National University of Civil Engineering (NUCE), Ministry of Construction (MOC), Hanoi Department of Construction (Hanoi DOC) in Vietnam, Saitama University, The Center for Environmental Science in Saitama (CESS) in Japan

Baseline Survey Report on Construction and Demolition Waste Landfills in Hanoi, Vietnam

October 2019

SATREPS
Science and Technology Research Partnership for Sustainable Development Program

SATREPS (Science and Technology Research Partnership for Sustainable Development) is a Japanese government program that promotes international joint research targeting global issues. Global challenges cannot be met by a single country or region acting on its own, so engagement by the international community is essential. To address these issues, SATREPS works through three- to five-year projects involving partnerships between researchers in Japan and developing countries. SATREPS projects are expected to lead to outcomes with potential for practical utilization, and to enhance the research capacity in the developing country.

The program is a collaboration between two Japanese government agencies: the Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA).

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Preface

Based on the agreement between the Socialist Republic of Vietnam and Japan, a JST-JICA SATREPS (Science and Technology Research Partnership for Sustainable Development) project began in February 2018. The SATREPS project targets the establishment of environmentally sound management of construction and demolition waste and its wise utilization for control of environmental pollution and production of new recycled construction materials; it will continue until March 2023.

This publication is the Baseline Survey Report on Construction and Demolition Waste (CDW) Landfills in Hanoi, Vietnam. The survey was carried out as a part of SATREPS project activities from 2018 to 2019. The objective of the survey was to identify the current situation of CDW landfill sites in Hanoi using basic information collection and a proposed check sheet on the project.

We would like to take this opportunity to thank the staff of the JICA Vietnam Office and the respective coordinators from the JICA headquarter and the JST for their continuous support on the SATREPS project.

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1. Summary

With rapid urbanization and economic growth on all fronts, much construction is conducted everywhere in Vietnam, especially in big cities such as Hanoi and Ho Chi Minh. The generation of construction and demolition waste (hereafter referred to as "CDW") is increasing year by year, and it is reported that the CDW generation accounts for 10–12% of total municipal solid waste generation (about 60,000 tons/day). Currently, the daily generation of CDW in Hanoi and Ho Chi Minh exceeds 3,000 tons/day. In order to maintain the environment and sustainable development, and save natural resources, the generated CDW must be managed adequately and reused/recycled. However, till now basic information on CDW dumping/landfilling sites (hereafter referred to as "CDW landfills") was lacking, even though those sites are the terminal destination in the CDW stream. Actual information on CDW landfills would contribute to the discussion of sustainable CDW management and future strategies among stakeholders. This report aims to identify the current condition of CDW landfills targeting Hanoi, Vietnam.

The survey consists of i) basic information survey and ii) check sheet survey. For the basic information survey, a total of seven CDW landfills (five closed/abandoned and two in operation) were investigated. On the other hand, the check sheet survey was carried out at four CDW landfills (two closed/abandoned and two in operation). All investigated sites were public lands which belong to Hanoi People's Committee and were/are operated by private companies except for Nhat Tan site. Land usage at all closed/abandoned CDW landfills is scheduled to be changed by Hanoi People's Committee (Note: Van Noi site is already used for the concrete plant facility). The land areas of CDW landfills varied widely between 2,000 to 94,000 m^2, while the closed/abandoned landfills were operated for six years irrespective of the difference in land area. Two CDW landfills under operation, Vinh Quynh and Thanh Tri sites, accept only typical CDW such as concrete, clay brick, soil, and sludge from construction and demolition works and town cleaning. However, some of closed/abandoned CDW landfills accepted not only CDW but also domestic waste. For all CDW landfills, the depth of dumped CDW was normally within 4 m depth from the ground surface and no dumping of hazardous waste was observed. Except for Duong Lien site which accepted domestic waste, the sanitary condition of the investigated CDW landfills was good, with normal vegetation, no insects, and no discolored soil or water. In addition, there was no threat of piled CDW collapse inside and/or outside the dumping sites. Based on the survey results, challenges and recommendations to improve current CDW management and to promote recycling of CDW in Hanoi are summarized.

2. Background and Objectives

In recent years, building and construction work has been increasing rapidly in urban areas of Vietnam, such as Hanoi, Hai Phong, Da Nang, and Ho Chi Minh, after the Vietnamese government issued Resolution 34/2007/NQ-CP [1]. Along with the rapid development in urban areas, construction and demolition waste (hereafter referred to as "CDW") has been increasing simultaneously. It is reported that the CDW generation accounts for 10–12% of total municipal solid waste generation (about 60,000 tons/day) [2]. Currently, the daily generation of CDW in Hanoi and Ho Chi Minh exceeds 3,000 tons/day [3]. The generated CDW has not been fully recycled, however, and a major part of generated CDW is brought to CDW landfills without any treatment. For example, around 40–56% of CDW daily generated in Viet Nam is brought to CDW landfills in Hanoi [4]. In the National Strategy for Integrated Management of Solid Waste up to 2025 and Vision towards 2050 [5], government targets to improve the current situation to 90% of CDW collection and 60 % of CDW recycling by 2025.

In order to achieve sound CDW management and to promote CDW recycling, it is necessary to understand the current CDW stream, including CDW generation, collection, reuse/recycling, and final disposal. However, till now there is no reliable data or information on the CDW landfills. The actual data and information of CDW landfills is important to discuss the sustainable CDW management and future strategies among stakeholders in Vietnam. Therefore, the objective of this report is to identify the current condition of CDW landfills in Hanoi based on i) a basic information survey and ii) a check sheet survey. The former aims to collect basic information on CDW landfills such as land area, operation years, acceptable waste, waste intake, and so on. The latter aims to investigate more detailed information such as actual type of dumped waste, thickness of the waste layer, on-site sanitary conditions, and the surrounding environment using a proposed check sheet of the SATREPS project.

3. Methodology

In this report, the baseline survey for CDW landfills consisted of two surveys: i) basic information survey, and ii) check sheet survey.

3.1. Basic information survey

A basic information survey for CDW landfills was carried out targeting seven CDW landfills located in Hanoi: Van Noi, Nguyen Khe, Vinh Quynh, Duong Lieu, Dan Phuong, Nhat Tan, and Thanh Tri. The locations are shown in Fig. 1. In order to identify the basic information of CDW landfills, 18 items were selected, and data was collected by interviews of landowners and operating companies, searches on the internet, and site visits. The items used in the survey are shown in Table 1.

