only hospital staff, but also contractors who collect disposals from rooms and transport the waste to off-site. It should be noted that in that case of incorrect waste disposal, ICD may be required to take responsibility and fined by their contractor.

Staff awareness

Most of the staff, including those supervisors, is well-ware of waste segregation and infection control at the hospital. However, as the hospital is overloaded with high traffic of patients and achieving annual plan, it is hard for the hospital management to pay attention for the staff behavior and the way it disposes the waste. Most of the medical personal realizes that their colleagues as well as themselves dispose waste into wrong boxes. Sometimes, they even try to find missing material in the disposal boxes. Such honest answers from questionnaires show the contrast between the ideal waste disposal and the real one. This also shows the difficulty to raise their awareness to change behavior of waste disposal.

(2) Technical issues of MWWSW management

This hospital does not have on-site waste treatment facility such as incinerator. Solid wastes generated at the hospital are mostly contracted out to URENCO. Exception is RI wastes that are stored until time of reaching half-life of each RI and returned to equipment supplier. Other

medical waste is separated into hazardous and non-hazardous solid wastes at hospital and hazardous wastes are stored in temporal waste storage until contracting out.

The hospital has a central wastewater treatment system which was installed in 1996. Wastewater treatment technology is anaerobic technology and is consisted with storage tank, sedimentation tank, aeration tank and disinfection tank. In the questionnaire survey nominal capacity of the system was 800m<sup>3</sup>/day. But in the interview, nominal capacity of the system was 1,500m<sup>3</sup>/day. Liquid wastes are pre-treated by a kind of wastes as described in Table 3.18 before discharging into a central wastewater treatment facility.

Hospital has a bio-safety cabinet, but HEPA filter is not changed for a long time.

**Table 3.18 Summary of liquid and solid waste treatment system (Bach Mai Hospital)**

Liquid waste	Treatment method	Solid waste	Treatment method
Liquid waste from Hemodialysis Department	Discharging into wastewater line without any treatment	Anatomical waste from OT	Transportation to pathology after treatment with special solution
Liquid waste from Infectious Disease Department	Discharging into wastewater line without any treatment	Anatomical waste from pathology	Transportation to ICD
Liquid waste from laboratories	Discharging into wastewater line after treatment at laboratories	All solid waste collected from each department to ICD	Sterilizing at ICD and handing over to URENCO
Blood waste from hematology laboratory	Collecting by cleaner belonging to department, and handing over to URENCO after sterilizing	RI waste	Storing until half-time of each RI, and return to supplier
Solution from X-ray film development	No liquid waste is generated since using digital X-ray film processor		

### (3) Environmental issues of MWWSW management

#### a. Environmental impact by MWWSW treatment facility

Effluent, noise, vibration and odor could be considered as factors of environmental impact on the surrounding area related to MWWSW treatment facility. But with regard to noise and vibration, driving machine of aeration and sludge withdrawal of medical wastewater treatment facility are the only source. The levels of noise and vibration are very low so that it does not make serious environmental impact on the surrounding area. Also, with regard to odor, wastewater holding tank and sludge tank are the main sources of odor, however these facilities are installed in the basement of the facility and are sealed in the ground. Therefore odor is not an environmental impact factor.

#### b. Water quality of wastewater treatment facility and soil analysis

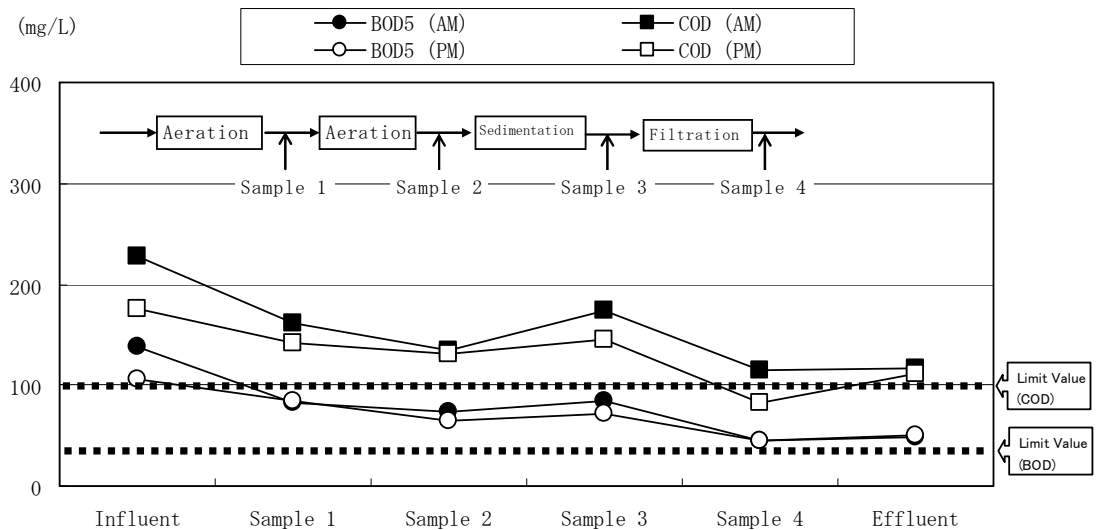
The survey was carried out on 27<sup>th</sup> September, and effluent was sampled twice in the morning and afternoon. 1 sample showed slightly alkaline. 5 parameters of TCVN7382-2004 such as BOD, S<sup>2-</sup>, NH<sub>4</sub><sup>+</sup>, PO<sub>4</sub><sup>3-</sup>, and Total coliforms exceeded limit values and *Shigella* was also detected. 3 parameters of QCVN24:2009/BTNMT such as Color, COD and T-N exceeded limit values but heavy metal such as Cd, Cu, Pb, Zn met limit values. Result of wastewater quality analysis is shown in Table 3.19 in which all the parameters of TCVN7382-2004 and 5 parameters of QCVN24:2009/BTNMT apt to exceed limit values are selectively shown.

Figure 3.9 shows the variation of BOD and COD by each unit of wastewater treatment facility. BOD and COD decreased gradually by unit processes however the levels were more than limit values and thus entire wastewater treatment facility of this hospital did not work well.

2 samples of soil in the hospital premise were analyzed for Pb, Zn, Cd, As and Cu of QCVN03:2008/BTNMT. All parameters met limit values and comparable with background levels.

**Table 3.19 Result of wastewater quality analysis (Bach Mai Hospital)**

Parameters	Unit	Wastewater (Effluent)		Limit Value	Remark
		AM	PM		
pH	-	7.6	7.8	6.5 - 8.5	TCVN 7382
SS	mg/L	47	68	100	ditto
BOD <sub>5</sub>	mg/L	48	51	30	ditto
S <sup>2-</sup> (H <sub>2</sub> S)	mg/L	2.4	1.2	1	ditto
NH <sub>4</sub> <sup>+</sup> (N)	mg/L	26	19	10	ditto
NO <sub>3</sub> <sup>-</sup> (N)	mg/L	<0.1	<0.1	30	ditto
Floral and faunal fat	mg/L	0.5	1.2	10	ditto
PO <sub>4</sub> <sup>3-</sup>	mg/L	3.8	12.1	6	ditto
Total Coliform	MPN/100mL	4.4E+07	5.1E+06	5,000	ditto
Samonella	-	ND	ND	ND	ditto
Shigella	-	++	++	ND	ditto
Vibrio cholera	-	ND	ND	ND	ditto
Total Alpha radian activity	Bq/L	0.05	0.04	0.1	ditto
Total Beta radian activity	Bq/L	0.46	0.52	1	ditto
Odor	-	bad	bad	uncomfortable	QCVN24:2009/BTNMT
Color	-	145	149	70	ditto
COD	mg/L	117	112	100	ditto
CN <sup>-</sup>	mg/L	0.08	0.08	0.1	ditto
T-N	mg/L	30.2	25.8	30	ditto



**Figure 3.9 Variation of BOD<sub>5</sub> and COD by unit processes (Bach Mai Hospital)**

c. Result of questionnaire survey on resident awareness

The survey results are included in the result described in E. National Institute of Gerontology because these hospitals are located close and survey was carried out for the same residents.

d. Environmental impact at the time of flood and disaster

The hospital is located in the urban area, surrounded by housing and commercial facilities. The wastewater treatment facility is away from the main road and has a wall of about 3m height. The



sedimentation tank, aeration tank and filtration tank which is about 5m in height and constructed on the ground surface. The storage tank and sludge tank are installed in the basement. When floods occur, there is a possibility of outflow of wastewater from the storage tank and sludge tank. Therefore environmental risk at the time of flood and disaster could become higher than that of existing states.

Medical solid waste is temporally stored in the storage room which does not have equipment to prevent water intrusion. Therefore there is a possibility of waste outflow out of the storage room when water level exceeds above the floor level during a flood.

## **H. Hue Central Hospital**

### **(1) Management issues of MWWSW**

#### Waste management body

##### **a. Organization**

Under Infection Control Committee, ICD, Nurse Department and IC Network work together to address infection control and waste management. Since the hospital has own incinerator plant in suburb area, Department of Environment, Department of Facility and Equipment are also involved with ICD to support technical aspects of the waste management.

##### **b. Budget and expenditure**

In 2008, the total hospital expenditures were 293 billion VND. From that, expense for in-hospital medical waste management accounted for 166.045 million VND, which is 0.06 % of the total. Maintenance and operational costs for incinerator plant are excluded. This cost of in-house waste management is higher than outsourcing it to contractors. However, hospital's incinerator generates additional income, although further study is required to calculate the whole cost and benefits of incinerator business.

#### Medical waste management

##### **a. Separate discharge system and pre-treatment**

The 4-kind segregation bag system is adopted, as it is in other hospitals. Even though the hospital has their own incinerator, it still needs to contract with industrial waste disposers for hazardous waste disposal. Most of the departments, which discharge chemical or infectious waste, conduct necessary chlorination or neutralization.

##### **b. Instruction and training**

Infection control and waste management training conducted not only by MOH, but also from on-going JICA's technical assistant project. Currently, ICD organizes 4-5 short training programs every year, and 2 times fresher's orientations that include waste management training. Infection Control Department recognizes that adequate training is necessary for students and contractors who come to hospital without proper training and discipline of waste management, although it has not allocated budget for that.

##### **c. Monitoring and feedback**

Nurse Department conducts monitoring and feedback on daily basis though reports are done monthly. Hospital staff recognizes that disposal bags are contaminated and is willing to participate in new trainings to acquire the latest information.

#### Staff awareness

The awareness is correlated with each department's policy and guidelines and individual motivation. Even the hospital attempts to standardize waste segregation in 4 categories, each department has own "how to separate" idea. Nonetheless, all waste is accumulated into 4 groups by non-medical cleaners. Even though, most of the hospital personal pays attentions to risk management, lack of cohesion and standards among departments can lead to accidents. We

believe that it will be beneficial to communicate the whole process of waste management and its flow, importance of waste separation (for instance, why dried waste is preferable to burn in the incinerator) and individual responsibility.

(2) Technical issues of MWWSW management

This hospital has an incinerator installed outside of the hospital and treats most of hazardous wastes. Exception is RI wastes which is stored until time of reaching half-life of each RI and returned to equipment supplier. Treatment of non-hazardous waste is contracted out to URENCO. Medical wastes are separated into hazardous and non-hazardous wastes at hospital and hazardous wastes are stored in temporal waste storage until transporting to the incinerator facility.

The hospital has a central wastewater treatment system which was installed in 1987 and expanded newly in 2006. Wastewater treatment technology of new system is aerobic treatment and the system is consisted with neutralization, sedimentation, aeration, coagulation/sedimentation and disinfection. Nominal capacity of the system is 1,100-1,250 m<sup>3</sup>/day but actually 900-1,000 m<sup>3</sup>/day of wastewater is treated. Liquid wastes are pre-treated by a kind of liquids as described in Table 3.20 and discharged into a central wastewater treatment facility.

Hospital has a bio-safety cabinet, but HEPA filter has not been changed for a long time.

**Table 3.20 Summary of liquid and solid waste treatment system (Hue Central Hospital)**

Liquid waste	Treatment method	Solid waste	Treatment method
Liquid waste from Hemodialysis Department	Discharging into wastewater line without any treatment	Anatomical waste from OT	Transportation to pathology after treatment with special solution
Liquid waste from Infectious Disease Department	Discharging into wastewater line without any treatment	Anatomical waste from pathology	Transportation to ICD
Liquid waste from laboratories	Discharging into wastewater line after treatment at laboratories	All solid waste except RI collected from each department to ICD	Incinerating by the hospital with incinerator
Blood waste from hematology laboratory	Collecting belong cleaner belong to department, and handing over to a private company after sterilizing	RI waste	Storing until half-time of each RI, and return to supplier
Solution from X-ray film development	No liquid waste is generated since using digital X-ray film processor		

(3) Environmental issues of MWWSW management

a. Environmental impact by MWWSW treatment facility

Effluent, noise, vibration and odor could be considered as factors of environmental impact on the surrounding area related to MWWSW treatment facility. But with regard to noise and vibration, driving machine of aeration and sludge withdrawal of medical wastewater treatment facility are the only source. The levels of noise and vibration are very low so that it does not make serious environmental impact on the surrounding area. Also, with regard to odor, wastewater holding tank and sludge tank are the main sources of odor, however these facilities are installed in the basement of the facility and are sealed in the ground. Therefore odor is not a environmental impact factor.

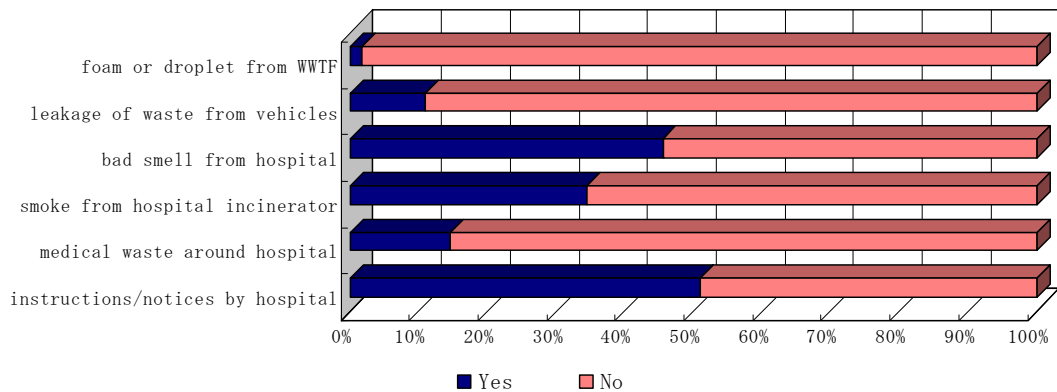
Air, water quality, and odor could be considered as factors of environmental impact related to incinerator. But the incinerator is located out side of town so that it doesn't make serious environmental impact.

b. Result of questionnaire survey on resident awareness

The survey was carried out near hospital and 55 residents replied to the questionnaire. 48 out of 55 residents have experienced inundation around their house and 17 out of 48 respondents answered the highest depth is above knee.

Around 15% of respondents have seen scattered medical waste around hospital. Around 46% of respondents have suffered from a bad smell from hospital. Around 35% of respondents have seen smoke generated from hospitals incinerator. Around 11% of respondents have seen drops or leakage of waste from waste collection vehicles. Only 1 out of 55 residents has seen flying foam or droplet from wastewater treatment facility at hospital.

Around 51% of respondents have received the instructions/notices by the hospital on the prevention of epidemical spread after disasters such as floods and/or during construction works of the hospital. The survey results are shown in Figure 3.10. The answer of “Yes” with less than 10% respondents is questionable.



**Figure 3.10 Result of resident awareness survey (Hue Central Hospital)**

c. Environmental impact at the time of flood and disaster

The hospital is located in the city, surrounded by housing and commercial facilities. The old wastewater treatment facility is away from the road; new facility is near the road. New wastewater treatment facility is installed in the basement and the height of facilities from ground level is about 2 m. Therefore there is not strong possibility of outflow of wastewater from treatment units of a new wastewater treatment facility during floods. On the other hand, there is a possibility for outflow of wastewater from a storage tank of the old wastewater treatment facility. Therefore environmental risk at the time of flood and disaster could become higher than that of existing states.

Medical solid waste is temporally stored in the storage room which does not have equipment to prevent water intrusion. Therefore there is a possibility of waste outflow out of the storage room when water level exceeds the floor level during a flood.

**I. Cho Ray Hospital**

(1) Management issues of MWWSW

Waste management body

a. Organization

Under Infection Control Committee, ICD, Nurse Department and IC Network work together to address infection control and waste management. The difference from other hospital is the fact that Nurse Department is responsible for outsourcing contracts. Therefore, in case of accidents, Nurse Department is able to instruct contractors to promptly implement hepatitis B vaccination. Most of ICD office space is located near laundry or sterilization area. In contrast, in Cho Ray Hospital, ICD conducts risk management and work together with other central administrative functions. This close coordination with administration is effective to discuss comprehensively and to strengthen the IC Network.

b. Budget and expenditure

In 2008, the total hospital expenditures were 1,148 billion VND. From that, expense for in-hospital medical waste management accounted for 528.776 million VND, which is 0.5 % of the total. However, this expenditure does not represent all costs and the actual cost will rise if contract fee for industrial waste disposers is included.

Medical waste management

a. Segregated disposal system and pre-treatment

The 4-kind segregation bag system is adopted, as it is in other hospitals. It is worth to note that that each department makes the list of recyclable materials, and stores them separately. Even though the hospital has own incinerator plant, it still needs to contract outsource for industrial waste disposal and other hazardous materials. Most of the departments, which discharge chemical or infectious waste, conduct necessary chlorination or neutralization. Dialyzing fluid is not neutralized and discharged directly into general drainage pipe, and hospital depends on the in-site purification system. Dialyzing fluid is easy to get molded and needs to be cleaned by chemical treatment process. Such liquids can increase the risk of damaging the in-site purification system.

b. Instruction and training

Cho Ray hospital is one of teaching hospitals along with Bach Mai and Hue Central Hospitals. They have a good training material and well-skilled trainers. However, as teaching hospital it accepts many trainees and students with poor knowledge of the waste disposal system. Such poor knowledge comes either from hospital's negligence to provide a proper training or attendees absenteeism. Hence, the chief nurse in each department has to pay attention to new comers, and always keep guideline in the workplace.

c. Monitoring and feedback

Generally speaking, monitoring and feedback systems work well, and each department does its outmost with sense of responsibility and ingenious attempt. Even though the situation is not perfect, the staff has a very positive attitude. Currently, the hospital can use their motivation to create innovative and effective approach to prevent accidents and contamination of waste.

Staff awareness

As big hospitals have high patient traffic it is not easy to communicate and build consensus between departments. Currently, hospital is going in the right direction with regards to control and waste management. It seems that the hospital's burden of waste will not be reduced, so that hospital should introduce so-called "3R" concept of "Reduce-Reuse-Recycle" with waste management to be a good model for other provincial hospitals.

(2) Technical issues of MWWSW management

The hospital does not have waste treatment facility such as incinerator. Wastes generated at the hospital are mostly contracted out to CITENCO, a waste management company. Medical wastes are separated into hazardous and non-hazardous wastes at hospital and hazardous wastes are stored in temporal waste storage until contracting out. RI waste is stored until time of reaching half-life of each RI and returned to equipment supplier.

The hospital has a central wastewater treatment system which was installed in 1975 and expanded in 2010. Wastewater treatment technology is basically sedimentation and system which is consisted with storage, grit removal, sedimentation and disinfection. Nominal capacity of the system is 500 m<sup>3</sup>/day but actually 3,000 m<sup>3</sup>/day of wastewater is generated. Recently hospital installed advanced wastewater treatment facility called Johkasou, a Japanese technology as a pilot project. Liquid wastes are treated separately by a kind of liquids as shown in Table 3.21 and then discharged into a central wastewater treatment facility.

Hospital has a bio-safety cabinet, but HEPA filter has not been changed for a long time.

**Table 3.21 Summary of liquid and solid waste treatment system (Cho Ray Hospital)**

Liquid waste	Treatment method	Solid waste	Treatment method
Liquid waste from Hemodialysis Department	Discharging into wastewater line without any treatment	Anatomical waste from OT	Transportation to pathology after treatment with special solution
Liquid waste from Infectious Disease Department	Discharging into wastewater line without any treatment	Anatomical waste from pathology	Transportation to ICD
Liquid waste from laboratories	Discharging into wastewater line after treatment at laboratories	All solid waste collected from each department to ICD	Sterilizing at ICD and handing over to a private company
Blood waste from hematology laboratory	Collecting by cleaner belonging to department, and handing over to a private company after sterilizing	RI waste	Storing until half-time of each RI, and return to supplier
Solution from X-ray film development	No liquid waste is generated since using digital X-ray film processor		

(3) Environmental issues of MWWSW management

a. Environmental impact by MWWSW treatment facility

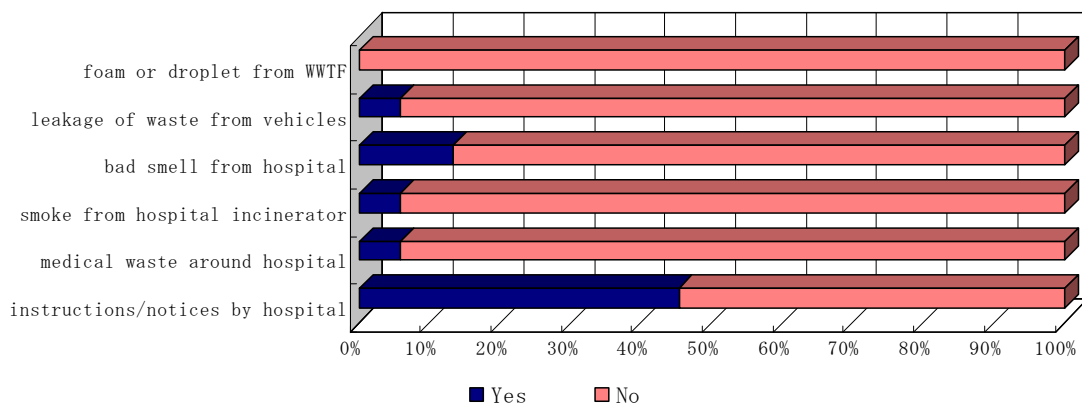
Effluent, noise, vibration and odor can be considered as factors of environmental impact related to MWWSW treatment facilities. With regard to noise and vibration, driving machine of sludge withdrawal is the only source. But the levels of noise and vibration are very low so that it may not make serious environmental impact on the surrounding area. Also, with regard to odor, storage tank and sludge tank are the main source, but these units are installed in the basement and are sealed in the ground. Therefore odor is not an environmental impact factor.

b. Result of questionnaire survey on resident awareness

The survey was carried out near hospital and 53 residents replied to the questionnaire. All of residents have experienced inundation around their house but none of residents answered the highest depth is above knee.

Around 6% of respondents have seen scattered medical waste around hospital and smoke generated from hospitals incinerator and drops or leakage of waste from waste collection vehicles. Around 13% of respondents have suffered from a bad smell from hospital. None of residents have seen flying foam or droplet from wastewater treatment facility at hospital.

Around 45% of respondents have received the instructions/notices by the hospital on the prevention of epidemical spread after disasters such as floods and/or during construction work of the hospital. The survey results are shown in Figure 3.11. The answer of “Yes” with less than 10% respondents is questionable.



**Figure 3.11 Result of resident awareness survey (Cho Ray Hospital)**

c. Environmental impact at the time of flood and disaster

The hospital is located in the urban area, surrounded by housing and commercial facilities. The new wastewater treatment facility, Johkasou is a prefabricated modular unit and set on the ground but odor removal is attached completely. There is no possibility of outflow of wastewater out of the units during floods unless water level reaches to the exhaust outlet.

Medical solid waste is temporally stored in the storage room which does not have equipment to prevent water intrusion. Therefore there is a possibility of waste outflow out of the storage room when water level exceeds the floor level during a flood.

### **3.2.4 Some findings of the survey and suggestion**

#### (1) Medical waste management system

##### Waste management body

Though a few hospitals do not establish a firm organization specialized in waste management, most surveyed hospitals develop concrete management body following the indication of MOH in their hospitals. Especially monitoring system by departments nurses becomes widespread each department through the IC Network. All surveyed hospitals are located in the middle of the cities, so that the all of them contract out the off-site treatment and those costs are accounted based on the same URENCO's procedure. There are different quantity and quality of pre-treatment policies of infectious waste in each hospital, and waste management costs that are accounted for other category such as medical consumables. This makes hard to estimate actual expenses of medical waste management, beside contract fees. Matter to be concerned is the training for waste management, and it is obvious that the budget is limited. Hospitals need not to just waiting budget allocation or training plan from MOH. The occupational accidents are daily possibly happened, therefore hospital's initiative is also important to launch training or promotion activities.

##### Medical waste management

The 4-kind segregation system of wastes is adopted to all surveyed hospitals, and the risk of medical waste is notified to hospital staffs generally. The issue is broad definition of the 4-kind segregation categories. For instance, yellow bag is for infectious waste, such as gauze and sharps stained with blood, and sharps should be separated to yellow hard container to prevent from injury. When general waste is thrown into yellow bag, the quantity of medical waste becomes more to be pre-treated. This segregation definition is entrusted to each department even in the same hospital, and non-medical waste collectors are not informed the differences. The hospital may need to re-confirm how each department deems 4-kind segregation categories.

Besides the 4-kind segregation system of wastes, wastewater is less represented than solid wastes due to flashing into sink immediately. Most of the hospitals have only general drainage, so that pre-treatment is possible only when safety-minded staffs set the reservoir tank.

Pursuantly, when staffs are given the information about a total waste treatment system including off-site treatment, they can recognize what they have to do under their duties. To make staffs awake for their responsibilities and willingness, hospital should provide the latest and constant information by in-hospital training. It is obvious that the hospital is hard to organize and distribute budget for training, however, leadership and cost-effective and innovative approach will help to lead their staffs.

##### Staff awareness

Hospital staffs have general awareness for the segregation of wastes and risk management from occupational infection. However, there is a great gap between understanding and behavior. Many interviewees feel waste segregation is not followed always, and the sense of corporate liability is weak in the workplace.

#### (2) Technical issues on MWWSW treatment

##### Liquid waste treatment technology

All hospitals have only one wastewater drainage line, therefore, all wastewater including infectious wastewater are discharged into same line. However, liquid waste from laboratories is treated by using special reagents before discharge at most hospitals based on the Decision No. 43/2007QD-BYT.

Followings are suggested for medical wastewater management;

- At least, wastewater from infectious disease department should be sterilized before discharging into general wastewater drainage line.
- Hospitals and MOH should consider adopting low running cost technology for wastewater treatment like a sterilization using ozone.
- Hospitals should have specialized staffs for maintenance of wastewater treatment facilities.

Medical waste treatment technology

Almost all hospitals have contracts with specialized company for waste collecting and disposal except for RI waste. RI waste is stored until when RI reaches the half-life and then returned to equipment supplier. Regarding sharp wastes like needle, hospitals should have a needle destroyer. A needle destroyer is good for sterilizing and destroying a needle tip. This equipment is very efficient to protect staffs from a danger of needle stick injury, and investment cost is not so high.

(3) Environmental issues

Performance of wastewater treatment system and effluent quality

According to the result of effluent analysis of wastewater treatment facilities, BOD<sub>5</sub>, COD, S<sup>2-</sup> and Total coli-forms exceed limit values at all hospitals. These parameters are typical indicators to show that water is polluted by organic substances. In general, levels of these parameters are higher in the afternoon than in the morning, which means healthcare activities of hospitals are more active in the afternoon. Especially in National Hospital of Endocrinology, the levels of BOD<sub>5</sub> and COD are extremely higher in the afternoon compared with other hospitals as shown in Figure 3.12. As pH of the same sample was 8.9, the highest in all samples, it is suspected that some sort of liquid waste was mixed with ordinary wastewater.

