Study
For
Integrated Environmental Improvement of Leuwigajah Disposal Site In West Java, Republic of Indonesia

Study Report

March 2009

Yachiyo Engineering Co., Ltd.

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Location of West Java Province

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Abbreviations

AMDAL	Environmental Impact Assessment
BAPEDA	Planning Board
BAPPENAS	National Development Planning Agency
BIT	Bandung Institute of Technoligy
BPLHD	Environmental Protection Agency of West Java Province
BPPT	Agency for the Assessment and Application of Technology
COD	Chemical Oxygen Demand
EC	Electrical Conductivity
GBWMC	Greater Bandung Waste Management Corporation (Former name of P3JB)
IIWTF	Integrated ntermediate Waste Treatment Facilities
JETRO	Japan External Trade Organization
LSWMC	Leuwigajah Soilid Waste Management Center
MSW	Municipal Solid Waste
QH’a layer	an alluvial and colluvial deposits layer of Quaternary-Late Pleistocene
P3JB	Greater Bandung Waste Management Center
PU	Ministry of Public Works
TARKIM	Construction and Planning Agency
TPV layer	a sandstone layer of volcano products of Tertiary-Poliocene
UPO	Operational Management Unit

EXECUTIVE SUMMARY

I. Background

Leuwigajah Disposal Site had been the largest waste disposal site in West Java Province in Indonesia, and it was an open dumping site. The total disposal wastes into this site had been about 3,700m^3 from Bandung City, Cimahi City and Bandung Regency. And its total area had been about 25.1ha.

On 20th February 2005, after two days of heavy rain, a tremendous landslide occurred at Leuwigajah Disposal Site. The quantity of collapsed waste was about 3.1 million m^3, the flow distance was maximum 950m, and the area covered by the waste was about 75ha. Almost all of the 141 deaths that occurred were residents, and the total amount of compensation for life, homes, fields, etc., amounted to more than Rp. 56 billion (about 800 million yen). After the landslide, the environmental impact from the landslide wastes was serious, and the daily household wastes had no where to be disposed and piled up around the cities.

The Indonesian authorities had sought a new site, however, it was quite difficult to secure final disposal site. Consequently restoration and reuse of the collapsed Leuwigajah Disposal Site has been adopted. Within the construction of new landfill, the rehabilitation program of Leuwigajah was finalized by Environmental Protection Agency of West Java Province (BPLHD). However, this program was insufficient especially technical foundations because of the lack of experiences. As a result, the local government has faced several problems, such as the central government has not approved this program, the local government could not fully explain the program for residents and so on.

II. Purpose of Study

The objective of this study is to investigate the adequacy for rehabilitation based on the strategic environmental protection measures, and to prepare the suggestions for rehabilitation and establishment of new landfill site.

III. Contents of Study

The Target Site of this study is Leuwigajah Disposal Site. And the contents of this study are shown in Figure 1. Based on these contents, this study suggests Leuwigajah Solid Waste Management Center (LSWMC) including a sanitary landfill and Integrated Intermediate Waste Treatment Facilities (IIWTF). LSWMC is required to be based on the rehabilitation program of Leuwigajah.