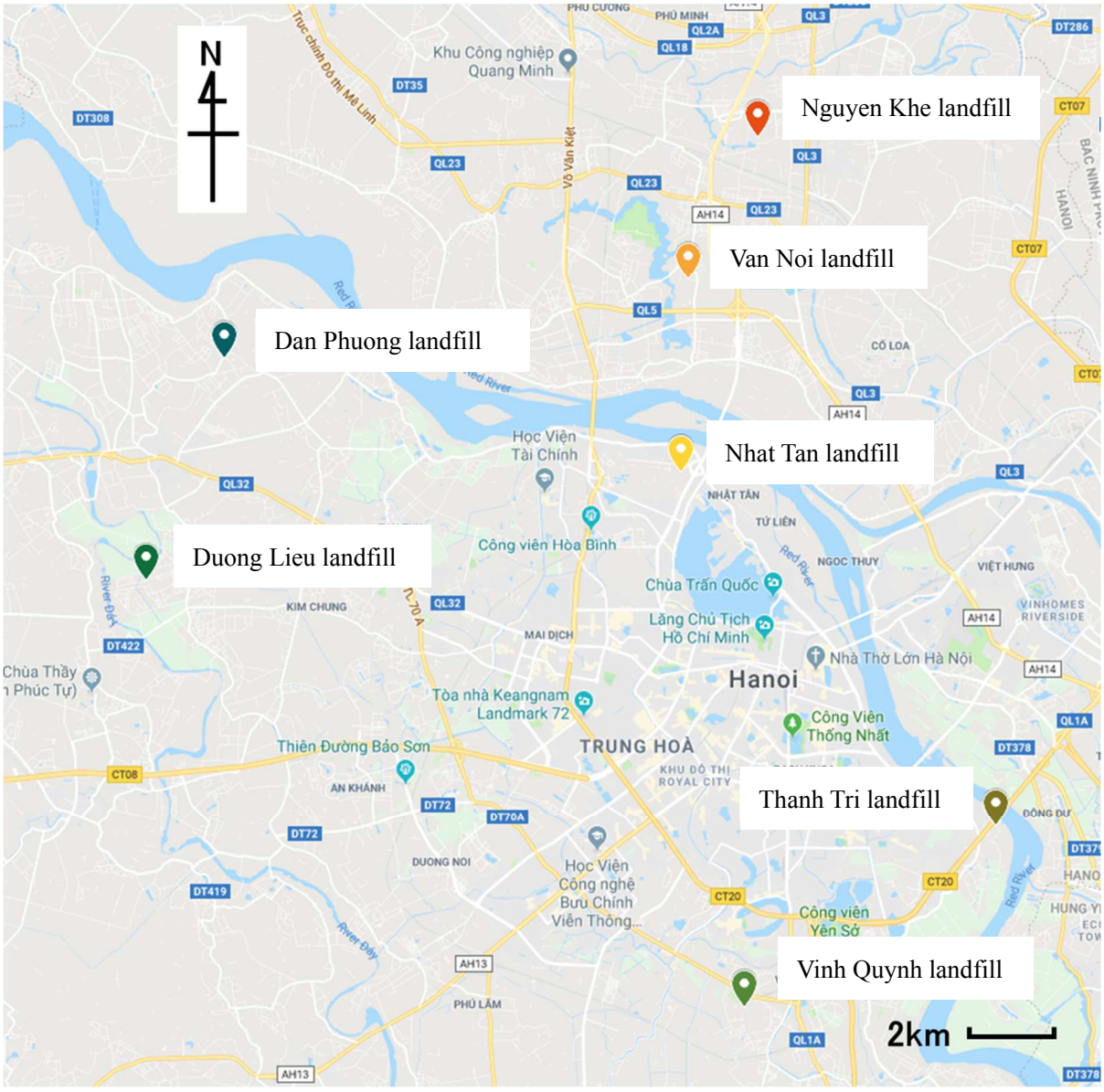


Figure 1. Location of seven CDW landfills in Hanoi.

Table 1. Items on the basic information survey.

Item no.	Content	[Site Name]
1	**GPS location**	
2	**Estimated area (m^2)**	
3	**Landowner**	
4	**Operation company/institute**	
5	**Number of workers**	
6	**Intake per day/week/month**	
7	**Operation years**	
8	**Estimated life years**	
9	**Photo**	
10	**Groundwater level**	
11	**Acceptable waste**	
12	**Previous land use**	
13	**Height of dumped waste**	
14	**Surrounding environment**	
15	**Accessibility**	
16	**Workability**	
17	**Weather**	
18	**Remarks**	

3.2. Check sheet survey

In order to investigate CDW landfills in more detail, including actual types of dumped waste, thickness of waste layers, on-site sanitary conditions, and surrounding environment, the check sheet survey was carried out at four CDW landfills: Nguyen Khe, Vinh Quynh, Duong Lieu, and Thanh Tri. The check sheet survey list is shown in Table 2. The items on the check sheet were determined by referring to the items listed in the field survey manual published by Japan Industrial Waste Management Foundation [6]. In the field survey, an actual excavation of the ground was carried out to identify the waste composition and groundwater level.

Table 2. Check sheet for CDW landfills.

Check Sheet for CDW Landfills

Date:
Weather:
Site name:
Surveyor name:

1. Current situation of landfill site

Waste type

Type: □Concrete □Brick □Tile □Rock □Wood □Plastic □Steel □Soil □Other ( )
Burnable waste: □No □Yes ( )
Hazardous waste: □Oil □PCB □Asbestos □Incinerated ash □Other ( )
Covering soil: □Whole area □Partial area □None

Site condition

Facility type: □Intermediate treatment facility □Final disposal facility □Transshipment facility □Illegal dumping
Collapse of Wall: □No □Yes ( )

Sedimentary condition of dumped CDW

Depth and/or height: □Less than 4 m □4 – 10 m □Over 10 m
Area size: ( ) m^2
Waste amount: ( ) m^3
Internal temperature: ( ) °C
Odor Area range: □None □Partial area □Whole area Type: □Hydrogen sulfide (H_2S) □Enteruria □Disinfectant □Oil □Smoke □Other ( ) H_2S measurement: Northern side ( ) ppm, Southern side ( ) ppm Eastern side ( ) ppm, Western side ( ) ppm

Collapse inside: □No □Yes ( )
Vegetation: □Normal □Abnormal □Discolor □Unnatural dry □No vegetation
Insects: □None □Centipedes □Flies □Mosquitoes □Other ( )
Discolored soil: □No □Yes ( ) m^2, ( ) color
Discolored water: □No □Yes ( ) color, pH ( ), ( ) ppm
Caving: □No □Yes ( )

Informant

Source: □Land owner □Operation company □Local citizen
Fire disaster in the past: □No □Unknown □Yes ( )
Type of waste: ( )
Incinerator: □No □Yes ( )
Other:

2. Surrounding environment

Water environment: □None □River □Pond □Channel
Well: □No □Yes ( ) m
Claim: □No □Yes ( )
Odor: □No □Yes ( )
Collapse outside: □No □Yes ( )
Insects: □None □Centipedes □Flies □Mosquitoes □Other ( )
Intruding water: □No □Yes ( ) pH, ( ) ppm
Discolored soil: □No □Yes ( ) m^2, ( ) color
Caving and/or Swelling: □None □Caving □Swelling ( )
Scattered: □No □Yes ( )

3. Other

4. Sketch of landfill site

4. Results of Surveys

4.1. Basic information survey

Earth views of the seven CDW landfills investigated are shown in Figs. 2–8, and basic data collected are summarized in Tables 3–9. Among the seven CDW landfills investigated, five (Van Noi, Nguyen Khe, Vinh Quynh, Duong Lieu, Dan Phuong) have already been closed or abandoned. Consequently, two CDW landfills at Nhat Tan and Thanh Tri are operating. The major results from basic information survey were summarized below:

1. Landowner and operation company: All investigated sites were public land that belongs to Hanoi People's Committee. Except for Nhat Tan site, all CDW landfills are/were operated by appointed private companies under the management of Hanoi Department of Construction (DOC).
2. Land use after closure: Currently, land usage of all closed and/or abandoned CDW landfills is scheduled to be changed by the Hanoi People's Committee. Among these landfills, the land usage of Van Noi site has already been altered, and it is used as a concrete plant.
3. Land area: The land areas of closed and/or abandoned CDW landfills varied widely between 2,000 to 94,000 m^2. The areas of the two landfills under operation, Van Noi and Thanh Tri, are 25,000 and 29,000 m^2.
4. Operation years: All closed and/or abandoned CDW landfills were used for six years irrespective of the difference in land area.
5. Acceptable waste: All investigated CDW landfills accepted/accept mainly CDW such as concrete and clay brick masonry, soil, and sludge generated by construction and demotion work, and town cleaning work. However, three of the closed and/or abandoned CDW landfills (Van Noi, Vinh Quynh, and Duong Lieu) accepted not only CDW but also domestic waste.
6. Previous land use: The land for CDW landfills was either pond/vacant land or used for agricultural purposes.
7. Height of dumped waste: For closed and/or abandoned CDW landfills, the height of dumped waste is estimated to be less than 5 m. On the other hand, the heights of the two landfills under operation, Van Noi and Thanh Tri, are greater than 5 m.