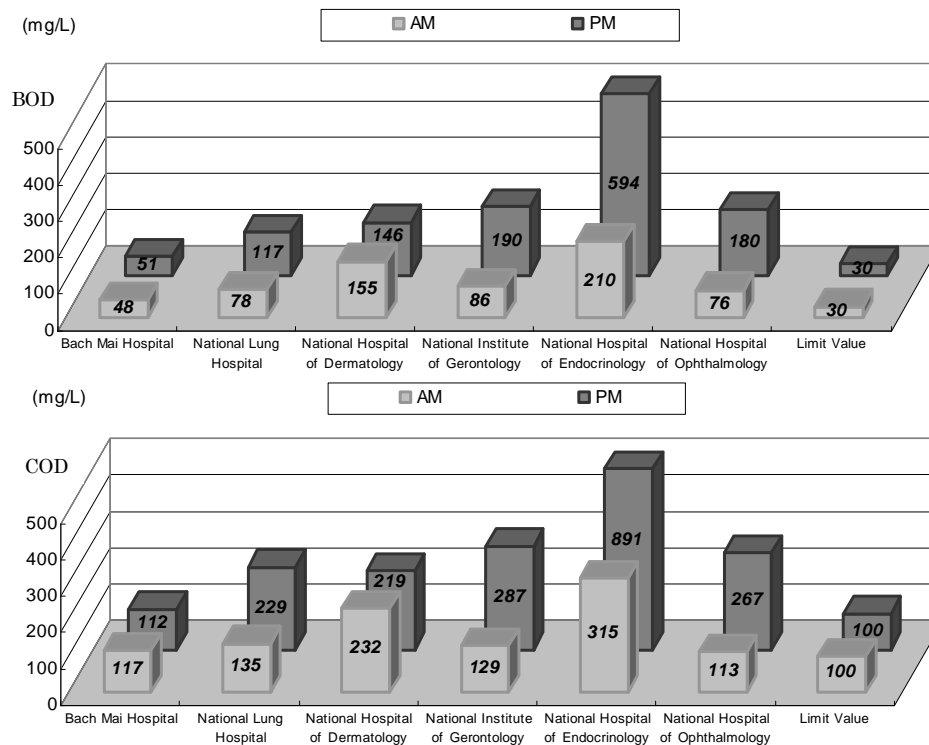
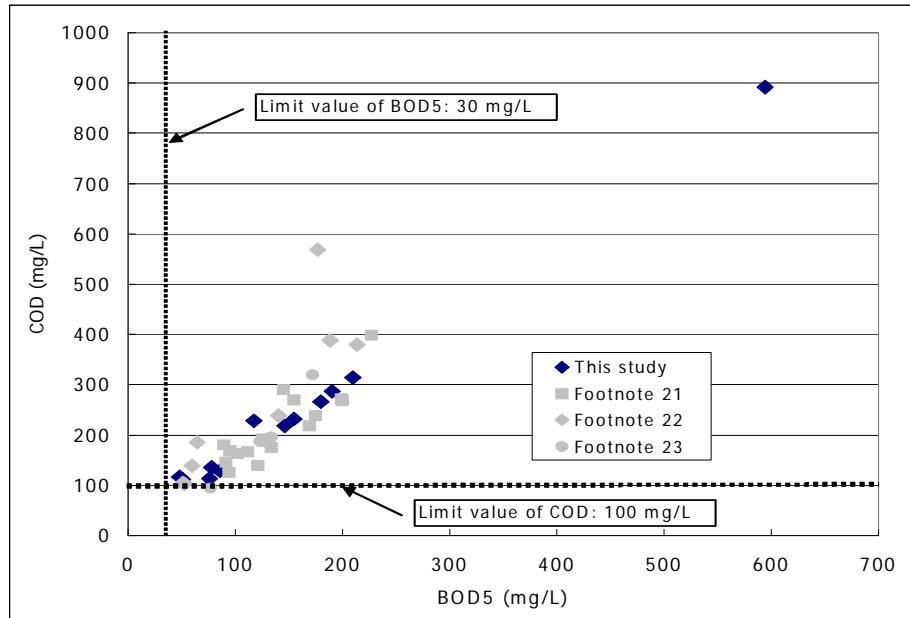


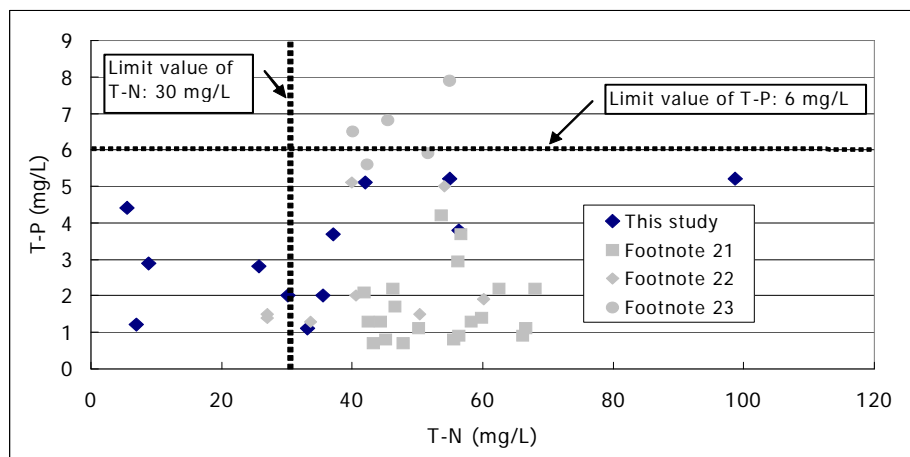
Figure 3.12 BOD<sub>5</sub> and COD levels of effluent of wastewater treatment facilities

In Figure 3.13, BOD<sub>5</sub> and COD are compared with other data reported in the past<sup>21, 22, 23</sup>. These data include analyses of effluents from general hospitals and specialty hospitals in both provincial and central levels. Apparently, none of them meets effluent standards of BOD<sub>5</sub> and COD and the values recorded in the sample of National Hospital of Endocrinology in this study are extremely high compared to others.



**Figure 3.13 Comparison of BOD<sub>5</sub> and COD of this study with those reported by other studies**

Figure 3.14 is a comparison of T-N and T-P. Effluent standard of T-N is not met at most hospitals in the previous reports but some data of this study are below the limit value. On the other hand, all data of this study meet the effluent standard of T-P, but 3 hospitals in the previous studies do not meet the standard of T-P.



**Figure 3.14 Comparison of T-N and T-P of this study with those reported by other studies**

<sup>21</sup> Report on Investment Project: Construct wastewater treatment plants for MOH's hospital and facilities, Center for Clean Water and Environmental Consultancy and Technology Transferring (CTC).

<sup>22</sup> Research Center for Environmental Technology and Sustainable Development (CETSD), Hanoi University of Science, Pollution Survey on Hospital Wastewater in Hanoi Area in the Project of Strengthening the Environmental Management Capacity for MONRE for the Implementation of the Decision 64, JICA, November 2005.

<sup>23</sup> Institute of Water Engineering and Environmental Technology (IWEET), Industrial Investigation for Preparation of Wastewater Treatment Guideline/Manual (for livestock, hospital and electroplating industries), Final Report, JICA, December 2009.



CN<sup>-</sup> was detected in the levels above limit values in some samples. Cyanide compounds are commonly used for chemical reagents at laboratory or testing work and as disinfectant. Detection of CN<sup>-</sup> above the limit value means liquid wastes of laboratory or testing rooms or used disinfectants are discharged into wastewater treatment facility without any pre-treatment or with incomplete treatment. Similarly, detection of the total beta radiation activity in exceeded limit value in the samples of National Hospital of Dermatology suggests that RI liquid waste was not treated in comply with the regulation of the Decision No. 43/2007QD-BYT.

Total coli-forms levels are extremely high compared to the limit value of 5,000 MPN/100mL for all samples as shown in Figure 3.15, suggesting insufficient or no disinfection at the final stage of wastewater treatment. Total coli-forms are typical indicator to show the level of water contamination by bacteria including pathogenic microbes. Although all of the coli-forms are not always pathogenic, there is a possibility that enteric bacteria is included if the level of total coli-forms are higher than the limit value. In fact, *Shigella* was detected in all samples. Since *Shigella* is enteric bacteria of human and monkey, this suggests human wastes were not treated satisfactorily at surveyed hospitals.

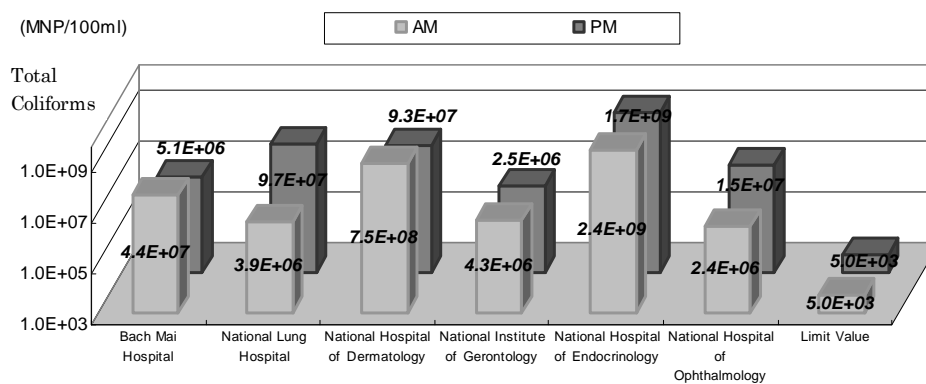


Figure 3.15 Total coli-forms levels in the effluent of wastewater treatment facilities

#### Medical waste storage

Solid waste in temporal storage was not managed by hospital staffs appropriately. Some storage did not have enough structure to prevent outflow of medical waste when natural disaster such as floods occurred. Guideline against disaster or floods is not prepared, so it is difficult that hospitals take proper countermeasure to prevent outflow of medical waste.

#### Soil contamination in the hospital premises

4 parameters of QCVN03:2008/BTNMT, Cd, Cu, Pb and Zn, met limit values in all soil samples. However, As exceeded limit value of 12 mg/kg in 5 samples obtained at 3 hospitals as shown in Figure 3.16. Since background levels of As at 4 points, BG Park 1, BG Park 2 and P Lake 1, P-Lake 2 were below the limit value, the reason of higher level of As at several soil samples was not clear. It is also said, however, soil in some regions in the northern Vietnam is contaminated by As in nature.

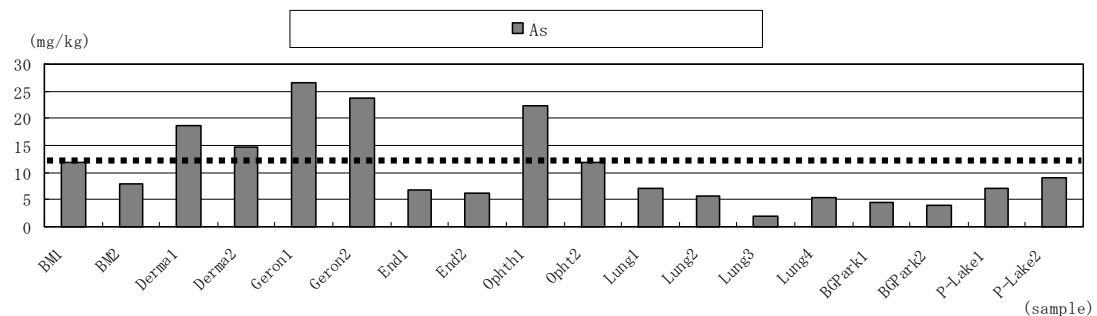


Figure 3.16 As levels in soil samples obtained at hospital premises

(4) Awareness of residents on environmental issues around hospitals

Survey results of awareness of residents around hospitals on environmental issues are summarized in Table 3.22. All survey hospitals are located in the areas affected by flooding, therefore, the risk of environmental pollution and spread of diseases caused by MWWSSW is concerned problems. Followings are thus recommended for hospitals to manage environmental issues.

- a. Hospitals should pay attention and give the instruction/notices to the residents to prevent spread of epidemics during the floods.
- b. Hospitals should implement a strict monitoring on the collection and transportation of medical waste to ensure no spillage during transportation of waste.

**Table 3.22 Summary of awareness survey of residents around hospitals**

Level	Hospital area					
	Lung Hospital	Ophthalmology Hospital	Acupuncture & Endocrinology Hospital	Gerontology, Dermatology & Bach Mai Hospital	Hue Central Hospital	Cho Ray Hospital
No problem	<ul style="list-style-type: none"> <li>•State of Wastewater management</li> </ul>	<ul style="list-style-type: none"> <li>•State of medical waste collection vehicles that transport</li> <li>•State of Wastewater management</li> </ul>	<ul style="list-style-type: none"> <li>•State of Wastewater management</li> <li>•State of medical waste collection vehicles that transport</li> </ul>			<ul style="list-style-type: none"> <li>•State of Wastewater management</li> </ul>
A little	<ul style="list-style-type: none"> <li>•State of medical waste management around the hospital</li> <li>•State of medical waste collection vehicles that transport</li> <li>•Sensible Impact of smock, odor from the hospital</li> </ul>	<ul style="list-style-type: none"> <li>•State of medical waste management around the hospital</li> <li>•Sensible Impact of smock, odor from the hospital</li> </ul>	<ul style="list-style-type: none"> <li>•State of medical waste management around the hospital</li> <li>•Sensible Impact of smock, odor from the hospital</li> </ul>		<ul style="list-style-type: none"> <li>•State of Wastewater management</li> <li>•State of medical waste management around the hospital</li> <li>•State of medical waste collection vehicles that transport</li> <li>•State of medical waste collection vehicles that transport</li> </ul>	<ul style="list-style-type: none"> <li>•State of medical waste management around the hospital</li> <li>•State of medical waste collection vehicles that transport</li> <li>•Sensible Impact of smock, odor from the hospital</li> </ul>
Average	<ul style="list-style-type: none"> <li>•State of inundation in the area</li> </ul>	<ul style="list-style-type: none"> <li>•State of inundation in the area</li> </ul>		<ul style="list-style-type: none"> <li>•State of inundation in the area</li> <li>•State of Wastewater management</li> <li>•State of medical waste collection vehicles that transport</li> <li>•Attention of the hospital to the possibility of spread disease when a flood is happen</li> </ul>	<ul style="list-style-type: none"> <li>•Attention of the hospital to the possibility of spread disease when a flood is happen</li> </ul>	<ul style="list-style-type: none"> <li>•Attention of the hospital to the possibility of spread disease when a flood is happen</li> </ul>
Problem	<ul style="list-style-type: none"> <li>•Attention of the hospital to the possibility of spread disease when a flood is happen</li> </ul>	<ul style="list-style-type: none"> <li>•Attention of the hospital to the possibility of spread disease when a flood is happen</li> </ul>	<ul style="list-style-type: none"> <li>•State of inundation in the area</li> <li>•Attention of the hospital to the possibility of spread disease when a flood is happen</li> </ul>	<ul style="list-style-type: none"> <li>•Sensible Impact of smock, odor from the hospital</li> <li>•State of medical waste management around the hospital</li> </ul>	<ul style="list-style-type: none"> <li>•State of inundation in the area</li> <li>•Sensible Impact of smock, odor from the hospital</li> </ul>	<ul style="list-style-type: none"> <li>•State of inundation in the area</li> </ul>

## **CHAPTER 4 ISSUES AND CHALLENGES OF MWWSW MANAGEMENT**

### **4.1 Necessity for Improvement of MWWSW Management System in Vietnam**

#### **4.1.1 Major concerns and points of control in MWWSW management**

In the early studies on occupational safety and diseases of waste collection workers conducted in the industrial countries showed that needle stick injury was one of the most frequently encountered injuries<sup>24</sup>. This is because wastes from some clinics and hospitals were discharged using plastic or paper bags together with normal wastes and loaded onto the waste collection vehicle manually. But not so much attention was paid yet on these injuries in those days to mitigate risk of disease infections. It was only in the middle of 1980s when medical waste management became new challenges of public health and waste management sectors after a mother saw her children play with syringe and other medical tools drifted ashore tremendously at the beach resort in the USA., and moved policy makers to tackle with medical waste problems.

On the other hand, health sectors have also become aware of a necessity to dispose of some sort of medical wastes safely, especially wastes generated from medical and laboratory practices linked to some highly infectious disease such as hepatitis B, C and HIV. This is not to purport to prevent outbreak of such infectious disease among waste management workers or general public but rather to prevent nosocomial infection among medical staffs, patients and their visitors. A range of reported cases of infection of hepatitis B, C and HIV are mostly due to the reuse of unsterilized syringes<sup>25</sup>. However, misuses of medical tools or occupational and accidental contact with infectious wastes are likely critical causes of nosocomial infections. Therefore healthcare facilities should have much concern and responsibility for appropriate medical waste management to prevent disease infection as well as to mitigate a threat to public health.

In Vietnam, a need for proper management of medical waste has been one of focal challenges in the environmental and waste management sectors. In fact improvement or development strategy or plan for MWWSW management has been repeatedly issued with a numerical achievement goal especially since 2003. Despite the massive build up of these strategy or plan, achievement of these goals is retarded because of various problems not only in health sectors but also of insufficient social infrastructure such as waste disposal system and urban drainage system, technical and financial constraints and so on. It may be true that due to insufficient public sewage systems, wastewater from healthcare facilities, if not treated to meet effluent standards, may cause a serious negative impact on the environment and public health. Especially during the rainy season and inundation the risk of these impacts may be heightened if untreated wastewater is overflowed or if medical waste is flowed out from the storage of healthcare facilities. Although a storage facility to keep medical wastes are required by the Regulation on Health Care Waste Management, not all the healthcare facilities own such storage where the storage space is at a premium as shown in the survey result of this study. In addition such risk may be further hiked at the healthcare facilities located in the densely populated area.

It can be said thus that prime concerns in MWWSW management are how to mitigate the risk of the environmental pollution and public health damage and to avoid a risk of nosocomial infection resulted from improper management of MWWSW at healthcare facilities. In addition, especially in the healthcare facilities located in urban area vulnerable to flooding in the rainy season, these risks are extremely multiplied. This is why development of appropriate system or improvement of malfunctioned system for MWWSW management is required urgently in Vietnam. The necessity for development or improvement of MWWSW management system in Vietnam means thus to avoid or mitigate these risks.

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<sup>24</sup> For example, J. A. Climino, Health and Safety in the Solid Waste Industry, American Journal of Public Health, Vol.65, No.1, 1975.

<sup>25</sup> Review of Health Impacts from Microbiological Hazards in Health-Care Wastes, Department of Blood Safety and Clinical Technology, Department of Protection of the Human Environment, World Health Organization, Geneva 2004.

#### **4.1.2 Relevance of issues and their causes in MWWSW management in Vietnam**

The prime concerns in MWWSW management are in 2 risks; (1) risk of environmental pollution and negative health effect, and (2) risk of nosocomial infection. The former risk is brought about by several events such as release of gaseous and liquid pollutants, waste littering or disease transmitting vectors bred in waste and wastewater, etc. More importantly, this risk may be enhanced if the general public lacks of risk information or ignores the risk. When pollutants levels exceed regulated concentration or if flooding occurred during rainy season and untreated wastewater is overflowed or if medical waste is flowed out from the storages, the risk will be more enlarged.

The risk of nosocomial infection is caused by several events or paths of diseases transmission such as airborne, blood borne and contagious diseases. Vectors may be another possible path for disease transmission. Both medical and non-medical staffs are exposed to the risk of infection of airborne, blood borne and contagious disease, while hospital staffs and patients/visitors are also at risk of diseases transmitted by vectors. These risks may increase if awareness or knowledge of patients/visitor toward the disease infection is low.

In Figure 4.1(a) and (b), these events/results, mostly inherent to the health sectors, are related to possible causes/reasons that may induce events/results. Figure 4.1(a) shows a case related to the risk of environmental pollution and health effect, while Figure 4.1(b) addresses the risk of nosocomial infection. Some events/results may be attributed to multiple causes/reasons or thereby form hierarchical structure (tree) of a cause-result relationship. These figures clearly illustrate the relationship or relevancy of the causes and subsequent results in MWWSW management that finally bring about the environmental pollution or a threat of nosocomial infection. These figures, in turn, may provide clear information on how to mitigate these risks effectively and efficiently. The shaded causes underlying at the lowest bottom of these trees suggest substantial and effective measures to remove or solve these causes, and thus enable to avoid or reduce the concerned risk.

Possible concerns regarding the prime risk in Figure 4.1(a) may exist elsewhere than described in this figure. For instance, accidental spillage of medical waste during transportation (from healthcare facilities to off-site treatment/disposal facilities), recycling or scavenging activities of medical wastes, and emission and effluent of the off-site treatment/disposal facilities may also pose different aspects of the risk linked to MWWSW management. Therefore, potential risks resulted from improper MWWSW management are diversified and risk control areas are widened accordingly. These concerns are excluded in Figure 4.1(a), however, these points of concern should be accounted as well to challenge the issues of MWWSW management. It should be kept in mind that negative impacts on the environment or public health caused by improper MWWSW management can occur not only in or in the vicinity of healthcare facilities, but also in the wide area outside healthcare facilities.

The issues to be challenged in the MWWSW management may be thus selected from Figure 4.1 (a) and (b) taking into account of the survey results of this study as well as existing reports or related research in Vietnam. These issues are broadly categorized into legal issues, management issues, technical issues, and environmental issues. These issues, if left unsolved, may entail a risk of negative impact to the environment and public health, and the outbreak of diseases in healthcare facilities.

These issues and challenges were discussed at the workshop held on October 19, 2010 with Vietnamese stakeholders to share and mutually understand information. Based on the discussion at the workshop issues and possible challenges are summarized in Table 4.1, in which major responsible agencies for respective challenges and priority of the challenges is also placed on. It will provide a basis for a further study to improve MWWSW management system in Vietnam and to design a road map for the further JICA's assistance program.

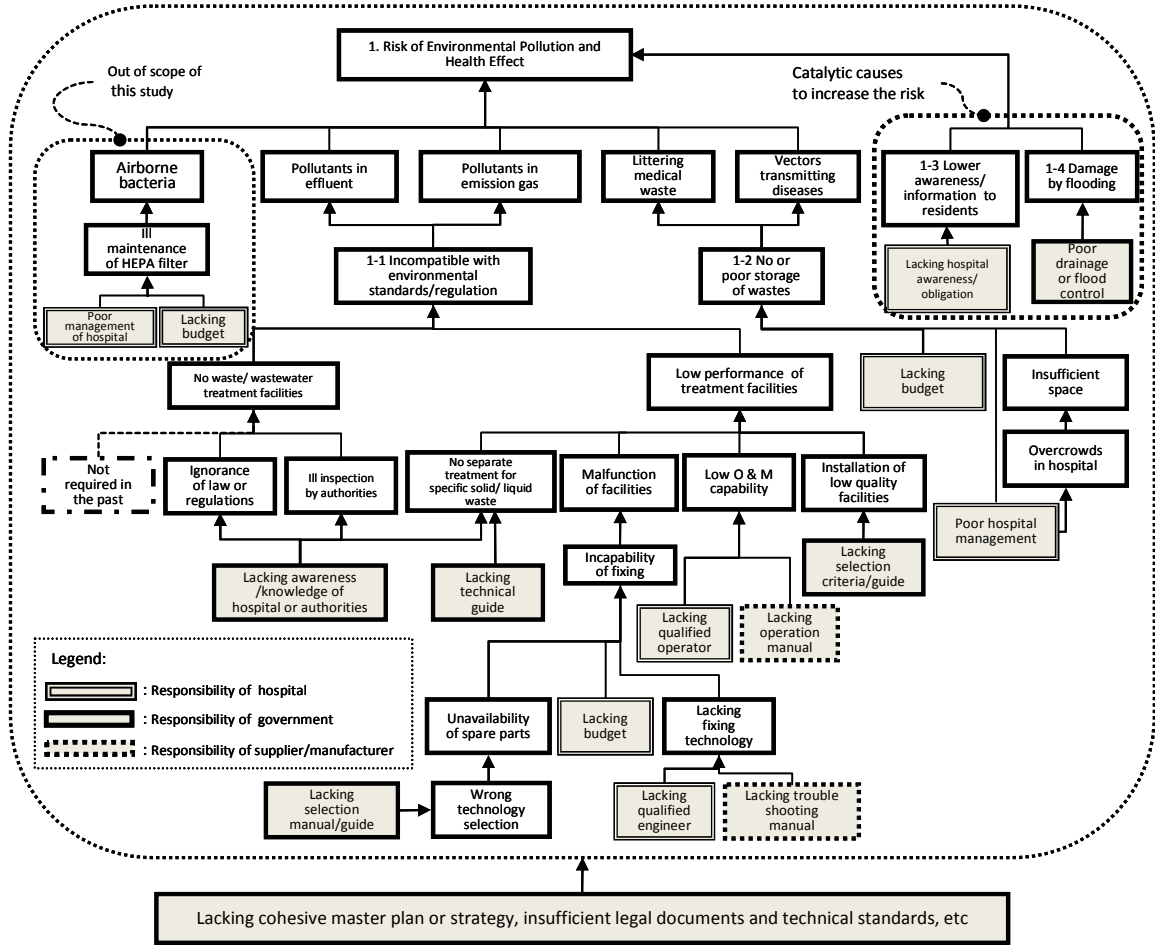


Figure 4.1 (a) Possible paths to trigger the risk of environmental pollution and health effect by inappropriate MWWSW management in Vietnam

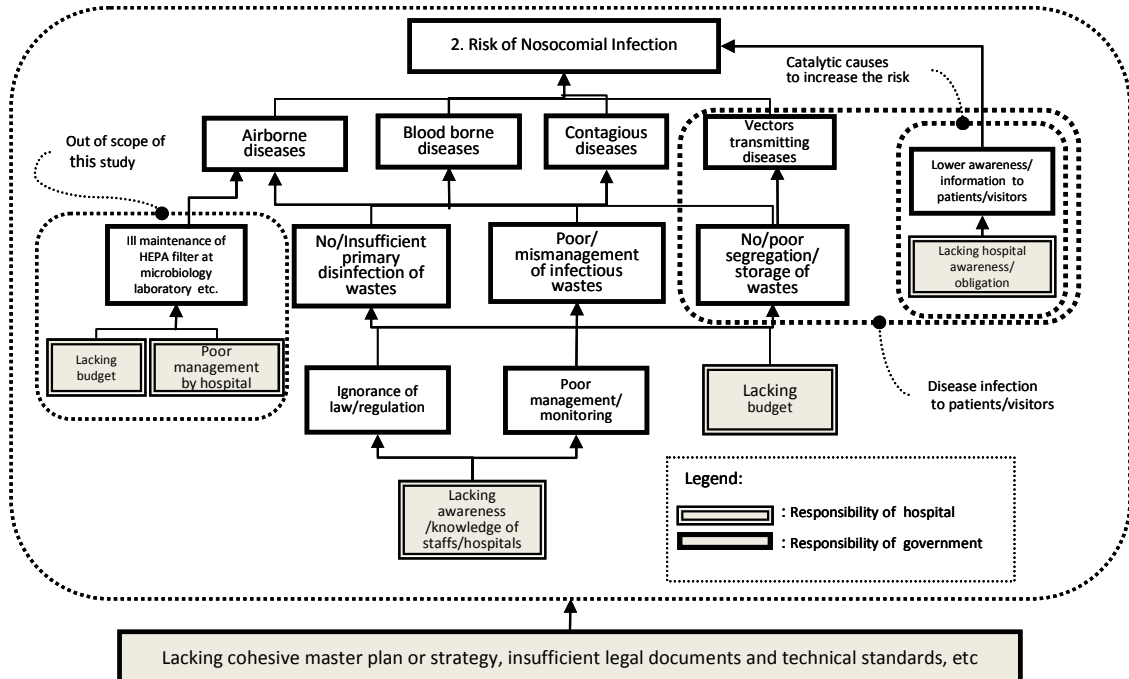


Figure 4.1 (b) Possible paths to trigger the risk of nosocomial infection by inappropriate MWWSW management in Vietnam

**Table 4.1 Issues and improvement measures of MWWSW management system in Vietnam**

Issues	Measures	Responsible agency	Selection priority
1. Lack of a master plan for MWWSW management	Establish a master plan for MWWSW management.	MOC(off-site system) in collaboration with MOH, MOH(on-site system)	Highest (MOC's master and MOH's master plan should be consolidated at early stage)
2. Inadequate description in the Regulation on Medical Waste Management	Review and amendment of the Regulation on Medical Waste Management to provide more detail regulations for: <ul style="list-style-type: none"> <li>• Hazardous medical waste and liquid waste,</li> <li>• Regular education, training and PR activities on MWWSW management, and</li> <li>• Measures to prevent environmental impact by medical waste,</li> <li>• Measures to prevent spread of epidemics in case of flooding</li> </ul>	MOH	Highest (Since Decision No.43 is the focal Regulation on healthcare wastes inadequacy and shortcomings should be improved quickly.
3. Lack of a technical guideline for MWWSW management	Establish a technical guideline for MWWSW management.	MOST MOH	High (Technical guideline is necessary but not in urgent)
4. Lack of a financial mechanism of the budget source for MWWSW management	Prepare a ministerial Circular between MOH and MOF on budget preparation and allocation for MWWSW management considering state support or increase of patient fee	MOH, MOF, MPI, National Assembly	High (O&M budget is requisite but, but creation of its funding mechanism takes long time)
5. Inadequate application and implementation of the Regulation	<ul style="list-style-type: none"> <li>• Enhance supervision and monitoring activities in hospitals.</li> <li>• Enhance the role and responsibility of hospital leaders and staffs.</li> </ul>	MOH Hospital leaders	Highest (Compliance of the Regulation is the highest requirement)
6. Insufficient human and financial resources for MWWSW management and responsibility of hospital leaders	<ul style="list-style-type: none"> <li>• Capacity development (including awareness and concrete management skills) of leaders and staffs of concerned agencies and hospitals</li> <li>• Prepare a financial mechanism to support MWWSW management cost</li> </ul>	MOH, MOF, MPI Hospitals	High (Human resources are already existed but development of them takes long time)
7. Lack of a proper MWWSW management model system (for others to follow)	<ul style="list-style-type: none"> <li>• Establish model system of different type of MWWSW management and to introduce the good models to other hospitals</li> <li>• Technology development on MWWSW management system in collaboration with Vietnamese academics and/or institutions.</li> </ul>	MOH(support and investment), MOST(technology) Universities/ Institutions	Low (Establishment model system is ranked lower priority compared with other measures)
8. Lack of separate treatment system for specific liquid wastes	Establish separate treatment system for specific liquid waste considering hospital characteristics and volume of such wastes as infectious liquid, RI liquid, hemodialysis liquid, laboratory liquid waste, and laundry wastewater.	MOH Hospital	High (Not all hospitals needs separate treatment system)
9. Lack of treatment system for medical wastewater and solid waste	<ul style="list-style-type: none"> <li>• Utilize the current facilities and equipments in a manner to mitigate environmental impact</li> <li>• New buildings must install the MWWSW management.</li> </ul>	MOH/PPC Hospital	Highest (Installation of facilities are prioritized among others)

## **4.2 Issues and Challenges on Legislation, Policy and Regulation**

(1) Lack of guide or direction to improve MWSSW management system (Issue 1 of Table 4.1)

Comprehensive and definite guide or direction to improve MWSSW management system is lacking to achieve long term strategies, visions and plans such as:

- Plan for Environmental Protection in Health Sector from 2009 to 2015 (No.1873/QD-BYT dated 28/5/2009),
- Master Plan for Development of the Network of Healthcare Institutions up to 2010 and the Vision up to 2020 (No.30/2008/QD-TTg dated 22/2/2008),
- National Strategy of Integrated Solid Waste Management up to 2025, Vision Towards 2050 (No. 2149/QD-TTg dated 17/12/2009), and
- National Strategy for Environmental Protection until 2010 and Vision Toward 2020 (No.256/2003/QD-TTg dated 2/12/2003).

