PURR – PARTNERSHIP FOR URBAN RESOURCE RECOVERY

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INITIAL ASSESSMENT OF SLUDGE MANAGEMENT AND CONTEXT IN FIVE CITIES: SON LA, LANG SON, HOA BINH, BAC NINH, AND BA RIA

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Household survey in Bac Ninh

CONTENTS

ABBREVIATION AND ACRONYMS

BOD	Biological Oxygen Demand
BUSADCO	Ba Ria-Vung Tau Urban Sewerage and Development Company
DOC	Department of Construction
DONRE	Department of Natural Resources and Environment
EAWAG	Swiss Federal Institute of Aquatic Science and Technology
EPFL	Swiss Federal Institute of Technology in Lausanne
HUCE	Hanoi University of Civil Engineering
JSC	Joint Stock Company
IESE	Institute of Environmental Science and Technology
LAWASE	Lang Son Water Supply and Sewerage Company
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MOF	Ministry of Finance
MOH	Ministry of Health
MONRE	Ministry of Natural Resource and Environment
MPI	Ministry of Planning and Investment
PC	People Committee
SANDEC	Department of Water and Sanitation in Developing Countries
SECO	Swiss State Secretary for Economy
URENCO	Urban Environmental Company
VIWASE	Vietnam Water, Sanitation and Environment Joint Stock Company
VWSA	Vietnam Water Supply and Sewerage Association
WB	World Bank
WHO	World Health Organization
WSSC	Water Supply and Sewerage Company
WWTP	Wastewater Treatment Plant

Summary report

This summary report provides an overview of the highlights and key findings of the Initial Assessment Study that was conducted in Son La, Lang Son, Hoa Binh, Bac Ninh, and Ba Ria Vietnam as part of the PURR (Partnership for Urban Resource Recovery) Project. The purpose of the Initial Assessment Study was to provide an overview of the current status of sanitation and sludge management, the regulatory environment, and to identify local stakeholders. The study was conducted to develop an understanding of the local context to provide a basis for evaluating reasonable management and treatment options of faecal and wastewater sludge in each of the cities. Faecal sludge is the sludge that is stored in onsite sanitation technologies such as septic tanks and pit latrines. Wastewater sludge is produced in wastewater treatment plants (WWTPs) during the treatment of sewerage. Information in the report includes:

- the national institutional framework,
- the local environmental and socio-economic context,
- the water supply system,
- the wastewater management practices, stakeholders and infrastructures,
- the solid waste collection, transport and disposal system,
- the existing faecal sludge management habits.

The summary report provides information on the project context, the objectives and methods for the Initial Assessment Study, an overview of the management system for water and sanitation in Vietnam, and results of surveys and interviews. All these aspects are covered in more detail in the full report which is included in Annex I.

The information gathered during this study will be used together with results of the following studies conducted within PURR to provide recommendations for potential treatment options for faecal and wastewater sludge.

Figure 1: Location of the five cities of the PURR project

1. PROJECT CONTEXT

Centralized and onsite sanitation systems exist side by side in Vietnam, and both systems produce sludge (i.e. sewer, wastewater, and faecal sludge). However, management solutions for sludge produced in urban areas of Vietnam are typically lacking.

PURR is a collaborative project between Sandec (the Department of Water and Sanitation in Developing Countries) at Eawag (the Swiss Federal Institute of Aquatic Science and Technology), HUCE (Hanoi University of Civil Engineering) and EPFL, (the Swiss Federal Institute of Science and Technology in Lausanne). The project is funded by SECO, (Swiss State Secretary for Economy), and focuses on the five provincial cities shown in

Figure 1. Viable options for sludge management, treatment, and resource recovery are evaluated, with a focus on the potential for anaerobic co-digestion of sludge, which is a promising technology for co-treatment and biogas production.

2. OBJECTIVES AND METHODS OF THE INITIAL ASSESSMENT STUDY

The goal of the Initial Assessment Study was to assess the influence of the environmental context, the institutional framework, and the existing practices and infrastructures for sanitation management. To collect this information, household surveys and interviews were conducted, together with a literature review.

One hundred households were surveyed in each of the five cities to obtain an overview on the types of onsite sanitation technologies, their operation and maintenance, and the faecal sludge emptying practices. The questionnaires used for this survey are available in Annex 2. Single households were selected to provide a broad overview of the sanitation system and to provide a representative data set in each of the five cities.

Semi-guided interviews were conducted with local ministries, wastewater and solid waste management utilities, and private companies providing faecal sludge emptying services. The regulatory framework and management practices for the collection, transport, treatment and disposal of these waste streams were discussed during the interviews. The list of contacted people and the questionnaires used for the interviews are shown in Annex 3, 4, and 5.

3. NATIONAL WATER AND SANITATION MANAGEMENT

Included in section 3 is information on the regulation, practices and infrastructure in the field of water and sanitation in Vietnam. More detailed information on the regulatory framework is provided in annex 6. The practices and infrastructures currently used for the wastewater management, as well as the solid waste and faecal sludge are further detailed in section 4 of the full report.

3.1. Institutional framework

Several regulatory texts have been promulgated since 1998, but there is no text regulating the management of sludge that is dredged from sewers, produced in wastewater treatment plants, or stored in onsite sanitation systems. Decree 88 defines the basic principles for investments and strategic development for rainwater drainage and wastewater management.

The National Government is responsible for the national state management of all activities in the water and sanitation sector, under the recommendations of the Ministry of Construction (MOC) and the Ministry of Agriculture and Rural Development (MARD), respectively for urban and rural areas. At the district level, Provincial People's Committees (PC) organize the services, and agencies represent the local ministries (i.e. DOC and DONRE).

3.2. Wastewater and faecal sludge management

Urban drainage systems consist mostly of combined sewer networks that collect rainwater and domestic wastewater. These are operated and maintained by public companies, under official contracts with the local PC (Nguyen, 2009).

Eighteen wastewater treatment plants were operational in Vietnam in 2013 (Le Duy et al., 2013). The cumulated design capacity of these treatment plants is estimated to 540,000 m^3/day, which allows the treatment of less than 10% of the domestic wastewater generated in urban areas of Vietnam.

Decree 88 requires each household to have a septic tank. Le Duy et al., (2013) estimate that 90% of household use septic tanks in urban areas of Vietnam. Most households only empty their septic tanks if they become blocked and overflow, at a mean estimated frequency of somewhere between three to ten years (Nguyen et al., 2011). Due to a lack of treatment infrastructure, emptying service providers usually dispose of faecal sludge in drains, fields, aquaculture, waterways or open areas. Several Urban Environmental Companies (URENCOs) provide services for faecal sludge and solid waste collection, transport and disposal, and commonly faecal sludge is discharged into the landfills that they operate.

4. BACKGROUND SITUATION IN THE FIVE PROJECT CITIES

4.1. Environmental and socio-economic context

The five project cities present different physical environment that are summarized in Table 1. A summary of socio-economic conditions of the five cities is given in Table 2. All of the 5 cities are experiencing rapid industrialization and urbanization.

Table 1. Summary of environmental conditions of the five cities

	Son La	Ba Ria	Hoa Binh	Bac Ninh	Lang Son
Geographic situation	300km northwest from Hanoi, near Chinese border	90km southeast from Ho Chi Minh City	75km west from Hanoi	30km northeast of Hanoi	150km northeast from Hanoi, near Chinese border
Topography	Mountainous	Flat	Mountainous	Flat	Mountainous
Altitude (m above sea level)	590-650	3-14	17-25	3-7	255-260
Temperature(°C) (min, mean, max)	10; 21; 30	23; 27; 33	20; 23; 27	16; 23; 29	12; 20; 28
Average annual rainfall (mm)	1,400	1,350	1,850	1,500	1,400

Table 2. Summary of socio-economic conditions of the five cities

	Son La	Ba Ria	Hoa Binh	Bac Ninh	Lang Son
Urban population (inhabitants)	66,515	69,293	70,859	92,118	140,459
Total district population (inhabitants)	107,282 (in 2012)	98,990 (In 2009)	90,920	153,530 (in 2010)	187,278 (in 2009)
Area (km2)	325	91	144	83	79
Density (pers/km^2)	330	1,082	630	1,858	2,371
Income (USD/pers.year)	920	3,785	845	3,155	1,130
Economic growth rate (%)	17	22	14	16	11

4.2. Wastewater management

In each of the 5 cities, old rainwater drainage networks that were initially designed for rainwater runoff are also used to transport wastewater. Currently, only Bac Ninh city has a WWTP; the wastewater in other cities is discharged directly to rivers without treatment.

Wastewater infrastructures are presented below, and Table 3 shows the distribution of responsibilities for water supply, wastewater, solid waste and faecal sludge for the five project cities (Lahmeyer, IGIP, ICC, ANVIET, 2013; Pöyry, 2008a, 2008b, 2009). For the three cities in the “Wastewater and Solid Waste Management – Program North II” of KfW (German Development Bank), the wastewater sludge treatment will be designed with digestion, thickening and dewatering to 40% dryness.

- **Bac Ninh:** The sewer network was extended, and a WWTP was constructed under KfW funding in the framework of the "Wastewater and Solid Waste Management – Program North I". The WWTP has been operational since July 2013, with a design capacity of 17,500m^3/d. It includes primary and secondary biological treatment. No wastewater sludge is produced yet.
- **Son La:** Under phase II of the KfW project, a separate sewer will be built, together with a WWTP with primary treatment through settling tank and secondary biological treatment through activated sludge. The design capacity as planned in the feasibility study is 6,860 m^3/d. These infrastructures are in the phase of final design.
- **Hoa Binh:** Under the phase II of KfW project, a combined sewer will be built, together with a wastewater treatment, including a direct treatment of wastewater in activated sludge basins at high load. The design capacity as planned in the feasibility study is 5,120 m^3/d.
- **Lang Son:** Under the phase II of KfW project, a combined sewer will be built, together with a wastewater treatment, including a direct treatment of wastewater in activated sludge basins at high load. These infrastructures are in the phase of final design. The design capacity as planned in the feasibility study is 5260 m^3/d.
- **Ba Ria:** A combined drainage and sewer network was built in the 1990s, which will be enhanced and extended as part of the SECO project. The new sewer network is planned as separate sewer. The wastewater treatment plant is still under final design. It is planned to treat 12,000m^3/day.

Table 3. Stakeholders in charge of the water supply, wastewater, solid wastes, and faecal sludge management in the five project cities

<table>
<tr><th>Management responsibility</th><th>Son La</th><th>Ba Ria</th><th>Hoa Binh</th><th>Bac Ninh</th><th>Lang Son</th></tr>
<tr><td>Water supply</td><td>Son La Water Supply JSC</td><td>Ba Ria – Vung Tai Water supply company</td><td>Hoa Binh Water supply company</td><td rowspan="2">Bac Ninh WSSC</td><td rowspan="2">LAWASE</td></tr>
<tr><td>Wastewater</td><td rowspan="2">Son La Urenco</td><td>BUSADCO</td><td rowspan="2">Hoa Binh URENCO</td></tr>
<tr><td>Solid waste</td><td>URENCO Ba Ria</td><td>Bac Ninh URENCO</td><td>Huy Hoang Ltd company</td></tr>
<tr><td>Faecal sludge</td><td>Son La Urenco + 3 companies</td><td>BUSADCO + 6 companies</td><td>Hoa Binh URENCO + 1 company</td><td>Bac Ninh URENCO + 4 companies</td><td>Huy Hoang Ltd company + 3 companies</td></tr>
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5. RESULTS OF THE SURVEYS AND INTERVIEWS

Based on the results from the 100 household surveys in each of the 5 cities, a comparison of different factors that may influence the characterisation of faecal sludge is presented below. The number of surveyed households does not provide a statistically representative data set. However, it allows a good overview of the existing situation that needs to be considered in a sludge management plan.

5.1. Sewer and wastewater sludge management in the five project cities

The frequency of sewer dredging is dependent on the budget provided by the provincial PC. The dredged sludge ends up either in a disposal site or landfill, as shown in Table 4.

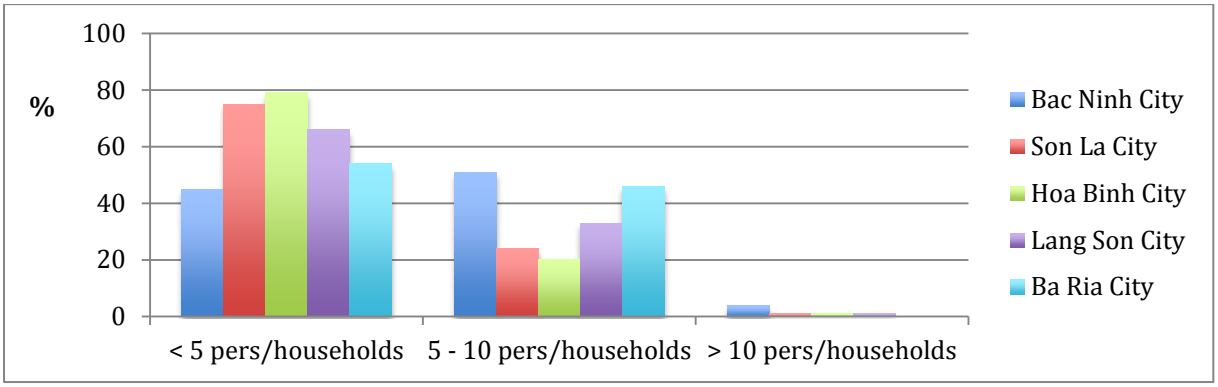
Table 4. Sewer maintenance practices and management of dredged sludge in 5 cities

	Bac Ninh	Son La	Lang Son	Hoa Binh	Ba Ria
Company in charge of sewer maintenance	Bac Ninh WSSC	URENCO	LAWASE	URENCO	BUSADCO – Ba Ria Drainage company
Dredging frequency	1 time/year for sewer and 4 times/year for manhole	3 times/year	2-3 times/year	no information	no information
Volume of sewer sludge dredged	20,000 m3/year	no information	40,000 m3/year	100 tons/year	4,534 m3/year
Disposal site	dumped in the Dong Ngo landfill	discharged to Son La URENCO garden and reuse as fertilizer	dumped in km No 10 in Quang Lac commune, landfill operated by LAWASE	dumped in old landfill situated 5 km in the north of the city	dumped in Cong Trang landfill, located about 7-8 km in the North of the city

5.2. Basic information on households and water provision

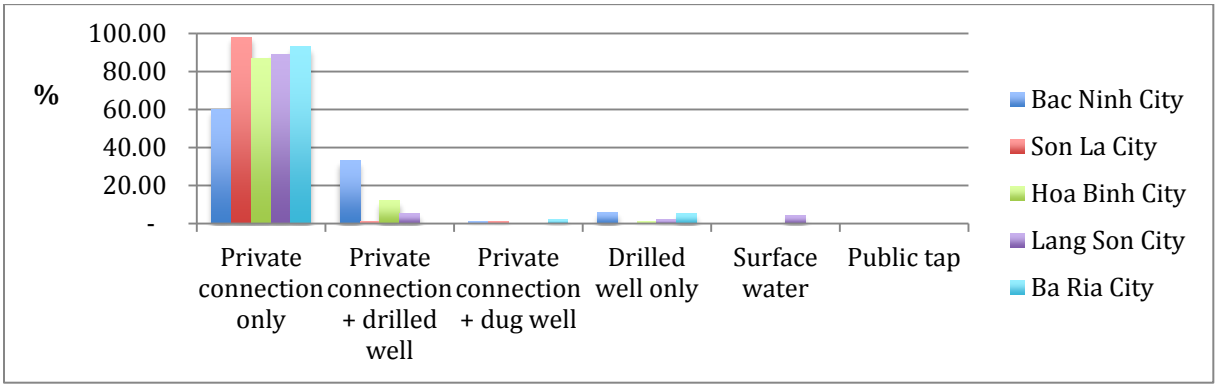
The number of people using each toilet/onsite sanitation system has a significant impact on the appropriate volume of the associated septic tank and the rate of faecal sludge accumulation. The number of residents per household/toilet on a percentage basis is reported in Figure 2.