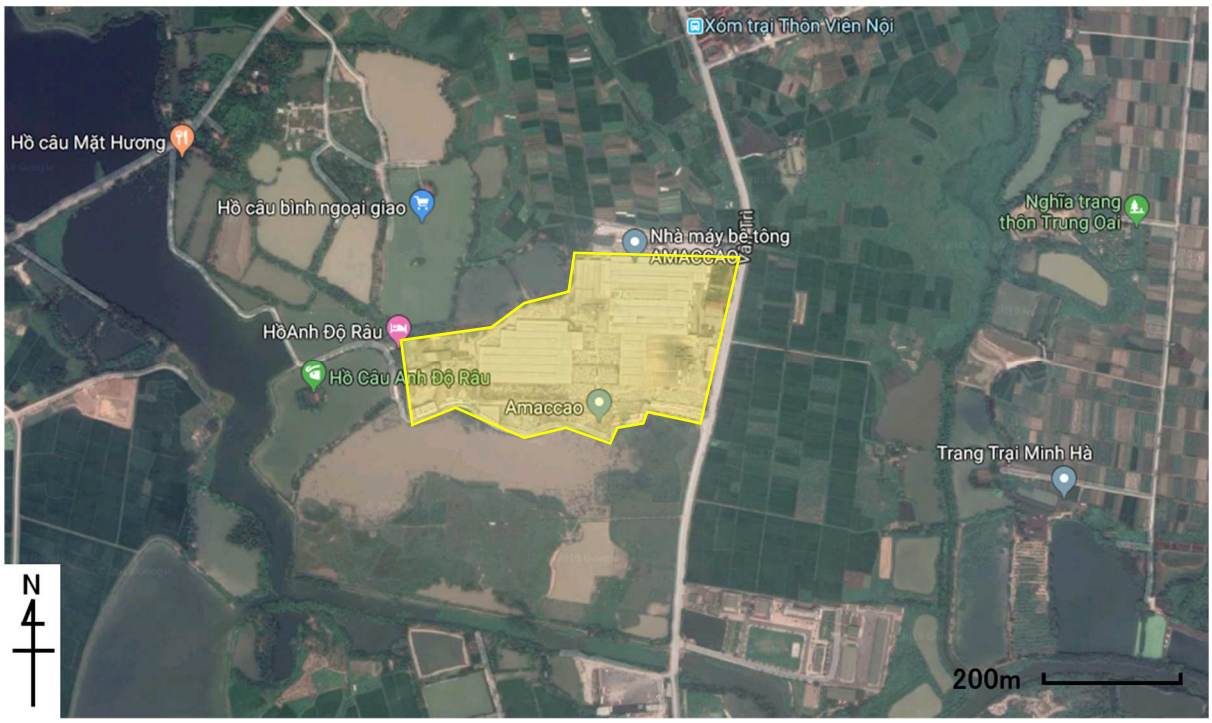


Figure 2. Earth view for Van Noi CDW landfill (Google Inc. Dated on July 01, 2019).

Figure 3. Earth view for Nguyen Khe CDW landfill (Google Inc. Dated on July 01, 2019).

Figure 4. Earth view for Vinh Quynh CDW landfill (Google Inc. Dated on July 01, 2019).

Figure 5. Earth view for Duong Lieu CDW landfill (Google Inc. Dated on July 01, 2019).

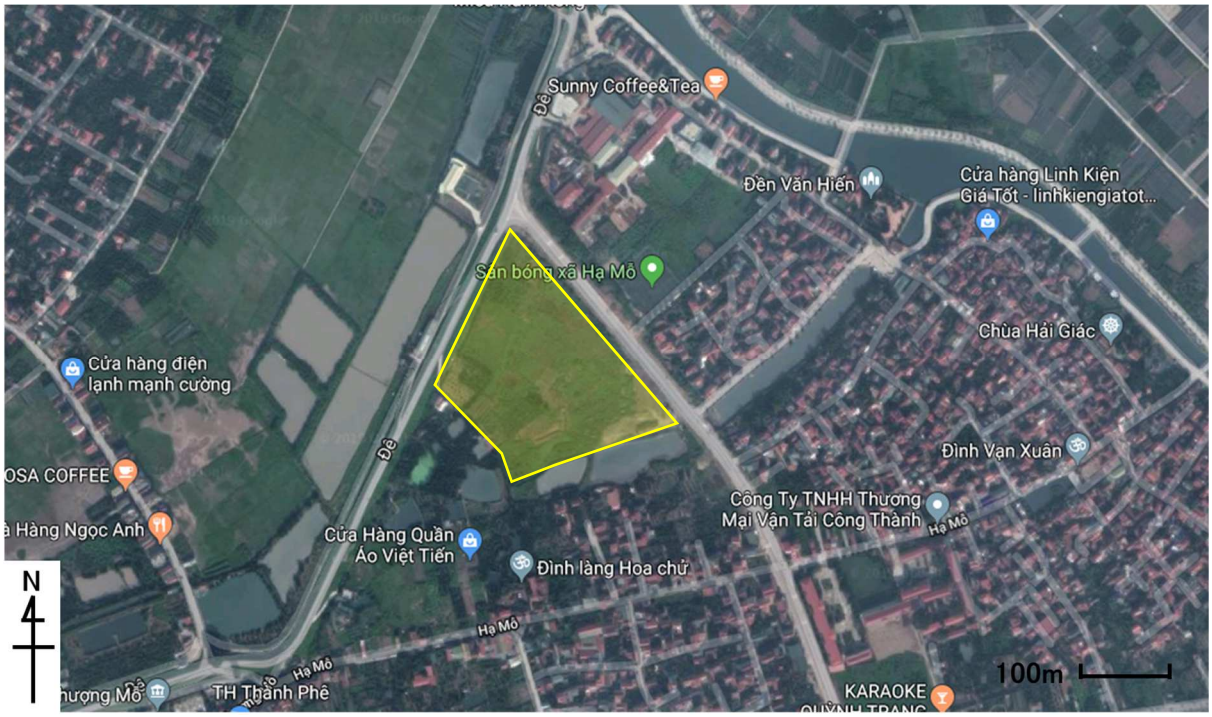


Figure 6. Earth view for Dan Phuong CDW landfill (Google Inc. Dated on July 01, 2019).

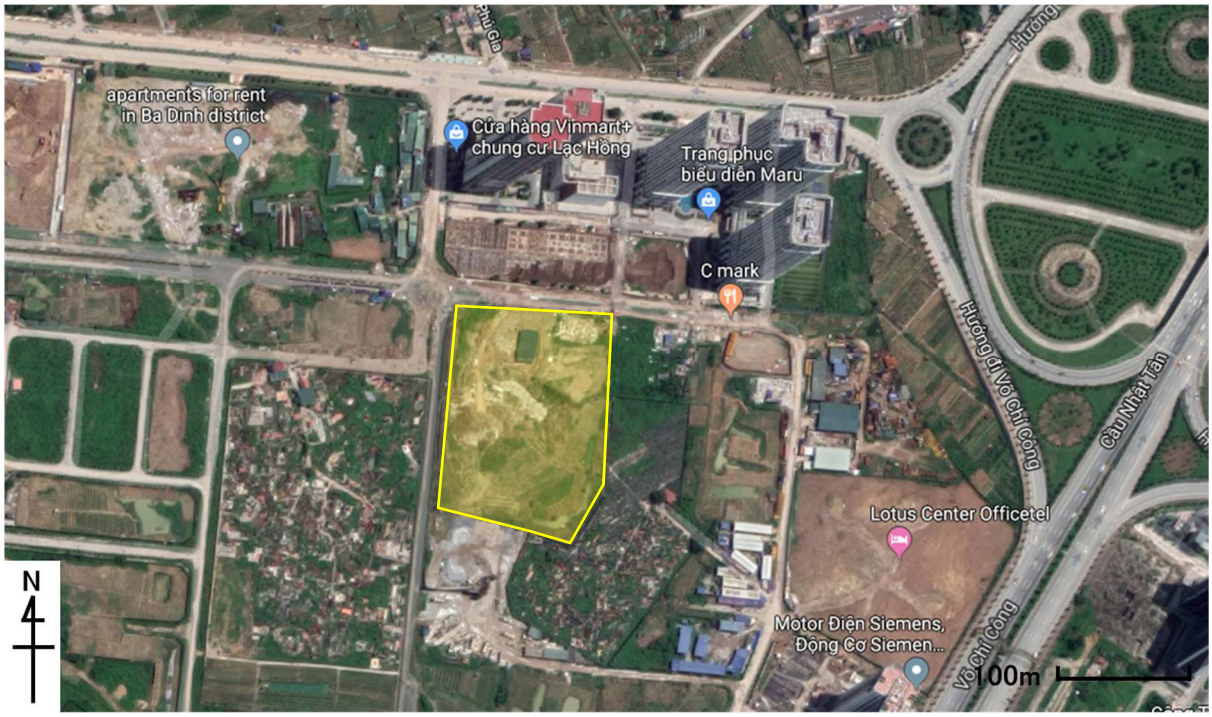


Figure 7. Earth view for Nhat Tan CDW landfill (Google Inc. Dated on July 01, 2019).

Figure 8. Earth view for Thanh Tri CDW landfill (Google Inc. Dated on July 01, 2019).

Table 3. Basic information survey for Van Noi CDW landfill.