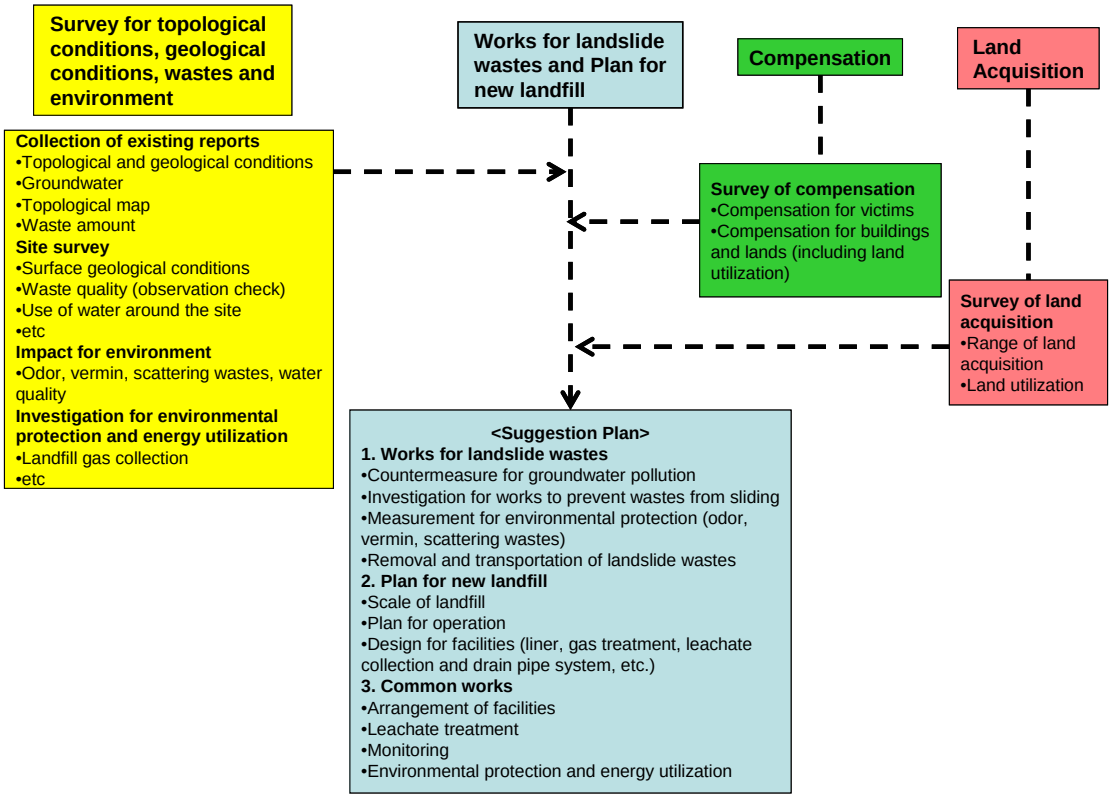


Figure 1 Contents of Study

IV. Results

This study implemented the observation checking of landslide wastes, the site surveys for landfill gas and water around the site and the interview survey for residents. In addition to these surveys, the following items were also investigated; Location and Access, Topographic Conditions, Geological Condition, Meteorological Conditions, Hydrological Conditions, Surrounding Land Use, Surrounding Water Use and Situation of Compensation, Land Acquisition and Environmental Impact Assessment (AMDAL).

Based on these results, this study prepares the design of LSWMC reflecting some requests from residents. Layout plan of LSWMC is shown in Figure 2. The buffer zone is secured enough for residents' request, and then the rest of the site is divided into 3 areas; 1: Rehabilitation Area, 2: Sanitary Landfill Area and 3: Facilities Area. Regarding the sanitary landfill, its lifespan is set as about 10 years (the capacity of landfill is about 200 million m^3).