Figure 2: Number of persons per household on a percentage basis in the 5 cities



The volume of water coming into a household also has a significant impact on faecal sludge volumes and characteristics. As shown in Figure 3, an average of 95% of households in this survey were connected to a piped drinking water network.

Figure 3: Water provision in 5 cities



5.3. Household sanitation systems

Flush toilets connected to septic tanks are the most common type of sanitation technology used by households. They were utilized by 98% of surveyed households in Bac Ninh, 100% in Ba Ria, 95% in Son La, 95% in Lang Son; and 94% in Hoa Binh. The results concerning sanitation systems in surveyed households in each city is provided in Table 5.

Table 5. Types of user interface, onsite containment technology and effluent discharge for each of the 5 cities.

Category	% household				
	Bac Ninh	Ba Ria	Son La	Lang Son	Hoa Binh
Flush toilet + septic tank + sewer	96	86	78	51	75
Flush toilet + septic tank + soak pit/open discharge	2	9	16	44	25
Flush toilet+ sewer	0	0	2	0	0
Flush toilet + open discharge	0	0	1	0	0
Pit latrine	0	0	2	3	0
Composting toilet	0	5	1	0	0
No toilet	2	0	0	2	0
Total	**100**	**100**	**100**	**100**	**100**

These results obtained during the 100 household surveys in the five cities were very similar to the information that was collected through surveys within the KfW project. The baseline survey within KfW project areas reported the following results (CEPAC and GFA, 2009, 2012, 2012):

- Bac Ninh. 97% of interviewed households owned a septic tank,
- Son La. 97% of interviewed households owned a septic tank,
- Lang Son. 93% of interviewed households owned a septic tank.

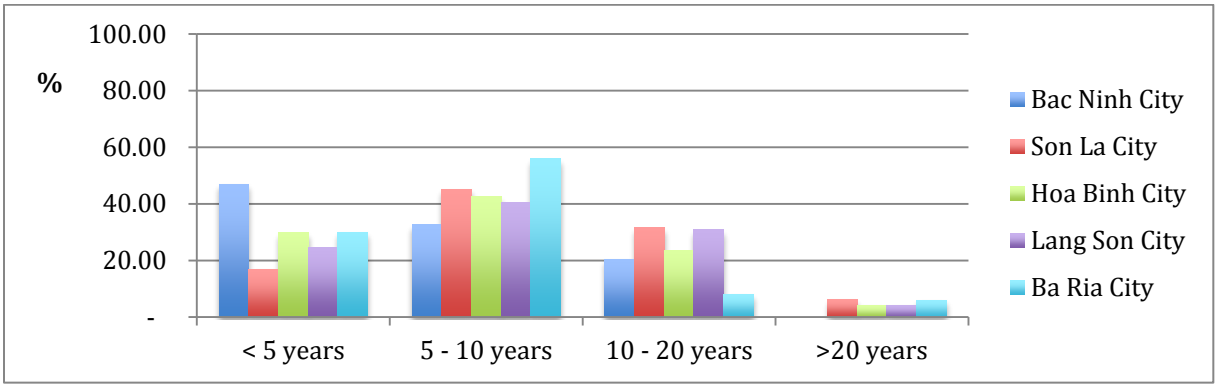
However, the comparison between the results of this study and the survey conducted by the local Health Offices in Hoa Bin and Ba Ria shows more differences, potentially due to these surveys also including peri-urban areas (values obtained during the interviews):

- Hoa Binh. 52% of interviewed households use a flush toilet connected to a septic tank,
- Ba Ria. 85% of interviewed households use a flush toilet connected to a septic tank.

In general, septic tanks are built at the same time the house is constructed. As shown in Figure 4, in Bac Ninh, 47% of surveyed households having a septic tank stated that it was built less than 5 years

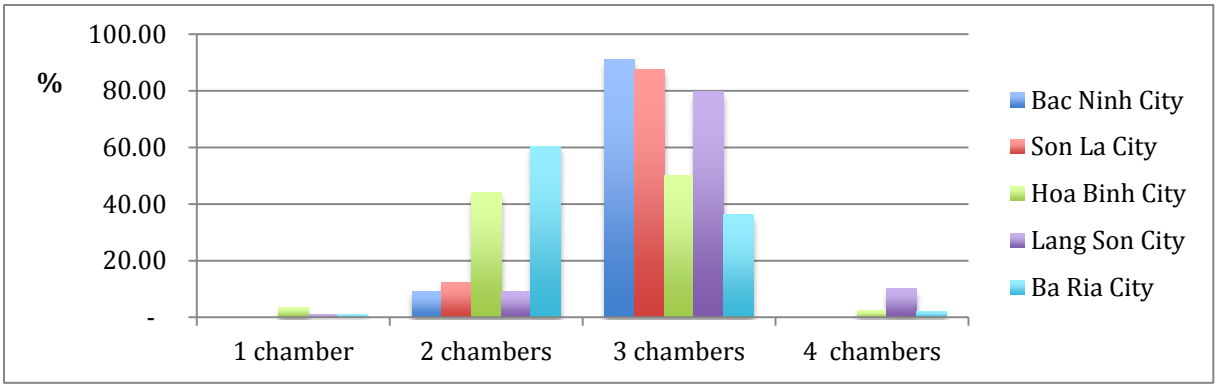
ago. In Son La, Hoa Binh, Ba Ria and Lang Son cities, the highest percentage of surveyed household stated that their septic tank was built 5 to 10 years ago.

Figure 4: Age of septic tanks in 5 cities



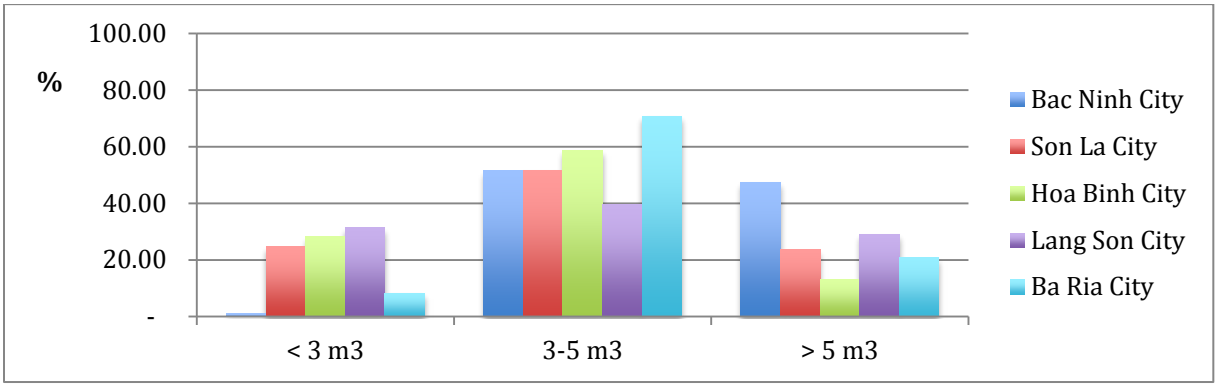
The number of chambers influences the settling capacity of the septic tank, and therefore can also have an impact on the characteristics of faecal sludge (e.g. solids concentration) (see Figure 5).

Figure 5: Septic tanks' chambers in 5 cities



Another important variable for sludge accumulation is the volume of a septic tank, which depends on the number of users and the available space for construction. The size of the septic tank has a strong influence on the emptying frequency, as most often, households wait until the tank is full or clogged. The reported volumes for septic tanks are shown in Figure 6.

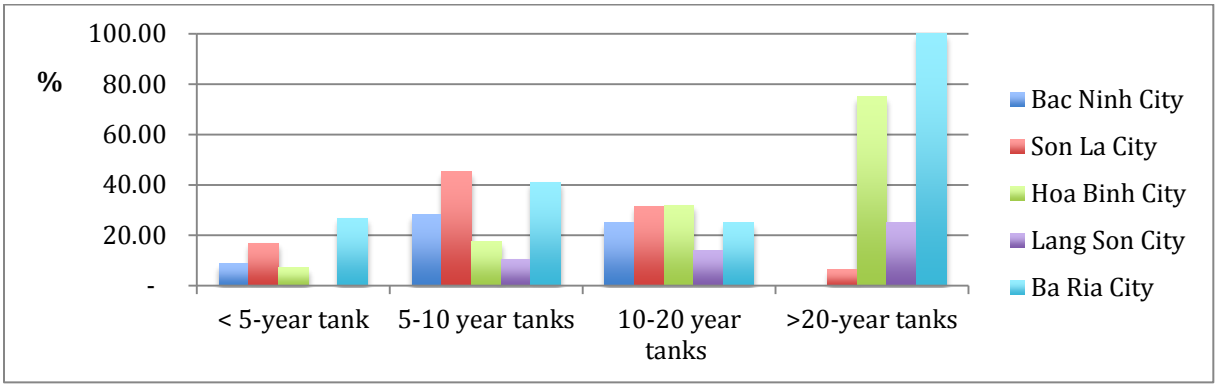
Figure 6: Septic tanks' volume in 5 cities



5.4. Household emptying practices

The percentage of surveyed households that had emptied their systems, together with the age of the septic tank, is reported in Figure 7. Among surveyed households, significant percentages had never emptied their septic tank, accounting for 81%, 86%, 80%, 89%, in Bac Ninh, Son La, Hoa Binh, and Lang Son, respectively. In Ba Ria 39% of surveyer household with a septic tank had never emptied it. This is due to most of the septic tanks (73%) being built less than ten years ago. In Figure 7, the emptying rate of Ba Ria is presented as 100%, but no household had septic tank over 20 years.

Figure 7: Percentage of emptied septic tanks in 5 cities, based on the age of the septic tank



5.5. Faecal sludge collection and treatment

Faecal sludge collection and transport services are provided based on an open market, with the public and private sectors competing for business based on customer demand. A summary of the emptying companies and the price range for emptying of septic tanks is provided in Table 6.

Table 6: Feacal sludge emptying companies and price in 5 cities

	Bac Ninh	Son La	Hoa Binh	Lang Son	Ba Ria
Public emptying company	URENCO	URENCO	URENCO	-	BUSADCO
Private emptying company	4 groups	3 groups	1 group	Huy Hoang + 3 groups	Dai Nam + (4-5) groups
Emptying price (VND/m^3)	200,000 – 300,000	150,000 – 200,000	300,000 – 400,000	150,000 – 200,000	200,000 – 300,000

Once collected, faecal sludge is either dumped in a landfill or used in agriculture or aquaculture. Ba Ria is currently the only city were a faecal sludge treatment plant exists that accept sludge province-wide. It was built by Dai Nam Company, who also operates it with a current capacity of 100-120 m^3/d. In Son La, faecal sludge collected by Son La URENCO is transported to a small pre-treatment unit, consisting of a small settling tank followed by a gravel filter.

6. CONCLUSIONS

Following are conclusions regarding the main factors that will influence the production, characteristics and potential management options for sludge based on the Initial Assessment Study.

6.1. Influence of institutional and stakeholder organization

Sludge management is not effectively addressed by local authorities and there is no existing regulatory framework that addresses the management of faecal sludge produced by septic tanks, even though septic tanks are required by Decree 88. There is also a lack of legal sites for disposal or treatment of faecal sludge. In the current situation, most private companies that collect and transport faecal sludge are providing public services illegally, as there is nowhere for them to legally discharge faecal sludge.

***Recommendations concerning the institutional and stakeholder organization**:*

Implementation of national standards for the regulation and enforcement of environmentally safe collection, transport, treatment, and resource recovery or enduse of all types of sludge are urgently needed. Sewer, wastewater and faecal sludges should be clearly distinguished, and clear responsibilities should be distributed to local authorities for each of them. Ideally emptying of septic tanks should occur on a regular period (e.g. 5 years), with treatment facilities located in each city at distances that are reasonable for transportation.

6.2. Influence of the local context

Raw information concerning the environmental context and infrastructures available need to be considered with the practices and habits when designing strategies for sludge management. For example the size and number of inhabitant is expected to influences the production of faecal and wastewater sludge produced. Lang Son and Bac Ninh are the more populated cities of the PURR project, and, higher faecal sludge production could be expected. However, households surveyed in Lang Son revealed a high percentage of septic tanks that were never emptied.

Recommendations concerning the local context*: The selection of wastewater and faecal sludge solutions should be based on the local context and practices. For example in Son La where faecal sludge treatment exists, it could be extended, and/or the planned composting plant could be used to co-compost municipal solid waste and sludge. In Ba Ria transport of faecal sludge to the existing faecal sludge treatment plant could be promoted. The co-treatment of faecal and wastewater sludge at the future or existing WWTP could be a possibility in each of the five cities.*

6.3. Influence of water supply, drainage and wastewater systems

Most households in the survey had flush toilets connected to septic tanks. The rapidly increasing populations together with the KfW and SECO drainage and wastewater projects that will connect households to sewers, will result in increasing volumes of sludge being produced in the coming years. The disposal of watery sludge in landfill is not a recommended option. The landfills in each of the cities are either non-lined, overcapacity, or far outside of the city boundaries. Transport of sludge over long distances is expensive, and discharge in the environment does not provide adequate protection of public health.