The measures are to establish master plans for MWSSW management system. Although such master plans are reportedly being prepared or reviewed currently, efforts are required to finalize as soon as possible in a manner to be harmonized and coherent with existing relevant policies and visions. This is why the priority of these measures is the highest.

(2) Insufficient or uncertain description in the Regulations on Healthcare Waste Management (Decision No.43/2007/QD-BYT) (Issue 2 in Table 4.1)

A confusion and misunderstanding in MWSSW management in healthcare facilities may result in increasing a health risk and negative impact on the environment. To avoid such risk a review and amendment of the Regulations on Healthcare Waste Management is necessary, reflecting the current situation of the country so that every healthcare facility can be complied without too excessive burden both in technically and financially. This measure is put also the highest priority to be tackled since this regulation is currently in effect. Special emphasis should be taken on the following items for a review and revision of the regulation:

- Segregation, temporal storage and on-site carriage of medical waste,
- Off-site transportation, means and equipments,
- On-site management and treatment technology of medical waste, especially non-burning technology and “a return to supplier”.
- Guide or criteria for recycling of medical waste,
- Environmental integrity of liquid waste treatment, and
- Clear guide for disposal method of expired medicine including cyto-toxic or geno-toxic medicine and radioactive waste.

(3) Lack of practical and scientifically verified technical guide for MWSSW management (Issue 3 in Table 4.1)

Lack of technical manual or selection criteria for medical wastewater treatment technology or system causes inappropriate installation of system and thus resulting in ill-operation and poor maintenance of the system. One measure for it is to establish technical guideline or manual for MWSSW treatment. Effort by MOH to issue such guideline or manual is reportedly being made. On the other hand some research institutions including the Institute of Environmental Technology (IET), VAST is preparing a similar technical manual. These efforts done by different organizations should be consolidated and collaborated to avoid unwanted confusion.

(4) Insufficient budget for operation of MWSSW treatment (Issues 4 and 6 in Table 4.1)

Lack of budget for MWSSW management is often ranked as a top reason that makes healthcare facilities into a source of environmental pollution. Because of budget deficit spare parts of system or necessarily consumables cannot be procured; a malfunctioned system cannot be fixed; even

daily operation is hampered. All these may trigger ineffective and ill operation of the system even if a new system is installed.

It is urgently required to develop policy or regulation to allocate proper budget for routine operation and maintenance of MWWSW treatment system at healthcare facilities. Basic costing information at actual MWWSW treatment facilities should be collected through a whole year and analyzed to prepare recurrent cost norm. Necessary amount of budget is, then, calculated by the technology or system considering consumables, utilities and workforce.

### **4.3 Issues and Challenges on Management and Operation**

#### **(1) Insufficient compliance with the Regulation (Issue 5 in Table 4.1)**

Although the regulation based on “Plan of Environmental Protection in Health Sector in Period from 2009 to 2015 (No.1873/2009/QD-BYT)” is widely used at healthcare facilities, the description of, especially for segregation and storage, is rather general and may give a different understanding for hazard level by hospital leaders and staffs. Hence, first of all, concrete manual or guideline is expected to be issued and understandable instruction will be delivered to all hospitals. Secondly, the concreteness is important to lead the correct action of waste segregation. Judgment criteria of infectious wastes should be described clearly and concretely. Considering the seriousness of the issues and a need of urgent measure this issue is counted the highest priority to tackle with.

Followings are a few possible countermeasures needed for an urgent reconsideration:

- Reconsidering adequate number of disposal collection times or containers in the hospital.
- Reconsidering adequate disposal boxes with hardness for needles and sharps not to recycling containers (single use).
- Reconsidering safer method to store collected wastes in the central storage area in the hospitals.

#### **(2) Insufficient management capability and its performance (Issues 5 and 6 in Table 4.1)**

According to the survey result of this study some hospital had not developed Infection Control Network and Department of Infection Control with enough personnel and authorities. Some of hospital management boards did not have enough attentions for the medical waste (solid and liquid) treatment, so that there was no discipline and incentive among hospital staffs.

MOH is recommended to urge hospital to cultivate leadership, and hospital management board will exercise leadership on waste management issue. Hospital management board will take effective action for concrete monitoring system. Enhancing the role and responsibility of hospitals leader is one of the countermeasures with the highest priority to be tackled.

#### **(3) Inadequate instruction and in-service training for staffs (Issue 6 in Table 4.1)**

Most medical staffs and non-medical hospital workers have basic knowledge and awareness of hazardousness of medical wastes. However, most of the workers do not know about whole process and how medical wastes will be treated finally, especially off-site treatment. Therefore awareness of responsibility to segregated wastes is relatively weak. This ambiguous action can induce occupational accident, such as needle stick to waste collectors. Hospital can provide whole information to hospital staffs for fully understanding of waste management, and staffs can have more responsibility and awareness for their actions for segregation and pre-treatment. Also this may lead better creative ideas how to treat waste reasonably and cost-effective. Hospital will lead staffs new way of thinking for safety management from personal level to colleagues and patients level.

#### **(4) Low priority of monitoring and reporting for waste management (Issues 5 and 6 in Table 4.1)**

For infection control in hospital, nurses in the Infection Control Network are assigned for regular monitoring and feedback to each department. However, waste segregation is not high priority in the monitoring system yet, and not many hospitals adopt penalty, work performance assessment



or promotion. MOH/hospitals will strengthen the monitoring items including waste segregation and primary treatment at each department. Also monitoring method can be reviewed to introduce scientific and evidence-based approach. Hospitals will introduce the feedback method to activate monitoring system referring other hospital's good practice.

(5) Lack of liability sharing with contractor of waste dealer (Issue 5 in Table 4.1)

Some hospitals supervise the activities of waste dealing contractor, but the others entrust all to the contractor about in-hospital service according to the contract. Generally dispatched workers (waste collectors and transporters) from contracted company have low motivation to work due to low wages, heavy duty and high risk for infection. This leads the workers to salvage collected wastes to gain supplementary income.

Hospitals are responsible for supervising contractors' activities and support to protect their health and safety. Hospital's affirmative support, such as suggestion and sharing costs for vaccination and health check will be advisable. Hospitals should monitor/supervise dispatched workers, indicate the contractor about risk of scavenging collected waste, and lead safer recycle method.

(6) Lack of promotion activities for patients/families and hospital staff (Issues 6 and 7 in Table 4.1)

Hospitals with overloaded patients and their families have trouble with massive amount of waste brought from outside. Also there is a possibility of contaminated waste discharged in ward by the family members who do not receive enough instruction about waste segregation and infectious risk from medical waste. This could be supervised by hospital staffs in each workplace. Naturally, this is not main responsibility of medical staff, but a part of responsibility of sanitation control of workplace. Therefore hospitals are supposed to clarify the environmental task in each workplace including instruction to in-patients. This issue should be a team approach, not giving a burden only to nurse. Anyone can attempt to tell in-patients and their family members what they to do for correct waste segregation.

Hospital is recommended to introduce the better system referring other hospital's good practice. For instance, some hospitals organize a medical professional contest which tests basic technical protocols, such as washing hands and debride. MOH/hospitals will consider introducing medical waste treatment in this kind of competition to promote willingness.

#### **4.4 Issues and Challenges on MWWSW Treatment**

(1) Lack of adequate capacity and technology of treatment facilities and equipment (Issues 8 and 9 in Table 4.1)

Raising awareness is necessary concerning with types, characteristics of medical wastes and capacity of medical waste treatment in hospital. Understanding of suitable technology and method of treatment for each type of medical waste (general waste, waste liquid from laboratories and X-ray processing machine, anatomical waste, and sharp waste) should be deepened. It is urgently required to define responsible departments for treatment facilities and equipment, enhancement of facility and equipment maintenance system, training for operation and maintenance of treatment facilities and equipment, and securing necessary budget for operation and maintenance of facility and equipment.

Especially followings are key requirements for hospitals for ensuring appropriate medical wastewater treatment, medical solid wastes and a protection of nosocomial infection:

Medical wastewater;

- Hospital should separate each type of wastewater line based on kinds of waste water,
- Hospital should treat wastewater from each department before discharging into general wastewater line, especially wastewater from infectious disease department.

- Hospital should consider a use of suitable and economical treatment technologies, such as ozone sterilizing to save operation cost.
- Hospital should employ technologies such as;
  - ◇ pH adjustment for laboratory waste water,
  - ◇ pH adjustment and biological treatment for hemodialysis wastewater,
  - ◇ Sterilization for infectious wastewater,
  - ◇ Storage for required period and dilution for RI wastewater.

Medical waste;

- Hospital should be segregated as general solid waste, infectious solid waste, sharp waste, RI and so on.
- Hospital should employ technologies such as;
  - ◇ Collection technology by specialized organization,
  - ◇ Incinerator with adequate air-pollution control devices,

To prevent nosocomial infection;

- Autoclave at infectious disease department for sterilizing all instruments, clothes and line from department should be installed,
- Autoclave at microbiology laboratory for sterilizing infectious instruments and media for cultivating bacteria should be installed,
- Bio-safety cabinet at microbiology laboratory for cultivating bacteria should be installed, and HEPA filter for bio-safety cabinet at microbiology laboratory should be periodically changed.

#### **4.5 Issues and Challenges on Environmental Protection**

- (1) Risk of environmental pollution due to insufficient MWWSW treatment (Issue 9 in Table 4.1)

If hospitals do not have waste water treatment facility or conduct proper operation and maintenance of MWWSW treatment facility, untreated or insufficiently treated medical wastewater may result in unexpected environmental impact on surrounding area of the hospitals on a day-to-day basis.

Followings are major challenges to reduce the environmental impact by such medical wastewater:

- Develop medical wastewater treatment facility,
- Improve proper technical operation and maintenance of medical wastewater treatment facility,
- Secure operation and maintenance cost to operate medical waste water treatment facility continuously, and
- Raise awareness of segregation of liquid wastes and treat them separately.

Some hospitals across the country have their own incinerators with improper technology. Therefore, emission gas and ash of such incinerators may cause unexpected environmental pollution in the surrounding area of the hospitals on a day-to-day basis. To reduce such environmental impact, development of centralized treatment facilities is one of the ways of treating hazardous medical wastes.

Followings are major challenges to reduce the environmental impact associated with hazardous medical waste treatment:

- Improve management skill of medical solid waste at temporal storage,
- Improve proper technical operation and maintenance of incinerator,
- Secure operation and maintenance cost for operation of incinerator continuously, and

- Develop centralized treatment facilities for medical wastes taking into consideration of a selection of appropriate site, appropriate incineration technology, wastes storage, residue treatment, monitoring plan, and risk communication with surrounding residence in advance.

(2) Risk of environmental pollution during a flood and natural disaster (Issue 9 in Table 4.1)

When a natural disaster or flooding occurs, there are possibilities of outflow of MWWSW from MWWSW treatment lines at the hospitals and may result in outbreak of infectious diseases.

Followings are major challenges to avoid such environmental and health impact by a disaster or floods on the surrounding area of the hospitals:

- Improve structure of equipment/tanks of medical wastewater treatment facility or temporal waste storage to prevent outflow of MWWSW,
- Establish technical guideline for medical wastewater treatment system or temporal waste storage to prevent outflow of MWWSW, and
- Manage medical wastes at temporal storage appropriately.

#### **4.6 Proposed Model System for MWWSW Management in Hospitals**

##### **4.6.1 Requirements for MWWSW management system proclaimed in the legal documents**

a. Organization structure and responsibility for MWWSW management in hospital

The Decision No.1895/1997/BYT-QD<sup>26</sup> prescribes that waste management in the hospitals is important task to avoid environmental pollution and to eliminate the sources of infectious diseases. The decision says that wastes should be segregated at sources, and competent departments should be responsible for a waste management and the hospital director has responsibility to ensure a proper waste management. For instance, the head of infection control department is responsible to organize implementation and supervise staff to implement waste treatment as stipulated. Staffs of waste treatment line is responsible to strictly follow the stipulations of technical issues, occupational safety, maintenance and use of equipment. The hospital director is responsible to; organize and assign staff and unit of waste management; supply adequately work and protective means, chemicals to treat waste; ensure safety for staff; and to implement periodical health examination of staff working for waste treatment.

As for wastewater/liquid waste, the hospital director is responsible to ensure a drainage system and underground tank to store and treat liquid waste from laboratory, X-ray room, clinical department, para-clinical department, other service rooms and storm water. Moreover, it is prescribed that wastewater must be treated before discharging to public drainage system, lake, or river. Discharging hazardous liquid waste without pretreatment is strictly prohibited.

b. Technology requirement for MWWSW management

Although some technical and management issues in this Decision were amended to the Decision No. 43/2007/QD-BYT<sup>27</sup>, basic direction and regulation for MWWSW management have been already prescribed in the Decision No.1895/1997/BYT-QD. More substantial measures especially for technologies of medical waste handling and treatment are described in the Decision No. 43/2007/QD-BYT. Nevertheless, actual situation of MWWSW management at healthcare facilities is not necessarily satisfactory as suspected by reiterative revision of development targets of MWWSW management system since 2003 (See Section 1.1). Especially there are several hospitals without wastewater treatment systems or even with systems failing to meet effluent standards. Some wastewater treatment systems at hospitals are not operated as planned because of a technical trouble, a lack of consumables and spare parts, or human issues.

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<sup>26</sup> Decision 1895/1997-QD- BYT dated on 19/9/1997 of the Minister of MOH on promulgating *Regulation on Hospital Management*

<sup>27</sup> Decision 43/2007/QD-BYT dated on 30/11/2007 of the Ministry of Health promulgating *Regulations on Medical Waste Management*

There may be several reasons and drawbacks for such situation including technical, economical and management constraints. Detail analysis of such reasons and drawback is not a scope of this study, but by taking into account physical condition and environmental constraints of most hospitals, appropriate MWWSW treatment systems or technologies are proposed in this Section. These systems and technologies are selected and proposed in line with the prevailing legal documents such as Decision No.43/2007/QD-BYT, Official letter No. 7164/2008/BYT-KCB<sup>28</sup>, and Vietnam Building Code QCXDVN 01: 2008/BXD<sup>29</sup>, etc. In addition, the systems and technologies proposed are mostly for healthcare facilities with beds, not for health center, commune health stations, preventive medicine centers, and research/training institutions. However, basic norm of selection of the system is considered to be common to those of healthcare facilities with and without beds.

#### **4.6.2 Medical wastewater treatment system and technology**

##### **(1) Principle and basic requirements**

Followings are basic requirements and principle for selection of system in the proposed model of medical wastewater treatment system.

- A septic tank should be installed at each building wherever a piped water or utility water is supplied.
- Wastewater treatment system should be installed at each healthcare facilities except for some places where multiple healthcare facilities are located at near sites each other.
- Proximity regulation of wastewater treatment units to residential or public buildings should be met.
- Separate treatment system of wastewater and medical liquid wastes should be employed, if necessary, based on the amount and characteristics of wastewater and liquid wastes.
- Toxic and hazardous liquid wastes should be treated properly based on the Decision No.43 /2007/QD-BYT.
- Storm water should be separately collected and discharged without mixing with medical wastewater.

The Vietnam Building Code (QCXDVN 01: 2008/BXD) requires a septic tank to treat domestic wastewater discharged from patients, healthcare staffs, etc even if the treatment efficiency of the septic tank is not high in general. However, a septic tank is a necessary unit at healthcare facility to equalize and hold wastewater before sending to the central wastewater treatment facility. The requirement for a separate treatment system for some kinds of medical liquid waste and other wastewater are underlined by both Vietnam Building Code (QCXDVN 01: 2008/BXD) and the Decision No.43 /2007/QD-BYT to ensure the safe treatment of such liquid waste and the performance of the central wastewater treatment facility. Separate drainage of storm water from the central wastewater treatment facility is also necessary to save a construction cost and to avoid abrupt change of load to the facility during rain (Decision No.43 /2007/QD-BYT).

Proximity requirement for wastewater treatment facilities regulated by Vietnam Building Code (QCXDVN 01: 2008/BXD) should be followed to ensure environmental safety. This regulation sets the minimum distance between wastewater treatment facility (units) and residential area, food processing factory, hospital, school and other public facilities as shown in Table 4.2. Although this requirement is set mainly for the municipal wastewater treatment facilities or some industrial wastewater treatment facilities, the wastewater treatment facilities at healthcare facilities should adopt this requirement as well.

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<sup>28</sup> Official letter No. 7164/2008/BYT-KCB dated 20/10/2008 of the Minister of Health on *Enhancing Implementation of Medical Waste Management*.

<sup>29</sup> Vietnam Building Code QCXDVN 01: 2008/BXD: Vietnam Building Code: Regional and Urban Planning and Rural Residential Planning.

**Table 4.2 Requirements of minimum environmental safe distance**

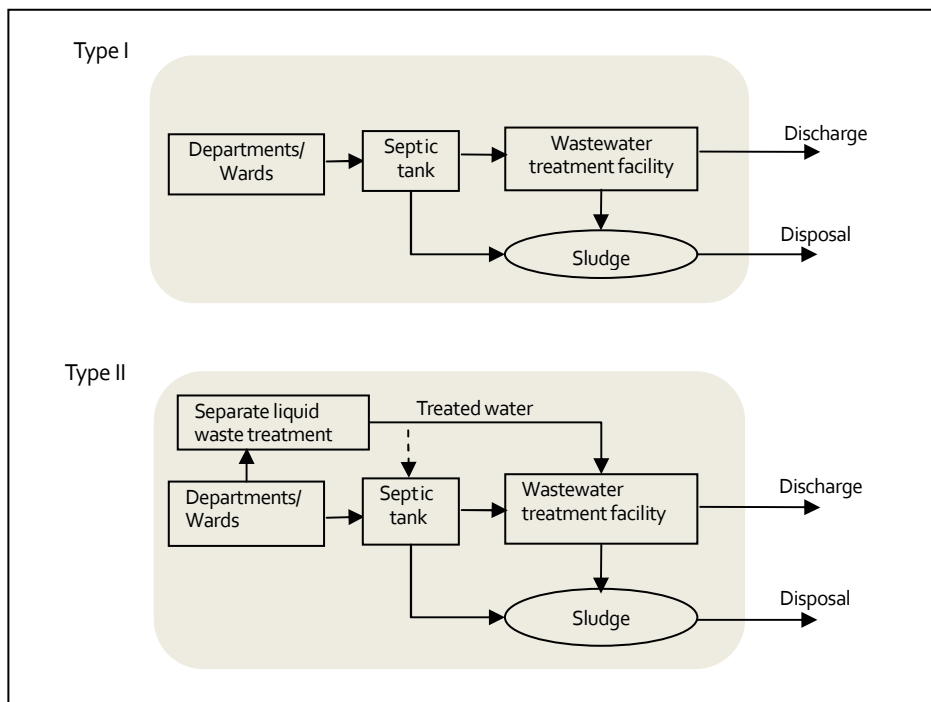
Facility/Unit process	Safe distance (m)	
	Less than 200 m <sup>3</sup> /day	More than 200 m <sup>3</sup> /day
Pump station	15	20
Physical treatment unit with sludge drying bed	100	200
Biological treatment units with sludge drying bed	100	150
Confined and hermetic units with deodorization system	10	15
Wetland unit	100	150
Planted irrigation land unit	50	200
Stabilization pond	50	200
Oxidation channel	50	150

Source: Vietnam Building Code QCXDVN 01: 2008/BXD: Vietnam Building Code: Regional and Urban Planning and Rural Residential Planning.

(2) Medical wastewater treatment system

2 types of principal wastewater treatment systems are proposed, as shown in Figure 4.2. Type I is a system in which all wastewater is treated at the central wastewater treatment system. Wastewater is discharged into a septic tank firstly and then sent to the wastewater treatment facility. Sludge accumulated in both septic tank and wastewater treatment facility is regularly withdrawn and disposed appropriately to ensure the performance of the system.

Type II has a separate treatment system for specific liquid wastes and other normal wastewater. Liquid wastes requiring separate treatment include, hazardous or toxic chemicals containing liquid waste, infectious liquid wastes, RI liquid wastes and high strength organic liquid such as dialyzer solution. These liquid wastes are pre-treated with special technologies and discharged into a septic tank or a central wastewater treatment line to ensure the adequacy of treatment of such wastes and to avoid impairment of the central wastewater treatment system.



**Figure 4.2 2 types for medical wastewater treatment system**

The criteria of the system selection are highly dependent on how much and what kinds of liquid wastes are discharged. It also needs to take into consideration whether the function of the wastewater treatment system is hampered or effluent standards are met even by mixing such liquid wastes. In designing wastewater treatment system the characteristics and the amount of wastewater must be fully surveyed taking into account of the range and the kinds of healthcare services at present and in future alike. The example of a schematic flow of Type II system is shown in Figure 4.3, in which kitchen, toilet and laundry, bath/shower rooms are major sources of so-called domestic wastewater while liquid wastes requiring a separate and specific treatments are laboratory wastewater, RI drainage, chemical liquid waste, infectious liquid waste, oily liquid waste. The sludge withdrawn from some treatment units is regarded as medical (solid) waste that may require a further treatment on site or off site before final disposal (Decision No.43 /2007/QD-BYT and Vietnam Building Code QCXDVN 01: 2008/BXD).

(3) Central wastewater treatment technologies

In the Decision No.43 /2007/QD-BYT, requirements of medical wastewater treatment system are prescribed as follows:

- Technologies and processes employed must meet effluent standards,
- The system must have a suitable throughput capacity,
- Effluent outfall must facilitate inspection and supervision of water quality,
- Sludge from wastewater treatment system must be managed as healthcare solid waste, and
- Effluent should be periodically analyzed and the record of facility operation and related quality test results should be kept.

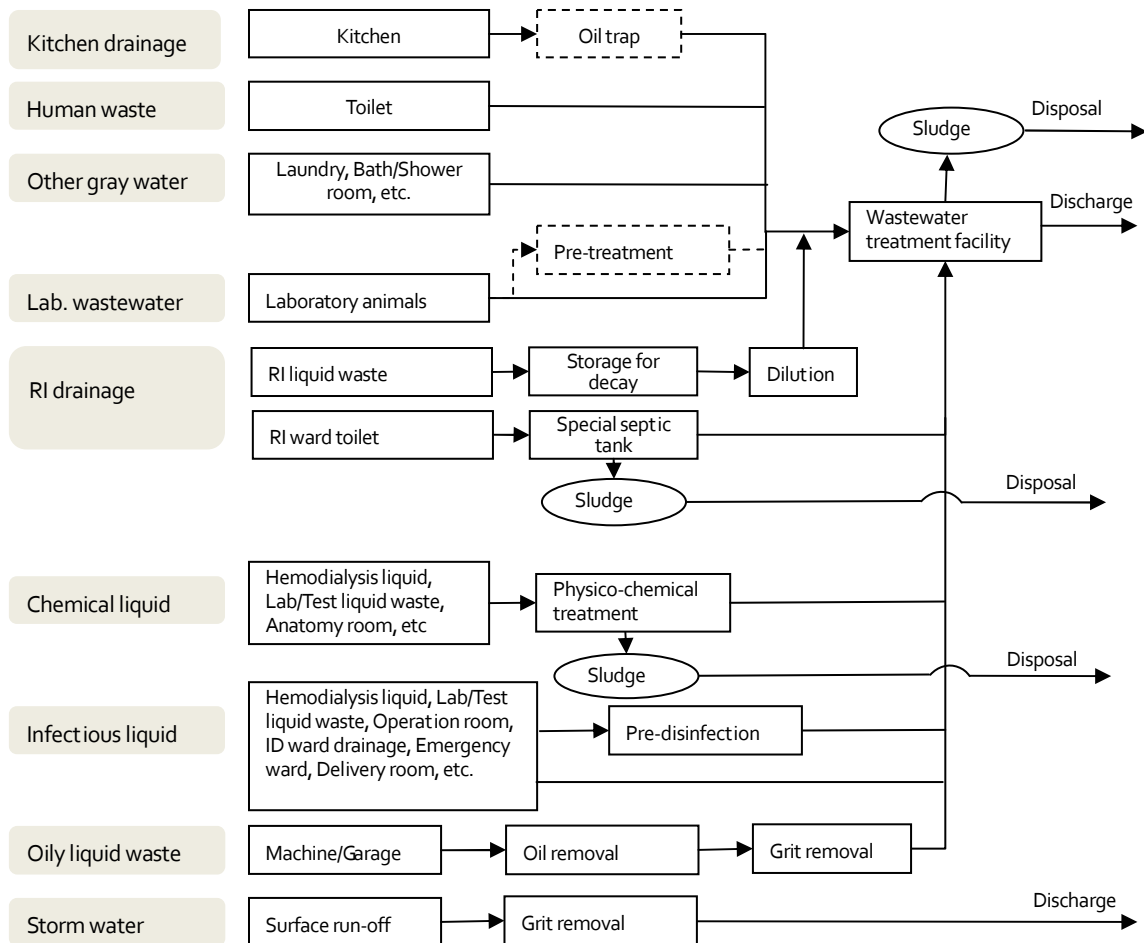


Figure 4.3 Example of Type II medical wastewater treatment system

Especially disinfection process is a necessary process to meet effluent standards of coli-forms. The throughput capacity of wastewater treatment facility is calculated based on the standard volume of hospital wastewater as shown in Table 4.3. However, actual amount of wastewater may increase more than that in Table 4.3 if the number of visitors or accompanied persons with patients is counted. The throughput capacity of the system should be determined considering this fact as well as the future expansion plan of the hospitals. Otherwise modular type system should be selected because of its capability to expand the throughput capacity. Besides these requirements, a power backup system is necessary for hospitals where electricity is frequently down due to a lack of enough power supply, especially for hospitals using aerobic biological process to prevent inactivation of microbes and subsequent degradation of effluent quality.

**Table 4.3 Standards for water supply and volume of hospital wastewater**

Hospital size (number of beds)	Water supply (l/bed/day)	Wastewater (m <sup>3</sup> /day)
<100	700	70
100-300	700	100-200
300-500	600	200-300
500-700	600	300-400
>700	600	>400
University hospital with more than 700 beds	1000	>500

Source: Center for Urban and Industrial Zone Environmental Economy, Hanoi University of Construction, 2002.

Various wastewater treatment technologies, both domestic and overseas technologies, have been employed in Vietnam, which are roughly categorized in Figure 4.4. For selection of technologies suitable to the hospitals, following criteria should be examined.

- Performance (ensuring effluent standards)
- Cost (affordable investment/recurrent cost)
- Size of the system (availability of land)
- Electricity (back-up system)
- Technology (appropriate technology)
- Environment (environmentally friendly), etc

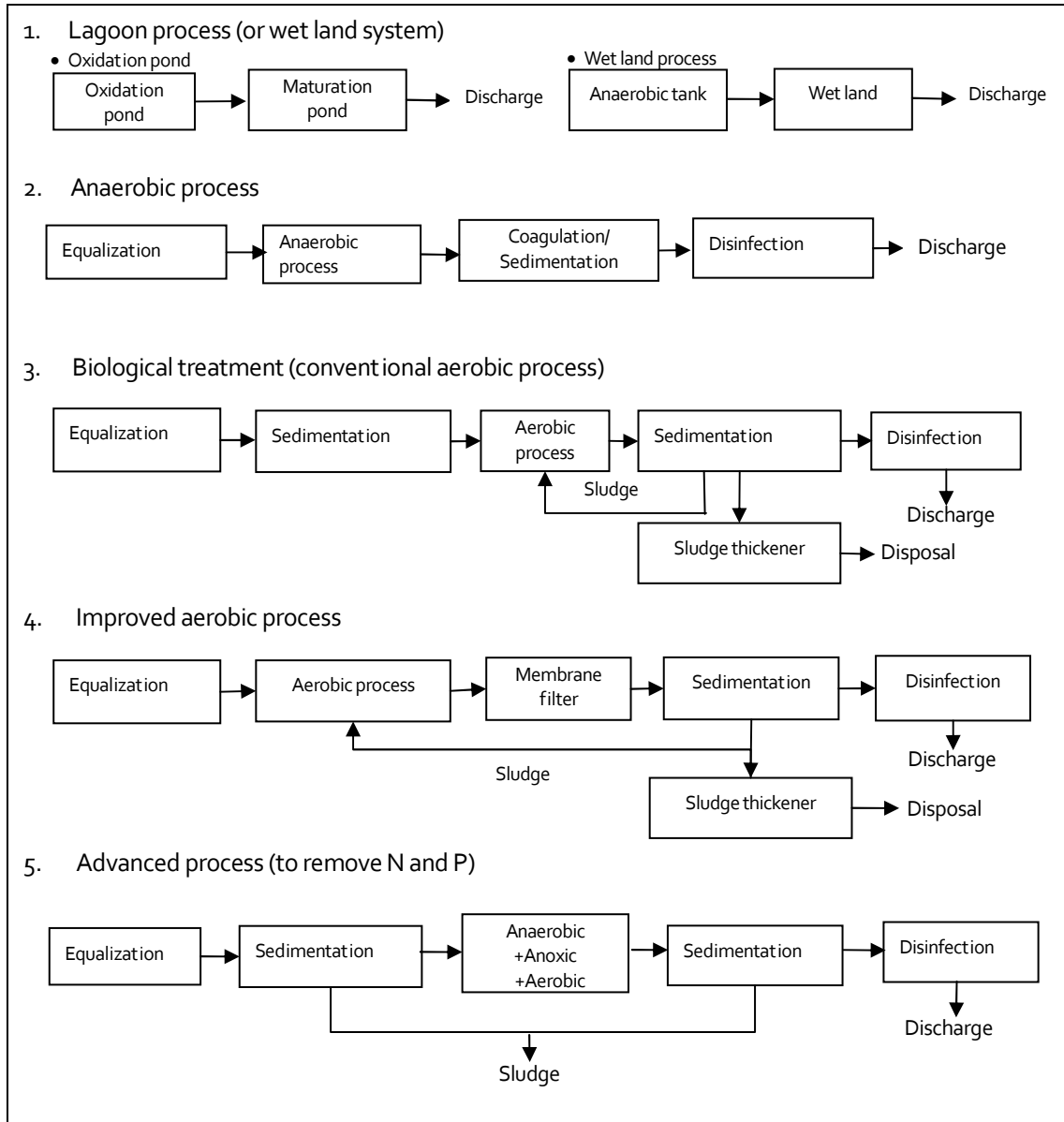


Figure 4.4 Medical wastewater treatment technologies used in Vietnam

Evaluation of these technologies based on the above criteria is summarized in Table 4.4 as an example. Considering these evaluation, proposed wastewater treatment systems/technologies are drawn as follows for 4 typical conditions of hospitals in Vietnam, which is shown in Table 4.5.