Item no.	Content	Van Noi
1	**GPS location**	21° 7' 52.212" N, 105° 48' 50.004" E
2	**Estimated area (m^2)**	94,000
3	**Landowner**	Hanoi People's Committee (public land)
4	**Operation company/institute**	Waste Treatment & Investment for Development of Hanoi Environment Joint Stock Company
5	**Number of workers**	1 guard (in the past)
6	**Intake per day/week/month**	40-50 trucks (daily intake in the past)
7	**Operation years**	6 years since 2008 to 2013
8	**Estimated life years**	None (Closed)
9	**Photo**	(See Fig. 2)
10	**Groundwater level**	Unknown
11	**Acceptable waste**	CDW, domestic wastes (in small amount by residential people surrounding)
12	**Previous land use**	Unknown
13	**Height of dumped waste**	Unknown (Currently, the landfill site is used for the concrete plant facility)
14	**Surrounding environment**	Van Tri lake, agricultural field, golf field
15	**Accessibility**	Good (30 min from NUCE)
16	**Workability**	No space
17	**Weather**	Wet season: May - October, heavy rain Dry season: November - April, small rain
18	**Remarks**	● No longer available, FULL since 2013. ● Land usage has been changed by Hanoi People's Committee in 2013. Currently, the land is used for AMACCAO Concrete Plant.

Table 4. Basic information survey for Nguyen Khe CDW landfill.

Item no.	Content	Nguyen Khe
1	**GPS location**	21° 10' 12.144" N, 105° 49' 56.352" E
2	**Estimated area (m^2)**	7,000
3	**Landowner**	Hanoi People's Committee (public land)
4	**Operation company/institute**	Waste Treatment & Investment for Development of Hanoi Environment Joint Stock Company
5	**Number of workers**	0
6	**Intake per day/week/month**	10-40 trucks (daily intake in the past)
7	**Operation years**	6 years since 2013 to 2018
8	**Estimated life years**	None (Closed)
9	**Photo**	(See Fig. 3)
10	**Groundwater level**	~ 10 m below the ground surface
11	**Acceptable waste**	Soil and sludge, CDW
12	**Previous land use**	Pond
13	**Height of dumped waste**	~ 5 m in height
14	**Surrounding environment**	Clay bricks manufacturing facilities, pond, driving school
15	**Accessibility**	Good (40 min from NUCE)
16	**Workability**	No space
17	**Weather**	Wet season: May - October, heavy rain Dry season: November - April, small rain
18	**Remarks**	● Abandoned more than 1 year before. Reason: FULL (Source: Mr. Dậu, contact from Delta Corporation), no guards but residential people surrounding gave cautions at that time. ● Currently, the most of piled CDW has been removed and the main area is used for stockyard for manufactured clay bricks. The land usage is scheduled to change in 2019 by Hanoi People's Committee. ● Type of dumped waste: Mainly sludge, soil, mixed with some CDW (brick, concrete, mortar…). ● There was a pond previously. A river separated from the Song Ca Lo river disappeared around the landfill site (see Fig. 3).

Table 5. Basic information survey for Vinh Quynh CDW landfill.

Item no.	Content	Vinh Quynh
1	**GPS location**	20° 56' 31.632" N, 105° 49' 41.52" E
2	**Estimated area (m^2)**	44,000
3	**Landowner**	Hanoi People's Committee (public land)
4	**Operation company/institute**	Environmental Technology and Ecology Joint Stock Company
5	**Number of workers**	1 guard
6	**Intake per day/week/month**	20-30 trucks (1.25 tons)
7	**Operation years**	6 years since 2013 to 2018
8	**Estimated life years**	None (Closed)
9	**Photo**	(See Fig. 4)
10	**Groundwater level**	2.5-3.5 m from the ground surface
11	**Acceptable waste**	CDW (brick concrete, tile, stone, wood, plastic, soil), domestic waste
12	**Previous land use**	Pond
13	**Height of dumped waste**	3.5 - 4.0 m from the ground surface
14	**Surrounding environment**	Pond, channel, agricultural field
15	**Accessibility**	Good (30 min from NUCE)
16	**Workability**	Enough space to work
17	**Weather**	Wet season: May - October, heavy rain Dry season: November - April, small rain
18	**Remarks**	● Under limited operation (ALMOST FULL). The land usage is scheduled to change in 2019 by Hanoi People's Committee. ● Available for visit with an official document from local government. ● Type of dumped waste was different among points inside.

Table 6. Basic information survey for Duong Lieu CDW landfill.

Item no.	Content	Duong Lieu
1	**GPS location**	21° 3' 12.384" N, 105° 39' 37.692" E
2	**Estimated area (m^2)**	2,000
3	**Landowner**	Hanoi People's Committee (public land)
4	**Operation company/institute**	Environmental Technology and Ecology Joint Stock Company
5	**Number of workers**	None (Closed)
6	**Intake per day/week/month**	10-20 trucks (daily intake in the past)
7	**Operation years**	6 years since 2013 to 2018
8	**Estimated life years**	None (Closed)
9	**Photo**	(See Fig. 5)
10	**Groundwater level**	Unknown
11	**Acceptable waste**	Domestic waste, soil, CDW
12	**Previous land use**	Agricultural field
13	**Height of dumped waste**	Less than 1 m height
14	**Surrounding environment**	Agricultural fields, local people have already illegally seized the area
15	**Accessibility**	Good (50 min from NUCE)
16	**Workability**	Small space to work
17	**Weather**	Wet season: May - October, heavy rain Dry season: November - April, small rain
18	**Remarks**	● Under operation but only for the dumping of domestic waste, reason: FULL, no entrance gate with no guard. ● Available for visit freely. The land usage is scheduled to change in 2019 by Hanoi People's Committee. ● Type of waste is unsuitable, poor environment.

Table 7. Basic information survey for Dan Phuong CDW landfill.

Item no.	Content	Dan Phuong
1	**GPS location**	21° 6' 40.464" N, 105° 40' 58.8" E
2	**Estimated area (m^2)**	37,000
3	**Landowner**	Hanoi People's Committee (public land)
4	**Operation company/institute**	Waste Treatment & Investment for Development of Hanoi Environment Joint Stock Company
5	**Number of workers**	1 guard (in the past)
6	**Intake per day/week/month**	30-40 trucks (daily intake in the past)
7	**Operation years**	6 years since 2008 to 2013
8	**Estimated life years**	None (Closed)
9	**Photo**	(See Fig. 6)
10	**Groundwater level**	Unknown
11	**Acceptable waste**	CDW
12	**Previous land use**	Rice field
13	**Height of dumped waste**	Unknown
14	**Surrounding environment**	Roads, residential areas being developed
15	**Accessibility**	Good (1 hour from NUCE)
16	**Workability**	No space
17	**Weather**	Wet season: May - October, heavy rain Dry season: November - April, small rain
18	**Remarks**	● No longer available. FULL since 2013, then some parts inside were illegally used by surrounding people to plant vegetables ● The land usage has been changed by Hanoi People's Committee since 2018 to develop a public park.

Table 8. Basic information survey for Nhat Tan CDW landfill.

Item no.	Content	Nhat Tan
1	**GPS location**	21° 4' 57.252" N, 105° 48' 38.988" E
2	**Estimated area (m^2)**	25,000
3	**Landowner**	Hanoi People's Committee (public land)
4	**Operation company/institute**	None
5	**Number of workers**	0
6	**Intake per day/week/month**	40-50 trucks (daily intake mixed 1.25 tons & 5 tons)
7	**Operation years**	Since 2017 till now
8	**Estimated life years**	Unknown (until full, or until owner claims land)
9	**Photo**	(See Fig. 7)
10	**Groundwater level**	4-5m below from the ground surface
11	**Acceptable waste**	Soil, construction sludge (after pile boring), CDW
12	**Previous land use**	Agricultural field
13	**Height of dumped waste**	~10 m in height
14	**Surrounding environment**	Concrete manufacturing company, high-rise buildings
15	**Accessibility**	Good (20 min from NUCE)
16	**Workability**	Small space to work
17	**Weather**	Wet season: May - October, heavy rain Dry season: November - April, small rain
18	**Remarks**	● The site is situated among many high-rise buildings that were raised from agricultural field; it is most likely that eventually, this area is going to be developed into a similar residential building. ● Groundwater level is determined by making reference to soil investigations carried out at nearby construction sites. ● Under operation, no entrance gate with no guard. ● Available for visit freely. ● Illegal dumping of waste happens during night time.

Table 9. Basic information survey for Thanh Tri CDW landfill.