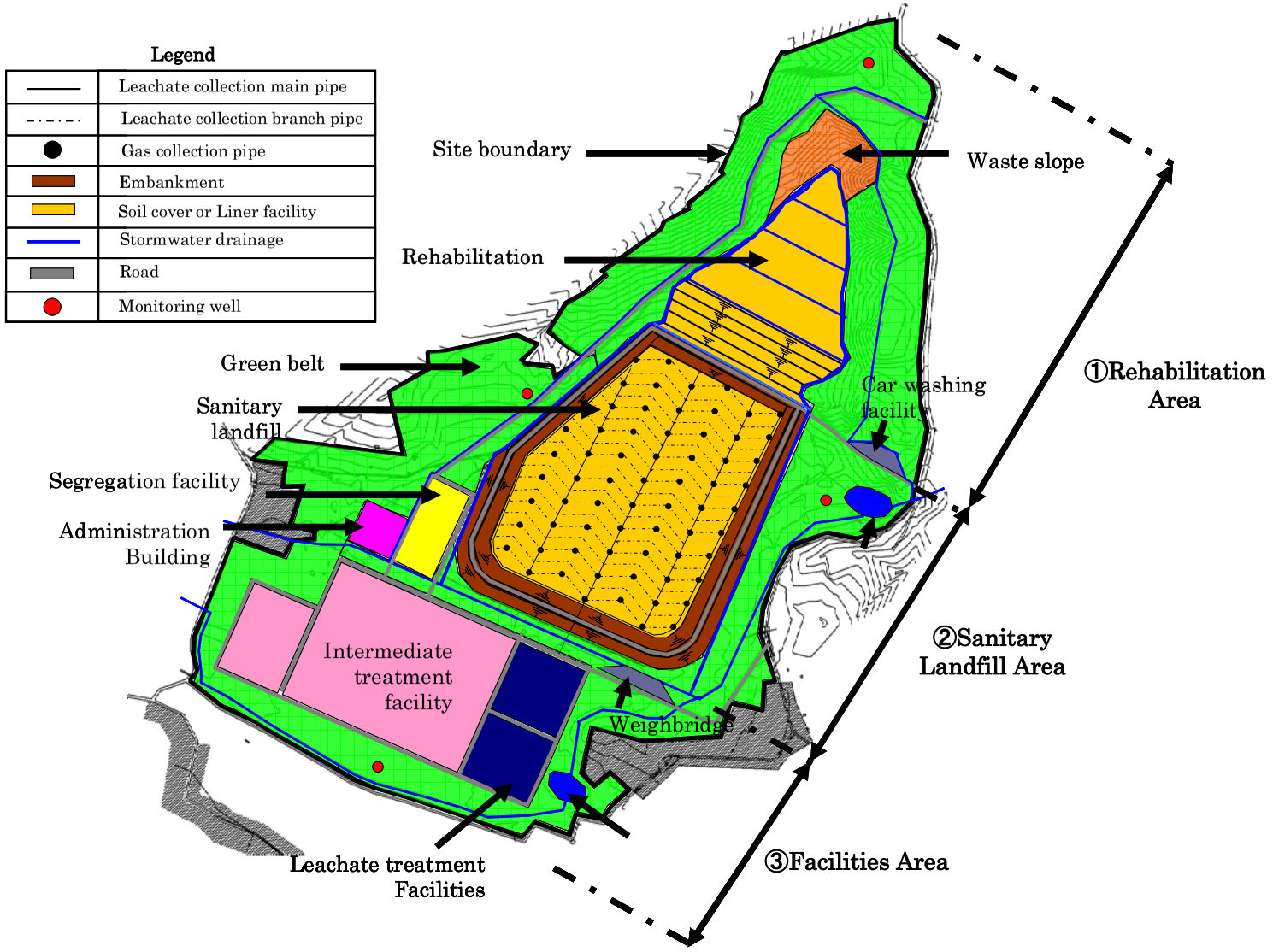
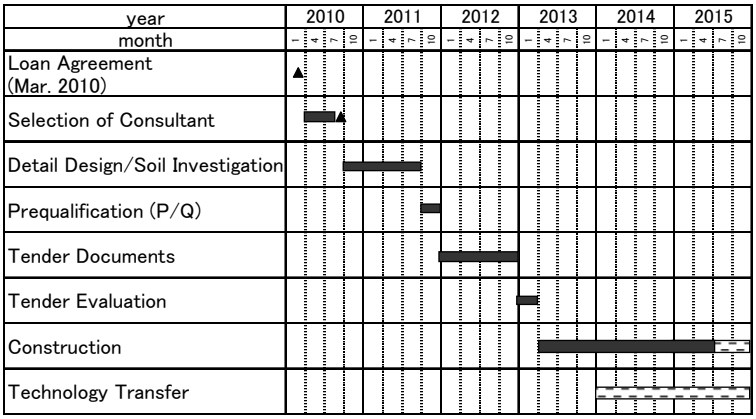


Figure 2 Layout Plan of LSWMC

According to Rehabilitation concept design and Sanitary landfill concept design in this study, the construction cost for LSWMC is estimated as about Rp. 213 billion. And Table 1 shows the project implementation schedule in case of applying JICA loan into the implementation cost.

Table 1 Project Implementation Schedule



V. Recommendations

Finally the components of LSWMC project are shown as Table 2. In order to make this project advance, it is required to examine each item in accordance with the policy of West Java.

Table 2 Components of LSWMC Project

No.	Component	Recommended Action	Financial Source
1	Temporary measure for waste management in the West Greater Bandung Area	Reinforcement of facilities in Sarimukti Landfill	Budget of the local and the central government
2	Rehabilitation and construction of infrastructure	1. Compensation and land acquisition	Budget of the local and the central government
		2. Rehabilitation and construction of infrastructure	
3	Rehabilitation and establishment of LSWMC	1. Rehabilitation of landslide wastes and construction of buffer zone	Budget of the local government
		2. Construction of treatment facility for landslide wastes and daily household wastes (segregation and biological treatment)	Japanese ODA and other financial support
		3. Construction of sanitary landfill and management of equipments	
		4. Land preparation for facilities by private sector	
4	Waste management by private sector	Construction and operation of other intermediate treatment facilities by private sector	Budget of private sector

CHAPTER 1 INTRODUCTION

1.1 Background[1]

Historical development showed that the Province of West Java is the first province formed in the region of Indonesia, based on Act No.11 Year 1950. For around 58 years since its formation, now West Java Province is composed of 16 Regencies and 9 Cities heading 584 sub districts, 5,201 villages and 609 political districts.