Recommendations concerning the water supply, drainage and wastewater management systems*: It will be beneficial to have a plan for sludge management taking into account the sludge production after the sewer extension and the WWTP construction. Adequate treatment and safe disposal or resource recovery are needed to provide adequate protection of human and environmental health.This would involve a more detailed assessment of the sludge produced by the sewer and WWTP.*

6.4. Influence of the existing faecal sludge infrastructures and practices

Feacal sludge collection and transport appears to be a profitable business, as between 1 to 5 private companies are already operating in each city, together with publicly owned companies. This also illustrates that significant volumes of faecal sludge are being produced and collected. This production is expected to increase with the average age of septic tanks and increasing urbanization.
Resource recovery from faecal sludge has a long history of use and acceptance in Vietnam, suggesting that resource recovery in agronomic and industrial settings should be accepted. Currently untreated faecal sludge is used in agriculture in each city, which is not recommended. In general, households empty their septic tanks at the end of the lunar year which needs to be considered in the design of treatment options.

Recommendations concerning faecal sludge management systems*: Sludge should be treated for pathogen reduction or used in areas where risk to human health is low (e.g. forestry).As faecal sludge is produced all over the year, but at variable volumes, co-treatment with other wastes streams could provide a good solution to balance volumes. Increased monitoring of faecal sludge emptying and patterns is required. It would provide more accurate estimates for faecal sludge production. This information together with the characterization study that is being conducted within the PURR project, would provide means to more accurately design sludge management technologies.*

A study will be conducted in 2014 to assess potential substrates for co-treatment, and a market demand study will be conducted in 2015. Based on this information, together with the existing context, regulatory framework, involved stakeholders, and existing sanitation management systems, recommendations will be made for sludge management options that promote resource recovery from endproducts.

ANNEX 1: FULL REPORT OF THE INITIAL ASSESSMENT STUDY

The purpose of this report is to provide the current context and state of sanitation in five provincial cities in Vietnam that are concerned by PURR (Partnership for Urban Resource Recovery) Project. These cities are Son La, Lang Son, Hoa Binh, Bac Ninh, and Ba Ria. The understanding of the local context and existing water and sanitation management options is important to evaluate reasonable management and treatment options of faecal and wastewater sludge in these cities.
Faecal sludge is the sludge that is stored in onsite systems, but not transported in any type of sewer. Examples of onsite systems can be septic tanks, which are sealed and constituted of at least two chambers to allow the sedimentation of suspended solids and a partial degradation of the pollution; and pit latrines, where the walls of the one-chamber tank can be sealed or not.
Wastewater sludge is the sludge that is retained and produced in the various steps of a wastewater treatment plant (WWTP).
The production of faecal sludge and reasonable management and treatment options depends on the following assessed aspects that are discussed below and in the report:

- the national institutional framework defines
    - the requirement for the construction and operation of onsite systems and sewer networks -> and therefore the production of faecal and sewer sludge,
    - the requirement and stakeholders in charge of the collection and transport of faecal sludge and sewer sludge -> and therefore the quality of services, emptying methods, price of emptying operation, which also influence the frequency of emptying, and the characteristics of the sludge that needs to be treated,
    - the requirement and stakeholders for the treatment, disposal and / or resource recovery of faecal sludge, wastewater, wastewater sludge and sewer sludge -> and therefore the availability of treatment plant, their possible design, the potential enduse or disposal options that are themselves depending on sludge characteristics,
- the local context defines
    - the type of onsite systems through hydrogeology -> which strongly defines the characteristics of faecal sludge,
    - the potential infiltration of rain or groundwater in the onsite systems and sewer networks -> which in turn influences the dilution, and the characteristics of the sludge,
    - the potential technical solutions for the transport and treatment of the sludge, through the topography, the temperature, the humidity, and other environmental variables,
    - the local habits that influences the faecal sludge production at the household level (e.g. diet, quantity of water used, type of sanitation options, type of water stored in the onsite systems, emptying frequency), as well as the sewer and wastewater sludge production,
- the water supply system influences
    - the quantity of water consumed by the households and local companies, and therefore the quantity of wastewater and the dilution of faecal and wastewater sludge,
- the wastewater management practices, stakeholders and infrastructures define
    - the characteristics of sewer sludge produced (e.g. combined sewer / separate sewers),
    - the frequency of sludge dredging, and therefore the quantity requiring treatment,

    - the characteristics and volumes of the wastewater sludge produced, which directly depends on the type of wastewater collected, and the technical design of the WWTP,
- the solid waste collection, transport and disposal system defines
    - the potential solid wastes that are easily available, sorted, and can be co-treated with faecal and wastewater sludge,
    - the potential disposal or co-treatment options,
- existing faecal sludge management habits influence
    - emptying frequency -> quantities of faecal sludge produced,
    - emptying method -> characteristics of faecal sludge that need to be treated (e.g. addition of water, complete / partial removal of faecal sludge),
    - existing treatment and enduse options.

This report focuses on the information gathered for the five above-mentioned cities, and therefore does not discuss the situation in peri-urban or rural areas.

1. PROJECT CONTEXT

Almost 30% of the population of Vietnam lives in urban areas, and urban populations are expected to continue increasing by 1 million people annually. Rapid urbanization increases the challenge of providing sanitation and affects natural resources and the environment, especially, in terms of water pollution. In Vietnam as in other low and middle income countries, centralized sewer-based sanitation systems have been recommended for cities due to high population densities, however, onsite systems have also simultaneously been promoted (e.g. pit latrines, septic tanks). Both centralized and onsite systems produce sludge (respectively referred to in this report as wastewater sludge, and faecal sludge) which require appropriate management strategies to protect public and environmental health.

In Vietnam, management solutions for sludge are typically lacking. Faecal sludge tends to be concentrated and high in pathogens, but characteristics vary based on many factors. A thorough understanding of practices for sludge management in Vietnam, and of sludge characteristics is necessary to develop appropriate models of management.

Throughout urban areas of Vietnam, a national regulation requires septic tanks at the household level. The liquid effluents are discharged into combined sewers and/or directly into the environment, and faecal sludge accumulates within the tank. In addition to the septic tanks, there are currently several development projects that aim to build wastewater infrastructures in provincial cities with populations of 80,000 to 170,000. In particular, SECO (Swiss State Secretary for Economy) has funded a project to improve the drainage and wastewater management in Ba Ria, and KfW (German Bank of Development) has similar projects in place in Bac Ninh, Hoa Binh, Lang Son, and Son La (see Figure 8: Location of the five cities in the PURR project.). Thus, the onsite and centralized systems will coexist in these cities, but there is currently no plan in place for the management of either type of sludge. In this context, the co-treatment of faecal and wastewater sludge provides a potential solution that could make the most efficient use of resources. PURR project also focuses on the potential for anaerobic co-digestion of sludge, which is a promising technology for co-treatment and biogas production.

PURR (Partnership for Urban Resource Recovery) is a collaborative project between Sandec (Department of Water and Sanitation from Eawag), (Swiss Federal Institute of Aquatic Science and Technology), HUCE (Hanoi University of Civil Engineering) and EPFL (Swiss Federal Institute of Science and Technology in Lausanne) to identify options for the co-treatment of, and resource recovery from,

faecal and wastewater sludge in Vietnam. This project is funded by SECO, the, and focuses on the five provincial cities shown in Figure 8. The project duration is three years. To evaluate potential treatment options, separate studies will be conducted to:

- understand the current state of sanitation in each of the five cities (this study),
- determine faecal and wastewater sludge characteristics,
- identify market demand for resource recovery from end-products of sludge treatment,
- assess the feasibility of co-digestion of faecal sludge and wastewater sludge.

Figure 8: Location of the five cities in the PURR project.

2. OBJECTIVES AND METHODS OF THE STUDY

The goal of the initial assessment study was to assess the influence of the physical, institutional and socioeconomic contexts on the production and characteristics of faecal and wastewater sludge. This background information is important to determine optimal sludge management strategies for urban areas in Vietnam.

A survey was conducted to understand the sanitation situation in the five cities, and assess the sludge production at the household level. Information was collected on:

- types of onsite sanitation technologies,
- operation and maintenance practices of these technologies,

- methods of emptying, and the frequency of faecal sludge collection.

Interviews were conducted with key local stakeholders to understand the regulatory and institutional framework for wastewater, solid waste and faecal sludge management, and the management practices for the collection, transport, treatment and disposal of these waste streams.

A systematic literature review was also carried out to understand the physical context (i.e. climate, geology, hydrology, topography), the socio-economic context and strategies and regulations at the national level for the management of these waste streams.

Next year, a market demand study will be conducted to complete the understanding of the local context of each of these five cities. Based on the information gathered through these two studies, recommendations for the appropriate treatment and resource recovery options in the 5 cities will be made.

2.1. Survey methodology

In-home interviews were conducted in 100 households in each of the five cities. Single households with 2 to 10 inhabitants in urban areas were selected. Five criteria were applied to select households that were surveyed:

- Location in relation to the area covered by the SECO and KfW projects (approx. 50 households within area, and 50 outside),
- Connection to sewer network (50 households connected, and 50 not connected),
- Type of street where the household is located (50 households on narrow lanes, and 50 in main streets)
- Type of building (40 individual or stand-alone houses, 40 multi-family households in adjacent arrangement, 20 villas situated in individual and separated terrains)

The proportion of households was selected to provide a broad overview of the sanitation system and be as representative as possible in each of the five cities. Therefore, the numbers had to be slightly adjusted for each city. Table 7 presents the breakdown of the number and types of houses, based on which the household were selectioned for the surveys.

Table 7: Theoretical distribution of the surveyed households based on the selection criteria

		Sewer connection		No sewer connection	
		Main street	**Narrow lane**	**Main street**	**Narrow lane**
Villa	**In project area**	3	2	3	2
	Out of project area	3	2	3	2
Adjacent	**In project area**	5	5	5	5
	Out of project area	5	5	5	5
Individual	**In project area**	5	5	5	5
	Out of project area	5	5	5	5
TOTAL		26	24	26	24

Prior to the survey, the wards where the surveys were conducted were selected together with local stakeholders that had a good understanding of the local situation. These stakeholders were then involved in the survey to facilitate contact with the local population. The following stakeholders were involved:

- Bac Ninh Water Supply and Sewerage Company (WSSC)
- Son La Urban Environmental Company (URENCO) and local surveyors
- Local surveyors
- Lang Son Water Supply and Sewerage Company (LAWASE) and local surveyors
- Ba Ria-Vung Tau Urban Sewerage and Development Company (BUSADCO)

Training was carried out by the survey team of HUCE prior to the surveys. Household surveys were carried out using the questionnaire form provided in Annex 2. They were carried out by teams of two people and took 25 minutes. The survey questionnaire contained four parts:

- general household information,
- type of onsite technology,
- emptying practices,
- evaluation of the faecal sludge management system.

2.2. Interview methodology

Semi-guided interviews were conducted with local ministries, wastewater and solid waste management utilities, and private companies providing faecal sludge emptying services. The managers of the companies were interviewed, together with employees from companies in the faecal sludge sector. As the role distribution for the management of wastewater, solid waste and faecal sludge is different in the five cities, a general list of questions was prepared, and the question were asked accordingly to the responsibilities of each interviewed stakeholder. Care was taken that all aspects were covered for each of the five cities.

Local waste management companies were contacted prior to the interviews and asked to send any documents that would be useful for answering the provided questions. This saved time during the interview, and provided a method to cross-check information. The questionnaire used for the interviews are provided in the Annex 4 and 5 together with the list of contacted people (Annex 3)

The questionnaire contained four sections:

- company activity, field of expertise, scope of activities, relation with the state,
- regulatory basis and organization of the company,
- existing infrastructure and management practices in relation to the company activities,
- sludge production, characteristics, and management methods.

3. NATIONAL BACKGROUND

3.1. Institutional framework

In the following sections, an overview of the main regulation and stakeholders involved in water and sanitation sectors are presented. Management systems are then separately presented for the water supply, drainage and wastewater, solid waste and faecal sludge sectors.

Information was collected on national laws and regulatory entities in the water and sanitation sector to understand the context? Indeed, laws and other regulatory texts define the type of management implemented, as well as the potential solutions.

The laws on water resources and on environment protection, respectively promulgated in 1998 and 1993 fix the basic principles concerning the water and sanitation sectors. Concerning the water supply and drainage in urban areas, several regulatory texts have been promulgated since 1998. The Decree 88 defines the basic principles concerning the investments and strategic development for the rainwater drainage and wastewater management. Decree 67, was promulgated in 2003 with the objective to limit the environmental pollution caused by wastewater. It fixes an environmental protection fee for sewage (i.e. < 10% of the water supply charge) that is already implemented by a large number of water supply companies (Le Duy et al., 2013). No text regulates the management of the sludge that is dredged from the sewers, produced in the wastewater treatment plants, or stored in the onsite sanitation systems. These are most often considered as solid wastes, and discharged in landfills despite their high water content.

3.2. Stakeholders organization

The main stakeholders in the water and sanitation sector and their roles are provided in
Table 8. The National Government performs the national state management of all activities in the water and sanitation sector. The Ministry of Construction (MOC) and the Ministry of Agriculture and Rural Development (MARD) are in charge of promulgating and implementing national laws and strategies concerning the water and sanitation sectors, respectively in urban and rural areas.

This report focuses on the situation in urban areas of the five PURR project cities. These are all classified under grade 3 of the urban classification defined in Vietnam. They are all provincial centers. Annex 7 presents this classification and the criteria used for it.

At the district level, Provincial People's Committees (PC) organize and develop water supply and sanitation services to fulfill the demands in their localities. They also participate in regional planning concerning the water and sanitation sector. The district agencies represent the local ministries (i.e. DOC, Department of Construction, and DONRE, Department of Natural Resources and Environment), and are in charge of the state management of water and sanitation sector activities at the provincial level.

As shown in
Table 8, the role distribution is not defined for the management of faecal sludge. The lack of regulation concerning the management of faecal, sewer and wastewater sludge results in low accountability feeling and willingness from the local authorities to implement efficient strategies. They also generally lack of dedicated means for faecal sludge management.