Item no.	Content	Thanh Tri
1	**GPS location**	20° 59' 21.6" N, 105° 53' 58.1" E
2	**Estimated area (m^2)**	29,000
3	**Landowner**	Hanoi People's Committee (public land)
4	**Operation company/institute**	Waste Treatment & Investment for Development of Hanoi Environment Joint Stock Company
5	**Number of workers**	4 guards
6	**Intake per day/week/month**	Unknown (fluctuated)
7	**Operation years**	Since 2017 till now
8	**Estimated life years**	5 years (up to 2022)
9	**Photo**	(See Fig. 8)
10	**Groundwater level**	5-10 m from the ground surface
11	**Acceptable waste**	CDW (brick, concrete, tile, stone, wood, glass, plastic, steel, soil)
12	**Previous land use**	Vacant land (Free area formed by sedimentation of Red River)
13	**Height of dumped waste**	~10 m in height, 1 m in depth
14	**Surrounding environment**	Red river, agricultural field, river sand-stock company
15	**Accessibility**	Good (20~30 min from NUCE)
16	**Workability**	Enough space to work
17	**Weather**	Wet season: May - October, heavy rain Dry season: November - April, small rain
18	**Remarks**	● Under operation with 2 guards. ● Available for visit. ● Type of waste: CDW mixed with a lot of soil ● Additional information: 01 crushing machine on display.

4.2. Check sheet survey

The data collected by the check sheet survey are shown in Tables 10–13. Photos of the sites are shown in Figs. 9–12. The major results of the check sheet survey are summarized as:

1. Waste type: Nguyen Khe, Vinh Quynh, and Thanh Tri landfills accepted mainly CDW such as concrete, clay brick, soil, and sludge. However, Duong Lien landfill site accepted not only CDW but also domestic waste.
2. Depth of dumped waste: most dumped CDW observed was within 4 m depth from the ground surface.
3. Covering soil: At Nguyen Khe and Vinh Quynh CDW landfills, a soil cover was observed at partial zones inside. On the other hand, there was no soil cover at other landfill sites.
4. Hazardous waste: Basically, there was no dumping of hazardous waste at investigated sites. However, a small amount of dumped incinerated ash was observed at Vinh Quynh landfill site.
5. Odor: At Vinh Quynh landfill site, a slight odor of hydrogen sulfide was observed inside the dumping area. At the Duong Lien landfill site, a rotten odor was strong both inside and outside the dumping site due to the dumped domestic waste.
6. Sanitary condition: Except for Duong Lien landfill site, which accepted domestic waste, the sanitary condition of investigated CDW landfills was good with normal vegetation, no insects, and no discolored soil or water.
7. Collapse of piled CDW: There was no threat of piled CDW collapse inside or outside the dumping sites.

Table 10. Check sheet for Nguyen Khe CDW landfill site.

Check Sheet for CDW Landfills

Date: 12 March 2019
Weather: Cloudy
Site name: Nguyen Khe CDW landfill site
Surveyor name: Isobe, Kato, Tan, Cham

1. Current situation of landfill site

Waste type

Type: □Concrete □Brick □Tile □Rock □Wood □Plastic □Steel ☑Soil ☑Other (Some concrete and clay brick masonry mixed with soil)
Burnable waste: ☑No □Yes ( )
Hazardous waste: □Oil □PCB □Asbestos □Incinerated ash □Other ( )
Covering soil: □Whole area ☑Partial area □None

Site condition

Facility type: □Intermediate treatment facility ☑Final disposal facility □Transshipment facility □Illegal dumping
Collapse of Wall: ☑No □Yes ( )

Sedimentary condition of dumped CDW

Depth and/or height: □Less than 4 m ☑4 – 10 m □Over 10 m
Area size: (7,000) m^2
Waste amount: ( ) m^3
Internal temperature: ( ) °C
Odor Area range: ☑None □Partial area □Whole area Type: □Hydrogen sulfide (H_2S) □Enteruria □Disinfectant □Oil □Smoke □Other ( ) H_2S measurement: Northern side ( ) ppm, Southern side ( ) ppm Eastern side ( ) ppm, Western side ( ) ppm
Collapse inside: ☑No □Yes ( )
Vegetation: ☑Normal □Abnormal □Discolor □Unnatural dry □No vegetation
Insects: ☑None □Centipedes □Flies □Mosquitoes □Other ( )
Discolored soil: ☑No □Yes ( ) m^2, ( ) color

Discolored water: ☑No □Yes ( ) color, pH ( ), ( ) ppm
Caving: □No ☑Yes (a big hole with 10 ~ depth)

Informant

Source: ☑Land owner □Operation company □Local citizen
Fire disaster in the past: □No □Unknown □Yes ( )
Type of waste: ( )
Incinerator: □No □Yes ( )
Other: Previously the land was used as a rice field.

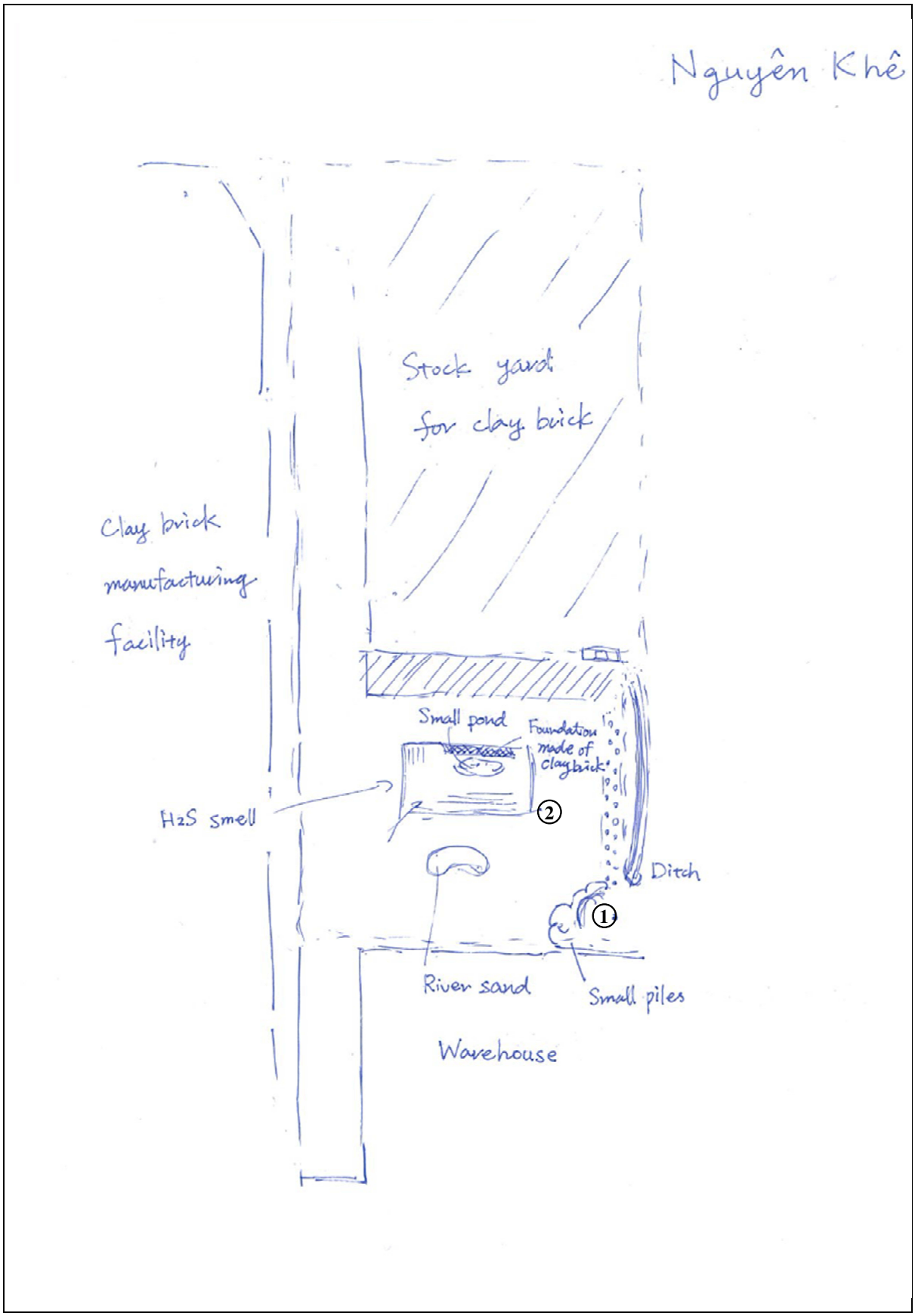
2. Surrounding environment

Water environment: □None □River ☑Pond □Channel
Well: ☑No □Yes ( ) m
Claim: ☑No □Yes ( )
Odor: ☑No □Yes ( )
Collapse outside: ☑No □Yes ( )
Insects: ☑None □Centipedes □Flies □Mosquitoes □Other ( )
Intruding water: ☑No □Yes ( ) pH, ( ) ppm
Discolored soil: ☑No □Yes ( ) m^2, ( ) color
Caving and/or Swelling: ☑None □Caving □Swelling ( )
Scattered: ☑No □Yes ( )

3. Other

The most of piled CDW has been removed already. There is a big excavated ground hole at the central zone of the site.