Table 4.4 Comparison of medical wastewater treatment technology

Criteria	Technology				
	Lagoon process	Anaerobic process	Conventional aerobic process	Improved aerobic process	Advanced process
Performance	+	+	++	++	+++
Cost	+	+	++	++	+++
Land requirement	+++	++	++	++	+
Technical viability	+++	++	++	++	+
Environmentally benign	+	++	++	+++	+++

Note: +: low, ++: medium, +++: high



**Case I:** General hospitals with more than 300 beds<sup>30</sup> and some special hospitals may require a separate treatment system for liquid wastes depending on the amount and quality of these liquid wastes. Wastewater quality must be carefully surveyed at the planning stage of wastewater treatment facility, taking into account of a possible expansion plan of the hospital and specialty as well.

**Case II:** If hospitals do not have enough space to construct or expand a conventional biological treatment system such as activated sludge, trickling filter, contact aeration technologies that require relatively large area, improved aerobic process or advanced biological process are optimal technologies. Especially, in the area where effluent standards are strict in terms of N or P, advanced processes are more favorable than improved aerobic process.

**Case III and Case IV:** If hospitals have land large enough to construct a conventional biological treatment system and comply with the proximity requirement, a conventional biological treatment system is applicable. Above all, hospitals, if their budgets for wastewater management are limited, may install lagoon system such as oxidation and maturation pond or a wet land system. These systems are generally cheaper but treatment efficiency is not so high.

**Table 4.5 Proposed medical wastewater treatment system/technology in Vietnam**

Case		System/Technology	Remarks
I	General hospitals with more than 300 beds or some specialty hospitals (depending on the specialty)	Centralized wastewater treatment facility + Stand alone liquid waste treatment systems (depending on the quality of liquid wastes).	Even general hospitals with less than 300 beds, a separate liquid wastes are required in some cases. Detail water quality survey by sources is needed before a construction.
II	Hospitals have not enough space for wastewater treatment facility.	Improved biological process, Advanced process	In case effluent standards are strengthened advanced systems are favorable than improved biological process.
III	Hospitals have enough space for wastewater treatment facility.	Conventional biological system (anaerobic or aerobic process)	Proximity requirements must be complied with.
IV	Hospitals have enough space capable to comply with proximity requirements, and budget constraints.	Lagoon process method, Wet land method	These technologies are generally cheap, but a performance is not so high.

### 4.6.3 Medical solid waste management system and technology

#### (1) Principle or basic requirements

Medical waste management systems or and technologies should be selected based on the following principle and requirements.

- Separation of waste at source is necessary, especially for hazardous medical waste and recyclables.
- The direction mentioned in the Official letter of the Minister of Health (No. 7164/2008/BYT-KCB) should be followed, especially at the district hospitals.
- Treatment technologies are selected in accordance with the Regulation on Medical Waste Management (Decision No.43 /2007/QD-BYT).
- System or technologies should be selected in accordance with the existing master plan or relevant plan if available.

<sup>30</sup> In the new effluent standards of healthcare facilities (QCVN 28:2010/BTNMT: National Technical Regulation on Health Care Wastewater), regulatory values are different for facilities with less than 300 beds from facilities with more than 300 beds. Bed number of 300 is set as merkmal for differentiation of regulatory value for effluent standards. The same merkmal is adopted for differentiation of proposed wastewater treatment systems in this study.

It is internationally recognized that hazardous medical wastes which needs careful and special management accounts only about 20 % of the total medical waste. It is thus essential to segregate these wastes at generation sources to ensure safer and easier management. Source separation of recyclable wastes should be encouraged to reduce the amount of medical waste to be treated since hospitals, in general, produce considerable amount of recyclables, such as plastics, glasses, papers, and metal cans, mostly of packaging materials of medical supply.

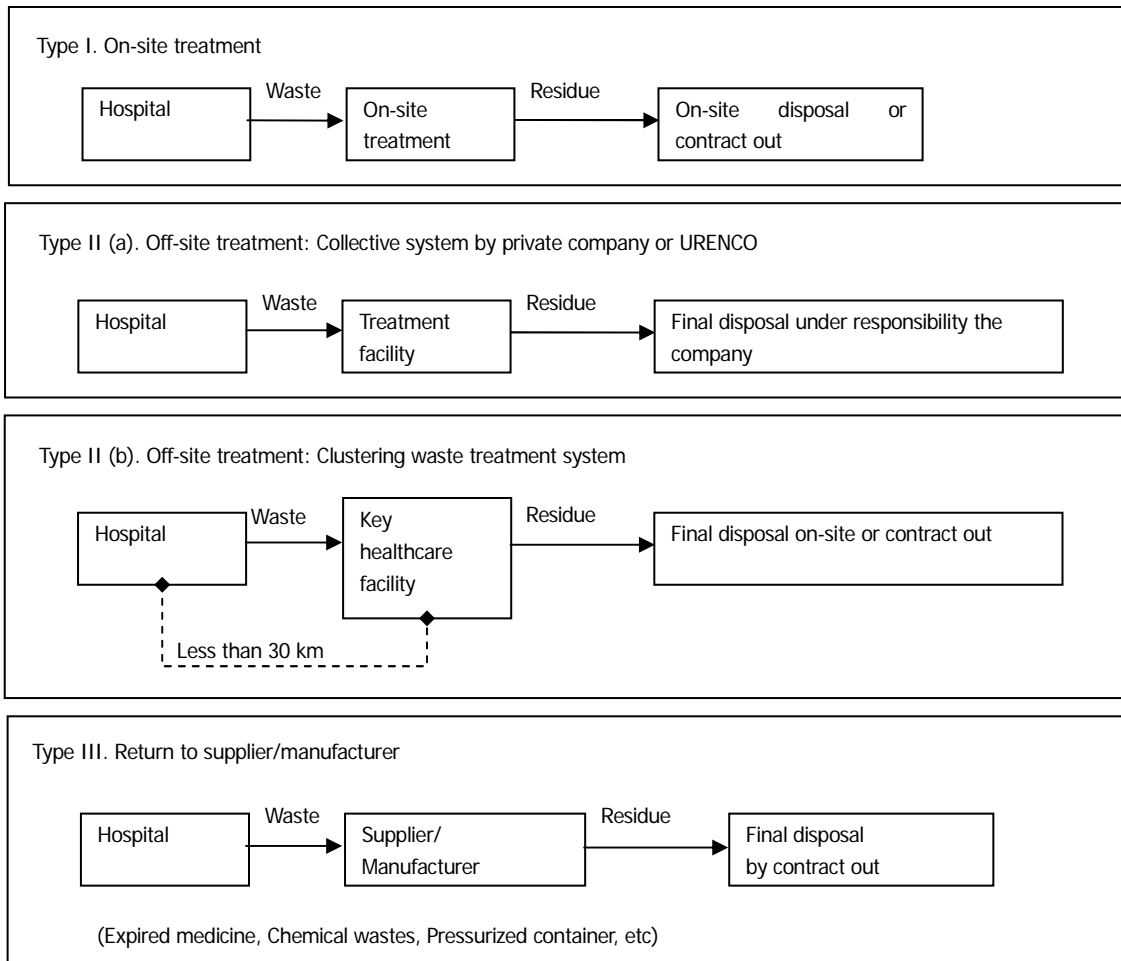
It is also important to follow the regional plan of medical waste management system if available. The nation's master plan for medical waste management is reportedly prepared by MOC in cooperation with relevant ministries. Additionally, the World Bank is reportedly requesting DOH to prepare master plan of medical waste treatment system in each province under the Bank's project.

The Official letter of the Minister of Health (No. 7164/2008/BYT-KCB) gives a direction to the medical waste treatment at the district level hospitals. However, this directions should be applied to other levels of hospitals as well. The key directions for medical waste management systems mentioned in this letter are as follows:

- Government managed cities where density of hospitals and healthcare facilities is high, and traffic system is well developed may apply a centralized model for hazardous medical waste treatment; a key treatment facility in the city may treat all hazardous medical waste generated in the city in order to save investment and operational cost,
- Cluster model is applicable to provincial and city level hospitals; hazardous medical waste are transferred and treated at healthcare facilities located within or near the cities (within 30 km from the hospital), and
- On-site waste treatment is applicable to healthcare facilities located in a remote area, employing suitable technologies.

## (2) Medical solid waste management system

Based on the direction of the Official letter of the Minister of Health (No. 7164/2008/BYT-KCB) and the requirements described in the Decision No.43 /2007/QD-BYT medical waste management systems in Vietnam are categorized as shown in Figure 4.5.



**Figure 4.5 Possible medical waste management systems in Vietnam**

Type I is applicable to the hospitals that can own and manage waste treatment systems by their own financial and technological capability. This system is also employed at hospitals located far from the center of city where regular waste collection services are less accessed, and Type II (a) and (b) systems are less applicable.

Type II is off-site treatment system at a centralized treatment facility. Such facility is owned by a private waste treatment companies (Type II (a)) or some key healthcare facilities in the region (Type II (b)). The former system is arranged by hospitals and directly contracted with private companies. Wastes are collected and treated by the companies. The later system may be arranged by DOH and employed if only throughput capacity of the treatment facilities of key healthcare facilities is enough large to accept wastes from other hospitals. Wastes are collected by the key hospitals or other entity depending on the system developed by DOH. In both cases, wastes are stored at hospitals by the time of collection, and thus hospitals must have appropriate waste storage facility prescribed in the Decision No.43 /2007/QD-BYT.

Type III is applied for some specific hazardous medical wastes. Pharmaceutical waste (expired medicine), cyto-toxic wastes, some chemical wastes, and pressurized container are among those treated by Type III system. Returning or acceptance of such wastes by suppliers or manufacturers should be included in the terms and condition of purchase agreement of those products.

### (3) Hazardous medical waste treatment technologies

Various technologies for hazardous medical waste treatment are available or being developed both in domestic and abroad. These are summarized in Table 4.6 by the kinds of applicable hazardous medical wastes. It is noteworthy that not single technology can treat all kinds of wastes.

Only a high temperature incinerator can treat most hazardous wastes except for a heavy metal containing inorganic waste. Hence, a multiple technologies must be used for a hazardous medical waste treatment in general.

In the Official letter of the Minister of Health (No. 7164/2008/BYT-KCB), the technologies for medical waste management are directed as:

- The provinces, cities, and hospitals that have incinerators may continue to use, but must conduct flue gas analysis according to existing regulations,
- The provinces, cities, and hospitals that have not waste treatment facilities or have incinerators malfunctioned should apply new environmentally sound technologies such as disinfection or microwave technologies.
- When installing a new incinerator, it should be equipped with devices to prevent air pollution abatement.

For selection of appropriate technologies for target hazardous wastes, following criteria should be considered.

- Quality and quantity of wastes to be treated
- Availability and technical viability
- Premise condition
- Cost (investment/recurrent)
- Availability of residue disposal
- Compliance with technical standards (incinerator) and environmental standards (emission gas)
- Accessible to spare parts and consumables

**Table 4.6 Technology applicable to hazardous medical waste treatment prescribed  
in the Regulation on Health Care Waste Management**

Technology	Infectious waste	Anatomical waste	Sharps	Pharmaceutical waste	Cytotoxic waste	Heavy metal containing waste	RI waste	Remarks
Incineration	Yes	Yes	Yes	Yes	Yes*	No	Yes**	* More than 1,000C ** Low-level
Chemical disinfection	Yes	No	Yes	No	No	No	No	Need liquid waste treatment
Autoclave	Yes	Yes/No	Yes	No	No	No	No	Need shredder and efficacy check
Microwave	Yes	Yes/No	Yes	No	No	No	No	Need shredder and efficacy check
Needle destruction	No	No	Yes	No	No	No	No	Need electricity
Neutralization /Inertization/ Stabilization	No	No	No	No	No	Yes	No	Burial after treatment
Pit burial /Cemetery	Yes	Yes	Yes	Yes	No	No	Yes***	Only if other methods are unavailable or less accessible. ***: Low-level
Return to supplier	No	No	No	Yes	Yes	Yes	Yes	Include in the purchase agreement

Source: Adapted from Safe Management of Wastes from Health-care Activities, WHO, 1999.

Incineration is a common technology being used at healthcare facilities in Vietnam. In some hospitals, however, autoclaving and microwave irradiation technologies (combined with autoclaving technology) have been used recently. Technologies other than incineration are designed for sterilization or disinfection (of infectious waste) and leaving considerable amount of treatment residues compared with incineration. This means hospital requires additional measures and expenses for residue disposal, i.e. cost for sterilization/disinfection and cost for final disposal of residues. Taking consideration of these facts, proposed medical (hazardous) waste treatment systems/technologies are summarized in Table 4.7.

Case I and Case II: If there are key hospitals (Case I) or private waste treatment companies such as URENCO (Case II) in the region, Type II (a) or (b) system can be employed in which hospitals can send their waste to the key hospitals or contract out to their wastes to private companies. Large-scaled incinerators (more than 200 kg/hour) are preferable at some key hospitals or at private waste treatment company rather than a small incinerator from viewpoints of a merit of scale. The wastes unacceptable by Type II (a) or (b) system are treated by Type III system.

Case III: Local hospitals located far from centralized waste treatment facility described in Case I and II should equip their own waste treatment facilities (Type I system). Possible technologies may be non-burning technologies or incinerator with full air pollution control devices in combination of Type III system if required.

Case IV: Especially hospitals in Case III with less than 50 beds, simple and small-scale technologies can be applicable if only waste is well separated at sources. In general, the amount of wastes generated at such hospitals is not so much and sharp items and placenta may be typical hazardous medical wastes. Needle destruction or pit burial are suitable technologies for the former while pit burial or burial at a graveyard for the later.

**Table 4.7 Proposed medical waste treatment system/technology in Vietnam**

Case		System/Technology	Remarks
I	There are key hospitals having waste treatment facility with excess throughput capacity.	Type II(a) system with a combination of Type III system if required	Efficient and feasible waste collection plan is required in this system. Storage of waste is required for hospitals complying with the Regulation.
II	There are private waste management companies having medical waste treatment facility.	Type II(b) system with a combination of Type III if required	Currently such companies include URENCO of Hai Phong, Hanoi, Da Nang and Ho Chi Minh. Treatment fee is negotiated between company and hospitals.
III	Hospitals located where Case I and II are inapplicable.	Type I system in combination with Type III system if required. Technologies are non-burning or incineration	Incinerator requires air pollution control devices to meet flue gas standards (QCVN 02:2008/BTNMT). Non-burning technologies are relatively costly and their performances are not always high.
IV	Hospitals located where Case I and II are inapplicable and having less than 50 beds.	Type I system in combination with Type III system if required. Technologies are a pit burial or cemetery burial	Major hazardous medical wastes generated from these hospitals are sharp items and anatomical waste (e.g. placenta).

#### 4.6.4 Operation of medical waste management

##### (1) Organizational framework

Effective management of medical waste requires the hospital to meet all legal obligations, public and environmental protection standards, and accomplish that in a cost-efficient manner. As a rule, proper medical waste management involves increasing attention on how to reduce the medical waste stream through pollution-preventing activities. It is a great challenge to balance these issues that requires senior management's and responsible staff's outmost commitment to ensure proper implementation of the medical waste handling activities throughout the hospital. In addition it requires technology and operational management that can enhance the proper flow of medical waste treatment. Human resource is a key factor in operational management. Under the organizational framework, top down approach, stemming from management's leadership and bottom up implementation by staff's individual involvement and willingness to participate is

pivotal in resolving improper medical waste disposal at the hospitals. Figure 4.6 shows how to develop organizational framework to implement adequate waste management flow in a hospital.

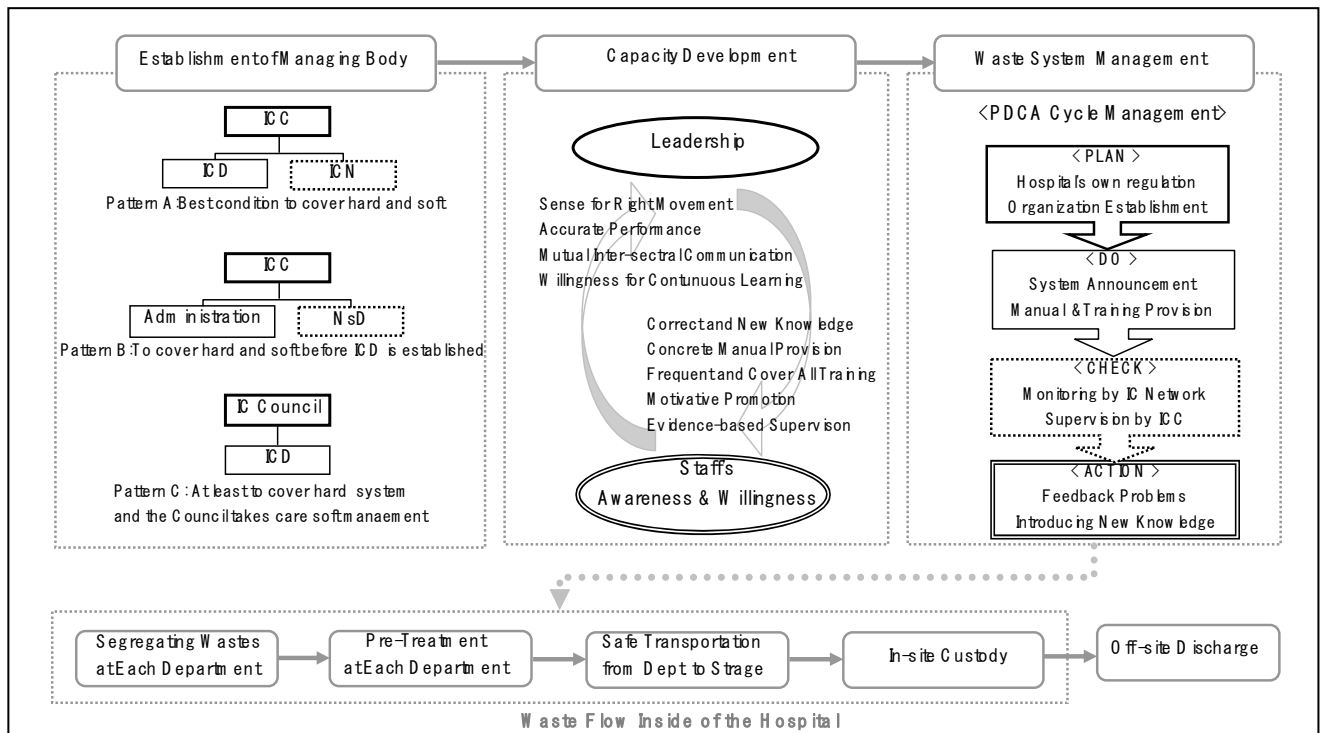


Figure 4.6 Proposed organization framework and flows

**Strengthening existing organization**

Table 4.8 shows the existing Organizational system and suggested actions to be strengthened;

**Table 4.8 Organizational system for infection control**

Existing organization	Action to take
Infection Control Committee (ICC) or Infection Control Council	<u>ICC should demonstrate its leadership:</u> Leadership is not for forcing people to follow. Rather ICC should enlighten hospital staffs by indicating the reality of the current condition of waste management, showing data of amount of the waste and cost for treatment, and then set up the goal to unify the staff to achieve it.
Infection Control Department (ICD)	<u>ICD should supervise the scientific condition of the hospital:</u> Generally ICD is not given great importance as it is not a department to cure or diagnose patients. However, ICD concerns more about facility and technology management. It is capable of indicating issues to be improved in a specific and objective manner, by showing scientific data such as waste water quality and quantity of solid medical waste.
Infection Control Network (ICN)	<u>ICN should involve and motivate staff for medical waste treatment:</u> ICN has potential to increase coordination within the hospital, by dividing the waste flow into several steps. ICN should engage in each step including generation of waste, collection within a designated area or floor, infection control, transfer to storage space, and procurement and contract of external services for waste management. Representatives from each department should jointly develop strategies understandable for staff in various groups. Such process enables ICN to ensure accountability and each staff of hospital fulfills self-responsibility.

### Management leadership

Knowing what is right for the hospital is at the heart of the leader's responsibilities. Visionary leadership is vital to align thousands of various tasks and tap the energies of the workers within the organization. This is especially true when attempting to reduce medical waste while ensuring its proper handling in a complex organization such as hospital. Proper management of medical waste is just one of many systems driving the hospital towards fulfilling its overall vision of providing excellent health care to its clients and the greater community as the final goal. The vision helps to frame the "right things" on which the hospital should be focused.

### Staff ownership from awareness

It is obviously inefficient if competent workers must wait for instruction to carry out their work tasks. The key to successful organizational management is to make people willing to perform their tasks under their own responsibility. Effective and successful medical waste management system within a hospital can be accomplished when all the staffs are positively involved to fulfill their responsibility and ownership of the treatment process.

#### (2) Developing strategy to minimize medical waste in each hospital

In minimizing medical waste it is essential to generate impacts which continually contribute to more cost-efficient operation and bottom-up the financial condition of the hospital. Eliminating or reducing is the only way for minimization of medical waste. There are several measures that can be institutionalized to achieve medical waste minimization including the following:

Process	Action to take
Waste prevention	Eliminating unnecessary medical waste generation
Source reduction	Reducing the amounts of medical waste generated
Reuse	Finding another use for a component so it does not become part of the medical waste
Recycling	Handling or treating the material so it can be used in another process

Essential activities in minimization of medical waste are to recognize the various waste, to initiate strategies to ensure that staffs proactively join training to minimize the generation of wastes, and to ensure that wastes are disposed separately. These tasks will require management's leadership in developing policies and staff training. The strategy should state the goal of the medical waste minimization program and identify new own hospital policies for handling and discarding medical waste as well as non-medical one generated in a same hospital. Other possible elements of the medical waste minimization strategy include:

Existing activities	Action to take
Staff training planning and follow-up monitoring	Create plan to confirm all staffs receiving training and achieve the established standards.
Monthly tracking mechanism for waste minimization	Create concrete checking list based on scientific and evidence based monitoring subjects.
Recognition or awards for achieving milestones in implementing the strategy.	Establish competition among departments towards reaching set goals with positive motivation/incentive
Forming a team or council to oversee and coordinate the medical waste minimization strategy	Use ICC and ICN framework to coordinate and promote waste minimization strategy.
Tangible reports, graphs and feedback to communicate results	Communicate monthly progress to staff

It is important to collect good baseline data of the amount of waste generated prior to implementing the waste minimization program. Medical waste generation data from the various

units in the hospital should be recorded on a Pareto Chart with the amounts of waste displayed in descending order. Pareto analyses can easily indicate the highest medical waste generating areas in which the minimization strategies should be initiated. This information should be displayed and communicated throughout the hospital.



## **CHAPTER 5 ROAD MAP AND PROPOSED JICA’S ASSISTANCE PROGRAM ON MWWSW MANAGEMENT IN VIETNAM**

In developing the roadmap and JICA cooperation program, it is necessary to respect the ownership of the Vietnamese side lead by MOH and taking into account efficient sharing roles among donors. This chapter proposes possible models of assistance which are necessary to help the Vietnamese side to achieve the overall goals on MWWSW management.

### **5.1 Road Map on MWWSW Management in Vietnam**

#### **5.1.1 Outline of road map**

Through the joint study activities by both Vietnamese C/P and JICA study team, such as stakeholder meetings and workshop, road map to introduce and realize the proper MWWSW management system in Vietnam was prepared.

The road map was prepared in order to achieve the following purposes.

- (1) MWWSW management system in Vietnam is improved.
- (2) Infection threat and environmental pollution by MWWSW are reduced.

The road map is consisted with 3 pillars: Policy, Laws and Regulations; Management and Operation; and Treatment System; and 8 tasks for these pillars as shown in Table 5.1.

**Table 5.1 Outline of road map**

No	Pillar	Task
1	Policy, Laws and Regulations	1-1 Establishment of the strategic plan on MWWSW management
		1-2 Improvement of regulations and standards on MWWSW management
		1-3 Establishment of guidelines for MWWSW management
2	Management and Operation	2-1 Establishment of MWWSW management system by medical and environmental administrative agencies in central and local governments
		2-2 Establishment of MWWSW management system and organization of MWWSW management in hospitals
3	Treatment System (Facilities)	3-1 Development of MWWSW treatment technology
		3-2 Installation of MWWSW treatment facilities
		3-3 Establishment of financing mechanism

The road map is summarized in Table 5.2 and outline of each task of the road map is described in Section 5.1.2.

Table 5.2 Road map to improve MWWSW management in Vietnam

Pillar	Task	Action	JICA assistance program applied	Responsible agencies	Goals	Tentative schedule					
						2011	2012	2013	2014	2015	
Policy, Laws and Regulations	1-1 Establishment of the strategic plan on MWWSW management	1-1-1 Establish the national strategic plan on MWWSW management	✓	MOC(off-site), MOH(on-site)	Policy and strategy on MWWSW management are developed and disseminated.						
		1-1-2 Disseminate the strategic plan on MWWSW management nationwide		MOC(off-site), MOH(on-site)							
	1-2 Improvement of regulations and standards on MWWSW management	1-2-1 Review and update inadequate description in regulations/standards on MWWSW management	✓	MOH	Role and responsibility of each relevant agencies/departments on MWWSW management are clarified. MWWSW management in hospitals is improved and enhanced by new regulations/standards.						
		1-2-2 Develop new regulations/standards for strengthening on MWWSW management		MOH							
		1-2-3 Disseminate new regulations/standards to relevant agencies/departments and hospitals		MOH, DOH							
		1-2-4 Implement MWWSW management by hospitals under new regulations/standards		Hospitals							
	1-3 Establishment of guidelines for MWWSW management	1-3-1 Develop guidelines for MWWSW management	✓	MOST, MOH	MWWSW management in hospitals is carried out properly according to the guidelines.						
		1-3-2 Disseminate the guidelines for MWWSW management		MOH, DOH							
		1-3-3 Implement MWWSW management by hospitals based on the guidelines		Hospitals							
	Management and operation	2-1 Establishment of MWWSW management system by medical and environmental administrative agencies in central and local governments	2-1-1 Develop and implement the plan of capacity development for medical administrative agencies in central and local governments	✓	MOH, DOH	MWWSW management is improved by medical and environmental administrative agencies in central and local government.		● ●	● ●	● ●	● ●
2-1-2 Develop and implement the plan of capacity development for environmental administrative agencies in central and local governments			✓	MONRE, DONRE			● ●	● ●	● ●	● ●	
2-1-3 Implement supervision and monitoring by medical administrative agencies based on the developed MWWSW management system				MOH, DOH							
2-1-4 I Implement supervision and monitoring by environmental administrative agencies based on the developed MWWSW management system				MONRE, DONRE							
2-2 Establishment of MWWSW management system and organization of MWWSW management in hospitals		2-2-1 Develop and implement the plan of capacity development for heads/staffs of hospitals and administrator/operator of MWWSW treatment facilities	✓	MOH, DOH	MWWSW management in hospitals is improved by heads/staffs of hospitals. MWWSW treatment facilities are managed and operated properly by administrator/operator.		● ●	● ●	● ●	● ●	
		2-2-2 Formulate management/operation system and organization for MWWSW management in hospitals	✓	Hospitals							
		2-2-3 Improve management/operation on MWWSW treatment facilities	✓	Hospitals							
		2-2-4 Implement supervision and monitoring by hospitals based on the established MWWSW management system		Hospitals							
Treatment system (facilities)		3-1 Development of MWWSW treatment technology	3-1-1 Study on MWWSW treatment technology and formulate coordination mechanism among concerned agencies and organizations		MOST, MOH, University & Institute	All hospitals apply the appropriate technology by reference to the developed technologies.					
			3-1-2 Implement the pilot/model project and verify MWWSW treatment technology	✓	MOST, MOH, University & Institute						
	3-1-3 Disseminate the verified MWWSW treatment technologies to hospitals nationwide			MOH, DOH							
	3-2 Installation of MWWSW treatment facilities	3-2-1 Establish the plan for installation of MWWSW treatment facilities in line with the strategic plan		MOH, MOC, PPC, Hospitals	All hospitals install appropriate MWWSW treatment facilities.						
		3-2-2 Promote installation of MWWSW treatment facilities in accordance with the plan	✓	MOH, MOC, PPC, Hospitals							
	3-3 Establishment of financing mechanism	3-3-1 Review and amend regulations to allocate and secure proper budget for MWWSW management		MOH, MOC, MPI, PPC	Necessary budget for MWWSW management is allocated and secured in all hospitals.						
		3-3-2 Allocate and secure proper budget for MWWSW management		MOH, PPC, DOH, Hospitals							

Note: MWWSW; medical waste water/ solid waste

●; It indicates the short-term implementation. It does not mean to be carried out continuously.