Table 8. Overview of the stakeholders

Entity	Responsibility
National Government	- Performs the national State management of water supply, drainage and solid waste activities in Vietnam; - Defines the strategies in these sectors based on the recommendations of MOC and MARD; - Promulgates and directs the implementation of strategies and orientations for water supply, drainage and wastewater, and solid waste development, planning and management at the national level.
Ministry of Construction (MOC)	- Manages water supply, drainage and solid waste activities in urban and industrial zones nationwide; - Studies and formulates strategies and policies on these sectors in urban and industrial zones nationwide and submits them to the Government or Prime Minister for promulgation ; - Organizes the implementation of programs and plans the development; - Promulgates the regulations, standards, economic or technical norms; - Guides, directs and inspects urban and industrial zones water supply, drainage and wastewater, and solid waste activities nationwide.
Ministry of Natural Resource and Environment (MONRE)	- Manages and monitors the quantity and quality of ground and surface water resources; - Issues regulation concerning water resources and pollution at the national level. - Controls the pollution related to drainage activities and wastewater discharge into water bodies; - Promulgates the priority policies of land use in solid waste activities; - Coordinate with MOC to guide the rehabilitation land use modifications and environmental monitoring after landfill closure.
Ministry of Planning and Investment (MPI)	- Studies and formulates mechanisms and policies to encourage and mobilize domestic and foreign investment capital sources for water supply, drainage and wastewater, and solid waste works; - Acts as coordinator in mobilizing official development assistance (ODA) capital sources for investment in water supply, drainage and wastewater, and solid waste development in the order of priorities approved by the Prime Minister.
Ministry of Finance (MOF)	- Performs the unified financial management of the ODA capital sources for investment in water and sanitation sectors; - Coordinates with MPI the balanced capital from state budget, the strategies and policies to encourage and mobilize domestic and foreign investment; - Coordinates with MOC and the MARD the principles and methods to determine clean water consumption and drainage prices, - Promulgates the price regulation and organizes the examination and supervision of their implementation nationwide; - Guides the implementation of the priority policies and the financial supports for private investment activities in the solid waste management sector.
Ministry of Health (MOH)	- Manages community health nationwide; - Promulgates standards of drinking water quality and clean water.
Provincial People's Committees (PPC)	- Manage water supply, drainage and wastewater, and solid waste activities in geographical areas under their management; - Define functions and tasks of the stakeholders and decentralize the management of water supply, drainage and solid waste activities to professional bodies.

3.3. Water supply in urban areas of Vietnam

Uban water supply systems in Vietnam is under the responsibility of the National Government. Priority has been put on investments for infrastructures, both for upgrading and new construction, and as a result the supply of drinking water has been greatly improved.

In Vietnam, there are 68 water supply companies that supply drinking water to urban areas. They are public companies or operate under a contract with the local authorities. Surface water sources account for 70% of the total water supply and 30% is sullied from ground water. There are more than 420 water supply systems with a total designed capacity of 5.9 million m^3/day. The operational capacity is 4.5 million m^3/day, which is equal to 77% of the designed capacity (ADB, 2010 & MOC, 2009)

By 2010, 18.15 million people had access to drinking water, accounting for 69% of the total urban population. The population with drinking water in urban areas of the same urban category than the 5 project cities is 45-55%. The average amount of water usage in urban areas is 80-90 L/person/d. In large cities such as Hanoi and Ho Chi Minh City, the consumption is 120-130 L/person/d (WHO & MOH, 2011). The current population with access to drinking water is still below the goals set by the national target program on urban water supply development.

3.4. Drainage and wastewater management in urban areas of Vietnam

This section presents the important features of the drainage and wastewater management, first focusing on sewer networks and their management, and then on the WWTP existing in Vietnam.

Many existing drainage networks in urban areas of Vietnam were constructed during the French colonial period. They have undergone significant disrepair, especially during the war, but in the past two decades significant repairs have been made since Vietnam has moved to a free economy. Urban drainage systems consist mostly of combined sewer networks that collect together rain water run-off and domestic wastewater. These include open channels, rivers, ponds and lakes, concrete sewers, and covered ditches. Most drainage systems in Vietnam are managed by publicly owned companies (e.g. Drainage Company, Water Supply and Sewerage Company or URENCO).

The service coverage of drainage and wastewater treatment is much lower than the coverage of drinking water supply (ADB, 2009). Sewer and drainage coverage at the national level is 40-50%, with a maximum average of 70% in large urban areas and only 10-20% in categories IV, V – urban areas.

The Decree 88 requires that each household has a septic tank. Domestic wastewater from households is pre-treated in septic tanks, where solids settle, a part of the organic matter is degraded, and the supernatant effluent goes to drainage channels, sewers, or to the environment. Many households are not connected to a sewer network due to a lack of tertiary networks that access households constructed on narrow roads or alleys (WHO & MOH, 2011). In these cases, wastewater flows into open ditches or leaches into the group. Some households do not have septic tanks and discharge their wastewater directly into the public sewer network. Many households have not had sludge removal from their septic tank for more than ten years. Therefore, the treatment is not effective, and the effluent is relatively high in solids, which sediment in sewerage systems and can be the source of odors during the dry season.

Following the drainage of effluent to sewers, for the most part wastewater then flows directly into

water bodies (rivers, springs, lakes and seas) without treatment. There are only a few cities with operating wastewater treatment plants.

Eighteen WWTP are operated in Vietnam in 2013, out of which 12 are situated in Hanoi, Ho Chi Minh City and Danang, and the other are in Bac Giang, Quang Ninh, Buon Ma Thuot, Lam Dong and Bac Ninh (Le Duy et al., 2013). These WWTP were designed as A2O (Anaerobic-Anoxic-Oxic), SBR (Sequencing Batch Reactor) or stabilization pond. Fourteen of these treatment plants treat wastewater from combined sewer, which is characterized with very low BOD concentrations ranging from 34 to 101 mg/l. The cumulated design capacity of these treatment plants is estimated to 540,000 m^3/day. In the current operational conditions, this probably allows the treatment of less than 10% of the domestic wastewater generated in urban areas of Vietnam.

Fees for wastewater collection and treatment in urban areas are already often collected by water companies. Commonly, 10% of the water supply fee is applied as an Environmental Protection Fee. This does not provide adequate funding to cover operation and maintenance costs for wastewater infrastructures. There are a lack of policies and appropriate models (e.g. public and private partnerships) to mobilize resources other than the state budget and development loans. Other financial flows throughout the sector need to be generated to reduce the financial burden from the government and increase the coverage and quality of services (WHO & MOH, 2011).

Public companies that implement the operation, maintenance, and repair of the sewers are also in charge of dredging it, and maintaining pumping stations (Nguyen, 2009). Other responsibilities include pipeline construction, sewer pipe production, and collection of faecal sludge from septic tanks. Due to a lack of dredging equipment, desluging is mostly done manually. Hanoi and Ho Chi Minh have mechanical dredging equipment.

Vietnam's regulatory framework does not yet regulate the sewer or wastewater sludge collection, treatment, or disposal. These sludge are commonly not treated and dumped into landfills together with solid waste. Laws regulating solid wastes do also not address sewer and wastewater sludge. For example, the sludge produced in the wastewater treatment plants in Hanoi is discharged at Nam Son landfill.

3.5. Solid waste management in urban areas of Vietnam

URENCOs are assigned to collect solid waste from households, rubbish on the streets, parks, and office. The Vietnamese government stipulates that medical centers and industrial units are responsible for collection and implementation of the treatment of their solid waste. But, in fact, the regulation is not enforced. There is very little available data on solid waste collection and treatment from industrial production units and medical centers. Most industrial producers and medical centers sign contracts with local URENCOs to collect their solid waste. In some cases, hazardous waste are mixed up with non-hazardous solid waste before URENCO come.

According to Nguyen et al., 2011, there are two common methods to collect of solid waste collection in Vietnam. In large streets and big cities, rubbish bins with a capacity of 100-200 liters are located at each side of the streets and small lanes, and residents bring their waste to the bins. Pedi-carts are used to collect rubbish from the bins and transport it to temporary solid waste storage sites at the end of each road. Compactor trucks with a 6-12m3 capacity are used to collect rubbish from bins and temporary storage sites and transport it to transfer stations. In Hanoi, there are three solid waste transfer stations. From the transfer stations, rubbish is compacted, loaded into trucks with the

capacity of 18-32m3 and transported to landfills.

In narrow lines and small cities, handcarts are used to collect rubbish. Workers push the handcarts and use bells to alert residents to bring rubbish stored in plastic bags. When the handcart is full, it is taken to temporary waste storage sites at the beginnings of lanes. Workers continue to collect rubbish in other lanes. During the night, compactor trucks with the capacity of 6-12m3 come to temporary storage sites to transport rubbish to landfills.

There is no law enforcing the implementation and operation of sanitary landfills in urban areas of Vietnam. Therefore, a large part of domestic solid wastes are discharged in non-sanitary dumping sites. The responsibility of implementing and distributing the responsibilities for the management of a landfill is attributed to PC. Currently, collection, transport and management of wastes on lakes, canals and rivers is not under the responsibility of any organization.

3.6. Faecal sludge management

Faecal sludge characteristics and volume are depending on the local and institutional context, and wastewater management organization presented above. These values may greatly vary from city to city. This section presents a rapid overview of general faecal sludge management practices in urban areas of Vietnam.

Households pay service providers to empty their septic tanks at a frequency reaching ten years (Nguyen et al., 2011). Most households only empty their septic tanks if they become blocked and overflow. One reason for very infrequent emptying is the emptying price, and another reason is that the septic tanks are frequently not accessible. They are often built underneath the house, and the floor needs to be broken to access them. The result is that solids in the effluent are high as sludge overpasses the designed storage height, and is washed out with supernatant.

A mix of state-owned, Joint stock companies (i.e. where state owns 50% of the shares) and private companies provide faecal sludge collection and transport services. Although this is illegal, and due to a lack of treatment infrastructure, service providers usually dispose of faecal sludge in drains, aquaculture, waterways or open areas. Several URENCOs provide services for both faecal sludge and solid waste collection and transport. Therefore, they commonly dispose of faecal sludge in landfills without any cost. As an example, every year, amounts of faecal sludge from septic tanks in Hanoi, Hai Phong, HCM Cities are estimated to 189,000; 80,500 and 336,000 m^3 respectively (Nguyen et al., 2013). Most of it is discharged without control in the environment.

In the regulatory framework of Vietnam, no distinction is made between faecal sludge, sewer sludge and wastewater sludge. These waste are not addressed by any regulatory text. In practice, they are most commonly considered and managed as solid wastes. Therefore, no city of Vietnam provides a satisfactory example of faecal sludge management. Even though there are no legal discharge sites, faecal sludge collection and transport operators in urban areas are generally required to obtain a business license to open and run a business.

People in rural areas widely apply untreated faecal sludge as a fertilizer, and there is a good potential for enduse of faecal sludge in Vietnam (AECOM & SANDEC, 2010). Indeed, it is common that emptying companies discharge faecal sludge in agriculture fields or aquaculture ponds. The Ministry of Health is currently drafting guidelines for composting human excreta into reusable fertilizer, based on the

World Health Organization's 2006 "Volume 4: Excreta and Grey Water Use in Agriculture" of the "Guidelines for the Safe Use of Wastewater, Excreta, and Grey Water".

In Hanoi, faecal sludge from public toilets that are operated by URENCO is currently discharged in a pond. Faecal sludge emptied by private companies is mostly discharged in drains and open areas in the city. In Hai Phong, a treatment plant built by the World Bank was designed to dry and compost faecal sludge and sewer sludge. In Da Nang, faecal sludge is discharged in a settling tank, from which the settled sludge is then pumped to a landfill. In Ho Chi Minh city, faecal sludge is dried and sold as compost by a private company. In Da Lat and Buon Ma Thuot, faecal sludge is co-treated with the wastewater at the WWTP. In Ba Ria, a private company operates a faecal sludge treatment plant under the principle of Upflow Anaerobic Sludge Blanket.

Due to the lack of regulatory framework and strategy for faecal sludge management, local governments have no incentive to promote faecal sludge management. They invest scarce resources in operating the few existing treatment facilities, or to support such projects once ODA project funding ends (AECOM & SANDEC, 2010).

4. RESULTS OF THE SURVEYS AND INTERVIEWS

From the results obtained during the surveys on 100 households in 5 cities, a comparison on different factors that may influence the volume produced, and characterisation of faecal sludge is presented below. The complete data resulting from the survey and interview is available on demand. The number of surveyed households does not allow to provide a statistically representative picture of the situation in the five cities. However, it allows a good overview of situations that are encountered. Three main conclusions can be drawn:

- There are overall tendencies that are common to the five cities, where most of the population living in the different areas surveyed use similar water supply and wastewater management infrastructures, but the household sanitation systems and practices still vary in a same city;
- Each city shows a different organizations and practices, and therefore requires specific assessment to define adequate sludge management options.

4.1. Environmental and economic context

The five project cities present different physical environment that are summarized in Table 9.

Table 9. Summary of environmental conditions of the five cities

	Son La	Ba Ria	Hoa Binh	Bac Ninh	Lang Son
Geographic situation	300km northwest from Hanoi, near Chinese border	90km southeast from Ho Chi Minh City	75km west from Hanoi	30km northeast of Hanoi	150km northeast from Hanoi, near Chinese border
Topography	Mountainous	Flat	Mountainous	Flat	Mountainous
Altitude (m above sea level)	590-650	3-14	17-25	3-7	255-260
Temperature(°C) (min, mean, max)	10; 21; 30	23; 27; 33	20; 23; 27	16; 23; 29	12; 20; 28
Average annual rainfall (mm)	1,400	1,350	1,850	1,500	1,400

A summary of socio-economic conditions of the five cities is given in Table 10. All of the 5 cities are experiencing rapid industrialization and urbanization, and a significant movement from agricultural to industrial and construction sectors. Hoa Binh and Son La have a similar economic distribution of

agriculture, forestry and fishery sectors accounting for approximately 15% of their GDP, services and commerce 50%, and industrial sector 35%. Ba Ria differs from the other cities with a higher contribution from industry and construction sectors to their GDP of 62%. In Lang Son, the main contribution to GDP is commercial services and tourism.

Table 10. Summary of socio-economic conditions of the five cities

	Son La	Ba Ria	Hoa Binh	Bac Ninh	Lang Son
Urban population (inhabitants)	66,515	69,293	70,859	92,118	140,459
Total district population (inhabitants)	107,282 (in 2012)	98,990 (In 2009)	90,920	153,530 (in 2010)	187,278 (in 2009)
Area (km2)	325	91	144	83	79
Density (pers/km^2)	330	1,082	630	1,858	2,371
Income (USD/pers.year)	920	3,785	845	3,155	1,130
Economic growth rate (%)	17	22	14	16	11

4.2. Wastewater management in the five project cities

In each of the 5 cities, the combined drainage system in residential neighbourhood catchments are typically constructed as flat-bottomed, rectangular covered channels, having little slope. Excepted in Ba Ria, and in the newly constructed network in Bac Ninh, open joints are frequent, that allow significant inflow and infiltration with typically high groundwater levels. The old drainage networks in Son La, Lang Son, Hoa Binh and Bac Ninh were initially designed for rainwater runoff (drainage) from city streets and public areas, not as combined sewerage systems. However, at present due to rapid urban growth, they are also used to transport wastewater. Currently, only Bac Ninh city has a WWTP, the wastewater in other cities is discharged directly to rivers without treatment.

The wastewater infrastructures are presented below, and Table 3Table 11. Stakeholders in charge of the water supply, wastewater, solid wastes, and faecal sludge management in the five project cities shows the responsibilities distribution for water supply, wastewater, solid waste and faecal sludge for the five project cities. For the three cities in the "Wastewater and Solid Waste Management – Program North II" of KfW, the wastewater sludge treatment will be designed with cold digestion, thickening and dewatering to 40% dryness (Lahmeyer, IGIP, ICC, ANVIET, 2013; Pöyry, 2008a, 2008b, 2009).