4. Sketch of landfill site



(a) Point ①

(b) Point ②

(c) Point ② (other view)

Figure 9. Photos of Nguyen Khe CDW landfill.

(Locations of Point ① and ② are given in "4. Sketch of landfill site" of the check sheet)

Table 11. Check sheet for Vinh Quynh CDW landfill site.

Check Sheet for CDW Landfills

Date: 13 March 2019
Weather: Cloudy
Site name: Vinh Quynh CDW landfill site
Surveyor name: Isobe, Kato, Tan, Cham

1. Current situation of landfill site

Waste type

Type: ☑Concrete ☑Brick ☑Tile ☑Rock ☑Wood ☑Plastic □Steel ☑Soil □Other ( )
Burnable waste: □No ☑Yes (Wood)
Hazardous waste: □Oil □PCB □Asbestos ☑Incinerated ash □Other ( )
Covering soil: □Whole area ☑Partial area □None

Site condition

Facility type: □Intermediate treatment facility ☑Final disposal facility □Transshipment facility □Illegal dumping
Collapse of Wall: ☑No □Yes ( )

Sedimentary condition of dumped CDW

Depth and/or height: ☑Less than 4 m □4 – 10 m □Over 10 m
Area size: (44,000) m^2
Waste amount: ( ) m^3
Internal temperature: ( ) °C
Odor Area range: □None ☑Partial area □Whole area Type: ☑Hydrogen sulfide (H_2S) □Enteruria □Disinfectant □Oil □Smoke □Other ( ) H_2S measurement: Northern side ( ) ppm, Southern side ( ) ppm Eastern side ( ) ppm, Western side ( ) ppm
Collapse inside: □No ☑Yes ( )
Vegetation: ☑Normal □Abnormal □Discolor □Unnatural dry □No vegetation
Insects: ☑None □Centipedes □Flies □Mosquitoes □Other ( )
Discolored soil: ☑No □Yes ( ) m^2, ( ) color

Discolored water: □No ☑Yes (at Point ④) color, pH ( ), ( ) ppm
Caving: ☑No □Yes (a big hole with 10 ~ depth)

Informant

Source: ☑Land owner □Operation company □Local citizen
Fire disaster in the past: □No □Unknown □Yes ( )
Type of waste: (Soil, sludge, CDW, some domestic waste)
Incinerator: □No □Yes ( )
Other: Previously the land was used as a rice field.

2. Surrounding environment

Water environment: □None □River ☑Pond □Channel
Well: □No □Yes ( ) m
Claim: □No □Yes ( )
Odor: □No ☑Yes (Smoky smell)
Collapse outside: ☑No □Yes ( )
Insects: ☑None □Centipedes □Flies □Mosquitoes □Other ( )
Intruding water: ☑No □Yes ( ) pH, ( ) ppm
Discolored soil: □No ☑Yes ( ) m^2, (Black) color
Caving and/or Swelling: ☑None □Caving □Swelling ( )
Scattered: ☑No □Yes ( )

3. Other

*Locations of Point ① to ④ are given in "4. Sketch of landfill site" of the check sheet

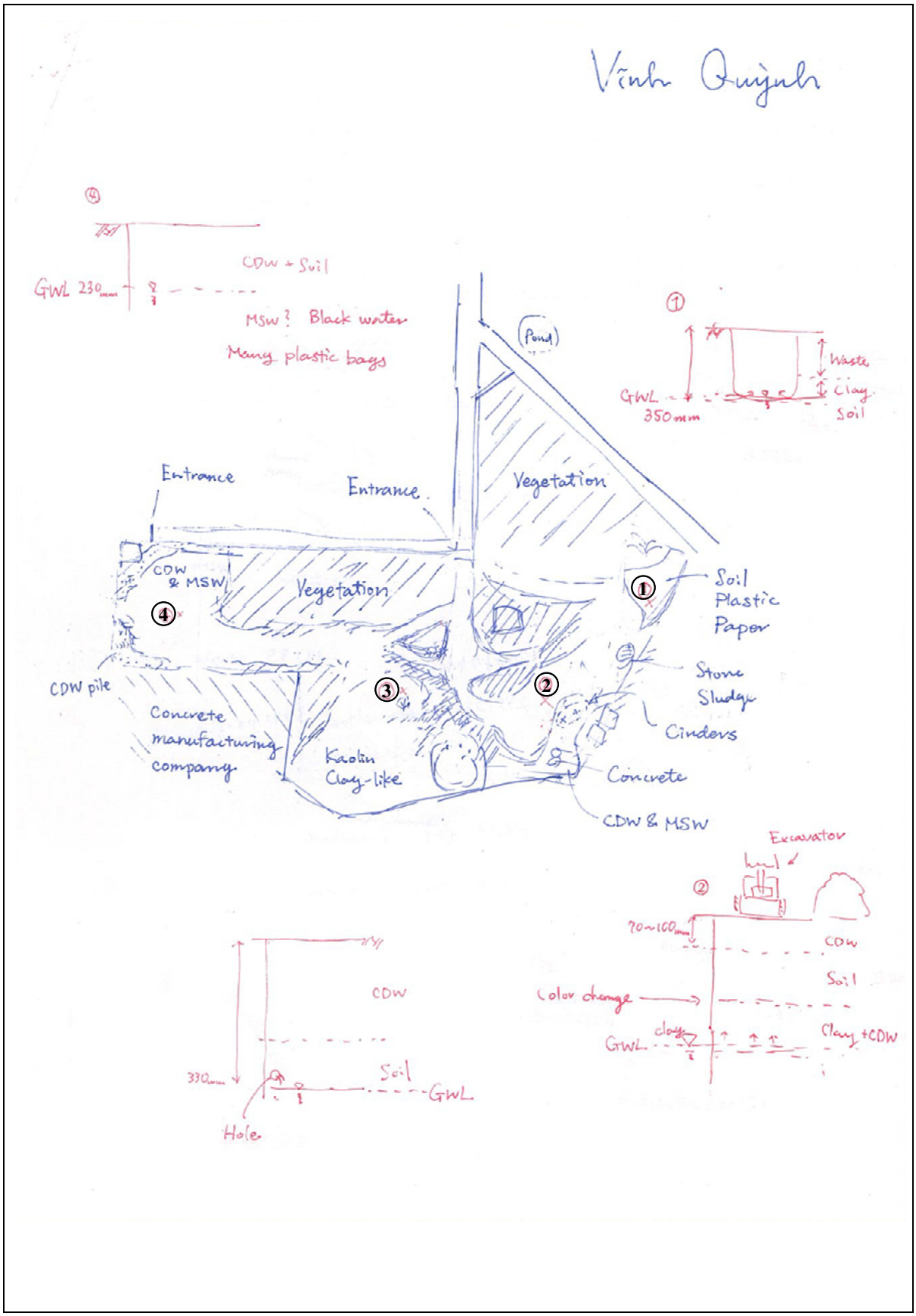
Ground excavation down to ~ 3m depth at 4 different points inside (Point ①, ②, ③, and ④).

Groundwater/perched water was observed at around 3 m depth at all points.

At points ① and ②, dumped concrete and clay bricks were observed within 1 m depth and a layer with dumped soil and sludge was observed down to ~ 2m.

At points ③ and ④, dumped concrete and clay bricks mixed with soil were observed down to ~3 m in depth.

4. Sketch of landfill site




(a) Point ①


(b) Point ②


(c) Point ③

(d) Point ④

Figure 10. Photos of Vinh Quynh CDW landfill.

(Locations of Point ① to ④ are given in “4. Sketch of landfill site” of the check sheet)

Table 12. Check sheet for Duong Lieu CDW landfill site.