## **5.1.2 Outline of each task of road map**

### (1) Policy, Laws and Regulations

#### a. Task 1-1: Establishment of the strategic plan on MWWSW management

**Background:** In Vietnam, comprehensive and definite guide or direction to improve the MWWSW management system is lacking. The master plan related to MWWSW management is recently prepared by MOH and MOC and they are under the approval process by the prime minister. The strategic plan on MWWSW management is necessary to accomplish a medium and long term strategies, visions and plans.

**Goal:** Policy and strategy on MWWSW management are developed and disseminated.

**Action:** The master plan is verified and the national strategic plan on MWWSW management should be prepared, if necessary. MOH and MOC should disseminate the master plan and/or the national strategic plan to the related agencies such as DOH, DOC, hospitals etc. by implementing seminars and/or workshops.

#### b. Task 1-2: Improvement of regulations and standards on MWWSW management

**Background:** There are insufficient or uncertain descriptions in regulations on MWWSW management. It may cause confusion and misunderstanding in MWWSW management in healthcare facilities. It is required to review and update the regulations, to unify and to meet the current situation of the country.

**Goal:** Role and responsibility of each relevant agencies/departments on MWWSW management are clarified. MWWSW management in hospitals is improved and enhanced applying the improved regulations/standards.

**Action:** Inadequate description in regulations/standards on MWWSW management is reviewed and updated and regulations/standards for strengthening MWWSW management are developed by MOH. After improved regulations/standards is enacted and enforced, MOH and DOH should disseminate it to relevant agencies/departments and hospitals by implementing seminars and/or workshops. And then proper MWWSW management, in line with the improved regulations/standards, should be implemented by hospitals.

#### c. Task 1-3: Establishment of guidelines for MWWSW management

**Background:** Technical guide for MWWSW treatment technology or system is lacking and most of existing facilities/systems are not verified scientifically. It is a part of reasons for installation of inappropriate treatment facilities and thus resulting in ill-operation and poor maintenance. It is required to establish technical guideline or manual for MWWSW management, including treatment and operation/ maintenance.

**Goal:** MWWSW management in hospitals is carried out properly according to the guidelines.

**Action:** The guidelines for MWWSW management are to be developed by MOH and MOST to meet the requirement and/or standards in Vietnam. And then MOH and DOH should disseminate it to hospitals by implementing seminars and/or workshops. Based on the guidelines, MWWSW management should be implemented properly by hospitals.

### (2) Management and Operation

#### a. Task 2-1: Establishment of MWWSW management system by medical and environmental administrative agencies in central and local governments

**Background:** Currently, medical and environmental administrative agencies in central and local government such as MOH, MONRE, DOH and DONRE might not lead an efficient and effective MWWSW management. One of the main reasons is insufficient number and capacity of human resources. Therefore, it is required to assign adequate number of staffs and develop capacity for

medical and environmental administrative agencies in central and local government to lead proper MWWSW management system in Vietnam.

Goal: MWWSW management is improved by the initiative of the medical and environmental administrative agencies in both central and local government.

Action: Capacity development program for medical and environmental administrative agencies in central and local governments should be developed and implemented. Based on the improved MWWSW management system, supervision and monitoring should be carried out in the proper manner by medical and environmental administrative agencies.

b. Task 2-2: Establishment of MWWSW management system and organization of MWWSW management in hospitals

Background: Heads/staffs of hospitals do not lead/provide efficient and effective MWWSW management in hospitals because of lack of capability. Administrator/operator of MWWSW treatment facilities do not have enough knowledge and experience so that they are facing difficulties to manage and operate MWWSW treatment facilities properly. It is required to develop capacity for heads/staffs of hospitals and administrator/operator of MWWSW treatment facilities to lead and provide proper MWWSW management system in hospitals.

Goal: MWWSW management in hospitals is improved by the initiative of heads and effort of staffs of hospitals. MWWSW treatment facilities are managed and operated properly by administrator/operator.

Action: Capacity development program for heads and/or staffs of hospitals and administrator/operator of MWWSW treatment facilities should be developed and implemented by MOH and DOH. Hospitals should formulate proper organization inside hospitals to manage proper MWWSW and improve management/operation on MWWSW treatment facilities. Based on the established MWWSW management system, supervision and monitoring should be carried out by hospitals.

### (3) Treatment System

a. Task 3-1: Development of MWWSW treatment technology

Background: Proper treatment technology on MWWSW to fit current situation of the country and achieve standards of Vietnam is not verified sufficiently. Most hospitals do not have enough information about suitable technology and method of treatment of MWWSW. It is required to develop suitable treatment technology to meet the current situation of the country.

Goal: All hospitals apply the appropriate technology by reference to the developed technologies.

Action: MWWSW treatment technology should be studied in coordination with related agencies; such as MOST, MOH, universities and institutes, and coordination mechanism among concerned agencies and organizations should be formulated. The pilot/model project should be implemented and appropriate treatment technology/system should be verified. And then MOH and DOH should disseminate the verified technologies/system to hospitals nationwide.

b. Task 3-2: Installation of MWWSW treatment facilities

Background: Appropriate MWWSW treatment facilities are not installed at many hospitals across the country. Infectious waste itself, wastewater and/or exhaust gas from the facilities may cause unexpected environmental impact on the surroundings.

Goal: All hospitals install appropriate MWWSW treatment facilities.

Action: The plan for the installation of MWWSW treatment facilities should be established in line with the master plan and/or strategic plan mentioned in Task 1-1. And then MOH, MOC, PPC and hospitals should promote installation of MWWSW treatment facilities in accordance with the plan above mentioned. Calling donors assistance might be one of the measures to realize this task.

(4) Establishment of financing mechanism

Background: Insufficient budget for both installation and operation of MWWSW treatment facilities/system is one of the reasons that healthcare facilities cause environmental pollution. It is required to allocate adequate budget for the facility installation and routine operation and maintenance of the MWWSW treatment system.

Goal: Necessary budget for MWWSW management is allocated and secured in all hospitals.

Action: Regulations and financial mechanism to allocate proper budget for MWWSW management should be reviewed by the related agencies such as MOH, MOF, MPI and PPC, and amended to meet the requirement. And then, proper budget for MWWSW management should be allocated and secured.

## 5.2 Proposed JICA's Assistance Program on MWWSW Management

### 5.2.1 Outline of proposed JICA's assistance program

Considering the road map to improve MWWSW management system in Vietnam, other donor's activities in the sector and JICA's resources and assistance policy, possible assistance schemes by JICA are: (1) technical assistance, (2) financial assistance (grant aid and yen loan), (3) training, and (4) expert dispatch. As shown below, 5 projects/program are proposed for the future JICA's assistance program in MWWSW management sector in Vietnam.

#### Technical Assistance Project (1)

- |  |
|--|
| <p><u>1. Project Title:</u> Strengthening Capacity of Medical Waste Water and Solid Waste Management System in Vietnam</p> <p><u>2. Implementation Agency:</u> MOH, DOH of model provinces, model hospitals</p> <p><u>3. Direct Beneficiaries:</u> Staff of implementation agencies,</p> <p><u>4. Indirect Beneficiaries:</u> Residents of the target areas</p> <p><u>5. Project Areas:</u> Hanoi and the model provinces to be selected</p> <p><u>6. Project Period:</u> 3 years from 2011</p> <p><u>7. Overall Goal</u><br/>MWWSW management system is improved and implemented effectively and satisfactorily in Vietnam</p> <p><u>8. Project Purpose</u><br/>Capacity of MWWSW management is improved in both central and local levels</p> <p><u>9. Outputs</u></p> <ul style="list-style-type: none"><li>- National strategic plan and guidelines for MWWSW management are prepared.</li><li>- Implementation plan of the MWWSW management is developed.</li><li>- Operation and maintenance system on the MWWSW treatment is established and/or strengthened.</li><li>- Appropriate technology/system of the MWWSW is developed.</li></ul> |
|--|

#### Technical Assistance Project (2)<sup>31</sup>

- |  |
|--|
| <p><u>1. Project Title:</u> Strengthening Capacity of Water Environmental Management in Vietnam</p> <p><u>2. Implementation Agency:</u> MONRE, DONRE of model provinces</p> <p><u>3. Direct Beneficiaries:</u> Staff of implementation agencies,</p> <p><u>4. Indirect Beneficiaries:</u> Residents of the target areas</p> <p><u>5. Project Areas:</u> Hanoi, Hai Phong, Hue, HCMC, Ba Ria Vung Tau</p> <p><u>6. Project Period:</u> 3 years from mid 2010</p> <p><u>7. Overall Goal</u><br/>Water environmental management system is improved and implemented in Vietnam</p> <p><u>8. Project Purpose</u><br/>Capacity of MONRE and target DONREs on water environment management is strengthened.</p> <p><u>9. Output</u></p> <ul style="list-style-type: none"><li>- Strengthening MONRE's capacity of making policy &amp; systems that are more effective &amp; enforceable</li><li>- Strengthening enforcement capacity of target DONREs on basic water pollution control</li><li>- Strengthening target DONRE's capacity of making effective water pollution control measures</li><li>- Strengthening target DONRE's capacity of promoting awareness of public and industrial sectors on water environment</li><li>- Strengthening capacity of MONRE and DONREs on information management and utilization</li></ul> |
|--|

<sup>31</sup> This project has started since August 2010.

### **Financial Assistance Project**

<p><b>1. Project Title:</b> Investment for Medical Waste Water and Solid Waste Treatment System in Vietnam</p> <p><b>2. Implementation Agency:</b> MOF, MPI, MOH, PPC and DOH of the target hospitals</p> <p><b>3. Project Period:</b> 4 years from 2013</p> <p><b>4. Target Hospitals:</b></p> <p>a. Medical wastewater treatment facilities</p> <ul style="list-style-type: none"> <li>• Hospitals managed by MOH: approx. 10 hospitals</li> <li>• Hospitals managed by Provinces: approx. 20 hospitals</li> </ul> <p>b. Medical solid waste treatment system</p> <ul style="list-style-type: none"> <li>• Off-site treatment (centralized system): approx. 3 sites (3 PPCs)</li> <li>• On-site treatment: approx. 10 hospitals managed by MOH and/or Provinces</li> </ul> <p>Note: Target hospitals will be selected based on the “Implementation plan of the MWWSW management” mentioned in the above “Technical Assistance Project-1”.</p>
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### **Training Program**

<p><b>1. Program Title:</b> Training for Strengthening Capacity of Medical Waste Water and Solid Waste Management in Vietnam</p> <p><b>2. Implementation Agency:</b> JICA</p> <p><b>3. Target groups:</b> MOH, DOH, Hospitals, MONRE, DONRE etc.</p> <p><b>4. Program Period:</b> approx. 2 years from 2011</p> <p><b>5. Target and Contents:</b></p>		
Target groups	Contents	Remarks (Frequency)
Staff of MOH, DOH, etc.	Implementation of policy, laws and regulations related to MWWSW management, supervising, monitoring and instruction on MWWSW to the hospitals by the government	1 time/year
Staff of Hospitals	Management, instruction and monitoring on MWWSW inside the hospitals	
Staff of MONRE, DONRE etc.	Management, supervision, monitoring and instruction on hazardous MWWSW inside the hospitals	1 times/year

### **Dispatch of JICA Expert**

<p><b>1. Title:</b> Dispatch of JICA Expert in Medical Wastewater and Solid Waste Management</p> <p><b>2. Implementation Agency:</b> VIHEMA/MOH</p> <p><b>3. Dispatch period:</b> 1 year from mid 2011</p> <p><b>4. Scope of Works of the Expert:</b></p> <ul style="list-style-type: none"> <li>- Assistance and advice to VIHEMA in respect of MWWSW management</li> <li>- Planning of JICA training program</li> <li>- Preparation and enhancing of JICA technical assistance program and financial assistance project</li> <li>- Others (Adjusting and coordinating with other donor projects)</li> </ul>
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These proposed projects/programs should be further discussed among related agencies and/or departments and finalized as detailed/concrete projects/programs considering the following points.

- It is reported that the following master plans are recently drafted and in the stage of final approval by the prime minister. A strategy and/or direction of some components described in proposed JICA’ assistance program are stated in the master plans. Therefore, these master plans should be reviewed and proposed JICA’s assistance program should be modified to meet the requirement of the master plans.
  - ✓ Master Plan of Medical Waste Management prepared by VIHEMA/MOH
  - ✓ Master Plan on Hazardous Solid Waste Treatment up to 2025 prepared by MOC
- The World Bank recently pledges budget for the improvement of medical wastewater management sector in Vietnam. However, detailed program will be decided based on the request from the Vietnamese side and requirement of the World Bank. In order to avoid an overlapping/ contradiction between 2 donors’ activities, proposed JICA’s assistance program should be adjusted considering the World Bank program.

- Program No. 5 “Dispatch of JICA Expert” is proposed to provide advice MOH to coordinate with other donor’s activities, including the World Bank, and modify proposed JICA’s assistance program.
- Program No.4 “Training Program” might be carried out as an individual program and/or combined with technical assistance program. So, this program can be combined with project No. 1 or No.2.
- Related project has already started since August 2010 with MONRE as a counterpart agency. In terms of water environmental management, MOH, DOH and hospitals should cooperate with this JICA on-going program.

### 5.2.2 Implementation plan of proposed JICA’s assistance program

The viability, duration and implementation order of the proposed projects/programs are to be discussed. Tentative implementation plan of proposed JICA’s assistance program for the next 5 years is shown in Table 5.3. Capacity development projects should be carried out in the early stage followed by the investment of facilities/equipment.

**Table 5.3 Tentative implementation plan of proposed JICA’s assistance program**

Project	Scheme	2011	2012	2013	2014	2015
1. Strengthening Capacity of Medical Waste Water and Solid Waste Management System in Vietnam	Technical assistance	■■■■■				
2. Strengthening Capacity of Water Environmental Management in Vietnam (in progress)	Technical assistance	■■■■■				
3. Investment for Medical Waste Water and Solid Waste Treatment System in Vietnam	Financial assistance			■■■■■		
4. Training for Strengthening Capacity of Medical Waste Water and Solid Waste Management in Vietnam	Training in Japan	●	●			
5. Dispatch of JICA Expert in the Medical Waste Water and Solid Waste Management	Expert dispatch	■■■				

Note: ●; It indicates the short-term implementation. It does not mean to be carried out continuously.

## **CHAPTER 6 CONCLUSION**

This study is to understand the situation about a wide range of issues related to the MWWSW management in Vietnam, and identify issues that hamper a proper MWWSW management, and then to propose the necessary measures to reduce MWWSW generation and to enhance proper treatment. The study area covers Hanoi City, Hue City and Ho Chi Minh City, target hospitals are 9 national hospitals/institutes, and relevant ministries and agencies to be studied are MOH, MONRE and relevant agencies.

Through the Study, whole picture on the MWWSW management in Vietnam has been clarified and the findings and proposals were served as a road map which shows measures to be taken by the related agencies and hospitals/institutes. Furthermore, recommendation for JICA to design a near future cooperation scheme in this sector was provided considering JICA's policy, cooperation direction and effectiveness of the program.

Major outputs of each Chapter are shown as follows.

In Chapter 2, administrative and legislative frame and policy and strategy on MWWSW management, organization structure and roles of related agencies/hospitals are stated.

In Chapter 3, current conditions and practices on MWWSW management has been studied through hearing survey to related agencies and other donors, fact finding survey at the target hospitals/institutes, output of the current JICA Study on Urban Environmental Management in Vietnam. In the central government level, relationship among related agencies and role of each agency has been clarified and, in the target hospitals/institutes, current conditions related to the management and operation, technology and environmental situation has been clarified.

In Chapter 4, based on the findings in Chapters 2 and 3, necessity of improvement or development of MWWSW management system in Vietnam has been clarified and issues and challenges on the aspect of "legislation, policy and regulation", "management and operation", "treatment technology" and "environmental protection" are compiled. Furthermore, model system for medical wastewater and solid waste treatment are proposed, and measures on proper operation and maintenance are also proposed.

In Chapter 5, in order to improve the MWWSW management system in Vietnam, road map composed of 3 pillars: "policy, laws and regulations", "management and operation" and "treatment system"; and 8 tasks together with their goals and actions are prepared. Target year of the road map is set in the year 2015 and main actor for each task is stated. And then, considering the variety of supporting scheme and capability of JICA, 5 items of JICA program are proposed.

In Vietnam, numbers of healthcare facilities in which MWWSW treatment facilities are installed are limited and, even installed, most of them are not meet current effluent standards. Therefore, hospitals are considered as a source of environmental pollution and outbreak of infectious diseases. In particular, if untreated MWWSW outflows during flooding, such risk will be heighten and widely spread. It is expected that by utilizing outputs of this study, proper measures have been taken and threat to outbreak of infectious diseases and environmental pollution will be minimized.



## **APPENDICES**



## **APPENDIX**

Appendix-1: Legal documents related to MWWSWM

Appendix-2 QCVN 02: 2008/BTNMT on National Technical Regulation on the Emission of Healthcare Solid Waste Incinerator

Appendix-3: QCVN 28:2010/BTNMT on National Technical Regulation on Healthcare Wastewater

Appendix-4: Allocation plan of the ENVIRONMENTAL CAREER budget in 2009

Appendix-5: Questionnaire sheets

Appendix-6: Results of awareness survey of medical staffs in hospitals

Appendix-7: Wastewater and soil analysis procedure and method

Appendix-8: Results of the environmental survey

Appendix-9: Comparison of survey results of Bach Mai, Hue Central and Cho Ray Hospitals



## **Appendix-1: Legal documents related to MWWSWM**

### **Policy, law and regulation**

- (1) Official letter 4527-ĐTg dated on 8/6/1996 of the Ministry of Health on *Guiding Treatment of Solid Waste from Hospitals*.
- (2) Order 199/1997/CT-TTg dated on 3/4/1997 of the Prime Minister on *Taking Urgent Measures in the Management of Solid Waste in the Urban Sector and Industrial Zones*.
- (3) Decision 1895/1997-QĐ- BYT dated on 19/9/1997 of the Minister of MOH on promulgating *Regulation on Hospital Management*.
- (4) Decision 152/1999/QĐ- TTg dated on 10/7/1999 of the Prime Minister approving *the Strategy of Waste Control in Urban Sector and Industrial Zones by the Year 2020*.
- (5) Decision 155/1999/QĐ- TTg dated on 16/7/1999 of the Prime Minister on the issuing of *Regulation on Hazardous Waste Management* (This Decision was amended to Decision 43/2007/QĐ-BYT dated on 30/11/2007).
- (6) Decision 2575/1999/QĐ-BYT dated on 27/8/1999 of the Minister of MOH of providing *Regulation on Medical Waste Management*.
- (7) Inter-Ministerial Circular 2237/1999/TTLT/BKHCNMT-BYT dated on 28/12/1999 guiding the implementation of the *Regulations on Safe Application of Radioactive Techniques in Medical Services*.
- (8) Decision 62/2001/QĐ-BKHCNMT dated on 21/11/2001 promulgating the *Technical Requirements for Incinerators of Medical Waste*.
- (9) Decree 13/2003/NĐ-CP dated on 19/2/2003 of the Government providing the *Provisions for the Commodities Prescribed As Being Dangerous/Toxic and Their Transportation on the Roads*.
- (10) Decision 64/2003/QĐ-TTg dated on 22/4/2003 by the Prime Minister approving the *Plan for Managing the Establishments Causing Seriously Environmental Pollution*.
- (11) Decree 67/2003/NĐ-CP dated on 13/6/2003 of the Government on *Environmental Protection Charges Regarding Wastewater*.
- (12) Circular 14/2003/TT-BKHCN dated on 11/7/2003 of Ministry of Science and Technology guiding *Safe Transportation of Radioactive Substances*.
- (13) Decision 256/2003/QĐ-TTg dated on 2/12/2003 by the Prime Minister on *National Strategy on Environmental Protection up to Year 2010 and Vision to 2020*.
- (14) Inter-ministerial circular 125/2003/TTLT-BTC-BTNMT dated on 18/12/2003 of the Ministry of Finance and the Ministry of Natural Resources and Environment guiding *Implementation of Decree No.67/2003/NĐ-CP*.
- (15) Decision 153/2004/QĐ-TTg dated on 17/8/2004 by the Prime Minister approving *Strategic Orientation for Sustainable Development (Viet Nam Agenda 21)*.
- (16) Order 23/2005/CT-TTg dated on 21/6/2005 of the Prime Minister on *Accelerating Solid Waste Management in Cities and Industrial Areas*.
- (17) Law 52/2005/QH11 on *Environmental Protection* promulgated on 29/11/2005.
- (18) Decree 51/2006/NĐ-CP dated on 19/5/2006 of the Government regulating *Penalization of Administrative Violence to Radioactive Safety and Control*.
- (19) Decree 80/2006/NĐ-CP dated on 9/8/2006 of the Government detailing *Implementation of Law on Environmental Protection*

- (20) Decree 81/2006/NĐ-CP dated on 9/8/2006 of the Government promulgating the *Regulation on Sanction against Administrative Violation in the Field of Protection of the Environment* (This Decree was amended to Decree No. 117/2009/ND-CP dated on 31/12/2009)
- (21) Decision 23/2006/QĐ-BTNMT dated on 26/12/2006 of the Ministry of Natural Resource and Environment on *Promulgating the List of Hazardous Waste*.
- (22) Circular 12/2006/TT-BTNMT dated on 26/12/2006 of the Ministry of Natural Resource and Environment on the *Instruction of the Condition, Documentation, Registration and Code of Hazardous Waste Management*.
- (23) Decree 59/2007 dated on 9/4/2007 of the Government promulgating the *Regulation on Solid Waste Management*.
- (24) Inter-ministerial Circular 106/2007/TTLT/BTC-BTNMT dated on 6/9/2007 of Ministry Finance and Ministry of the Natural Resources and Environment revising and updating Inter-Ministerial Circular No.125/2003/TTLT-BTC-BTNMT.
- (25) *Law 03/2007/QH12 on Prevention and Control of Infectious Diseases dated on 21/11/2007*.
- (26) Decree 174/2007/ND-CP dated on 29/11/2007 of Government on *Environmental Protection Charges Regarding Solid Waste*.
- (27) Decision 43/2007/QĐ-BYT dated on 30/11/2007 of the Ministry of Health promulgating *Regulations of Medical Waste Management*.
- (28) Circular 13/2007/TT-BXD dated on 31/12/2007 of the Ministry of Construction providing *Guidance on Some Causes in Decree No.59/2007/ND-CP*.
- (29) Decree 21/2008/ND-CP dated on 28/2/2008 for Amending and Supplementing a Number of Articles of the Government's Decree No.80/2006/ND-CP.
- (30) Circular 39/2008/TT-BTC dated on 19/5/2008 of the Ministry of Finance providing *Guidance on Implementation of Decree No.174/2007/ND-CP*.
- (31) Official letter 7164/2008/BYT-KCB dated 20/10/2008 of the Minister of Health on *Enhancing Implementation of Medical Waste Management*.
- (32) Decision 30/2008/QĐ-TTg dated on 22/2/2008 of the Prime Minister approving *Plan of Healthcare Network Development till 2010 with a Vision to 2020*.
- (33) Decision 1873/2009/QĐ-BYT dated on 28/5/2009 promulgating *Plan of Environmental Protection in Health Sector in Period from 2009 to 2015*.
- (34) Circular 18/2009/TT-BYT dated on 14/11/2009 by the Ministry of Health *Guiding Implementation of Infection Control Activities in the Healthcare Facilities*.
- (35) Decision 2149/2009/QĐ-TTg dated on 17/12/2009 approving the *National Strategy for Integrated Management of Solid Waste up to 2015 with a Vision to 2050*.
- (36) Decree No. 117/2009/ND-CP dated on 31/12/2009 on Handling of Law Violations in the Domain of Environmental Protection.

### **Environmental design and technical standards/criteria/code**

- (1) TCVN 5939-1999: Air quality- Emission standards for healthcare solid waste incinerator: Allowable limits (This standard became legally binding standards in QCVN 02: 2008/BTNMT).
- (2) TCVN 6707-2000: Prevention and warning signs for hazardous waste.

- (3) TCVN 6705-2000: Non-hazardous solid wastes - Classification.
- (4) TCVN 6706-2000: Hazardous solid wastes - Classification.
- (5) TCVN 6696-2000: Requirements for environmental protection for sanitary landfills.
- (6) TCXDVN 261-2001: Landfill - Standard for designing.
- (7) TCVN 7241-2003: Health care solid waste incinerators-Determination of dusts concentration in flue gas.
- (8) TCXDVN 320-2004: Hazardous waste Landfill - Standard for designing.
- (9) TCVN 7382-2004: Hospital wastewater-Effluent standards.
- (10) TCVN 7380-2004: Healthcare solid waste incinerators- Specifications.
- (11) TCVN 7381-2004: Healthcare solid waste incinerator- Assessment and appraisal methods.
- (12) TCVN 5945-2005: Industrial wastewater- Effluent standards (This standard became legally binding standards in QCVN 24:2009/BTNMT).
- (13) TCXDVIN 365-2007: General hospital design guideline.
- (14) QCVN 02; 2008/BTNMT: National technical regulation on the emission of healthcare solid waste incinerators.
- (15) QCVN 01; 2008/BXD: Vietnam Building Code-Regional and urban planning and rural residential planning.
- (16) QCVN 24:2009/BTNMT: National technical regulation on industrial wastewater.
- (17) QCVN 28:2010/BTNMT: National Technical Regulation on Health Care Wastewater





## Appendix-2: QCVN 02: 2008/BTNMT on National Technical Regulation on the Emission of Healthcare Solid Waste Incinerator

### 1. GENERAL REGULATIONS

#### 1.1. Scope

These national regulations regulate allowable maximum values of pollution parameters of gas emission emitted from solid healthcare waste incinerator.

#### 1.2. Applied subjects

This regulation is applied to state management organization regarding environment, all organizations and individuals manufacturing, importing solid healthcare waste incinerator located in Vietnam territory.

#### 1.3. Explanation of technical terms

### 2. TECHNICAL REGULATIONS

#### 2.1 Allowable limits of emission gas emitted solid healthcare waste incinerator

Allowable limits of emission gas emitted solid healthcare waste incinerator during normal operation do not exceed limits regulated in Table 1

Table 1: List and allowable limits of each pollution parameters

No	Parameter	Chemical formulation	Unit	Allowable limits	Analyzing method
1	Dust		mg/Nm <sup>3</sup>	115	TCVN 7241: 2003
2	Hydrogen fluoride	HF	mg/Nm <sup>3</sup>	2	TCVN 7243 : 2003
3	Hydrogen chloride	HCl	mg/Nm <sup>3</sup>	100	TCVN 7244 : 2003
4	Carbon monoxide	CO	mg/Nm <sup>3</sup>	100	TCVN 7242 : 2003
5	Nitrogen oxide	NO <sub>x</sub>	mg/Nm <sup>3</sup>	250	TCVN 7245 : 2003
6	Sulfur dioxide	SO <sub>2</sub>	mg/Nm <sup>3</sup>	300	TCVN 7246 : 2003
7	Mercury	Hg	mg/Nm <sup>3</sup>	0.55	TCVN 7557-2 : 2005
8	Cadmium	Cd	mg/Nm <sup>3</sup>	0.16	TCVN 7557-3 : 2005
9	Lead	Pb	mg/Nm <sup>3</sup>	1.2	TCVN 7557-3 : 2005
10	Total Dioxin/Furan		Ng – TEQ/Nm <sup>3</sup>	2.3	TCVN 7566-1 : 2005
	Dioxin	C <sub>12</sub> H <sub>8</sub> -NCl <sub>n</sub> O <sub>2</sub>			TCVN 7566-2 : 2005
	Furan	C <sub>12</sub> H <sub>8</sub> -NCl <sub>n</sub> O			TCVN 7566-3 : 2005
	NOTE N: number of Chloride atom N*: 2 ≤ n ≤ 8 TEQ				

#### 2.2. Ash

Ash generated from incineration, flying ashes collected from treatment parts and chimney must be collected and treated as regulations.