- **Bac Ninh:** The sewer network was extended, and a WWTP was constructed under KfW funding in the framework of the "Wastewater and Solid Waste Management – Program North I". The WWTP is in operation since July 2013, with a design capacity of 17,500m^3/d. The WWTP includes primary and secondary biological treatment. No wastewater sludge treatment is being performed yet, as sludge is not produced. The combined drainage and sewer network includes networks that existed prior to the KfW project and sewers that were constructed as part of the project.
- **Son La:** Under phase II of the KfW project, a separate sewer will be built, together with a WWTP with primary treatment through settling tank and secondary biological treatment through activated sludge. The existing sewer network is in bad conditions, and cannot be extended within the project. The design capacity as planned in the feasibility study is 6,860 m^3/d. These infrastructures are in the phase of final design. The existing combined drainage and sewer network is of poor quality.
- **Hoa Binh:** Under the phase II of KfW project, the existing combined sewer will be extended, as it is partly in good conditions. A wastewater treatment, including a direct treatment of wastewater in

activated sludge basins at high load will be built. The design capacity as planned in the feasibility study is 5,120 m^3/d. These infrastructures are in the phase of final design. The existing combined drainage and sewer network is of poor quality.

- **Lang Son:** Under the phase II of KfW project, the existing combined sewer will be extended, as it is partly in good conditions. A wastewater treatment, including a direct treatment of wastewater in activated sludge basins at high load will be built. These infrastructures are in the phase of final design. The design capacity as planned in the feasibility study is 5,260 m^3/day. The existing combined drainage and sewer network is of poor quality.
- **Ba Ria:** A combined drainage and sewer network was built in the 1990s, which will be enhanced and extended as part of the SECO project. The new sewer network is planned as separate sewer. The wastewater treatment plant is still under final design. A long basin with aerobic and anaerobic zones is planned to treat 12,000m^3/day. The wastewater sludge will be stabilized by aeration, thickened, centrifuged, and dewatered through lime addition to reach a dryness content of 30%.

Table 11. Stakeholders in charge of the water supply, wastewater, solid wastes, and faecal sludge management in the five project cities

Management responsibility	Son La	Ba Ria	Hoa Binh	Bac Ninh	Lang Son
Water supply	Son La Water Supply JSC	Ba Ria – Vung Tau Water supply company	Hoa Binh Water supply company	Bac Ninh WSSC	LAWASE
Wastewater	Son La Urenco	BUSADCO	Hoa Binh URENCO		
Solid waste		URENCO Ba Ria		Bac Ninh URENCO	Huy Hoang Ltd company
Faecal sludge	Son La Urenco + 3 companies	BUSADCO + 6 companies	Hoa Binh URENCO + 1 company	Bac Ninh URENCO + 4 companies	Huy Hoang Ltd company + 3 companies

4.3. Sewer and wastewater sludge management in the five project cities

At present, there is no legal framework concerning the sewer and wastewater sludge management in the five project cities. Therefore, very few information are recorded and available.

The companies managing the sewer are also in charge of its maintenance under their contract with the local PC. Therefore, the portion and frequency of dredged sewer depends on the budget accorded by PC.

URENCO Hoa Binh and BUSADCO in Ba Ria are responsible for dredging the sewer of the primary, secondary and tertiary networks. In Bac Ninh, Son La and Lang Son, the local communities are in charge of dredging the tertiary network, and local URENCO or Wastewater companies are responsible only for the primary and secondary sewer network.

Where the company is not operating the landfill or the treatment plant, a fee is paid for the discharge of the sewer sludge. This is the case for the cities of Bac Ninh and Ba Ria. More information on the sewer sludge management is given in Table 12.

Table 12. Sewer sludge management agencies in 5 cities

	Bac Ninh	Son La	Lang Son	Hoa Binh	Ba Ria
Company in charge of sewer maintenance	Bac Ninh WSSC	URENCO	LAWASE	URENCO	BUSADCO – Ba Ria Drainage company
Dredging frequency	1 time/year for sewer and 4 times/year for manhole	3 times/year	2-3 times/year	no information	no information
Volume of sewer sludge dredged	20,000 m3/year	no information	40,000 m3/year	100 tons/year	4,534 m3/year
Disposal site	dumped in the Dong Ngo landfill	discharged to Son La URENCO garden and reuse as fertilizer	dumped in km No 10 in Quang Lac commune, landfill operated by LAWASE	dumped in old landfill situated 5 km in the north of the city	dumped in Cong Trang landfill, located about 7-8 km in the North of the city

4.4. Solid waste management in the five project cities

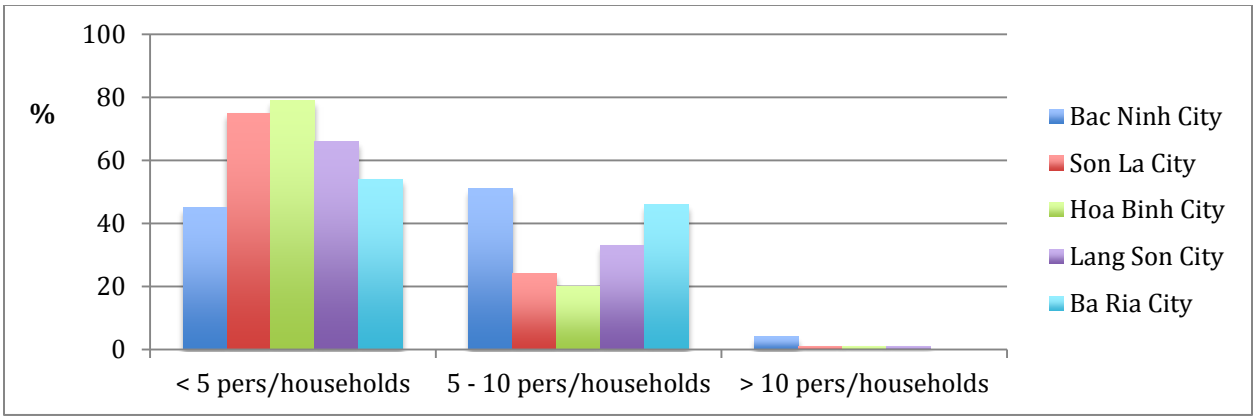
The management of solid waste is not the focus of this report. However, as sludge is currently being disposed in landfills together with the municipal solid waste, some basic information are given below concerning the landfills in the five cities.

- **Bac Ninh.** A sanitary landfill is under construction. Currently a temporary unlined landfill receives all types of solid wastes until the new one is opened.
- **Son La.** A sanitary landfill is under construction that will include a composting plant for the municipal organic wastes. Currently a unlined landfill is in used until the new one is opened.
- **Hoa Binh.** A new sanitary landfill was constructed, but is not yet in operation. Until it is open a non-sanitary and unlined landfill is in use for all the solid wastes collected in the city.
- **Lang Son.** Municipal solid waste is transported to a transfer station, from where it is transported to a landfill operated by Huy Hoang Ltd company.
- **Ba Ria.** Municipal solid wastes are currently discharged in a landfill that is operated by Ba Ria Urenco. A new sanitary landfill and composting plant are under construction. The local PC and DOC have a project where all types of waste will be treated separately. Both private and public companies are encouraged to build treatment plants on this site.

4.5. Basic information on households and water provision

The number of users for each toilet has a significant impact on the appropriate volume of septic tank and the rate of faecal sludge accumulation. The number of residents per household/toilet on a percentage basis are reported in Figure 9.

Figure 9: Number of persons per household on a percentage basis in the 5 cities

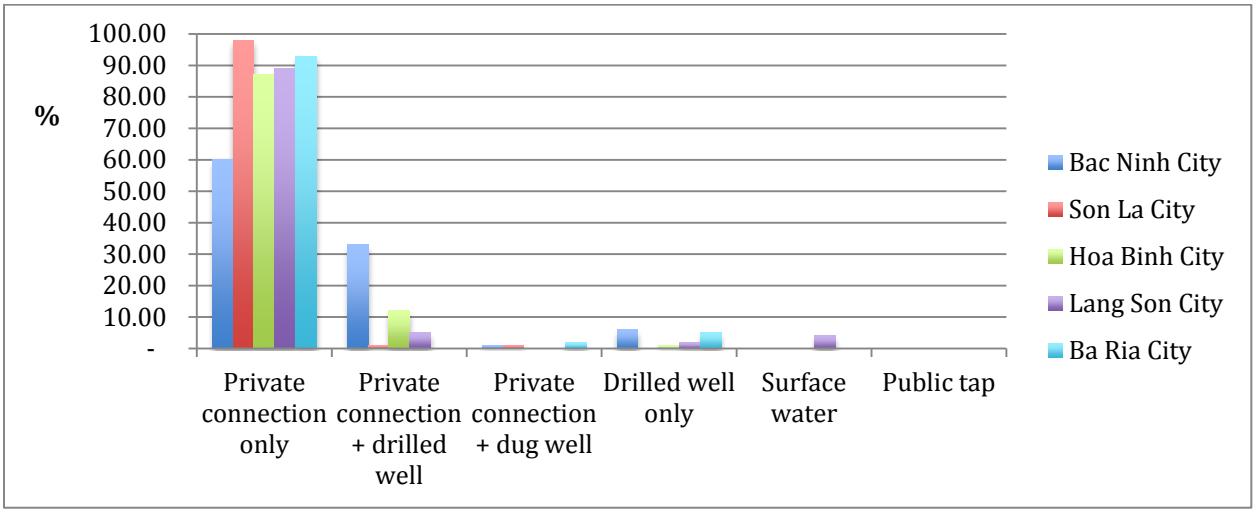


The volume of water coming into a household also has a significant impact on faecal sludge volumes and characteristics. This is especially important if greywater (i.e. wastewater from kitchen, shower and other cleaning purposes) is discharged in the onsite system together with blackwater (i.e. wastewater from toilets). Over the five cities, about 90% of the households discharge only blackwater in their onsite system. Therefore, the overall consumption in water is really influential for only 10% of the surveyed households.

Another important influence of the water supply on the characteristics of faecal sludge is the use of flush or dry toilets. In general, households having direct access to a good water supply more likely have flush toilets, and therefore produce more diluted and watery faecal sludge.

As shown in Figure 10, an average of 95% of households in this survey were connected to a piped drinking water network, with a minimum percentage of 94 in Lang Son and Bac Ninh, and a maximum percentage of 100 in Son La. The surveyed households, which were not connected to the water supply network all used drilled well or surface water for water provision.

Figure 10: Water provision in 5 cities



4.6. Household sanitation systems

Flush toilets connected to septic tanks are the most common type of sanitation technology used by the surveyed households. They were utilized by 98% of surveyed households in Bac Ninh, 100% in Ba Ria, 95% in Son La, 95% in Lang Son, and 94% in Hoa Binh. These high percentages confirm the importance of implementing adequate and environmental-friendly faecal sludge management systems in the five cities concerned.

Mechanical emptying is recommended in these cities, as the sludge from septic tank is generally easily pumped. At the opposite, pit latrine sludge is more compacted, and often require other emptying means. A very low percentage of surveyed household were equipped with pit latrines, only in Son La and Lang Son.

The percentage of household discharging the septic tank supernatant in soak pit or open areas varies between 44% in Lang Son, and 2% in Bac Ninh. This represents non-negligible environmental risks, which should be reduced thanks to the different programs implemented by KfW and SECO. 2% of interviewed households in Bac Ninh and Lang Son have no toilet and practice open defecation due to limited budget. The results of the surveyed households in each city is provided in Table 13.

Table 13. Types of user interface, onsite containment technology and connections to sewer for each of the 5 cities.

Category	% household				
	Bac Ninh	Ba Ria	Son La	Lang Son	Hoa Binh
Flush toilet + septic tank + sewer	96	86	78	51	75
Flush toilet + septic tank + soak pit/open discharge	2	9	16	44	25
Flush toilet+ sewer	0	0	2	0	0
Flush toilet + open discharge	0	0	1	0	0
Pit latrine	0	0	2	3	0
Composting toilet	0	5	1	0	0
No toilet	2	0	0	2	0
Total	**100**	**100**	**100**	**100**	**100**

The results obtained during the survey of 100 households in the five cities are very similar to the information that was collected through surveys within the KfW project. The baseline survey "Incorporating Knowledge – Attitude – Practice and Customer Satisfaction" carried out by CEPAC within KfW project areas reported the following results (CEPAC and GFA, 2009, 2012, 2012):

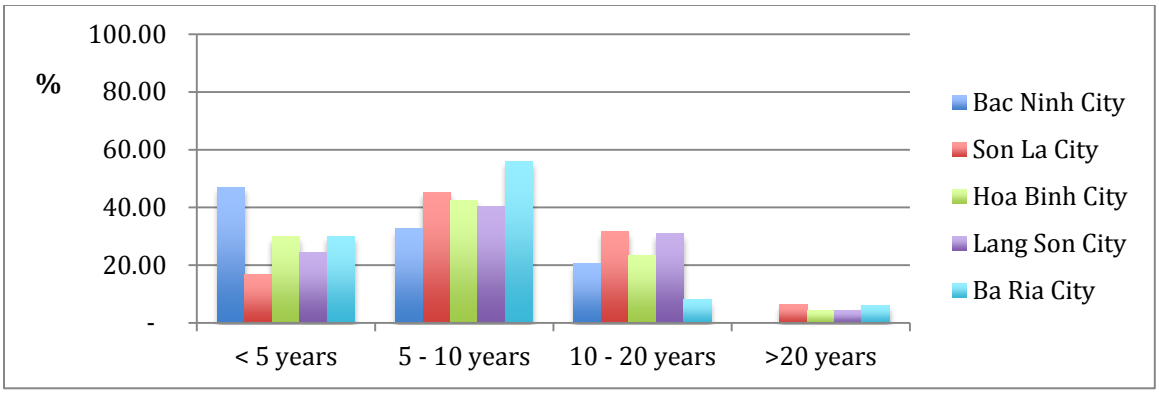
- Bac Ninh. 97% of interviewed households owned a toilet, and 95% of them used flush toilets connected to a septic tank. Some households in peri-urban wards utilized pit latrines or ventilated improved pit latrines.
- Son La. 97% of interviewed households owned a toilet, out of which 75% were connected to the combined drainage sewerage network.
- Lang Son. 93% of interviewed households owned a toilet, out of which 52% were connected to combined drainage sewerage network.