Check Sheet for CDW Landfills

Date: 14 March 2019
Weather: Cloudy
Site name: Duong Lieu CDW landfill site
Surveyor name: Isobe, Kato, Tan, Cham

1. Current situation of landfill site

Waste type

Type: ☑Concrete ☑Brick □Tile □Rock □Wood □Plastic □Steel ☑Soil ☑Other (Domestic waste)
Burnable waste: □No ☑Yes (Domestic waste)
Hazardous waste: □Oil □PCB □Asbestos □Incinerated ash □Other ( )
Covering soil: □Whole area □Partial area ☑None

Site condition

Facility type: □Intermediate treatment facility ☑Final disposal facility □Transshipment facility □Illegal dumping
Collapse of Wall: □No ☑Yes (~ 1m collapse of retaining clay wall)

Sedimentary condition of dumped CDW

Depth and/or height: ☑Less than 4 m □4 – 10 m □Over 10 m
Area size: (2,000) m^2
Waste amount: ( ) m^3
Internal temperature: ( ) °C
Odor Area range: □None □Partial area □Whole area Type: □Hydrogen sulfide (H_2S) □Enteruria □Disinfectant □Oil □Smoke ☑Other (Rotten smell from dumped domestic waste) H_2S measurement: Northern side ( ) ppm, Southern side ( ) ppm Eastern side ( ) ppm, Western side ( ) ppm
Collapse inside: ☑No □Yes ( )
Vegetation: ☑Normal □Abnormal □Discolor □Unnatural dry □No vegetation
Insects: □None □Centipedes ☑Flies □Mosquitoes □Other ( )
Discolored soil: ☑No □Yes ( ) m^2, ( ) color

Discolored water: ☑No □Yes ( ) color, pH ( ), ( ) ppm
Caving: ☑No □Yes ( )

Informant

Source: □Land owner □Operation company □Local citizen
Fire disaster in the past: □No □Unknown □Yes ( )
Type of waste: (Soil, sludge, CDW, some domestic waste)
Incinerator: □No □Yes ( )
Other:

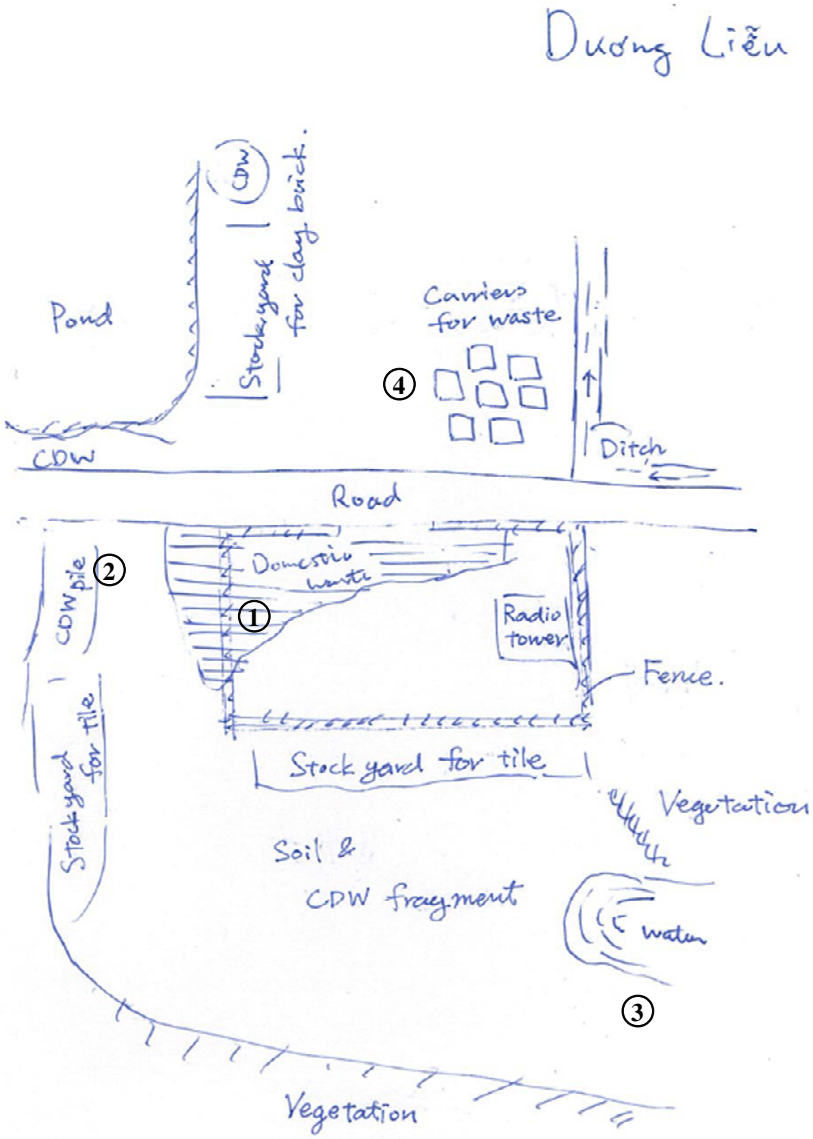
2. Surrounding environment

Water environment: □None □River ☑Pond □Channel
Well: □No □Yes ( ) m
Claim: □No □Yes ( )
Odor: □No ☑Yes (Rotten smell)
Collapse outside: ☑No □Yes ( )
Insects: □None □Centipedes ☑Flies □Mosquitoes □Other ( )
Intruding water: ☑No □Yes ( ) pH, ( ) ppm
Discolored soil: ☑No □Yes ( ) m^2, (Black) color
Caving and/or Swelling: ☑None □Caving □Swelling ( )
Scattered: □No ☑Yes (Some domestic waste)

3. Other

Collected domestic waste and CDW are dumped in the area surrounded by brick walls There were a lot of scattering of domestic waste with rotten smell. Small piles of CDW were distributed near the domestic waste station.

4. Sketch of landfill site



(a) Point ①

(b) Point ③

(c) Point ③ (d) Point ④

Figure 11. Photos of Duong Lieu CDW landfill.

(Locations of Point ① to ④ are given in "4. Sketch of landfill site" of the check sheet)

Table 13. Check sheet for Thanh Tri CDW landfill site.

Check Sheet for CDW Landfills

Date: 14 March 2019
Weather: Cloudy
Site name: Thanh Tri CDW landfill site
Surveyor name: Isobe, Kato, Tan, Cham

5. Current situation of landfill site

Waste type

Type: ☑Concrete ☑Brick ☑Tile ☑Rock ☑Wood ☑Plastic ☑Steel ☑Soil □Other ( )
Burnable waste: ☑No □Yes ( )
Hazardous waste: □Oil □PCB □Asbestos □Incinerated ash □Other ( )
Covering soil: □Whole area □Partial area ☑None

Site condition

Facility type: □Intermediate treatment facility ☑Final disposal facility □Transshipment facility □Illegal dumping
Collapse of Wall: ☑No □Yes ( )

Sedimentary condition of dumped CDW

Depth and/or height: □Less than 4 m ☑4 – 10 m □Over 10 m
Area size: (25,000) m^2
Waste amount: ( ) m^3
Internal temperature: ( ) °C
Odor Area range: ☑None □Partial area □Whole area Type: □Hydrogen sulfide (H_2S) □Enteruria □Disinfectant □Oil □Smoke □Other ( ) H_2S measurement: Northern side ( ) ppm, Southern side ( ) ppm Eastern side ( ) ppm, Western side ( ) ppm
Collapse inside: ☑No □Yes ( )
Vegetation: □Normal □Abnormal □Discolor □Unnatural dry ☑No vegetation
Insects: □None □Centipedes ☑Flies □Mosquitoes □Other ( )
Discolored soil: ☑No □Yes ( ) m^2, ( ) color

Discolored water: ☑No □Yes ( ) color, pH ( ), ( ) ppm
Caving: ☑No □Yes ( )

Informant

Source: □Land owner ☑Operation company □Local citizen
Fire disaster in the past: ☑No □Unknown □Yes ( )
Type of waste: (CDW from demolition sites)
Incinerator: ☑No □Yes ( )
Other:

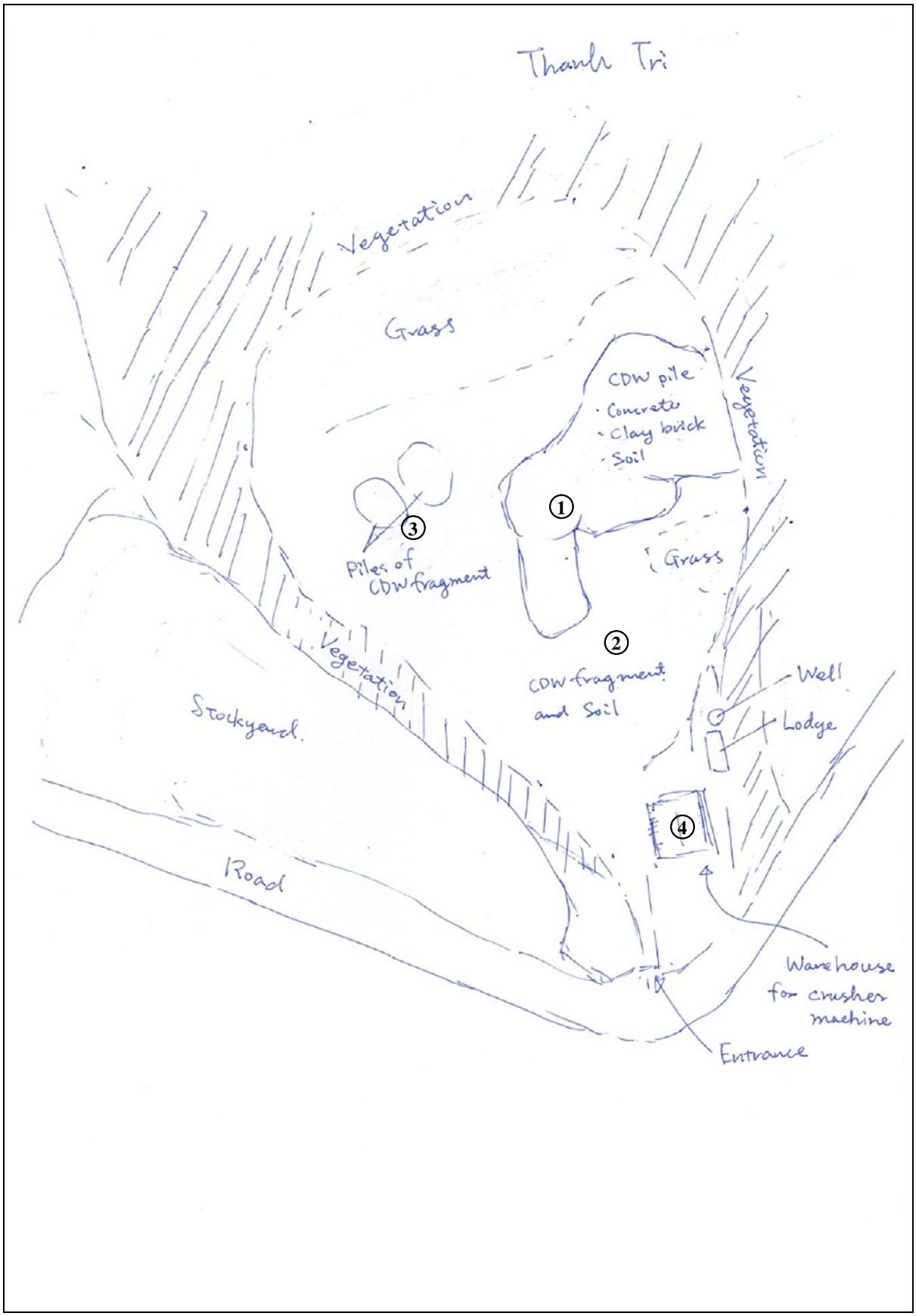
6. Surrounding environment

Water environment: □None ☑River □Pond □Channel
Well: □No ☑Yes (5-6) m depth from ground surface
Claim: ☑No □Yes ( )
Odor: □No ☑Yes (Rotten smell)
Collapse outside: ☑No □Yes ( )
Insects: ☑None □Centipedes □Flies □Mosquitoes □Other ( )
Intruding water: ☑No □Yes ( ) pH, ( ) ppm
Discolored soil: ☑No □Yes ( ) m^2, (Black) color
Caving and/or Swelling: ☑None □Caving □Swelling ( )
Scattered: ☑No □Yes ( )

7. Other

Dumped CDW was piled on the ground (height ~ 3-4 m). Stock yards of construction materials such as crushed stone and sand were located next to the disposal site. A mobile type crushing machine is stored in the site.

8. Sketch of landfill site



(a) Point ①

(b) Point ②

(c) Point ③ (d) Point ④

Figure 12. Photos of Thanh Tri CDW landfill.

(Locations of Point ① to ④ are given in “4. Sketch of landfill site” of the check sheet)

5. Concluding Remarks

In order to identify the current condition of CDW landfills in Hanoi, a basic information survey and check sheet survey were carried out. For the basic information survey, a total of seven CDW landfills (five closed/abandoned and two under operation) were investigated. On the other hand, the check sheet survey was carried out at only four CDW landfills (two closed/abandoned and two in operation). All investigated sites were public lands which belong to Hanoi People's Committee and were/are operated by private companies appointed by Hanoi DOC except for Nhat Tan site. Two CDW landfills under operation, Vinh Quynh and Thanh Tri sites, accept only typical CDW from construction and demolition works and town cleaning. However, some of closed/abandoned CDW landfills accepted not only CDW but also domestic waste. The land areas of CDW landfills varied widely between 2,000 to 94,000 m^2, while the years of operation of closed/abandoned landfills were six years. The depth of dumped CDW was normally within 4 m deep from the ground surface, and no dumping of hazardous waste was observed. The sanitary condition of investigated CDW landfills was good with normal vegetation, no insects, no discolored soil or water, except for the Duong Lien site which accepts domestic waste. Besides, there was no threat of piled CDW collapse inside or outside the dumping sites.

Due to the rapid urbanization and development, CDW generation is increasing daily in Hanoi. Till now, except for an informal dumping site, the collected CDW was dumped at formal dumping sites in Hanoi in a relatively safe manner, with no serious impact on the surrounding environment. However, it is clear that the increase in CDW generation threatens to reduce the intended lifetime of CDW landfill sites, and direct dumping of CDW raises serious concerns over its impact on the surrounding environment in the future. To improve current CDW management and to promote recycling of CDW in Hanoi, challenges and recommendations are summarized as follows:

1) Record of CDW landfill sites

There is no recorded document issued by the authority, although they were declared by Hanoi DOC to be official CDW landfills. A suitable recording system that describes the types and amounts of accepted CDW, generating/discharge places of construction and demolition works, and the transportation company of CDW is necessary to manage CDW landfill sites and estimate the duration of operation (i.e., lifetime).

2) Technical support for management of CDW landfill sites

Training of staff members and technical guidelines for sound management of CDW landfill sites are necessary to minimize the environmental impact on surrounding areas.

3) Plan and strategy for developing CDW landfill sites

A proper plan and strategy for developing a CDW landfill site that fully considers the source generation (e.g., scheduled construction and development plan, planned demolition works), transportation of generated CDW, and the surrounding environment must be developed and implemented to establish a sustainable CDW management system.

4) Promotion of CDW recycling

Along with dumping the CDW in a safe manner, alternative methods to treat CDW (i.e., reuse and recycling CDW) must be considered, studied, and implemented.

References

1. Resolution No.34/2007/NQ-CP on a Number of Solutions to the Amelioration and Reconstruction of Damaged or Degraded Condominiums.
2. Ministry of Natural Resources and Environment (MONRE), 2011. State of Environmental Report 2011 on Solid Waste management (MONRE), Vietnam.
3. Tuan, N.V., T.T. Kien, D.T.T. Huyen, T.T.V. Nga, N.H. Giang, N.T. Dung, Y. Isobe, T. Ishigaki, and K. Kawamoto. 2018. Current status of construction and demolition waste management in Vietnam: Challenges and opportunities. Int. J. GEOMATE, 15(52): 23-29. DOI: https://doi.org/10.21660/2018.52.7194.
4. Decision No.609/2014/QD-TTg Master Plan on Solid Waste Disposal of Hanoi Capital to 2030, with a Vision to 2050.
5. Decision No. 2149/2009/QD-TTg on Approving the National Strategy on Integrated Solid Waste Management up to 2025, and Vision to 2050.
6. Japan Industrial Waste Management Foundation, 2006. Field Survey Manual for Illegal Waster Dumping Site to Remove Obstacles (in Japanese).