### 3. ANALYZING METHODS

3.1. Frequency of sampling and regular measurement of pollution parameters regulated in clause 2.1 follow regulations of authorized organizations, to ensure pollution parameters in emission gas emitted from solid healthcare waste incinerator do not exceed allowable limits

3.2. Analyzing methods of pollutant concentration in emission gas emitted from solid healthcare waste incinerator are complied to following national standards:

TCVN 7241:2003, Solid healthcare waste incinerator – Analyzing methods of dust concentration in emission gas.

TCVN 7242:2003, Solid healthcare waste incinerator – Analyzing methods of carbon monoxide (CO) concentration in emission gas.

TCVN 7243:2003, Solid healthcare waste incinerator – Analyzing methods of acid flohydric (HF) concentration in emission gas.

TCVN 7244: 2003, Solid healthcare waste incinerator – Analyzing methods of acid hydrogen chloride (HCl) concentration in emission gas.

TCVN 7245: 2003, Solid healthcare waste incinerator – Analyzing methods of acid nitrogen oxide (NO<sub>x</sub>) concentration in emission gas.

TCVN 7246: 2003, Solid healthcare waste incinerator – Analyzing methods of sulfur dioxide (SO<sub>2</sub>) concentration in emission gas.

TCVN 7566 - 1: 2005, Solid healthcare waste incinerator – Analyzing methods of PCDD/PCDF concentration – Part 1: Sampling

TCVN 7566 - 2: 2005, Solid healthcare waste incinerator – Analyzing methods of PCDD/PCDF concentration – Part 2: Extracting and cleaning

TCVN 7566 - 3: 2005, Solid healthcare waste incinerator – Analyzing methods of PCDD/PCDF concentration – Part 3: Quantitative and qualitative

TCVN 7557 - 1: 2005, Solid healthcare waste incinerator – Analyzing methods of heavy metal concentration in emission gas- Part 1 : General requirements

TCVN 7557 – 2: 2005, Solid healthcare waste incinerator – Analyzing methods of heavy metal concentration in emission gas- Part 2: Analyzing method of mercury concentration

TCVN 7557 – 3: 2005, Solid healthcare waste incinerator – Analyzing methods of heavy metal concentration in emission gas- Part 3: Analyzing method of cadmium and lead concentration

### 4. IMPLEMENTATION ORGANIZATION

4.1. State management organization regarding environment and all organizations and individuals manufacturing, importing solid healthcare waste incinerator must comply to this national technical

regulations

4.2. Solid healthcare waste incinerators that are in use before the date this national technical regulations come into effect are allowed to apply the limit of nitrogen oxide (NO<sub>x</sub>) of 350 mg/Nm<sup>3</sup> and the limit of cadmium (Cd) of 1 mg/Nm<sup>3</sup> until December 31<sup>st</sup> 2011; from January 1<sup>st</sup> 2012, they must apply the limits regulated in Table 1 of this national technical regulations.

This national technical regulation replace the compulsory Vietnamese standards TCVN 6560:1999 – Air quality – Gas emission of solid healthcare waste incinerator – Allowable limits that was issued in compliance to Decision No 35/2002/QĐ-BKHCNMT dated June 25<sup>th</sup> 2002 of Minister of Science, Technology and Environment.



## Appendix-3: QCVN 28:2010/BTNMT on National Technical Regulation on Healthcare Wastewater

### 1. GENERAL PROVISIONS

#### 1.1. Scope

Regulation stipulates the allowed maximum value of parameters and pollutants in healthcare wastewater of healthcare facilities.

#### 1.2. Targets

This regulation is applicable to organizations and individuals related to the operation of medical waste water discharged into the environment.

#### 1.3. Glossary

In this Regulation, the terms below are construed as follows:

1.3.1. Healthcare wastewater is waste liquid discharged from Examination and Treatment facilities.

1.3.2. Wastewater Receiving Sources are the sources: surface water, coastal waters, drainage systems, where healthcare wastewater discharged into them.

### 2. TECHNICAL REGULATIONS

2.1. Healthcare wastewater must be treated and disinfected before being discharged into the environment.

2.2. Allowed Maximum Value (C<sub>max</sub>) of the parameters and pollutants in healthcare wastewater being discharged into Wastewater Receiving Sources are calculated as follows:

$$C_{max} = C \times K$$

In which:

C is the value of the parameters and the pollutants, as a basis to calculate C<sub>max</sub>, defined in Table 1.

K is the coefficient of the scale and type of healthcare facility, defined in Table 2

For parameters: pH, total coliforms, Salmonella, Shigella and Vibrio Cholera in healthcare wastewater, using K = 1.

**Table 1 - C Value of pollution parameters**

No	Parameters	Unit	C value	
			A	B
1	pH	-	6,5 – 8,5	6,5 – 8,5
2	BOD5 (20oC)	mg/l	30	50
3	COD	mg/l	50	100
4	Total suspended solid substances (TSS)	mg/l	50	100
5	S <sup>2-</sup> (H <sub>2</sub> S)	mg/l	1,0	4,0
6	NH <sub>4</sub> <sup>+</sup> (N)	mg/l	5	10
7	NO <sub>3</sub> <sup>-</sup> (N)	mg/l	30	50
8	PO <sub>4</sub> <sup>3-</sup> (P)	mg/l	6	10
9	Floral and faunal fat	mg/l	10	20
10	Total radian activity α	Bq/l	0,1	0,1
11	Total radian activity β	Bq/l	1,0	1,0

No	Parameters	Unit	C value	
			A	B
12	<i>Total Coliform</i>	MPN/ 100ml	3000	5000
13	<i>Salmonella</i>	Unit/ 100 ml	KPH	KPH
14	<i>Shigella</i>	Unit/ 100ml	KPH	KPH
15	<i>Vibrio cholerae</i>	Unit/ 100ml	KPH	KPH

Notes:

- KPH: No detected
- Parameters (Total radian activity  $\alpha$ , Total radian activity  $\beta$ ) only are applied for healthcare facilities using radioactive source.

In Table 1:

- Column A prescribed C value of the parameters and pollutants as a basis for calculating the allowed maximum value in healthcare wastewater is discharged into water sources used for domestic water supply purposes.
- Column B prescribed C value of the parameters and pollutants as a basis for calculating the allowed maximum value in healthcare wastewater is discharged into water sources no used for domestic water supply purposes.
- Healthcare Wastewater discharged into the sewage system of residential area applies C value specified in column B. In case of healthcare wastewater in collection system leading to the centralized wastewater treatment system must be disinfected, parameters and other contaminants apply in accordance with the principles/regulations of operation & management units of centralized wastewater treatment system.

### 2.3. Value of the coefficient K

**Table 2- Value of the coefficient K**

Types	Scale	K value
Hospitals	$\geq 300$ beds	1,0
	$< 300$ beds	1,2
Other healthcare facilities		1,2

## 3. ANALYSIS METHODS

3.1. Analysis methods of pollution parameters in healthcare wastewater are according to Current Vietnamese Standards as follows:

- TCVN 6492:1999 (ISO 10523:1994) Water quality - Analysis pH;
- TCVN 6001 - 1:2008 Water quality – Analysis (BOD<sub>n</sub>) – Part 1: Dilution method and culturing with adding allylthiourea;
- TCVN 6491:1999 (ISO 6060:1989) Water quality – Analysis (COD);
- TCVN 6625:2000 (ISO 11923:1997) Water quality – Analysis SS by filtering through glass fiber filters;
- TCVN 6637:2000 (ISO 10530:1992) Water quality - Determination of dissolved sulfide - optical method

using Green metylen

- TCVN 5988:1995 (ISO 5664:1984) Water quality - Determination of ammonia by distillation and titration;
- TCVN 6180:1996 (ISO 7890 – 3:1988) - Water quality - Determination of nitrate - spectrometry method using acid sunfosalixylic;
- TCVN 6494:1999 - Water quality - Determination of fluoride ions, chloride, nitrite, Orthophotphat, bromide, nitrate and soluble Sulfate by Ion Liquid Chromatography;
- Determination of total Floral and faunal fat follows US EPA Method 1664 Extraction and gravimetry (Oil and grease and total petroleum hydrocarbons);
- TCVN 6053:1995 Water quality – Measurement of alpha radioactivity in water without salty. Thick source method;
- TCVN 6219:1995 Water quality - Measurement of beta radioactivity in water without salty;
- TCVN 6187 - 1:2009 (ISO 9308 - 1:2000/Cor 1:2007) Water quality - Detection and enumeration of coliform bacteria, heatproof coliform bacteria and Premise Escherichia coli - Part 1 - Membrane filtration method;
- TCVN 6187 - 2:1996 (ISO 9308 - 2:1990) Water quality - Detection and enumeration of coliform bacteria, heatproof coliform bacteria and Premise Escherichia coli - Part 2: Multiple tube method;
- TCVN 4829:2001 Microbiology - General guidance for methods to detect Salmonella;
- SMEWW 9260: 9260 Detection of Pathogenic Bacteria, Standard methods for the Examination of Water and Wastewater;

3.2. Accept the application of the methods determined by the international standards with precision equal to or higher than the national standard. When there is no national standard for determining the parameters specified in this regulation shall apply international standards.

#### 4. IMPLETATION PROVISIONS

4.1. Organizations and individuals related to the operation of Healthcare wastewater discharged into the environment must comply with the provisions of this regulation.

4.2. State management agency on environmental have responsibility to guide, inspect and supervise the implementation of this regulation.

4.3. In the case of national standards cited in Section 3.1. of this Regulation amended, supplemented or replaced shall apply the new version.





#### Appendix-4: Allocation plan of the ENVIRONMENTAL CAREER budget in 2009

Attachment to Decision No.1642/QD-BYT dated on May 13, 2009

No	Units/Tasks	Implementing time	Budget	Notes
1	Da nang C hospital		5,333	
1.1	Building medical wastewater treatment system	2008-2009	833	Transferred from the task of 2008
1.2	Investing Infectious medical waste treatment equipment applying Micro-wave technology combining with autoclave at Danang C hospital	2009 - 2010	4,500	
2	E hospital		2,413	
	Building medical wastewater treatment system at E hospital	2008-2009	2,413	Transferred from the task of 2008
3	Centered pulmonary tuberculosis hospital		4,500	
	Investing Infectious medical waste treatment equipment applying Micro-wave technology combining with autoclave at Centered pulmonary tuberculosis hospital	2009 - 2010	4,500	
4	Centered Otorhinolaryngology hospital		3,400	
	Supporting for building medical wastewater treatment system at Centered Otorhinolaryngology hospital	2009 - 2010	3,400	
5	Quy Hoa National Leprosy Dermatology hospital		2,500	
	Building medical wastewater treatment system at Quy Hoa National Leprosy Dermatology hospital	2009 - 2010	2,500	
6	K hospital		2,000	
	Building Medical waste collection & treatment system of K hospital at the facility "Tam Hiep"	2009 - 2010		
7	Hanoi University of Pharmacy		256	
	Installing, replacing exhausted fumes system of 4 chemical subjects at Hanoi University of Pharmacy	2008-2009	256	Transferred from the task of 2008
8	National institute of Medicine Test		613	
	Improving, upgrading wastewater and exhausted gas treatment system at site I- National institute of Medicine Test	2008-2009	613	Transferred from the task of 2008
9	Bach Mai hospital		200	
	Supporting for building medical waste treatment system at Bach Mai hospital	2009	200	
10	Medical Equipment & Project Department		500	
	Building medical wastewater treatment Projects for hospitals at centered level.	2009	500	
11	National institute of occupational & Environmental Health		7,184	
11.1	Buiding Hospital Environmental Monitoring Program in period 2009 - 2015	2008-2009	180	Transferred from the task of 2008
11.2	Study on Medical Waste Treatment Process which has be able to recycle	2008-2009	619	Transferred from the task of 2008
11.3	Investigating the current status of medical waste management and treatment at units belonging to health preventive system & proposing Countermeasure aiming to minimize pollution	2008-2009	585	Transferred from the task of 2008
11.4	Monitoring and analyzing Environment in Health sector at North areas in 2009	2009	1,900	
11.5	Enhancing Environmental monitoring capacity in Health sector at North areas	2009	1,900	
11.6	Implementing the task of monitoring – analyzing occupational medium and enhancing capacity in 2009	2009	600	
11.7	Evaluating the current status of medical waste management and treatment at private health units and proposing Countermeasures aiming to minimize pollution	2009-2010	350	
11.8	Establising Economic-Technic norm in medical waste	2009	700	

	management & treatment activities			
11.9	Buiding Hosptial Environmental CODEs	2009	350	
12	Nha Trang Pasteur Institue		3,100	
12.1	Monitoring and analyzing Environment in Health sector at Central and Tay Nguyen areas in 2009	2009	1,100	
12.2	Enhancing Environmental monitoring capacity in Health sector at Central and Tay Nguyen areas in 2009	2009	2,000	
13	Hochiminh Institue of Hygienic and Public Health		2,510	
13.1	Monitoring and analyzing Environment in Health sector at South areas in 2009	2009	600	
13.2	Enhancing Environmental monitoring capacity in Health sector at South areas in 2009	2009	1,500	
13.3	Surveying Arsenic Pollution level in water surface at 9 provinces belonging to Mekong delta	2009	410	
14	Department of management of examining and treating medically		500	
	Enhancing State managment capacity on medical waste at hosptial	2009-2010	500	
15	Department of Phamarceutial management			
	Study on the current status of medical waste management and proposing countermeasures for waste management at Units producing medicine in Vietnam	2008-2009	230	Transferred from the task of 2008
16	General Department of Preventive Medicine and Environment		2,994	
16.1	Building Evaluation process of Public health state relating to Industrial environment pollution	2008-2009	550	Transferred from the task of 2008
16.2	Evaluating the influent level of using water sources polluted Arsenic on residents' health at 10 communes belonging to Hanoi, Hanam, Hungyen, Tiengiang, Dongthap.	2008-2009	135	Transferred from the task of 2008
16.3	Establishing Guidlines of medical waste managment for health stations at commune level	2009-2010	500	
16.4	PR activities, Training course on technical points, seminar, checking and monitoring, appraising, Checking and taking over Environmental protection tasks and other activities so as to serve environmental managment in Health sector	2009		
-	Organizing Seminar, training course on technical points about environmental protection in Health sector	2009	270	
-	Regularly Establishing 01 page about environmental protection in Health sector for Newspaper "Health & Life"	2009	130	
-	Establishing and printing guide book about medical waste management and Healthy impact assessment	2009	500	
-	Establishing Rules on managing tasks, projects, plans of environmental protection which uses environmental career budget managed by MOH directly	2009	10	
-	Checking, monitoring, appraising, checking and taking over Environmental protection tasks	2009	730	
-	Stationery, contacting, photocopy and other activities for environmental management in Health sector	2009	169	
17	Vietnam Food Administration		148	
17.1	Evaluating The current status of generating waste and affecting on public health of one village specially in slaughtering dogs	2008-2009	18	Transferred from the task of 2008
17.2	Evaluating the state of waste source, safe-hygienic food administration level at food shops on pavement at 7 pointed wards in Hanoi city	2008-2009	130	Transferred from the task of 2008
18	Hanoi Medical University		1,860	
18.1	Evaluating the state of environmental pollution and public health at some areas which are high pottential hazards at Hatay province and Proposing countermeasures for minimizing.	2008-2009	793	Transferred from the task of 2008

18.2	Evaluating the state of environmental pollution and public health at Bien Hoa and Sai Dong industrial parks	2008-2009	347	Transferred from the task of 2008
18.3	Determining Parasitic pathogens in vegetable and aqua-products used wastewater of some North cities and rurals causing the diseases for Human	2008-2009	720	Transferred from the task of 2008
19	Thai Binh Medical University		400	
	Establishing intervention model to reduce environmental pollution caused by food processing units at household scale in Red River Delta's rural areas.	2009-2010	400	
Total			40,641	



## Appendix-5: Questionnaire sheets

### Appendix 5-1: Questionnaire Sheet on Medical Waste and Wastewater Management in the hospital

#### 1. General Information on the Hospital

1.1 Name of the hospital: \_\_\_\_\_

1.2 Name, position and department of the respondent of this questionnaire:

\_\_\_\_\_

1.3 No. of the bed: Nominal \_\_\_\_\_ ; Actual \_\_\_\_\_

1.4 No. of the staff

	a. Full-time	b. Part-time	c. Sub-total
a. Administration			
b. Physician			
c. Nurse			
d. Medical technician			
e. Others			
f. Total			

1.5 Average number of patients and operation (Please clarify daily, monthly or annually)

a. In-patients: \_\_\_\_\_

b. Out-patients: \_\_\_\_\_

c. Number of minor operation: \_\_\_\_\_

d. Number of operation: \_\_\_\_\_

e. Number of testing: \_\_\_\_\_

1.6 Please provide written information on the following items:

a. Organization of the hospital

b. History of the hospital

c. Plan view of the hospital

d. Budget (income/expenditure) in 2008 or 2009

1.7 Inundation experience around the hospital in the last 10 years: Yes/No

If Yes, how much was the record high water level and its year:

1.8 If you have or had a cooperation projects by other donors in the area of waste and wastewater management system, please specify.

Name of the donor:

Year of the project:

Content of project:

Amount of resources:

## 2. Medical Waste Management

2.1 Department in charge of waste management: \_\_\_\_\_

2.2 Please fill up the average amounts of wastes by the following categorization based on the recent record.

Medical waste			Amount*	
Hazardous medical waste	Infectious waste	Sharps (Category A)		
		Non-sharps (Category B)		
		Highly infectious (Category C)		
		Anatomical (Category D)		
		Sub-total		
	Chemicals	Pharmaceutical		
		Hazardous chemicals		
		Cytotoxic waste		
		Heavy metal		
		Sub-total		
	Radioactive waste			
	Pressurized container			
	Non-hazardous healthcare waste	General waste regarded as household waste		

Note: \* Please specify the unit such as kg/day or liter/day.

2.3 Practices of waste segregation at source and on-site transportation

a. Sharp items are separated: Yes/No

If Yes, which container is used (please tick);

- Regulated carton boxes
- PET bottles/Plastic bins/Metal canes
- Other carton boxes
- Others:

b. Bags used for waste segregation

Which color is used for:

Infectious waste: \_\_\_\_\_

Other hazardous waste: \_\_\_\_\_

Domestic waste: \_\_\_\_\_

Recyclables: \_\_\_\_\_

c. Tools for on-site transportation of waste and their number

Handcart: \_\_\_\_\_

Wheeled bin: \_\_\_\_\_

Other: \_\_\_\_\_

2.4 Temporal waste storage for hazardous medical waste (Select one)

a. Storage room with air conditioning and ventilation

b. Storage room without air conditioning or ventilation

c. Storage room shared with other usage

d. No storage room

2.5 Please tick any ways you carry out to treat/dispose of your wastes categorized in the table.

Medical waste	Technology								
	On-site							Off-site	
	Incineration	Needle destruction	Autoclave	Microwave	Chemical disinfection	Neutralization/Inertization/Stabilization	Pit burial/Cemetery	Return to supplier	Others
Sharps (Category A)									
Non-sharps (Category B)									
Highly infectious (Category C)									
Anatomical (Category D)									
Pharmaceutical									
Hazardous chemicals									
Cytotoxic waste									
Heavy metal									
Radioactive waste									
Pressurized container									
General waste regarded as household waste									

2.5 If you use any of following technologies for treatment/disposal of waste, please fill up the following Table.

Technology	Supplier or manufacturer name	Year of installation	Nominal capacity (kg/hr or other unit)	Actual amount of treatment (kg/hr or other unit)	Operation time (hours/day or days/week)	Initial investment cost (VND or US\$)
Incinerator						
Autoclave						
Microwave						
Built-in chemical disinfection device						

2.6 If you contract out your waste treatment/disposal off-site, how much do you pay for it ?

Waste type	Unit fee (including transportation cost) (VND/ton or VND/m3)	Frequency of transportation
Hazardous medical waste		
Non-hazardous medical waste		
Treatment residue		

2.7 Please fill up the number of waste management workers and staffs

	Hospital staff	Contractor	Total
Manager			
Waste collection			
Waste treatment			

2.8 Please fill up annual expenditure of waste management (in 2009 or 2008)

	Items	Cost (VND/year or month)
Discharge and storage	Purchase of plastic bags	
	Purchase of containers	
	Purchase of handcart or trolley	
On-site treatment	Utility (electricity, water, gas, etc)	
	Consumables (Chemicals, tool, etc.)	
	Spare parts	
	Wage of workers	
	Off-site treatment (of residue and non-hazardous healthcare waste)	
	Other expenditure	
Off-site treatment	Hazardous healthcare waste	



	Non-hazardous healthcare waste	
	Wages of workers	
	Other expenditure	

2.9 If you operate incinerator:

- a. Frequency of flue gas analysis: \_\_\_\_\_
- b. Fee for flue gas analysis: \_\_\_\_\_
- c. Name of institute or company for flue gas analysis:  
\_\_\_\_\_

**3. Wastewater management**

3.1 Department in charge of wastewater management: \_\_\_\_\_

3.2 Do you have wastewater treatment system? (Select one)

- a. Yes, we have.
- b. Yes, we have. But it does not work (we don't operate).
- c. No, we don't have.(Go to Question 3.7 and 3.8)

3.3 Year of installation (If upgraded or expanded, please clarify them also):

Initial installation: \_\_\_\_\_

Upgrade or expansion: \_\_\_\_\_

3.4 Technology of current wastewater treatment system and process flow

a. Wastewater treatment technology (generic name):

\_\_\_\_\_

b. Brief description of process flow:

(Example: Influent →Grit remover→Sedimentation→Aeration→Coagulation /Sedimentation→Disinfection→Effluent)

c. Capacity of wastewater treatment system

Total amount of wastewater generation: \_\_\_\_\_ m<sup>3</sup>/day

Nominal capacity of the system: \_\_\_\_\_ m<sup>3</sup>/day

Actual capacity of the system: \_\_\_\_\_ m<sup>3</sup>/day

d. Initial investment cost

Cost items	Cost (VND)
Construction (Civil work)	
Equipment and accessory	
Consultancy	
Project management	
Others	
Total	

3.5 (For those who selected b. in Question 3.2) please select the reason(s) why the system does not work.

- a. The system is malfunctioned (and can't be fixed).
- b. Effluent quality does not meet effluent standards.
- c. Wastewater amount is over the capacity of the system.
- d. We don't have enough budget to operate the system.
- e. We don't have technical staff to operate the system.

(Go to Question 3.8)

3.6 Operation and maintenance of the system

a. Operation and maintenance cost

Items	Cost (VND/year or month)
Utility (electricity, water, gas, etc)	
Consumables (Chemicals, tool, etc.)	
Spare parts	
Wage of workers	
Off-site treatment of sludge	
Other expenditure	
Total	

b. Sludge withdrawal

Frequency of sludge withdrawal: \_\_\_\_\_ times/month or year

Average amount of sludge withdrawn per time: \_\_\_\_\_ m<sup>3</sup>

Treatment/disposal of sludge (on-site or off-site) : \_\_\_\_\_

c. Please fill up the number of wastewater treatment workers and staffs

	Hospital staff	Contractor	Total
Manager			

Wastewater treatment facility operator			
Other task			

3.7 Effluent analysis (Water quality analysis)

- a. Frequency of effluent analysis: \_\_\_\_\_
- b. Fee for effluent analysis: \_\_\_\_\_
- c. Name of institute or company for effluent analysis:  
\_\_\_\_\_

d. Please attach the recent results of effluent analysis.

3.8 Do you have separate treatment system for the following liquid wastes?.

- a. Yes, we have.

Liquid wastes	Treatment technology (please specify)
Acid or Alkali	
Organic solvent	
Heavy metals containing liquid	
Photochemical	
Disinfectants/Formalin	
Radio active/isotope	
Others (please specify)	

- b. No, we don't have. We mix them with other wastewater.
- c. No, we don't have but contract out for a treatment.
- d. No, we don't have because we don't generate such liquid wastes.

**4. Training and awareness raising activities**

4.1 Training and awareness raising activity

- a. Please tick activities in the following table you carry out to raise awareness of healthcare waste and wastewater management for hospital staffs. (Multiple selection)

Activities or methods	
<input type="checkbox"/>	Leaflet or poster for waste segregation in the hospital
<input type="checkbox"/>	Periodical campaign for a proper waste and wastewater management in the hospital
<input type="checkbox"/>	Holding workshop or seminar on waste and wastewater management in the hospital
<input type="checkbox"/>	Participation on workshop or seminar outside hospital
<input type="checkbox"/>	Task force or committee formation to enhance a proper waste and wastewater

	management in the hospital
	Having own training/educational program in the hospital
	Others (Please specify: _____ )
	Not particular

- b. Please tick activities in the following table you carry out to improve capability of waste and wastewater management workers. (Multiple selection)

Activities or methods	
	Periodical training/education for occupational safety and measures for incidents
	Periodical training for waste or wastewater handling method
	Participation on workshop or seminar outside hospital
	Manual preparation for safe waste and wastewater handling
	Others (Please specify: _____ )
	Not particular

EOF

## Appendix 5-2: Awareness survey of medical staffs in specific departments in the hospitals/institutes

Health-care waste management • Rapid assessment tool			
<b>1 General</b>			
100	Health care facility:		
101	Name of interviewee and position:		
102	Name of the chief of the department:		
103	Contact tel number:		
104	Contact E-mail:		
n°	topic	data	comments / multiple choice
<b>2 System</b>			
201	Do you know there are several regulation (degree, decision, etc.) about medical waste?		[1] yes; [2] no;
202	If yes, when did you know that?		[1] since when I learnt at school; [2] since when I started to work here; [3] at in-service training; [4] oneday by someone; [5]other
203	Do you know there is a system about medical waste in your hospital?		[1] yes; [2] no;
204	If yes, when did you know that?		[1] since when I learnt at school; [2] since when I started to work here; [3] at in-service training; [4] oneday by someone; [5]other
205	Have you ever seen the manual about the medical waste treatment?		[1] yes; [2] no;
<b>3 Management</b>			
301	Have you ever discuss about the infection control in your work place (department)?		[1] yes; [2] no;
302	If yes, when did you do that?		[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5]other
303	Have you ever discuss about the medical waste management in your work place (department)?		[1] yes; [2] no;
304	If yes, when did you do that?		[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5]other
305	Have you ever instructed about the medical waste treatment by the hospital?		[1] yes; [2] no;
306	Have you ever received the in-service training including the medical waste treatment?		[1] yes; [2] no;
307	If yes, when did you learn it?		[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5]other
308	Have you ever instructed how to deal with biohazard and occupational accidents by the hospital?		[1] yes; [2] no;

309	Do you know who is responsible for infection control and medical waste management in your work place?		[1] yes; [2] no;
310	Do you know to whom accidents happen in your work place?		[1] yes; [2] no;
311	Have you ever seen the manual dealing with biohazard and occupational accidents at your work place?		[1] yes; [2] no;
<b>4 Existing Problem</b>			
401	Have you ever met the disaster (flood or any kind of medical risk) on your duty?		[1] yes; [2] no;
402	Have you ever felt the danger of disease infection on your duty?		[1] yes; [2] no;
403	When did it happen?		(multiple choice) [1] cut fingers by sharps; [2] sticked fingers by needle; [3] touched danger blood ; [4] touched danger medical substance; [5] other ( )
404	Do you know what substances are dangerous at your work place?		Open question:
405	If yes, do you know how are they dangerous?		Open question:
406	Do you think your work place is messy by wastes?		[1] yes; [2] no;
407	Have you ever seen the disposal bag was mixed with different kinds of waste?		[1] yes; [2] no;
408	Have you ever seen your colleague throwed waste into the wrong box?		[1] yes; [2] no;
409	Have you ever throw medical waste into the wrong box by mistake?		[1] yes; [2] no;
410	Have you ever put into your hands into the medical waste box to find what you missing?		[1] yes; [2] no;
<b>5 Personal Awareness</b>			
501	Do you think there is a risk to be infected by disease because of your occupation?		[1] yes; [2] no;
502	Do you pay attention not to be infected by disease your duty?		[1] yes; [2] no;
503	If yes, what do you do to avoid to be infected?		(multiple choice) [1] follow guidelines; [2] put gloves; [3] wash hands; [4] rinse mouth; [5] other ( )
504	Do you want to know about your risk about the infection control?		[1] yes; [2] no;

505	Do you think there is a link between the infection control and medical waste?		[1] yes; [2] no;
506	Do you want to know about medical waste treatment to avoid your risk?		[1] yes; [2] no;
507	Do you feel is there necessary to be discuss about medical waste treatment in your work place more often?		[1] yes; [2] no;
508	Do you feel is there necessary to be discuss about infection control in your work place more often?		[1] yes; [2] no;
<b>6 Personal Effort</b>			
601	Do you try to keep your work environment tidy?		[1] yes; [2] no;
602	Do you try to keep the rule of segregation of medical waste not only yourself but also to your colleagues?		[1] yes; [2] no;
603	Do you try to pay attention to keep your work environment clean?		[1] yes; [2] no;
604	If so, what do you do?		(multiple choice) [1] pick up trash on the floor; [2] wipe tables; [3] keep materials in order; [4] mark danger materials; [5] other ( )
<b>7 Personal expectations</b>			
701	Do you prefer that your work place much cleaner?		[1] yes; [2] no;
702	Do you want to learn more about risk management?		[1] yes; [2] no;
703	Do you want others to learn more about the infection control issue, because you feel they don't know it?		[1] yes; [2] no;
704	Do you want others to learn more about the medical waste management issue, because you feel they don't know it??		[1] yes; [2] no;
705	Do you want to share your knowledge about infection control and medical waste management to others?		[1] yes; [2] no;
706	Do you wish that the hospital will provide more information about waste management to patients and their family?		[1] yes; [2] no;

**Appendix 5-3: Awareness survey of non-medical staffs in specific departments in the hospitals/institutes**

Health-care waste management • Rapid assessment tool		
n°	topic	comments / multiple choice
<b>1 General</b>		
100	Health care facility:	
101	Name of interviewee and position:	
102	Name of the chief of the department:	
103	Contact tel number:	
104	Contact E-mail:	
n°	topic	data
<b>3 Management</b>		
305	Have you ever instructed about the medical waste treatment by the hospital?	[1] yes; [2] no;
306	Have you ever received the in-service training including the medical waste treatment?	[1] yes; [2] no;
307	If yes, when did you learn it?	[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other
308	Have you ever instructed how to deal with biohazard and occupational accidents by the hospital?	[1] yes; [2] no;
309	Do you know who is responsible for infection control and medical waste management in your work place?	[1] yes; [2] no;
310	Do you know to whom when accidents happen in your work place?	[1] yes; [2] no;
<b>4 Existing Problem</b>		
401	Have you ever met the disaster (flood or any kind of medical risk) on your duty?	[1] yes; [2] no;
402	Have you ever felt the danger of disease infection on your duty?	[1] yes; [2] no;
403	If yes, when did it happen?	(multiple choice) [1] cut fingers by sharps; [2] sticked fingers by needle; [3] touched danger blood ; [4] touched danger medical substance; [5] other ( )
404	Do you know what substances are dangerous at your work place?	Open question:
405	If yes, do you know how are they dangerous?	Open question:



n°	topic	data	comments / multiple choice
<b>5 Personal Awareness</b>			
501	Do you think there is a risk to be infected by disease because of your occupation?		[1] yes; [2] no;
502	Do you pay attention not to be infected by disease your duty?		[1] yes; [2] no;
503	If yes, what do you do to avoid to be infected?		(multiple choice) [1] follow guidelines; [2] put gloves; [3] wash hands; [4] rinse mouth; [5] other ( )
504	Do you want to know about your risk about the infection control?		[1] yes; [2] no;
505	Do you think there is a link between the infection control and medical waste?		[1] yes; [2] no;
506	Do you want to know about medical waste treatment to avoid your risk?		[1] yes; [2] no;

## Appendix 5-4: Awareness survey of residents on Medical Waste and Waste water management

Note: These questionnaires are directed to residents living in the vicinity of hospitals.