The comparison between the results of this study and the survey conducted by the local Health Offices in Hoa Bin and Ba Ria shows more differences (values collected during the interviews). This is probably due to the fact that these surveys were conducted at a larger scale, and also included peri-urban areas, which were not concerned in this survey. The studies conducted by the local Health Offices reported the following results:

- Hoa Binh. 52% of interviewed households used a flush toilet connected to a septic tank; 10% relied on pit latrines; 4% on composting toilets, 4 % on VIP toilets, and 29% had no sanitation system, and practice open defecation.
- Ba Ria. 85% of interviewed households used a flush toilet connected to a septic tank; and 15% used pour flush pit latrines.

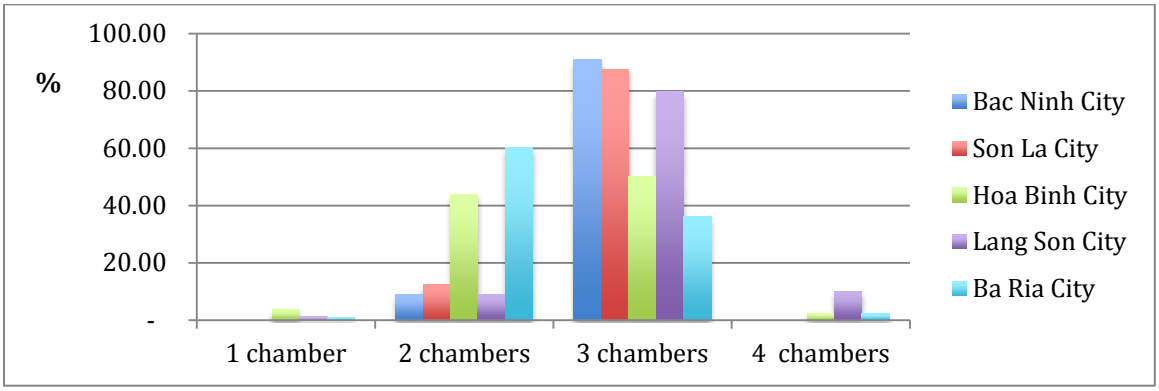
In general, septic tanks are built at the same time the house is constructed. As shown in Figure 11, in Bac Ninh, 47% of surveyed households having a septic tank stated that it was built less than 5 years ago. In Son La, Hoa Binh, Ba Ria and Lang Son cities, the highest percentage of surveyed household stated that their septic tank was built 5 to 10 years ago. The number of septic tank that were built more than 20 years ago in the surveyed households was very low in all the cities, and null in Bac Ninh. These numbers are consistent with the recent development of these cities.

Figure 11: Age of septic tanks in 5 cities



Among the surveyed households having a septic tank, in Bac Ninh, Son La, Hoa Binh, Lang Son and Ba Ria, the percentage were people remember the number of chamber of their septic tank is 97, 94, 89, 94, and 91, respectively. The number of chamber influences the settling capacity of the septic tank, and therefore can influence the characteristics of faecal sludge (e.g. solid concentration). As shown in Figure 12, more than 75% of the households have septic tanks with three chambers in Bac Ninh, Son La and Lang Son. In Ba Ria, about 60% have two chamber, and 35% three chamber. In Hoa Binh, approximately half of the households had septic tanks with two chambers, and the other half had three chambers. One-chamber septic tanks mostly exist in old houses and 4-chamber tanks are used in new houses where additional treatment is preferred.

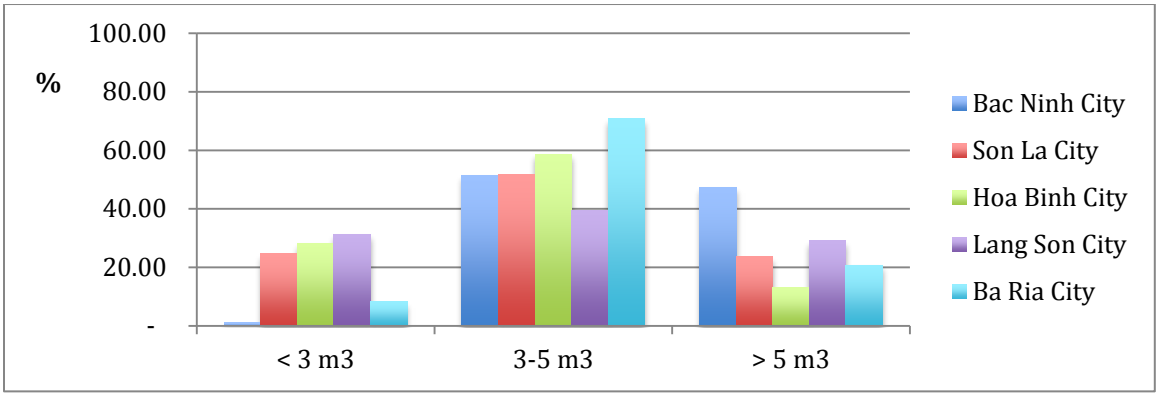
Figure 12: Septic tanks' chambers in 5 cities



Another important variable for sludge accumulation is the volume of a septic tank, which depends on the number of users and the available space for construction. The information available on the volume of the septic tank in the surveyed households is less reliable for the cities of Hoa Binh and Ba Ria, as only 46 and 24 households remembered this information, respectively. For the other cities, similar percentage of households surveyed knew the volume than the number of chamber. The size of the septic tank has a strong influence on the emptying frequency, as most often, household wait until the tank is full. This influence the volume of faecal sludge that need to be managed over the years, but also its characteristics, as microorganisms have more time to degrade the organic compounds in larger tanks.

The reported volumes for septic tanks are shown in Figure 13. Small septic tanks of less than 3m^3 can be found in more than 25% of the household owning septic tanks in Son La, Hoa Binh and Lang Son. In Bac Ninh about half of the households own septic tanks between 3 and 5 m^3, and the other half have bigger tanks. In Ba Ria the volume of the septic tanks is bigger than 3 m^3 in more than 90% of surveyed households.

Figure 13: Septic tanks' volume in 5 cities



4.7. Household emptying practices

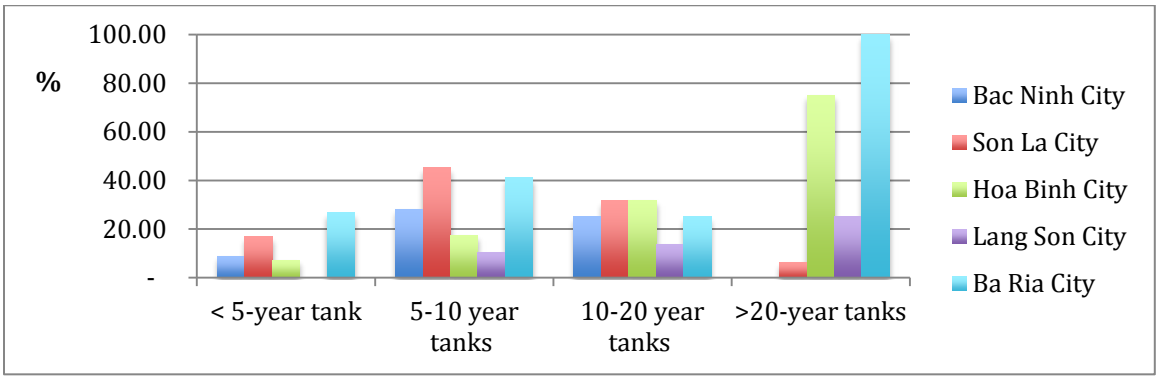
The percentage of surveyed households that emptied their systems, including the age of the septic tank, is reported in Figure 14. Among surveyed households, very high percentage did never empty their septic tank, accounting for 81%, 86%, 80%, 89%, in Bac Ninh, Son La, Hoa Binh, and Lang Son,

respectively. In Ba Ria 39% of surveyer household having a septic tank did never empty it. This can be explained as most of the septic tanks (73%) were built less than ten years ago, when the mean estimated emptying frequency reaches 10 years.

In general, only a small part of the septic tanks that were built less than 5 years ago has been emptied. In Ba Ria, about 27% of these were emptied. In all other cities, this percentage is less than 10%. The emptying rate for onsite systems of 5 to 10 years is also better in Ba Ria, with 41% of the systems of this age which were emptied. In average, 25% of the onsite systems having between 10 and 20 years were emptied. In Figure 14, the emptying rate of Ba Ria is presented as 100%, this is due to the fact that no surveyed household had septic tank over 20 years.

As more than 70% of the households have a septic tank that was built less than ten years ago, it is expected that more and more faecal sludge will be emptied the coming 5 to 10 years, when these will fill up. This emphasize the urgent need to find solutions for the management of faecal sludge in the five cities of the project, as well as in other cities presenting similar situation.

Figure 14: Percentage of emptied septic tanks in 5 cities, based on the age of the septic tank



4.8. Faecal sludge collection and treatment

In the 5 studied provinces, DOCs are the main responsible for feacal sludge management. Based on DOC's recommendations, provincial PC takes decisions on feacal sludge related issues. However, faecal sludge is still not considered as a priority by local authorities.

Feacal sludge collection and transport services are an open market, and the public and private sector compete based on customer demand. The price of feacal sludge emptying is not fixed, and is negotiated between emptiers and households. A summary of the emptying companies and the price range applied in the five cities provided in Table 14.

Table 14: Feacal sludge emptying companies and price in 5 cities

	Bac Ninh	Son La	Hoa Binh	Lang Son	Ba Ria
Public emptying company	URENCO	URENCO	URENCO	-	BUSADCO
Private emptying company	4 groups	3 groups	1 group	Huy Hoang + 3 groups	Dai Nam + (4-5) groups
Emptying price (VND/m^3)	200,000 – 300,000	150,000 – 200,000	300,000 – 400,000	150,000 – 200,000	200,000 – 300,000

In all of the five cities, private companies discharge the faecal sludge contained in their trucks in agriculture (e.g. rubber tree or coffee plantations, or familial farmland). In Bac Ninh and Hoa Binh, private emptiers interviewed also stated they discharge faecal sludge in aquaculture ponds. Based on the MARD Decision 04/2007-QG, this is illegal, as waste products issued from animal or human should not be used as amendment for the growth of vegetables (Le Duy et al., 2013). However, this seems a very common and well accepted practice. In general, farmers do not pay for faecal sludge and trucks discharge it on their land for no cost.

Ba Ria is currently the only city were a faecal sludge treatment plant exists that accept faecal sludge province-wide. Dai Nam Company constructed and operates it, with a current capacity of 100- 120 m^3/d. The faecal sludge collected by the 6 -8 companies during the day is transported to a large emptying truck of 12 m^3, which transports the sludge to the upflow anaerobic sludge blanket reactor operated by Dai Nam. The sludge from household septic tank is discharged for free at Dai Nam treatment plant, but sludge from commercial activities is received with a fee of 40,000 VND/m^3. No information on the way to distinguish these two types of faecal sludge was found.

In Son La, faecal sludge collected by Son La Urenco is transported to a small pre-treatment unit, consisting of a small settling tank with followed by a gravel filter. It is planned that the endproducts are then used in aquaculture and for tree plantations.

5. CONCLUSIONS

The following conclusions concern specifically the management of wastewater and faecal sludge in urban areas of Vietnam. They are organized following the main factors influencing the production, characteristics and potential management options for sludge:

- institutional framework and stakeholder organization,
- local context,
- water supply, wastewater and drainage systems,
- faecal sludge infrastructures and management system.

Together with additional information that will be collected through other studies concerning the characterization of faecal sludge, the availability of other wastes that can be co-treated with sludge, and the market demand for different valuable end-products, the results of this initial assessment study will serve to provide recommendations concerning potential options for the treatment of faecal sludge and wastewater sludge in the five project cities. These recommendations should also be useful for other cities in Vietnam, and in South-East Asia.

5.1. Influence of the institutional and stakeholder organization

Sludge management is not effectively addressed by local authorities and there is no existing regulatory framework that addresses the management of faecal sludge produced by septic tanks, even though septic tanks are required by Decree 88. There is also a lack of legal sites for disposal or treatment of faecal sludge. In the current situation, most private companies that collect and transport faecal sludge are providing public services illegally, as there is nowhere for them to legally discharge faecal sludge.

Recommendations concerning the institutional and stakeholder organization*: Implementation of national standards for the regulation and enforcement of environmentally safe collection, transport, treatment, and resource recovery or enduse of all types of sludge are urgently needed. Sewer, wastewater and faecal sludges should be clearly distinguished, and clear responsibilities should be distributed to local authorities for each of them. Ideally emptying of septic tanks should occur on a regular period (e.g. 5 years), with treatment facilities located in each city at distances that are reasonable for transportation.*

5.2. Influence of the local context

Raw information concerning the environmental context and infrastructures available need to be considered with the practices and habits when designing strategies for sludge management. For example the size and number of inhabitant is expected to influences the production of faecal and wastewater sludge produced. Lang Son and Bac Ninh are the more populated cities of the PURR project, and, higher faecal sludge production could be expected. However, households surveyed in Lang Son revealed a high percentage of septic tanks that were never emptied.

Recommendations concerning the local context*: The selection of wastewater and faecal sludge solutions should be based on the local context and practices. For example in Son La where faecal sludge treatment exists, it could be extended, and/or the planned composting plant could be used to co-compost municipal solid waste and sludge. In Ba Ria transport of faecal sludge to the existing faecal sludge treatment plant could be promoted. The co-treatment of faecal and wastewater sludge at the future or existing WWTP could be a possibility in each of the five cities.*

5.3. Influence of the water supply, drainage and wastewater systems

Most households in the survey had flush toilets connected to septic tanks. The rapidly increasing populations together with the KfW and SECO drainage and wastewater projects that will connect households to sewers, will result in increasing volumes of sludge being produced in the coming years. The disposal of watery sludge in landfill is not a recommended option. The landfills in each of the cities are either non-lined, overcapacity, or far outside of the city boundaries. Transport of sludge over long distances is expensive, and discharge in the environment does not provide adequate protection of public health.

Recommendations concerning the water supply, drainage and wastewater management systems*: It will be beneficial to have a plan for sludge management taking into account the sludge production after the sewer extension and the WWTP construction. Adequate treatment and safe disposal or resource recovery are needed to provide adequate protection of human and environmental health. This would involve a more detailed assessment of the sludge produced by the sewer and WWTP.*

5.4. Influence of the existing faecal sludge infrastructures and practices

Faecal sludge collection and transport appears to be a profitable business, as between 1 to 5 private companies are already operating in each city, together with publicly owned companies. This also illustrates that significant volumes of faecal sludge are being produced and collected. This production is expected to increase with the average age of septic tanks and increasing urbanization.
Resource recovery from faecal sludge has a long history of use and acceptance in Vietnam, suggesting that resource recovery in agronomic and industrial settings should be accepted. Currently untreated faecal sludge is used in agriculture in each city, which is not recommended. In general, households empty their septic tanks at the end of the lunar year which needs to be considered in the design of treatment options.

Recommendations concerning the faecal sludge management system*: Sludge should be treated for pathogen reduction or used in areas where risk to human health is low (e.g. forestry).As faecal sludge is produced all over the year, but at variable volumes, co-treatment with other wastes streams could provide a good solution to balance volumes. Increased monitoring of faecal sludge emptying and patterns is required. It would provide more accurate estimates for faecal sludge production. This information together with the characterization study that is being conducted within the PURR project, would provide means to more accurately design sludge management technologies.*

A study will be conducted in 2014 to assess potential substrates for co-treatment, and a market demand study will be conducted in 2015. Based on this information, together with the existing context, regulatory framework, involved stakeholders, and existing sanitation management systems, recommendations will be made for sludge management options that promote resource recovery from endproducts.

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5. http://vi.wikipedia.org/wiki/;
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7. Hoa Binh Province People Committee Offical website: http://www.hoabinh.gov.vn/;
8. Hoa Binh City People Committee Offical website: http://ubndtp.hoabinh.gov.vn/
9. Hoa Binh Department of Industry and Trade website: http://www.socongthuonghoabinh.gov.vn/
10. Lang Son Provincial People Committee Offical website: http://www.langson.gov.vn/
11. Ba Ria-Vung Tau Provincial People Committee Offical website: http://www.baria-vungtau.gov.vn/web/guest
12. Ba Ria-Vung Tau City People Committee Offical website http://baria.baria-vungtau.gov.vn

Annex 2: Questionnaire for the household survey

Interviewer: Date: Time: Group:
City……
Interview No:
Address: No…….. Street……
Type of building (number of stories, number of household in the same house,…):
Ward…….
Comments on interview (observation, visits, other person, place to see, other remarks):

We are from …… company. We are participating on a research project related to feacal sludge management in our city. The goal of the project is to search solutions to improve the management of wastewater and faecal sludge. Therefore, we need to understand what the situation on sanitation in the households is. We would like to discuss with you on this subject. The interview could last for 30 minutes. Your information will be used for research purpose only and will not be shared out of the research team. Could we start the interview?

PART 1: GENERAL INFORMATION ON THE HOUSEHOLD

1- Full name: ……..

2- Is the interviewed leading the household?

Yes 1❑
No 2❑

3- Status of household leader

Owner 1❑
Tenant 2❑
Other 3❑ Specify: …….

4- Number of persons living in the concession :

Total: ……

5- Main occupation of the household leader

Civil servant 1❑
Trader 2❑
Farmer 3❑
No activity 4❑
Other 5❑ Specify: …….

6- Source of water supply (can be several of them)? (PIE CHART)

Private connection 1❑
Public tap 2❑
Dug well 3❑
Drilled well 4❑
Surface water 5❑
Other 6❑

7- How much do you pay per month for water? ……VNĐ

8- What is the approximate quantity of water you use (specify if different sources)? …….. (m^3/day) or ……(m^3/month)

9- How much does your family earn per month? ……VND

PART 2 : SANITATION TECHNOLOGY

10- What kind of sanitation facility do you have?

Flush toilet, directly connected to sewer 1❑
Flush toilet + septic tank, connected to sewer 2❑

Flush toilet + septic tank + soak pit or open discharge 3❑
Pit latrine 4❑
VIP Latrine 5❑
Composting toilet (1 or 2 vaults) 6❑
No mix / urine separation toilet (1 or 2 vaults) 7❑
Other (Specify) 8❑
No toilet 9❑

In case there is no toilet: what is the habit (shared, open space, public toilet, other) ?

If no toilet, go to question 28.

11- Wastewater received in septic tank (sanitation facility) is from (can be several of them):

Toilet 1❑
Bathing, washing, cleaning 3❑
Other 4❑

12- Do you throw other materials in the pit / tank (e.g. solid wastes, oil, chemicals, manure,…) or do you add chemicals to improve degradation in it?

Yes 1❑ If yes, please specify.....
No 2❑

13- When did you build the septic tank?

< 5 years 1❑
5 – 10 years 2❑
10 – 20 years 3❑
> 20 years 4❑

14- Information on the onsite sanitation system (septic tank or other):

Volume:…….. (m^3)
Chamber:…….. (chamber)
Other characteristics:

How easy accessible is it for emptying:

Need to break the floor for assess 1❑
In the Kitchen
In the bathroom
Elsewhere:
Easy access through manhole, cap cover or other 2❑
Other, please specify: 3❑

PART 3 : EMPTYING PRACTICE

15- Did you already empty your pit? When last time?

Yes 1❑ If yes, when?.....
No 2❑

16- When the pit is full, what do you do?

I empty immediately 1❑
I empty if I have money 2❑
I empty if I have support 3❑
I close the pit 4❑
Other 5❑ Specify:…….

17- What kind of emptying service do you use?

Manual 1❑
Mechanical 2❑
Other 3❑ Specify:…….

18- If manual emptying is used, who does it?

Family member 1❑
Manual emptier 2❑

Other 3❑ Specify:…….

19- If mechanical emptying is used, what kind of company do you choose?

Public 1❑
Private 2❑
Company name, telephone (if any):…
Reason:……
Type of contract / relationship with them: ……

20- Distance from emptying trunk to the tank: …… (m)

21- How much do you pay for the service?

…… (VNĐ) for manual emptying;
…… (VNĐ) for mechanical emptying (truck).

22- What is the emptying frequency?

Twice a year 1❑
Once a year 2❑
< 5 years/time 3❑
5 - 10 years/time 4❑
Other 5❑ Specify: ……..

23- Do you or someone else reuse the sludge?

Yes 1❑
No 2❑

24- If yes, who is reusing it? Do you pay / get paid for it?

25- Do you pay / get paid for it? ……

Yes 1❑ If yes, how much / how?.....
No 2❑

26- For what is faecal sludge reused, in which period?

What is the treatment process, if any?……

PART 4 : FSM IMPROVEMENT

27- Where do liquid effluents after septic tank get discharged?

Drainage channel 1❑
River, lake, canal 2❑
Open space 3❑
Other 4❑
Specify: ……..

28- Where do other type of wastewater (cleaning/washing/bathing,…) get discharged ?

Drainage channel 1❑
River, lake, canal 2❑
Open space 3❑
Other 4❑
Specify: ……..

29- Do you care where your feacal sludge brought to?

Yes 1❑
No 2❑

30- How much are you willing to add up to the current payment for emptying service to improve the situation? ……..…… VNĐ

31- Would you accept that sludge from your facility is treated and marketed?

Yes 1❑
No 2❑

Thank you for your support!

Annex 3: List of persons contacted during the study

No	Name	Organisation	Position
1	Friedrich Lantzberg	Lahmeyer GKW Consultants	Project Director
2	Mr Đinh Quang Hiệp	Bac Ninh WSSC	President, Director
3	Mr Nguyễn Xuân Quyết	Bac Ninh WSSC	Manager of Bac Ninh Sewerage Entreprise,
4	Mr Nguyen VanThái	Bac Ninh WSSC	Assistant WSSC, PMU officer
5	Mr Chu Thanh Hai	DOC Bac Ninh	Head of Infrastructure Management Office
6	Mr Cảnh	URENCO Bac Ninh	Vice Director
7	Mr Nguyễn Trường Giang	URENCO Bac Ninh	PMU officer
8	Mr Hung	URENCO Bac Ninh	FS Emptying Worker
9	Mr Tua	FS Emptying group	FS Emptying Worker
10	Trần Mạnh Hồng	URENCO Son La	President, Director PMU
11	Mr Thanh	URENCO Son La	Vice Director PMU
12	Mr Toàn	URENCO Son La	Officer PMU
13	Mr Nguyen Duc Tuan	URENCO Son La	Head of Planning Office
14	Mr Ky	URENCO Son La	FS Emptying Worker
15	Mrs Hang	DONRE Son La	Environmental Resources Office
16	Mr Lam	DOC Son La	Infrastructure Management Office
17	Mr Cuong	FS Emptying group in Son La	FS Emptying Worker
18	Mr Lê Văn Liên	Hoa Binh PC	Vice President, Director PMU
19	Mr Hùng	Hoà Bình PC	Vice Director of PMU
20	Mr Chung	Hoà Bình PC	PMU officer
21	Mrs Trang	Hoà Bình PC	Infrastructure Management Office
22	Ms Trang	Hoà Bình PC	Health Office
23	Mr Trần Khắc Định	Hoa Binh URENCO	Director
24	Mr Tua	Hoa Binh URENCO	FS Emptying Worker
25	Mr Hung	FS Emptying group	FS Emptying Worker
26	Mr Nguyễn Hữu Chung	LAWASE	Director
27	Mr Quyết	LAWASE	Deputy Technical Director, Vice Director PM
28	Mr Tuấn	LAWASE	Technical Officer
29	Mr Phong	LAWASE	Technical Officer
30	Mr Luu	DOC Lang Son	Infrastructure Management Office
31	Mr Đinh Trọng Cảnh	Huy Hoang Company in Lang Son	Director
32	Mr Nguyen Phuc Hai	BUSADCO	Head of Technical Office
33	Mr Nguyen Xuan Bang	BUSADCO	Technical Office
34	Mr Trong	BUSADCO	FS Emptying Worker
35	Mr Dung	DONRE Ba Ria	Pollution Control Office
36	Mr Nguyen Trong Thuy	DOC Ba Ria	Head of Infrastructure Management Office
37	Mr Hai	Dai Nam Emptying group in Ba Ria	Director
38	Mr Hung	Le Gia Nhu Emptying group in Ba Ria	FS Emptying Worker
39	Mr Nam	Tan Thanh Emptying group in Ba Ria	FS Emptying Worker

Annex 4: Questionnaire for the interview of local authorities

Interviewer: Date:
Comments on interview (observation, visits, other person, place to see, other remarks):

1- General information:

- Full name of interviewed person: ……
- Position / Organization: ……
- Contact of interviewed person:
- Responsibilities:……

PART 1: SOCIO-ECONOMIC CONTEXT OF THE CITY

2- Population distribution per administrative division. Population forecast to horizon 2020 and 2025.

3- Please indicate on the city map the different areas (new city/old city/residential/commercial/industrial/administrative areas; connected/non connected to sewer network areas) or **provide the city land use map**.

4- Main economic activities and their shares to GDP of the city? Please indicate the most important occupations in each areas.

4-1. Agriculture–Forestry-Aquaculture: …….
4-2. Industry–Construction: . …….
4-3. Services:……

5- Orientation of economic development in the city. What will be the focused domain? Are there any document presenting the strategy in this field? Is it possible to obtain it ?

6- If available, is it possible to get a list of the hotel, restaurants, administrative buildings and hospital of the city?

PART 2: STATE MANAGEMENT ON WATER SUPPLY AND SANITATION

	Water Supply	Water drainage	Solid wastes	Feacal sludge
7- Functions/duties of your agency on the domain?				
8- Legal framework at national and local level applied on the domain?(Please provide local legal framework, if any)				
9- Annual state subsidy for the domain?				
10- Do you know any public and private companies providing service on the domain?				
11- Are there other stakeholders involved in the management (collection, transport, treatment, resource recovery, disposal)? Please describe their roles				
12- What are the contract-types of the companies? (contract, bidding,…)				
13- Scope of service of the company?				
14- Do you know any project related to the domain implementing in the city?				
15- Main challenges and difficulties in the management of the domain? Also related to the population development, land uses, and geographical features (slope, rivers, …).				
16- To improve the management of the domain in the future, would you have any idea or opinion?				

PART 3: EXISTING INFRASTRUCTURE OF THE CITY

17- Please describe the existing infrastructure of water supply:

17-1. Water sources:

17-2. Capacity:

17-3. Percentage or number of serviced households……..

18- Please describe the existing infrastructure of wastewater and drainage:

18-1. Estimated volume of wastewater generated in the city (m^3/day):

18-2. Estimated wastewater origin?

……% domestic
……% service (governmental administration and offices)
……% commerce, hotels and restaurants
……% industry
……% hospital
……..% other (specify)

18-3. Collected wastewater:…….(m^3/day) or ……%

18-4. Characteristics of sewer system:

- Combine/separate:……
- Year of construction:
- Remarks on design or construction:
- Difficulties in the management and operation of the infrastructures ?

18-5. Percentage of household connected to network? ……

- Total:
- Per district / area:

19- Please describe the existing situation of solid waste collection, transport and treatment:

19-1. Estimated volume of solid waste generated in the city (tonnes/day): ……..

19-2. Origin of solid wastes?

……% domestic ……% industry ……% hospital…….% others

19-3. Collected volume :…….(tonnes/day) or ……%

19-4. Discharged sites and their capacity? (Please indicate on the map)

19-5. Is solid waste reused? If yes, please specify treatment method, capacity and products?

20- Do your agency (or other related agencies) investigate the toilet facilities at households in the city? If yes, please provide the data.

Flush toilet, directly connected to sewer	……. (households) or……..(%)
Flush toilet + Septic tank, connected to sewer	……. (households) or……..(%)
Flush toilet + Septic tank + open space	……. (households) or……..(%)
Pit (dry) toilet (= traditional latrine)	……. (households) or……..(%)
Other (specify)	……. (households) or……..(%)
No toilet	……. (households) or……..(%)

In case there is no toilet: what is the habit (shared, open space) ?

(Data could be extrapolated from investigation. Please provide data sources)

21- Please describe the existing situation of collection, transport and treatment of feacal sludge:

21-1. Estimated volume of feacal sludge generated in the city (tonnes/day):……

21-2. Collected volume:……. (tonnes/day) or ……%

21-3. How is feacal sludge emptied?

How is feacal sludge treated?

21-4. Is feacal sludge reused? If yes, please specify treatment methods and capacity, products?

22- In your opinion, is uncontrolled feacal sludge a pollution in the city? If yes, what should be done to improve the situation?

23- Do you know any evidence of environmental pollution and disease transmission due to uncontrolled feacal sludge? If yes, what should be done to improve the situation?

PART 4: DATA AND REPORTS TO BE COLLECTED

- Environmental Status Report (if any)
- Socio-economic development reports in 3 recent years (if any)
- Report on socio-economic development planning (if any)
- Planning on urban infrastructure development, water supply and drainage, solid waste management (if any)

Thank you for your support!