1. What is your profession?
  - (a) Housewife
  - (b) Student
  - (c) Shop owner
  - (d) Office worker
  - (e) Retired
  - (f) Others: \_\_\_\_\_
2. How long are you living at current address?
  - (a) Less than 5 years.
  - (b) 5~10 years
  - (c) More than 10 years
3. Have you ever experienced inundation around your house? (a)Yes, (b)No
4. If Yes, when it was and what is the highest depth of water? (a)Below knee, (b)Above knee
5. Have you ever received the instructions/notices by the hospital on the prevention of epidemical spread after disasters such as floods and/or there have any construction activities in the hospital? (a)Yes, (b)No
6. Have you ever seen scattered medical waste around hospital? (a)Yes, (b)No
7. Have you ever seen smoke generated from hospitals incinerator? (a)Yes, (b)No
8. Have you ever suffered from a bad smell (such as burnt smell or offensive odor) from hospital? (a)Yes, (b)No
9. If Yes, how often were you bothered by that bad smell from hospital?
  - (a) Every day
  - (b) Often
  - (c) Sometimes
10. Have you ever seen drops or leakage of waste from waste collection vehicles that transport medical waste? (a)Yes (b)No
11. If Yes, how often did you see them?
  - (a) Every day
  - (b) Often
  - (c) Sometimes
12. Have you ever seen flying foam or droplet from wastewater treatment facility at hospitals? (a)Yes, (b) No
13. If Yes, how often did you see them?
  - (a) Every day
  - (b) Often
  - (c) Sometimes

**Appendix-6: Results of awareness survey of medical staffs in hospitals**

**Results of awareness survey in terms of system**

System	National Lung Hospital					National Hospital of Ophthalmology					National Hospital of Acupuncture					National Hospital of Endocrinology					Remark										
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]		[1]	[2]	[3]	[4]	[5]					
Do you know there are several regulation (degree, decision, etc.) about medical waste?	88%	13%				0%	100%	0%			0%	100%	0%			0%	80%	20%			0%	80%	20%			0%					[1] yes; [2] no;
If yes, when did you know that?	31%	13%	50%	0%	0%	0%	30%	20%	50%	0%	0%	38%	38%	0%	0%	0%	40%	30%	50%	0%	10%	40%	30%	50%	0%	0%					[1] since when I learnt at school; [2] since when I started to work here; [3] at in-service training; [4] oneday by someone; [5] other
Do you know there is a system about medical waste in your hospital?	100%					0%	100%				0%	100%				0%	90%	10%			0%	90%	10%			0%					[1] yes; [2] no;
If yes, when did you know that?	0%	56%	44%			0%	10%	30%	60%		0%	0%	75%	38%	0%	0%	10%	40%	40%	20%	0%	10%	40%	40%	20%	0%					[1] since when I learnt at school; [2] since when I started to work here; [3] at in-service training; [4] oneday by someone; [5] other
Have you ever seen the manual about the medical waste treatment?	100%					0%	100%				0%	100%				0%	100%				0%	100%				0%					[1] yes; [2] no;

System	National Institute of Gerontology					National Hospital of Dermatology					Bach Mai hospital					Hue Central Hospital					Cho Ray Hospital					Remark										
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]		[1]	[2]	[3]	[4]	[5]					
Do you know there are several regulation (degree, decision, etc.) about medical waste?	88%	13%				0%	77%	23%			0%	88%	13%			0%	88%	13%			0%	100%	0%			0%	100%	0%			0%					0% [1] yes; [2] no;
If yes, when did you know that?	50%	50%	0%	0%	0%	0%	15%	8%	8%	23%	0%	5%	14%	5%	45%	0%	19%	44%	0%	0%	0%	21%	21%	68%	0%	0%	21%	21%	68%	0%	0%					[1] since when I learnt at school; [2] since when I started to work here; [3] at in-service training; [4] oneday by someone; [5] other
Do you know there is a system about medical waste in your hospital?	100%					0%	92%				0%	100%				0%	100%				0%	100%				0%	100%				0%					0% [1] yes; [2] no;
If yes, when did you know that?	13%	75%	13%	0%	0%	0%	38%	38%	0%	8%	0%	9%	5%	0%	36%	0%	69%	31%	0%	0%	0%	47%	47%	47%	0%	0%	47%	47%	47%	0%	0%					[1] since when I learnt at school; [2] since when I started to work here; [3] at in-service training; [4] oneday by someone; [5] other
Have you ever seen the manual about the medical waste treatment?	100%					0%	62%				0%	88%				5%	88%				13%	84%	16%			0%	84%	16%			0%					0% [1] yes; [2] no;

### The results of Awareness survey in terms of management

Management	National Lung Hospital					National Hospital of Ophthalmology					National Hospital of Acupuncture					National Hospital of Endocrinology					Remark						
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]		[1]	[2]	[3]	[4]	[5]	
Have you ever discuss about the infection control in your work place (department)?	100%	0%	/	/	/	0%	100%	0%	/	/	0%	0%	/	/	/	70%	30%	/	/	/	0%	70%	30%	/	/	/	0% [1] yes; [2] no;
If yes, when did you do that?	25%	44%	0%	0%	31%	0%	20%	60%	0%	20%	0%	25%	75%	0%	0%	10%	30%	0%	0%	40%	20%	30%	0%	0%	20%	[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other	
Have you ever discuss about the medical waste management in your work places (department)?	88%	13%	/	/	/	0%	100%	0%	/	/	0%	100%	0%	/	/	80%	20%	/	/	/	0%	80%	20%	/	/	0% [1] yes; [2] no;	
If yes, when did you do that?	31%	50%	0%	0%	13%	6%	40%	40%	0%	20%	0%	25%	75%	0%	0%	20%	20%	0%	0%	50%	20%	20%	0%	0%	10%	[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other	
Have you ever instructed about the medical waste treatment by the hospital?	94%	6%	/	/	/	0%	100%	0%	/	/	0%	100%	0%	/	/	80%	20%	/	/	/	0%	80%	20%	/	/	0% [1] yes; [2] no;	
Have you ever received the in-service training including the medical waste treatment?	100%	0%	/	/	/	0%	90%	10%	/	/	0%	100%	0%	/	/	70%	30%	/	/	/	0%	70%	30%	/	/	0% [1] yes; [2] no;	
If yes, when did you learn it?	13%	88%	0%	0%	0%	0%	20%	30%	10%	30%	0%	25%	63%	0%	13%	0%	20%	20%	0%	30%	0%	20%	20%	0%	30%	[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other	
Have you ever instructed how to deal with biohazard and occupational accidents by the hospital?	94%	6%	/	/	/	0%	80%	20%	/	/	0%	100%	0%	/	/	60%	40%	/	/	/	0%	60%	40%	/	/	0% [1] yes; [2] no;	
Do you know who is responsible for infection control and medical waste management in your work place?	100%	0%	/	/	/	0%	100%	0%	/	/	0%	100%	0%	/	/	100%	0%	/	/	/	0%	100%	0%	/	/	0% [1] yes; [2] no;	
Do you know to whom when accidents happen in your work place?	100%	0%	/	/	/	0%	100%	0%	/	/	0%	100%	0%	/	/	100%	0%	/	/	/	0%	100%	0%	/	/	0% [1] yes; [2] no;	
Have you ever seen the manual dealing with biohazard and occupational accidents at your work place?	100%	0%	/	/	/	0%	80%	20%	/	/	0%	100%	0%	/	/	70%	30%	/	/	/	0%	70%	30%	/	/	0% [1] yes; [2] no;	

Management	National Institute of Gerontology					National Hospital of Dermatology					Bach Mai hospital					Hue Central Hospital					Cho Ray Hospital					Remark	
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]		
Have you ever discuss about the infection control in your work place (department)?	100%	0%				0%	0%				0%	94%	6%			0%	84%	16%			0%	16%				0%	[1] yes; [2] no;
If yes, when did you do that?	13%	50%	25%	0%	13%	0%	0%	8%	0%	0%	5%	19%	38%	6%	18%	5%	21%	16%	5%	42%	16%	5%	0%			[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other	
Have you ever discuss about the medical waste management in your work place (department)?	88%	13%				0%	8%				0%	100%	0%			0%	74%	26%			0%	[1] yes; [2] no;					
If yes, when did you do that?	13%	50%	25%	0%	13%	0%	8%	0%	8%	8%	9%	36%	9%	0%	32%	0%	26%	0%	16%	37%	26%	0%	0%			[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other	
Have you ever instructed about the medical waste treatment by the hospital?	88%	13%				0%	0%				0%	82%	9%			0%	100%	0%			0%	[1] yes; [2] no;					
Have you ever received the in-service training including the medical waste treatment?	100%	0%				31%	8%				0%	91%	9%			0%	89%	11%			0%	[1] yes; [2] no;					
If yes, when did you learn it?	13%	50%	38%	0%	0%	8%	31%	8%	8%	8%	18%	32%	9%	9%	14%	0%	0%	26%	5%	37%	11%	5%	26%			[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other	
Have you ever instructed how to deal with biohazard and occupational accidents by the hospital?	88%	13%				0%	8%				0%	73%	27%			0%	79%	21%			0%	[1] yes; [2] no;					
Do you know who is responsible for infection control and medical waste management in your work place?	88%	13%				0%	0%				0%	91%	9%			0%	95%	5%			0%	[1] yes; [2] no;					
Do you know to whom when accidents happen in your work place?	88%	13%				0%	8%				0%	82%	5%			0%	95%	5%			0%	[1] yes; [2] no;					
Have you ever seen the manual dealing with biohazard and occupational accidents at your work place?	75%	25%				0%	15%				0%	68%	27%			0%	74%	26%			0%	[1] yes; [2] no;					

## Results of Awareness survey in terms of Existing Problem

Existing Problem	National Lung Hospital					National Hospital of Ophthalmology					National Hospital of Acupuncture					National Hospital of Endocrinology					Remark						
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]		[1]	[2]	[3]	[4]	[5]	
Have you ever met the disaster (flood or any kind of medical risk) on your duty?	81%	19%				0%	40%	60%			0%	100%	0%			0%	60%	40%			0%	60%	40%			0%	[1] yes; [2] no;
Have you ever felt the danger of disease infection on your duty?	81%	19%				0%	100%	0%			0%	100%	0%			0%	80%	20%			0%	80%	20%			0%	[1] yes; [2] no;
When did it happen?	44%	50%	25%	44%	13%	19%					0%	60%	70%	60%	0%	38%	100%	63%	50%	0%	0%	20%	60%	30%	30%	20%	(multiple choice) [1] cut fingers by sharps; [2] stuck fingers by needle; [3] touched danger blood ; [4] touched danger medical substances; [5] Other ( )
Do you know what substances are dangerous at your work place?							Blood, body fluids, sputum, disease sample, bacterium, chemical					Blood, body fluids, antibiotic, X-ray, sharp objects, pus, chemical				hepatitis B, C virus, HIV, Medical waste & general waste, infectious blood, formaldehyde, chemical						chemical, X-ray, blood, injection instrument, body fluid, sharps					Open question:
Id yes, do you know how are they dangerous?							Contamination, occupational diseases					contamination				contamination, allergy, toxic, high risk of infectious diseases						contamination, affect genes, burn, exposure to diseases					Open question:
Do you think your work place is messy by wastes?	13%	88%				0%					30%	70%				88%	13%				70%	20%					[1] yes; [2] no;
Have you ever seen the disposal bag was mixed with different kinds of waste?	50%					0%	50%				90%	10%				75%	25%				90%	0%					[1] yes; [2] no;
Have you ever seen your colleague throwed waste into the wrong box?	69%					0%	31%				100%	0%				63%	38%				80%	10%					[1] yes; [2] no;
Have you ever throw medical waste into the wrong box by mistake?	63%					0%	38%				0%	100%				50%	50%				80%	10%					[1] yes; [2] no;
Have you ever put into your hands into the medical waste box to find what you missing?	13%					0%	88%				30%	70%				0%	100%				0%	80%					[1] yes; [2] no;



### Results of Awareness survey in terms of Personal Awareness

Personal Awareness	National Lung Hospital					National Hospital of Ophthalmology					National Hospital of Acupuncture					National Hospital of Endocrinology					Remark						
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]		[1]	[2]	[3]	[4]	[5]	
Do you think there is a risk to be infected by disease because of your occupation?	100%	0%				100%	0%				0%	100%	0%			90%	0%				10%	0%				10%	[1] yes; [2] no;
Do you pay attention not to be infected by disease your duty?	100%	0%				100%	0%				0%	100%	0%			80%	10%				10%	10%				10%	[1] yes; [2] no;
If yes, what do you do to avoid to be infected?	88%	75%	69%	38%	0%	70%	100%	100%	60%	50%	0%	75%	100%	100%	38%	13%	40%	50%	20%	10%	10%	50%	50%	10%	10%	10%	(multiple choice) [1] follow guidelines; [2] put gloves; [3] wash hands; [4] rinse mouth; [5] Other ( )
Do you want to know about your risk about the infection control?	100%	0%				100%	0%				0%	100%	0%			80%	10%				10%	10%				10%	[1] yes; [2] no;
Do you think there is a link between the infection control and medical waste?	100%	0%				100%	0%				0%	100%	0%			90%	0%				10%	0%				10%	[1] yes; [2] no;
Do you want to know about medical waste treatment to avoid your risk?	100%	0%				100%	0%				0%	100%	0%			80%	10%				10%	10%				10%	[1] yes; [2] no;
Do you feel is there necessary to be discuss about medical waste treatment in your work place more often?	100%	0%				100%	0%				0%	100%	0%			90%	0%				10%	0%				10%	[1] yes; [2] no;
Do you feel is there necessary to be discuss about infection control in your work place more often?	100%	0%				100%	0%				0%	100%	0%			90%	0%				10%	0%				10%	[1] yes; [2] no;



Personal Awareness	National Institute of Gerontology					National Hospital of Dermatology					Bach Mai hospital					Hue Central Hospital					Cho Ray Hospital					Remark					
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]						
Do you think there is a risk to be infected by disease because of your occupation?	75%	25%				0%	31%	69%			0%	95%	0%			5%	88%	13%			0%	100%	0%			0%	100%	0%			0% [1] yes; [2] no;
Do you pay attention not to be infected by disease your duty?	88%	13%				0%	92%	8%			0%	95%	0%			5%	100%	0%			0%	95%	5%			0%	100%	0%			0% [1] yes; [2] no;
If yes, what do you do to avoid to be infected?	88%	63%	50%	13%		0%	85%	85%	38%	0%	0%	86%	73%	68%	14%	5%	44%	50%	44%	31%	0%	74%	84%	26%	11%	0%	84%	84%	26%	11%	(multiple choice) [1] follow guidelines; [2] put gloves; [3] wash hands; [4] rinse mouth; [5] Other ( )
Do you want to know about your risk about the infection control?	100%	0%				0%	100%	0%			0%	91%	5%			5%	100%	0%			0%	100%	0%			0%	100%	0%			0% [1] yes; [2] no;
Do you think there is a link between the infection control and medical waste?	88%	13%				0%	100%	0%			0%	100%	0%			0%	100%	0%			0%	89%	11%			0%	100%	0%			0% [1] yes; [2] no;
Do you want to know about medical waste treatment to avoid your risk?	100%	0%				0%	77%	23%			0%	95%	5%			0%	100%	0%			0%	100%	0%			0%	100%	0%			0% [1] yes; [2] no;
Do you feel is there necessary to be discuss about medical waste treatment in your work place more often?	100%	0%				0%	100%	0%			0%	82%	18%			0%	100%	0%			0%	100%	0%			0%	100%	0%			0% [1] yes; [2] no;
Do you feel is there necessary to be discuss about infection control in your work place more often?	100%	0%				0%	100%	0%			0%	86%	14%			0%	81%	0%			19%	100%	0%			0%	100%	0%			0% [1] yes; [2] no;



## Appendix-7: Wastewater and soil analysis procedure and method

### 1. Wastewater analysis

#### 1.1 Equipments, instruments and chemicals for sampling and sample preservation

##### (1) Water samples

- Sampling tool for water sample: crowbar, plastic bucket.
- Volume for each water sample is 4.5 liters, taken into 2 plastic bottles with volume of 1.5liter- and 3 bottles with volume of 0.5liter. Some prepared chemical solutions are added for sample stabilization and preservation.
- pH meter and thermometer for measuring of pH of water and water temperature on site.
- Chemical for preserving sample:  $H_2SO_4$ ,  $HNO_3$ ,  $NaOH$ ,
- Insulating Container + Ice for preserving samples at  $4^{\circ}C$

##### (2) Auxiliary equipments

- GPS equipment for identification of sampling point according to Coordinate System VN 2000.
- Digital camera for taking photograph on the site.
- Mark pen, label, etc

##### (3) Personnel protection equipments

- Rubber plastic glove, boot.
- Activated carbon mask

#### 1.2 Sampling procedures

*(TCVN 4556 – 1985: Method for selection keeping, transportation of waste water samples)*

##### (1) Instrument for sampling

- PE Bottles with the volume of 1.5 liters and 0.5 liter.
- All bottles must be washed by water of soap, alkali, acid or mixture of  $K_2Cr_2O_7$  and  $H_2SO_4$ . After that, they must be carefully washed by distilled water. Before taking waste water into bottle, they must be coated at least one time by waste water. In case of microorganisms, the bottle should be washed by Ethanol solution.

##### (2) Taking samples

- Selecting site for taking samples: This step is supported by technical advisors of Yachiyo Engineering Co., Ltd.
- Frequency of taking samples: 2time/day (in the morning and in the afternoon)

##### (3) Sample preservation and transportation

- Samples will be transported to the lab as soon as possible
- Keeping samples in the ice box at 4 °C
- Covering and lining bottles by soft paper or fabric as transporting samples to the lab.
- Chemical for preserving samples must be appropriate for analytical procedure.
- Conditions of sample preservation and storage for analyzing in the lab listed as follows:

**Containers, preservation techniques and storage times for water sample**

Parameter	Container	Preservation	Maximum holding time
pH	Plastic or glass	None required	Analyze immediately
SS,	Plastic, glass	Cool, 4 °C	7 days
BOD <sub>5</sub>	Plastic, glass	Cool, 4 °C	2 days
COD	Plastic, glass	Cool, 4 °C H <sub>2</sub> SO <sub>4</sub> to pH < 2	28 days
S <sup>2-</sup>	Plastic, glass	None required	1 day
NH <sub>4</sub> <sup>+</sup>	Plastic, glass	Cool, 4 °C H <sub>2</sub> SO <sub>4</sub> to pH < 2	28 days
NO <sub>3</sub> <sup>-</sup>	Plastic, glass	Cool, 4 °C	2 days
Floral and faunal fat	Plastic, glass	Cool, 4 °C H <sub>2</sub> SO <sub>4</sub> to pH < 2	28 days
PO <sub>4</sub> <sup>3-</sup>	Plastic, glass	Cool, 4 °C	2 days
Coliform, salmonella, shigella, vibrio cholera	Plastic, glass	Cool, 4 °C	10 hours
α - radioactivity, β - radioactivity	Plastic, glass	Cool, 4 °C	2 days
Temperature	Plastic, glass	None required	Analyze immediately
Odor	Plastic, glass	None required	Analyze immediately
Color	Plastic, glass	H <sub>2</sub> SO <sub>4</sub> to pH < 2	3 days
As, Hg, Pb, Cd, Cu, Zn, Ni, Mg, Fe, Sn	Plastic, glass	Cool, 4 °C HNO <sub>3</sub> to pH < 2	6 months
Cr (III, VI)	Plastic, glass	Cool, 4 °C	2 days
CN <sup>-</sup>	Plastic, glass	Cool, 4 °C, NaOH to pH>12	14 days
Phenol	Plastic, Glass	Cool, 4 °C H <sub>2</sub> SO <sub>4</sub> to pH < 2	28 days
F <sup>-</sup>	Plastic, glass	None required	28 days

Parameter	Container	Preservation	Maximum holding time
Cl <sup>-</sup>	Plastic, glass	None required	28 days
Total N	Plastic, glass	Cool, 4 °C	10 days
Total P	Plastic, glass	Cool, 4 °C	10 days

### 1.3 Analysis method

All parameter are analyzed according to Current Vietnamese Standards, as follows:

#### Standards for waster analysis

No	Parameter	Analysis method
1	pH	TCVN 6492 – 1999 (ISO 10523 – 1994)
2	SS	TCVN 6625:2000 (ISO 11923:1997)
3	BOD <sub>5</sub>	TCVN 6001 - 1995 (ISO 5915-1989)
4	S <sup>2-</sup> (calculated as H <sub>2</sub> S)	TCVN 4567-1998 or SMEWW 4500 - S <sup>2-</sup>
5	NH <sub>4</sub> <sup>+</sup> (calculated by N)	TCVN 5988:1995 (ISO 5664-1984)
6	NO <sub>3</sub> <sup>-</sup> (calculated by N)	TCVN 6180 – 1996 (ISO 7890 (3)-1998)
7	Floral and faunal fat	SMEWW 5520 - B
8	PO <sub>4</sub> <sup>3-</sup> (calculated by PO <sub>4</sub> <sup>3-</sup> )	TCVN 6494 – 2:2000 (ISO 10304-2:1995)
9	Total Coliforms	TCVN 6187-1:1996 (ISO 9308 – 1:1990 (E))
10	Salmonella	SMEWW 9260 B
11	Shigella	SMEWW 9260 E
12	Vibrio cholera	SMEWW 9260 H
13	α - radioactivity	TCVN 6053:1995 (ISO 9696:1998)
14	β - radioactivity	TCVN 6219:1995 (ISO 9697:1992)
15	Temperature	TCVN 4557:1988
16	Color	TCVN 6185:2008
17	Odor	by sense
18	COD	TCVN 6491-1999 (ISO 6060-1989)
19	As	TCVN 6626-2000
20	Hg	TCVN 7877:2008
21	Pb, Cd, Cu, Zn, Ni, Sn	TCVN 6193 - 1996
22	Mn	TCVN 6002:1995 (ISO 6333 – 1986)
23	Cr (III), Cr (IV),	TCVN 6222:2008
24	Fe	TCVN 6177:1996 (ISO 6332-1988)

25	CN <sup>-</sup>	TCVN 6181 – 1996 (ISO 6703 – 1- 1984)
26	Phenol	TCVN 6216:1996 (ISO 6439-1990)
27	F <sup>-</sup> , Cl <sup>-</sup>	TCVN 6494:1999
28	Total Noil sampling	TCVN 6638:2000
29	Total P	TCVN 6202-1996

## 2. Soil analysis

### 2.1 Soil sampling

(TCVN 5297:1995 – Soils quality - Sampling - General requirements)

#### (1) Sampling soil

- Maximum volume for each soil sample is needed for analyzing is 0.3kg and taken in to 02 zip-lock PE plastic bags.
- Sampling tool: equipment of taking sample according to height, shovel of digging soil.

(2) Instrument of taking soil samples: All black plastic bags are dry and clean.

#### (3) Taking samples

- Selecting site for taking samples: This step is supported by technique Advisors of Yachiyo Engineering Co., Ltd.
- Frequency of taking samples: one time.

#### (4) Preservation and transportation

- Taking samples to the lab as soon as possible
- Keeping samples in the dark.