Annex 5: Questionnaire for interview of wastewater and solid waste companies

Interviewer: Date:
Comments on interview (observation, visits, other person, place to see, other remarks):

INTERVIEW TO SEWERAGE AND URENCO COMPANIES

Company name: ……
Address: ……..
Telephone: ……Fax:…….. E-mail:……Web-site:…….
Full name of interviewed person: ……
Contact of interviewed person:
Position: ……
Responsibilities:
OBJECTIVES OF THE INTERVIEW:

- To understand the company's activities in the fields of wastewater drainage and/or collection/transport/treatment of solid waste and feacal sludge;
- To understand the state management and current infrastructures related to the above-mentioned fields
- To understand the status and practices in the fields of wastewater drainage and/or collection/transport/treatment of solid waste and feacal sludge in the city

SCOPE OF THE STUDY:

- In the urban area

PART 1: GENERAL INFORMATION ON THE COMPANY

1. Company category:

1.1. One member State limited liability company: ☐
1.2. Private limited liability company: ☐
1.3. Joint stock company: ☐
1.4. Other: ☐ Specify ……

2. General information of company:

2.1. Organization chart (*Please provide with paper)* ……

	Drainage (Collection/transport/treatment/reuse of rainwater, wastewater and sewer sludge dredging)	Solid wastes (Collection/transport/discharge/treatment/reuse)	Feacal sludge (Collection/transport/discharge/treatment/reuse)
2.2. Activities AND scope of service			
2.3. Contract-type with the government, the population, and the private and public companies: (contract, bidding, …)			
2.4. Financial indicators in the last 3 years: total income, income per activity, and financial support (with source) *(Please provide with paper)*			
2.5. Cost norm (VNĐ/m3 and VNĐ/tonnes) for : • Collection, • Transport • Treatment • Resource recovery • discharge			
2.6. Is there different costs for: • Households • Private companies and buildings • Public buildings			

PART 2: INFORMATION ON STATE MANAGEMENT

	Drainage (Collection/transport/treatment/reuse of rainwater, wastewater and sewer sludge dredging)	Solid wastes (collection/transport/discharge/ treatment/reuse)	Feacal sludge (collection/transport/discharge/treatment/reuse)
3. Legal framework at national and local level applied to the company's activities (including management and operation & maintenance, environmental protection, public health) (*Please provide local legal framework, if any)*			
4. Combien et contact if any other public and private companies with their capacity, acting on the city			
5. Do you have any recommendation to improve the management (in terms of infrastructure, geographical distribution, acceptation and participation by the population, collaboration with the other stakeholders, finances, staff) ?			
6. Do you know any environmental and sanitation project implementing in the city? If yes, please provide some information on the projects (technical description, area, capacity, timeframe for design, building, operation, stakeholders involved.)			

PART 3: COMPANY'S ACTIVITY ON DRAINAGE AND WASTEWATER SECTOR

7. Please describe the existing infrastructure of wastewater drainage (possible to indicate on the map)

7.1. Estimated volume of wastewater generated in the city (m^3/day):

7.2. Wastewater origin?

……% domestic
……% service (governmental administration and offices)
……% commerce, hotels and restaurants
……% industry
……% hospital
…….% other (specify)

7.3. Collected wastewater:…….(m^3/day) or ……%

7.4. Design characteristics of sewer system (if several areas are different, please specify, and show on the map) :

7.4.1.Type of sewer: a) combined ☐ b) Separate ☐

7.4.2.With overflow chamber: c) yes ☐ d) no ☐

7.4.3.Type of pipe: e) closed pipe ☐ f) open channel ☐

7.4.4.Year of construction: ……

7.4.5.Remarks on design or construction:

7.4.6.Difficulties during operation that relate to the slope

7.4.7.Length of the sewer system:

Primary:……
Secondary……
Tertiary……

7.5. Percentage of household connected to network? ……

Total:
Per district / area (*Please indicate on the map)*

7.6. Total amount of dredging sludge (sewer sludge) (m^3/year or tonnes/year)?

7.7. Dredging methods (material, staff, …) ?

7.8. Dredging frequency and period?

7.9. Treatment and disposal mode and areas ?

8. After collected, wastewater is disposed at

River, pond, other natural aquatic body 1❑
Drainage channel 2❑
Open space 3❑
Agricultural land (irrigation) 4❑
Other 5❑ Specify: ……

8.1. Is wastewater reused? If yes, please specify

8.2. Type of resource recovery:

Industry 1❑
Irrigation in agriculture (fruits, vegetables or trees) 2❑
Green areas 3❑
Other 4❑ Specify: ……

8.3. Type of treatment (if any) before reuse :

PART 4: GENERAL INFORMATION ON FAECAL SLUDGE MANAGEMENT IN CITY

9. Do you have information related to toilet facilities at households in the city? If yes, please provide data:

9.1. Design characteristics of onsite systems (if several areas are different, please specify, and show on the map!) (please show pictures to describe these) :

Flush toilet, directly connected to sewer	……. (households) or……..(%)
Flush toilet + Septic tank, connected to sewer	……. (households) or……..(%)
Flush toilet + Septic tank + open space or soak pit	……. (households) or……..(%)
pit (dry) toilet (= traditional latrine)	……. (households) or……..(%)
Other (specify)	……. (households) or……..(%)
No toilet	……. (households) or……..(%)

In case there is no toilet: what is the habit (shared, open space) ?

(Data could be extrapolated from investigation. Please provide data sources)

9.2. Access to toilet

At household / building	……. (households) or……..(%)
Shared between several houses	……. (households) or……..(%)
No toilet	……. (households) or……..(%)

(Data could be extrapolated from investigation. Please provide data sources)

9.3. In your opinion, percentage of septic tanks received wastewater from:

Toilet	……. %
Toilet and bathing, washing, cleaning	……. %
Other	……. %

9.4. Remarks on design or construction of onsite systems (number of chamber, sealed / unsealed, material used, robustness, …):

9.5. Remarks on operation of onsite systems (type of material thrown in, additional chemical used, maintenance habits, efficiency, …): ……

10. Faecal sludge origin by type of building?

……% domestic
……% service (governmental administration and offices)
……% commerce, hotels and restaurants
……% industry
……% hospital
…….% other (specify)

11. Estimated volume of faecal sludge generated in the city (m^3/day):

12. After collecting, what is done with the feacal sludge:

13. Does manual emptying exist / other methods for emptying in your city?

14. Do you know other companies? How many trucks do they have and their capacity (m3) ? Name: ……(m^3/day) or ……%
Name: ……(m^3/day) or ……%
Name: ……(m^3/day) or ……%
Name: ……(m^3/day) or ……%

PART 5: COMPANY ACTIVITY IN FAECAL SLUDGE MANAGEMENT

15. In the amount of sludge collected by your company, please specify the origin: (theo thu tu)

Households:	…… (m^3/day or year)
Residential building:	…… (m^3/day or year)
Restaurants, services:	…… (m^3/day or year)
Public toilets :	…… (m^3/day or year)
Other:	…… (m^3/day or year)

16. Data on average emptying volume and frequency

No	Category	Average emptying volume per onsite system (e.g. per septic tank), m^3	Frequency (years/time)
(1)	(2)	(3)	(4)
1	Single households in urban areas		
2	Residential building (more than two story and than one family)		
3	Single households in peri-urban areas		
4	Services (governmental administration, offices)		
5	Restaurants, hotels…		
6	Commerce		
7	Industries		
8	Hopital		
9	Other		

17. Do you remark differences between the characteristics of the faecal sludge from the different categories and onsite sytems (septic tank, pit latrine, public toilet) in terms of color, viscosity, solid materials, odors, etc…?
18. and since when):

    Truck 1: ……Age: …….Specification of the pump: …
    Truck 2: ……Age: …….Specification of the pump: …
    Truck 3: ……Age: …….Specification of the pump: …
    Truck 4: ……Age……Specification of the pump: …

18.1. Voyage per truck per day:

    Min: ……
    Average: ……
    Max:……..

18.2. Total voyage of trucks for other type of wastes (grease from restaurants, industrial wastes, …): voyage/year or m^3/year and tonnes/year

18.3. Number of days in service of trucks per year:……(days/year);

19. Are there periods (days, weeks, months when emptying activitiy is greated / lesser? When? Why?
20. After collected, faecal sludge is disposed at:

    River, pond, other natural aquatic body 1❑
    Drainage channel 2❑
    Open space 3❑
    Agricultural land (irrigation) 4❑
    Other 5❑ Specify: ……

21. Do you get paid or need to pay someone to discharge faecal sludge?
22. Is faecal sludge reused? If yes, please specify

22.1. Type of resource recovery:

    Industry 1❑
    Irrigation in agriculture (fruits, vegetables or trees) 2❑
    Green areas 3❑
    Other 4❑ Specify: ……

22.2. Quantity of faecal sludge reused (please, specify quantities for different type of enduse):
……(m^3/day or year) or ……%

22.3. Type of treatment (if any) before reuse (please specify treatment, design, quantities, contact of people involved, periods,…) :

PART 6: COMPANY'S ACTIVITY ON SOLID WASTE SECTOR

23. Please locate the existing infrastructure of solid waste in the map.

24. Please describe the existing infrastructure of solid waste:

24.1. Estimated volume of solid waste generated in the city (m^3/day):

24.2. Solid waste origin by type of building?

……% or m^3 or ton domestic
……% or m^3 or ton service (governmental administration and offices)
……% or m^3 or ton commerce, hotels and restaurants
……% or m^3 or ton industry
……% or m^3 or ton hospital
……% or m^3 or ton other (specify)

25. After collected, solid waste is disposed at:

Landfill sanitary 1❑ capacity: ……
Simple landfill 2❑ capacity: ……..
Open space 3❑ capacity: …….
Other 4❑ Specify: ……

…….. Capacity: ……

26. Is solid waste sorted? Is it reused? If yes, please specify

26.1. Type of resource recovery:

Industry 1❑
Irrigation in agriculture (fruits, vegetables or trees) 2❑
Other 3❑ Specify: ……

26.2. Quantity of solid waste reused :

…….(m^3/day or year) or ……%

26.3. Type of treatment (if any) before reuse :

PART 7: DATA AND REPORTS TO BE COLLECTED

- Annual summary report (2012)
- Report on existing and planning water supply and drainage infrastructures (if any)
- Documents on design of infrastructures (if any)
- Documents on organization of company
- Financial income and expenses
- Activity report on wastewater / drainage / solid waste / faecal sludge / sewer sludge management

Thank you for your support!

Annex 6: National regulations for urban water and sanitation in Vietnam

Sector	Official decisions, decrees and laws
General laws	- Law on Water Resource, promulgated on May 20, 1998; - Law on Environment Protection, promulgated in 1993 and revised on November 29, 2005.
Water supply	- Decision No. 63/ 1998/ QD-TTg, dated on 18th March 1998, ratifying the orientation for the water supply development of urban areas and industrial zones up to the year 2020. In 2009, the government updated the development orientations for urban water supply by the Decision No. 1929/2009/ QD-TTg dated on 20th November 209 describes the orientations for development of water supply in Vietnam's urban centers and industrial zones up to 2025 and a vision toward 2025; - Decree No. 117/ 2007/ ND-CP of 11th July 2007 on clean water production, supply and consumption, covers activities in the domains of production, supply and consumption of clean water under concentrated water supply systems in urban areas, rural areas, industrial zones, export processing zones, hi-tech parks and economic zones. The decree No 124/2011 ND-CP dated December 28, 2011 to amend and update the Decree No 117/2007/ND-CP on production, supply and consumption of drinking water was timely issued; - Decision No. 16/ QD-BXD dated 31st December 2008 issued by Ministry of Construction (MoC) on issue Regulations on Water Supply Safety.
Water drainage	- Decision No.35/ 1999/ QD-TTg, dated on 5th March 1999, ratifying the orientation for the urban drainage and sanitation development up to the year 2020. In 2009, the government also updated the development orientations for urban water drainage by the Decision No 1930/QD-TTg dated November 20, 2009, in which there was description of development orientations of drainage sector (urban drainage and wastewater) in urban areas and industrial parks up to 2025 and a vision to 2050; - Decree No.88/ 2007/ ND-Cp of 28th May 2007, on urban and industrial zones water drainage provides for water drainage activities in urban centers and industrial zones, economic zones, export processing zones, hi-tech parks. The decree regulates the drainage investment and development, and defines the responsibility in public management in regard to drainage activities from planning to investment, management, and operation to fee collection, inspection and fining defenders. The decree also stipulates rights and obligations of organizations, individuals and households to take part in drainage activities. For rural residential areas, if possible, the decree also encourages the construction of centralized drainage systems. The decree is being reviewed and updated to be more appropriate to the actual situation; - Decree No. 67/2003/NĐ-CP dated June 13, 2003 issued by the government on the fee of environmental protection for wastewater and the Decree No 04/2007/NĐ-CP dated on January 8, 2007 on revision and amendment of several articles of the Decree No 67/2003/NĐ-CP.
Solid waste	- Decision No 59/2007/ND-CP, dated on April 9, 2007, issues by Government, on the solid waste management and Circular No 13/2007/TT-BXD, dated 31/12/2007, on the detail guidance of several articles in decision No 59/2007/ND-CP; - Decision No 2038/QĐ-TTg, dated on November 15, 2011, issues by the Prime Minister, on the approval of the General Project for Healthcare Waste Management in the period of 2011 – 2015 and orientation to the year 2020.

Annex 7: Classification of urban centers in Vietnam

Grade	Socio-economic functions	Total population	Population density (person/km^2)	Non-agricultural labor force
Special grade	Capital or national center	> 5,000,000	> 15,000	> 90%
Grade 1	• National center • Inter-provincial center	> 1,000,000[1] > 500,000[2]	> 12,000[1] > 10,000[2]	> 85%
Grade 2	• Provincial center • Inter-provincial center	> 800,000[1] > 300,000[2]	> 10,000[1] > 8,000[2]	> 80%
Grade 3	• Provincial center • Inter-provincial center	> 150,000	> 6,000	> 75%
Grade 4	Intra-province reginal or provincial center	> 50,000	> 4,000	> 70%
Grade 5	District or inter-communal center	> 4,000	> 2,000	> 65%

(Source: Decree 49/2009/ND-CP)

The regulations concerning the urban water sector are different from that for rural areas, this report focuses on urban areas. There are several types of urban areas in Vietnam, as defined at the end of 2011 by the MoC Vietnam has 753 urban areas that are classified as follows:

- 2 special urban areas that are Hanoi and Ho Chi Minh City
- 3 central cities classified in category I - urban areas, including Hai Phong, Da Nang and Can Tho; 8 provincial cities classified in categories I – urban areas, including Hue, Da Lat, Nha Trang, Quy Nhon, Buon Ma Thuot, Thai Nguyen and Nam Dinh.
- 11 provincial cities are classified in category II – urban areas, including Bien Hoa, Ha Long, Vung Tau, Viet Tri, Hai Duong, Thanh Hoa, My Tho, Long Xuyen, Pleiku, Phan Thiet and Ca Mau.
- 47 urban areas are categories III that are a town or a provincial city, the five selected cities in the project are in categories III.
- 42 urban areas are categories IV that are towns or township, townlets

640 urban areas are categories V that are townlets

[1] City under Central government authority
[2] City under Provincial government authority