### 2.2 Soil analysis

All parameter are analyzed according to Current Vietnamese Standards, as follows:

#### **Standards for waster analysis**

No	Parameter	Analysis method
1	Pb, Zn, Cd, As, Cu	TCVN 6649:2000 (ISO 11466:1995) and TCVN 6496:1999 (ISO 11047:1995)

**Appendix-8: Results of the environmental survey  
1. Survey on Wastewater Quality at selected hospitals**

	Unit	Bach Mai Hospital	National Lung Hospital	National Hospital of Dermatology	National Institute of Gerontology	National Hospital of Endocrinology	National Hospital of Ophthalmology	Limit Value	Remark
Date		2010/9/27	2010/9/28	2010/9/27	2010/9/27	2010/9/28	2010/9/28	-	-
Sampling time		9:30 14:25	9:30 13:50	11:10 15:30	10:50 15:15	11:30 15:00	11:00 15:20	-	-
pH	-	7.6 7.8	7.4 7.6	7.8 8.0	7.8 8.1	7.5 8.9	8.6 8.2	6.5 - 8.5	TCVN 7382
SS	mg/l	47 68	15 26	129 68	56 57	62 48	34 39	100	ditto
BOD <sub>5</sub>	mg/l	48 51	78 117	155 146	86 190	210 594	76 180	30	ditto
S <sup>2-</sup> (calculated as H <sub>2</sub> S)	mg/l	2.4 1.2	3.6 3.2	2.7 1.7	3.4 5.0	6.4 53.7	3.0 8.8	1	ditto
NH <sub>4</sub> <sup>+</sup> (calculated by N)	mg/l	26 19	4.4 7.8	4.9 45.8	53.2 78.4	34.5 38.9	32.6 30.8	10	ditto
NO <sub>3</sub> <sup>-</sup> (calculated by N)	mg/l	<0.1 <0.1	0.3 <0.1	<0.1 <0.1	<0.1 1.5	<0.1 0.7	<0.1 <0.1	30	ditto
Floral and faunal fat	mg/l	0.5 1.2	1.0 0.7	0.9 0.7	1.5 0.4	1.1 0.8	2.0 0.5	10	ditto
PO <sub>4</sub> <sup>3-</sup> (calculated by PO <sub>4</sub> <sup>3-</sup> )	mg/l	3.8 12.1	4.3 9.8	20.4 25.7	22.6 26.8	19.7 34.6	6.4 11.8	6	ditto
Total Coliforms	MNP/100ml	4.4E+07 5.1E+06	3.9E+06 9.7E+07	7.5E+08 9.3E+07	4.3E+06 2.5E+06	2.4E+09 1.7E+09	2.4E+06 1.5E+07	5,000	ditto
Salmonella	-	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	ditto
Shigella	-	++	++	+	+++	++	++	Not detected	ditto
Vibrio cholera	-	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	ditto
Total alpha radian activity	Bq/l	0.05 0.04	0.03 0.02	0.03 0.04	0.05 0.04	0.02 0.03	0.04 0.04	0.1	ditto
Total beta radian activity	Bq/l	0.46 0.52	0.49 0.35	1.05 1.12	0.68 0.52	0.84 0.61	0.78 0.62	1	ditto
Temperature	°C	29.4 29.5	29.4 28.5	28.3 28.4	28.8 29.2	28.3 28.9	27.8 28.1	40	QCVN 24:2009/BTNMT
Odor	-	bad odor	Bad odor	Bad odor	Bad odor	Bad odor	Bad odor	uncomfortable	ditto
Color	-	145	37 66	315	347 388	332 456	63 41	70	ditto
COD	mg/l	117	135 229	232 219	129 287	315 891	113 267	100	ditto
As	mg/l	<0.001	<0.001	0.001	0.001	0.004	0.012 0.015	0.1	ditto
Hg	mg/l	0.0002	0.0004	0.0004	0.0005	0.0005	0.0004	0.003	ditto
Pb	mg/l	0.001	0.001	0.001	0.001	0.002	0.002	0.001	ditto
Cd	mg/l	0.0001	0.0002	0.0002	0.0002	0.0003	0.0002	0.002	ditto
Zn	mg/l	0.012 0.008	0.010 0.008	0.003 0.003	0.058 0.058	0.083 0.119	0.055 0.006	3	ditto
Ni	mg/l	0.002 0.003	0.003 0.004	0.10 0.20	0.003 0.005	0.006 0.006	0.005 0.002	0.5	ditto
Mn	mg/l	<0.001	0.003	0.002	<0.001	0.005 0.01	<0.001 <0.001	1	ditto
Cu	mg/l	0.005 0.003	0.005 0.002	0.003 0.003	0.003 0.007	0.004 0.004	0.004 0.003	2	ditto
Fe	mg/l	<0.1 0.1	0.1 0.2	<0.1 0.1	0.1 0.7	0.4 1.2	0.2 2.5	5	ditto
Sn	mg/l	0.001	<0.001	<0.001	0.001	0.001	<0.001	1	ditto
Cr (III)	mg/l	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	1	ditto
Cr (VI)	mg/l	0.002 0.002	0.004 0.005	0.005 0.004	0.005 0.009	0.008 0.013	0.004 0.003	0.1	ditto
CN <sup>-</sup>	mg/l	0.08 0.08	0.70 0.18	<0.01 <0.01	2.70 2.22	0.43 3.90	<0.01 0.08	0.1	ditto
Phenol	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.5	ditto
F <sup>-</sup>	mg/l	1.1 1.2	1.1 1.5	1.3 1.5	1.5 1.5	5.9 1.5	1.1 1.5	10	ditto
Cl <sup>-</sup>	mg/l	60.3 58.3	41.7 51.8	84 76	74.6 85.9	71.0 78.1	30.5 30.5	600	ditto
Total N	mg/l	30.2 25.8	6.9 8.9	5.6 54.8	98.7 56.4	37.1 42.0	35.6 33.2	30	ditto
Total P	mg/l	2.0 2.8	1.2 2.9	4.4 5.1	3.8 5.2	3.7 5.1	2.0 1.1	6	ditto

## 2. Survey on Wastewater Quality of each units at two hospitals

### A. National Lung Hospital

Parameters	Unit	Influent	Aeration	Aeration	Sedimentation	Effluent	Limit Value	Remark
pH	-	7.3	7.9	8.0	7.8	7.4	6.5 - 8.5	TCVN 7382
		7.5	7.9	8.1	8.1	7.6		
SS	mg/L	19	33	24	14	15	100	ditto
		29	24	24	15	26		
BOD <sub>5</sub>	mg/L	87	117	95	123	78	30	ditto
		145	120	109	135	117		
S <sup>2-</sup> (H <sub>2</sub> S)	mg/L	6.3	4.3	2.7	5.1	3.6	1	ditto
		4.3	20	3.4	1.7	3.2		
NH <sub>4</sub> <sup>+</sup> (N)	mg/L	9.7	7.2	6.1	8.2	4.4	10	ditto
		11.5	8.2	9.3	7.5	7.8		
NO <sub>3</sub> <sup>-</sup> (N)	mg/L	0.1	<0.1	0.2	0.7	0.3	30	ditto
		0.1	0.7	0.4	0.2	<0.1		
Floral and faunal fat	mg/L	1.2	1.3	0.9	1.1	1.0	10	ditto
		2.0	1.9	1.5	0.8	0.7		
PO <sub>4</sub> <sup>3-</sup> (PO <sub>4</sub> <sup>3-</sup> )	mg/L	3.6	6.5	6.6	6.4	4.3	6	ditto
		2.7	6.6	6.7	6.7	9.8		
Total Coliform	MPN/100mL	1.1E+07	2.4E+07	4.6 E+06	4.5 E+06	3.9 E+06	5,000	ditto
		5.2 E+07	1.4 E+07	2.7 E+06	3.5 E+07	9.7 E+07		
Samonella		Not detected	Not detected	Not detected	Not detected	Not detected	ND	ditto
Shigella		+	++	+	+++	++	ND	ditto
		++	++	+	+	++		
Vibrio cholera		Not detected	Not detected	Not detected	Not detected	Not detected	ND	ditto
Total Alpha radian	Bq/L	0.04	0.03	0.01	0.04	0.03	0.1	ditto
		0.03	0.04	0.02	0.02	0.02		
Total Beta radian	Bq/L	0.45	0.51	0.36	0.29	0.49	1	ditto
		0.34	0.40	0.38	0.31	0.35		
Temperature		30.0	29.2	29.3	29.5	29.4	40	QCVN24:2009/BTNMT
		29.4	28.1	28.7	28.4	28.5		
Odor	-	Bad odor	Bad odor	Bad odor	Bad odor	Bad odor	uncomfortable	ditto
		Bad odor	Bad odor	Bad odor	Bad odor	Bad odor		
Color		22	33	30	28	37	70	ditto
		21	30	24	33	66		
COD	mg/L	186	241	183	254	135	100	ditto
		315	258	234	186	229		
As	mg/L	0.001	0.002	0.001	0.005	<0.001	0.1	ditto
		0.003	<0.001	<0.001	0.02	0.001		
Hg	mg/L	0.0005	0.0003	0.0003	0.0003	0.0004	0.01	ditto
		0.0004	0.0003	0.0003	0.0004	0.0005		
Pb	mg/L	0.001	0.001	0.001	0.001	0.001	0.5	ditto
		0.001	0.001	0.001	0.001	0.001		
Cd	mg/L	0.0002	0.0002	0.0002	<0.0001	0.0002	0.01	ditto
		0.0002	0.0002	<0.0001	0.0002	0.0002		
Zn	mg/L	0.142	0.029	0.039	0.018	0.010	3	ditto
		0.004	0.039	0.018	0.024	0.024		
Ni	mg/L	0.004	0.004	0.004	0.004	0.003	0.5	ditto
		0.004	0.004	0.003	0.004	0.004		
Mg	mg/L	0.003	0.003	0.004	0.003	0.003	1	ditto
		0.003	0.003	0.003	0.003	0.003		
Cu	mg/L	0.002	0.002	0.002	0.002	0.005	2	ditto
		0.001	0.002	0.002	0.002	0.002		
Fe	mg/L	0.2	0.9	0.6	0.4	0.1	5	ditto
		0.2	0.6	0.6	0.3	0.2		
Sn	mg/L	0.002	0.001	0.001	0.002	<0.001	1	ditto
		<0.001	0.001	0.002	<0.001	0.001		
Cr(III)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	1	ditto
		<0.001	<0.001	<0.001	<0.001	<0.001		
Cr(VI)	mg/L	0.009	0.006	0.003	0.003	0.004	0.1	ditto
		0.005	0.003	0.002	0.004	0.005		
CN <sup>-</sup>	mg/L	0.26	0.21	0.17	0.19	0.70	0.1	ditto
		0.35	0.29	0.25	0.19	0.18		



Parameters	Unit	Influent	Aeration	Aeration	Sedimentation	Effluent	Limit Value	Remark
Phenol	mg/L	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	0.5	ditto
F	mg/L	1.3 1.3	1.1 1.3	1.2 1.3	1.3 1.5	1.1 1.5	10	ditto
Cl	mg/L	39.1 35.5	44.0 48.3	48.3 46.9	45.4 46.1	41.7 51.8	600	ditto
T-N	mg/L	13.2 15.5	9.7 10.3	8.6 12.1	7.4 9.2	6.9 8.9	30	ditto
T-P	mg/L	1.0 0.9	1.7 1.7	1.7 1.8	1.5 1.7	1.2 2.9	6	ditto

Notes: upper; samples in AM, lower; samples in PM

## B. Bach Mai Hospital

Parameters	Unit	Influent	Aeration	Aeration	Sedimentation	Filtration	Effluent	Limit Value	Remark
pH	-	7.6 7.6	7.8 7.5	7.6 7.6	7.7 7.5	7.6 7.6	7.6 7.8	6.5 - 8.5	TCVN 7382
SS	mg/L	108 72	123 64	69 51	75 32	38 45	47 68	100	ditto
BOD <sub>5</sub>	mg/L	138 105	82 84	74 65	85 72	45 45	48 51	30	ditto
S <sup>2-</sup> (H <sub>2</sub> S)	mg/L	3.9 2.4	2.6 0.9	1.2 0.5	1.7 0.7	2.9 1.4	2.4 1.2	1	ditto
NH <sub>4</sub> <sup>+</sup> (N)	mg/L	35 44	29 32	28 29	29 33	25 25	26 19	10	ditto
NO <sub>3</sub> <sup>-</sup> (N)	mg/L	<0.1 0.2	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	30	ditto
Floral and faunal fat	mg/L	1.7 2.9	2.1 1.8	1.1 1.5	0.8 2.3	1.9 0.9	0.5 1.2	10	ditto
PO <sub>4</sub> <sup>3-</sup> (PO <sub>4</sub> <sup>3-</sup> )	mg/L	12.3 18.6	8.7 12.6	6.2 13.3	7.9 11.2	4.2 10.9	3.8 12.1	6	ditto
Total Coliform	MPN/100mL	4.7E+07 7.3 E+06	5.1E+07 4.5 E+06	3.9E+07 5.8 E+07	4.1E+07 6.2 E+07	4.8E+07 4.9 E+07	4.4E+07 5.1 E+07	5,000	ditto
Samonella		Not detected Not detected	Not detected Not detected	Not detected Not detected	Not detected Not detected	Not detected Not detected	Not detected Not detected	ND	ditto
Shigella		+++ +++	+++ ++	+++ +++	++ ++	+++ +++	++ ++	ND	ditto
Vibrio cholera		Not detected Not detected	Not detected Not detected	Not detected Not detected	Not detected Not detected	Not detected Not detected	Not detected Not detected	ND	ditto
Total Alpha radian activity	Bq/L	0.06 0.05	0.03 0.04	0.04 0.03	0.03 0.03	0.02 0.04	0.05 0.04	0.1	ditto
Total Beta radian activity	Bq/L	0.65 0.72	0.34 0.65	0.42 0.49	0.69 0.57	0.54 0.48	0.46 0.52	1	ditto
Temperature		29.5 29.0	29.2 29.2	29.3 28.9	29.5 29.5	29.6 29.4	29.4 29.5	40	QCVN24:2009 /BTNMT
Odor	-	Bad odor Bad odor	Bad odor Light odor	Light odor Light odor	Bad odor Light odor	Bad odor Bad odor	Bad odor Bad odor	uncomfortable	ditto
Color		160 168	152 174	147 142	171 155	131 134	145 149	70	ditto
COD	mg/L	227 175	162 142	135 131	174 146	115 83	117 112	100	ditto
As	mg/L	0.003 0.002	<0.001 0.003	<0.001 0.002	0.001 0.001	<0.001 0.004	<0.001 0.001	0.1	ditto
Hg	mg/L	0.0004 0.0004	0.0004 0.0003	0.0003 0.0003	0.0003 0.0003	0.0003 0.0003	0.0002 0.0002	0.01	ditto
Pb	mg/L	0.001 0.001	0.001 0.001	0.001 0.001	0.001 0.001	0.001 0.001	0.001 0.001	0.5	ditto
Cd	mg/L	0.0002 0.0002	0.0001 <0.0001	<0.0001 <0.0001	0.0001 <0.0001	0.0002 <0.0001	0.0001 <0.0001	0.01	ditto
Zn	mg/L	0.015 0.032	0.014 0.010	0.015 0.007	0.013 0.006	0.012 0.008	0.012 0.008	3	ditto
Ni	mg/L	0.003 0.004	0.003 0.003	0.003 0.004	0.003 0.003	0.003 0.003	0.002 0.003	0.5	ditto
Mg	mg/L	0.002 0.002	<0.001 0.001	<0.001 0.001	<0.001 0.002	<0.001 0.001	<0.001 0.001	1	ditto

Parameters	Unit	Influent	Aeration	Aeration	Sedimentation	Filtration	Effluent	Limit Value	Remark
Cu	mg/L	0.004 0.004	0.005 0.002	0.004 0.002	0.005 0.002	0.004 0.002	0.005 0.003	2	ditto
Fe	mg/L	0.1 0.1	0.1 0.1	0.1 <0.1	<0.1 0.1	<0.1 <0.1	<0.1 0.1	5	ditto
Sn	mg/L	0.001 0.001	0.001 0.001	0.001 0.057	0.001 0.002	0.001 0.002	0.001 0.001	1	ditto
Cr(III)	mg/L	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	1	ditto
Cr(VI)	mg/L	0.003 0.004	0.003 0.003	0.003 0.003	0.003 0.003	0.003 0.003	0.002 0.002	0.1	ditto
CN <sup>-</sup>	mg/L	0.17 0.25	0.12 0.14	0.13 0.15	0.10 0.10	0.08 0.08	0.08 0.08	0.1	ditto
Phenol	mg/L	0.005 <0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	0.5	ditto
F	mg/L	1.1 1.9	1.4 1.8	1.2 1.5	1.3 1.7	1.5 1.4	1.1 1.2	10	ditto
Cl <sup>-</sup>	mg/L	62.5 70.3	72.4 58.9	55.8 55.4	66.7 58.2	40.8 57.4	60.3 58.3	600	ditto
T-N	mg/L	40.7 51.2	34.5 36.7	33.1 34.6	34.2 38.9	27.8 33.1	30.2 25.8	30	ditto
T-P	mg/L	3.2 4.5	2.5 3.2	2.5 3.0	2.4 3.1	2.5 2.9	2.0 2.8	6	ditto

Notes: upper; samples in AM, lower; samples in PM





## Appendix-9: Comparison of survey results of Bach Mai, Hue Central and Cho Ray Hospitals

### 1. Comparison of the environmental survey results

Name	Wastewater		Solid wastes	
	Type of liquid waste	Treatment methods	Type of solid wastes	Treatment method
Bach Mai Hospital	Waste liquid from Hemodialysis Department	Discharging into wastewater line without any treatment	Anatomical waste from OT	Transportation to pathology after treatment with special solution
	Waste liquid from Infectious Disease Department	Discharging into wastewater line without any treatment	Anatomical waste from pathology	Transportation to ICD
	Waste liquid from laboratories	Discharging into wastewater line after treatment at laboratories	All solid waste collected from each department to ICD	Sterilizing at ICD and handing over to URENCO
	Blood waste from hematology laboratory	Collecting by cleaner belonging to department, and handing over to URENCO after sterilizing	RI waste	Storing until half-time of each RI, and return to supplier
	Solution from X-ray film development	No waste liquid is generated since using digital X-ray film processor		
	Waste liquid from Hemodialysis Department	Discharging into wastewater line without any treatment	Anatomical waste from OT	Transportation to pathology after treatment with special solution
	Waste liquid from Infectious Disease Department	Discharging into wastewater line without any treatment	Anatomical waste from pathology	Transportation to ICD
Hue Central Hospital	Waste liquid from laboratories	Discharging into wastewater line after treatment at laboratories	All solid waste except RI collected from each department to ICD	Incinerating by the hospital with incinerator
	Blood waste from hematology laboratory	Collecting belong cleaner belong to department, and handing over to a private company after sterilizing	RI waste	Storing until half-time of each RI, and return to supplier
	Solution from X-ray film development	No waste liquid is generated since using digital X-ray film processor		
	Waste liquid from Hemodialysis Department	Discharging into wastewater line without any treatment	Anatomical waste from OT	Transportation to pathology after treatment with special solution
	Waste liquid from Infectious Disease Department	Discharging into wastewater line without any treatment	Anatomical waste from pathology	Transportation to ICD
	Waste liquid from laboratories	Discharging into wastewater line after treatment at laboratories	All solid waste except RI collected from each department to ICD	Incinerating by the hospital with incinerator
	Blood waste from hematology laboratory	Collecting belong cleaner belong to department, and handing over to a private company after sterilizing	RI waste	Storing until half-time of each RI, and return to supplier
Cho Ray Hospital	Waste liquid from Hemodialysis Department	Discharging into wastewater line without any treatment	Anatomical waste from OT	Transportation to pathology after treatment with special solution
	Waste liquid from Infectious Disease Department	Discharging into wastewater line without any treatment	Anatomical waste from pathology	Transportation to ICD
	Waste liquid from laboratories	Discharging into wastewater line after treatment at laboratories	All solid waste collected from each department to ICD	Sterilizing at ICD and handing over to CITENCO
	Blood waste from hematology laboratory	Collecting by cleaner belonging to department, and handing over to CITENCO after sterilizing	RI waste	Storing until half-time of each RI, and return to supplier
	Solution from X-ray film development	No waste liquid is generated since using digital X-ray film processor		
	Waste liquid from Hemodialysis Department	Discharging into wastewater line without any treatment	Anatomical waste from OT	Transportation to pathology after treatment with special solution
	Waste liquid from Infectious Disease Department	Discharging into wastewater line without any treatment	Anatomical waste from pathology	Transportation to ICD

## 2. Comparison of awareness survey of medical staffs

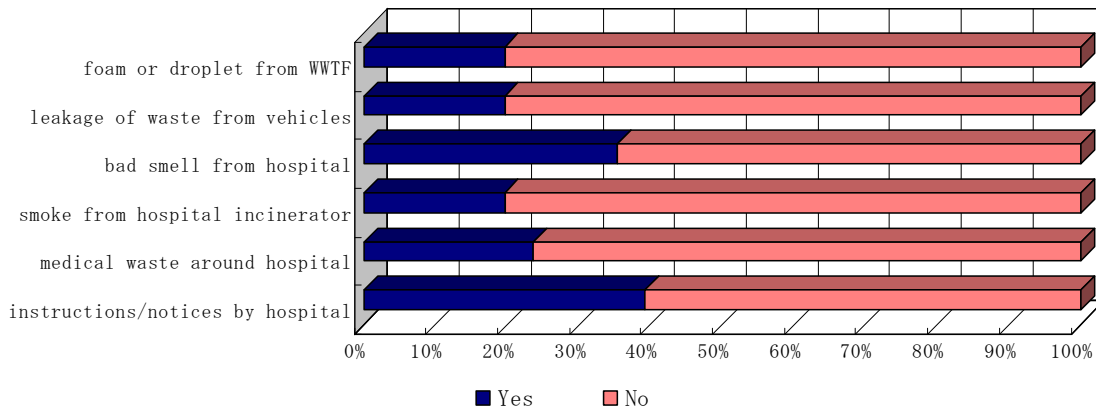
System	Bach Mai Hospital						Hue Central Hospital						Cho Ray Hospital						Remark
	Answer						Answer						Answer						
	1	2	3	4	5	NA	1	2	3	4	5	NA	1	2	3	4	5	NA	
Do you know there are several regulation (degree, decision, etc.) about medical waste?	95%	5%	/	/	/	0%	88%	13%	/	/	/	0%	100%	0%	/	/	/	0%	[1] yes; [2] no;
If yes, when did you know that?	9%	36%	45%	5%	14%	5%	25%	19%	44%	0%	0%	13%	21%	21%	68%	0%	0%	0%	[1] since when I learnt at school; [2] since when I started to work here; [3] at in-service training; [4] oneday by someone; [5] other
Do you know there is a system about medical waste in your hospital?	91%	/	/	/	/	0%	100%	/	/	/	/	0%	100%	/	/	/	/	0%	[1] yes; [2] no;
If yes, when did you know that?	0%	50%	36%	0%	5%	9%	0%	69%	31%	0%	0%	0%	0%	47%	47%	0%	11%	0%	[1] since when I learnt at school; [2] since when I started to work here; [3] at in-service training; [4] oneday by someone; [5] other
Have you ever seen the manual about the medical waste treatment?	91%	/	/	/	/	5%	88%	/	/	/	/	13%	84%	16%	/	/	/	0%	[1] yes; [2] no;

Management	Answer						Answer						Answer						Remark
	Answer						Answer						Answer						
	1	2	3	4	5	NA	1	2	3	4	5	NA	1	2	3	4	5	NA	
Have you ever discuss about the infection control in your work place (department)?	95%	5%	/	/	/	0%	94%	6%	/	/	/	0%	84%	16%	/	/	/	0%	[1] yes; [2] no;
If yes, when did you do that?	36%	5%	14%	0%	36%	5%	19%	38%	6%	5%	18%	5%	21%	16%	5%	0%	42%	16%	[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other
Have you ever discuss about the medical waste management in your work place (department)?	86%	14%	/	/	/	0%	100%	0%	/	/	/	0%	74%	26%	/	/	/	0%	[1] yes; [2] no;
If yes, when did you do that?	36%	9%	0%	0%	32%	14%	44%	19%	0%	6%	31%	0%	26%	0%	16%	0%	37%	26%	[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other
Have you ever instructed about the medical waste treatment by the hospital?	82%	9%	/	/	/	9%	100%	0%	/	/	/	0%	100%	0%	/	/	/	0%	[1] yes; [2] no;
Have you ever received the in-service training including the medical waste treatment?	91%	9%	/	/	/	0%	100%	0%	/	/	/	0%	89%	11%	/	/	/	0%	[1] yes; [2] no;
If yes, when did you learn it?	18%	32%	9%	9%	14%	18%	13%	63%	19%	0%	0%	0%	0%	26%	26%	5%	37%	11%	[1] in 6 months; [2] in the year; [3] last year; [4] in 2 years; [5] other
Have you ever instructed how to deal with biohazard and occupational accidents by the hospital?	73%	27%	/	/	/	0%	100%	0%	/	/	/	0%	79%	21%	/	/	/	0%	[1] yes; [2] no;
Do you know who is responsible for infection control and medical waste management in your work place?	91%	9%	/	/	/	5%	100%	0%	/	/	/	0%	95%	5%	/	/	/	0%	[1] yes; [2] no;
Do you know to whom when accidents happen in your work place?	82%	5%	/	/	/	5%	94%	6%	/	/	/	0%	95%	5%	/	/	/	0%	[1] yes; [2] no;
Have you ever seen the manual dealing with biohazard and occupational accidents at your work place?	68%	27%	/	/	/	5%	100%	13%	/	/	/	0%	74%	26%	/	/	/	0%	[1] yes; [2] no;

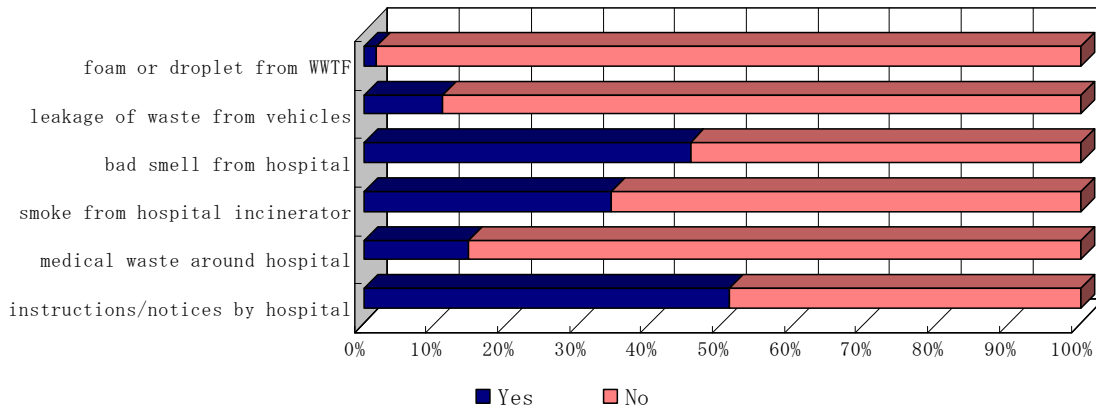
Existing Problem	Bach Mai Hospital						Hue Central Hospital						Cho Ray Hospital						Remark
	Answer						Answer						Answer						
	1	2	3	4	5	NA	1	2	3	4	5	NA	1	2	3	4	5	NA	
Have you ever met the disaster (flood or any kind of medical risk) on your duty?	50%	45%	/	/	/	5%	81%	19%	/	/	/	0%	63%	37%	/	/	/	0%	[1] yes; [2] no;
Have you ever felt the danger of disease infection on your duty?	45%	5%	/	/	/	5%	88%	13%	/	/	/	0%	84%	16%	/	/	/	0%	[1] yes; [2] no;
When did it happen?	32%	64%	45%	32%	23%	9%	31%	44%	44%	19%	13%	6%	21%	16%	68%	42%	0%	11%	(multiple choice) [1] cut fingers by sharps; [2] stuck fingers by needle; [3] touched danger blood ; [4] touched danger medical substance; [5] other ( )
Do you know what substances are dangerous at your work place?	needles, sharp objects, patients' body fluids, blood, X-ray, blood, pus						body's fluids, blood, epithilium promide, phenol, chlorofo, cchemical,						Immunology test,chemical,acid, dye,formol, xylen, acid,Te-99m, I 131						Open question:
Id yes, do you know how are they dangerous?	HIV, hepatis B, C, leuko exposure,bacteria, toxioic,contamination						contamination, making burn, poison, HIV, hepatitis B, C, causes cancer						contamination, making burn, poison, HIV, hepatitis B, C, causes cancer						Open question:
Do you think your work place is messy by wastes?	27%	68%	/	/	/	5%	56%	44%	/	/	/	0%	26%	74%	/	/	/	0%	[1] yes; [2] no;
Have you ever seen the disposal bag was mixed with different kinds of waste?	59%	27%	/	/	/	5%	75%	25%	/	/	/	0%	47%	53%	/	/	/	0%	[1] yes; [2] no;
Have you ever seen your colleague throwed waste into the wrong box?	55%	41%	/	/	/	5%	44%	56%	/	/	/	0%	63%	37%	/	/	/	0%	[1] yes; [2] no;
Have you ever throw medical waste into the wrong box by mistake?	50%	45%	/	/	/	5%	31%	69%	/	/	/	0%	32%	68%	/	/	/	0%	[1] yes; [2] no;
Have you ever put into your hands into the medical waste box to find what you missing?	36%	59%	/	/	/	5%	19%	100%	/	/	/	0%	21%	79%	/	/	/	0%	[1] yes; [2] no;

Personal Awareness	Answer						Answer						Answer						Remark
	1	2	3	4	5	NA	1	2	3	4	5	NA	1	2	3	4	5	NA	
Do you think there is a risk to be infected by disease because of your occupation?	95%	0%	/	/	/	5%	88%	13%	/	/	/	0%	100%	0%	/	/	/	0%	[1] yes; [2] no;
Do you pay attention not to be infected by disease your duty?	95%	0%	/	/	/	5%	100%	0%	/	/	/	0%	95%	5%	/	/	/	0%	[1] yes; [2] no;
If yes, what do you do to avoid to be infected?	86%	73%	68%	32%	14%	5%	44%	50%	44%	6%	31%	0%	74%	84%	84%	26%	11%	0%	(multiple choice) [1] follow guidlines; [2] put gloves; [3] wash hands; [4] rinse mouth; [5] other ( )
Do you want to know about your risk about the infection control?	91%	5%	/	/	/	5%	100%	0%	/	/	/	0%	100%	0%	/	/	/	0%	[1] yes; [2] no;
Do you think there is a link between the infection control and medical waste?	100%	0%	/	/	/	0%	100%	0%	/	/	/	0%	89%	11%	/	/	/	0%	[1] yes; [2] no;
Do you want to know about medical waste treatment to avoid your risk?	95%	5%	/	/	/	0%	100%	0%	/	/	/	0%	100%	0%	/	/	/	0%	[1] yes; [2] no;
Do you feel is there necessary to be discuss about medical waste treatment in your work place more often?	82%	18%	/	/	/	0%	100%	0%	/	/	/	0%	100%	0%	/	/	/	0%	[1] yes; [2] no;
Do you feel is there necessary to be discuss about infection control in your work place more often?	86%	14%	/	/	/	0%	81%	0%	/	/	/	19%	100%	0%	/	/	/	0%	[1] yes; [2] no;

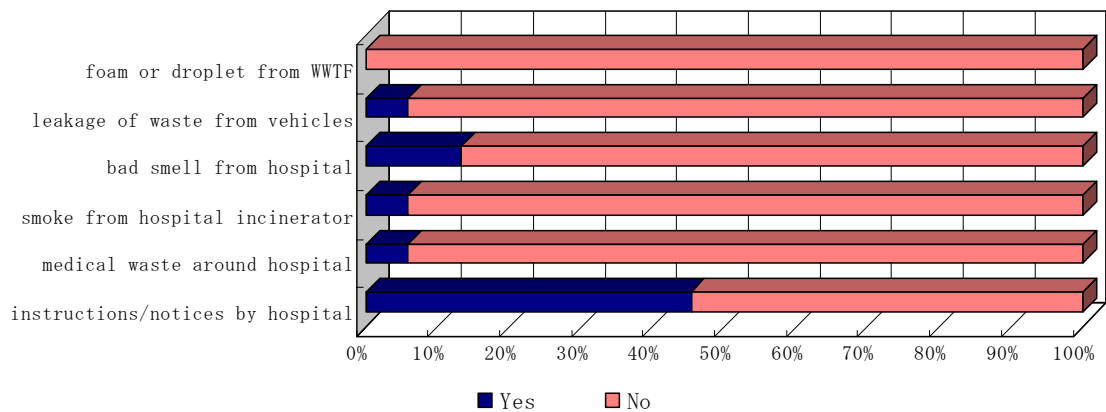
### 3. Comparison of residents' awareness survey results



**Result of resident awareness survey (Bach Mai Hospital)**



**Result of resident awareness survey (Hue Central Hospital)**



**Result of resident awareness survey (Cho Ray Hospital)**