West Java Province is geographically positioned between 5°50 - 7°50 south latitude and 104° 48 - 104 ° 48 east longitudes. The area of West Java is 35,746.26 km^2 including the main land and small islands (48 Islands in Indonesian Ocean, 4 Islands in Java Sea, 14 Islands in Banten Gulf and 20 Islands in Sundanese Strait). The land of West Java can be distinguished as steep mountainous region in the south with the height of more than 1,500 m above sea level, the region of hill slope slightly in the mid height 100 to 1,500 m above sea level, the region of large plateau in the north with 0 to 10 m height above sea level, and region of river flow. Climate in West Java is tropical and average rainfall is 2000 mm per year, but in several mountainous regions rainfall is 3,000 to 5,000 per year.

Population in the West Java Province is now about 39 million people and has continued to rise since 2001. According to this population growth, the amount of waste has been increased as well.

1.1.1 Current Waste Management in Indonesia

1) Domestic Solid Waste Statistics

Indonesian State Ministry of Environment implemented the questionnaire survey about Municipal Solid Waste (MSW) management in whole areas in 2006[2]. According to its results, several features in regard to landfill in Indonesia are found as follows.

The total amount of waste generation in Indonesia is estimated as about 39 million t/year (Table 1-1). The largest amount of waste is generated in Java Area where the population density is the highest of all.

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[1] Reference:
http://www.jabar.go.id/jabar/public/77193/menu.htm

[2] Reference:
Indonesian Domestic Solid Waste Statistics Year 2008
State Ministry of Environment, The Republic of Indonesia

Table 1-1 Estimation of Waste Generation in Indonesia

Group Area	Population (million person)	Waste Generation (million t/year)
Sumatera	15.4	8.7
Jawa	64,6	21.2
Balinusra	4.1	1.3
Kalimantan	4.9	2.3
Sumapapua	4.9	5.0
Total	93.9	38.5

Figure 1-1 shows the composition of MSW in Indonesia. It is found that the ratio of food wastes was the largest of all as 58%.

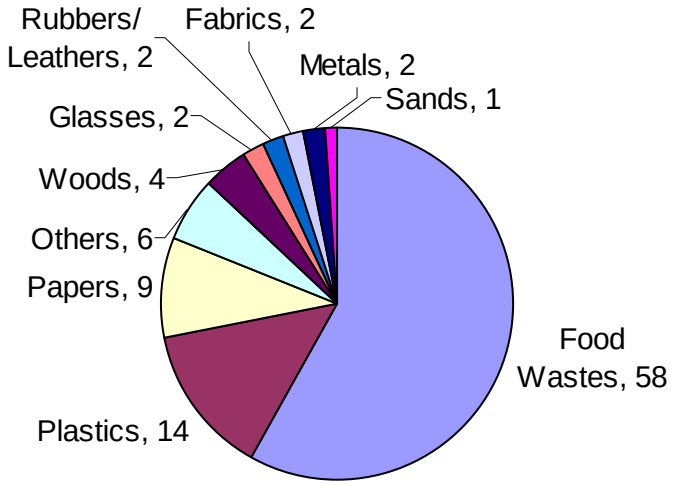

Figure 1-1 Average Composition of Waste in Indonesia

Table 1-2 shows the number of landfill (disposal site) in each Group Area. The total number is 179 sites. According to the report of Indonesian State Ministry of Environment, 98% of all landfills are active and 6% of all were regional (area-wide) landfills. It is found that the number of landfill has a correlation with the total amount of waste generation. The number of landfills in Java, which is 75 sites, is the largest of all.

Table 1-2 Number of Landfills in Indonesia

Group Area	Number of Landfills
Sumatera	57
Jawa	75
Balinusra	11
Kalimantan	19
Sumapapua	17
Total	179

Note: Answered rate: 33%

The amount of disposal waste into landfill is estimated as Table 1-3. The total amount is estimated as about 14 million t/day. The ratio of waste disposal to waste generation is about 30% in all Group Areas except for Balinusra. Balinusra seems to receive wastes from other areas because the waste disposal is larger than its waste generation.

Table 1-3 Estimation of Disposal Waste into Landfill in Indonesia

Group Area	Disposal Waste into Landfill (million t/year)	Ratio of Disposal Waste per Waste Generation (%)
Sumatera	2.5	28.7
Jawa	7.0	33.0
Balinusra	1.7	130.8
Kalimantan	0.7	30.4
Sumapapua	1.6	32.0
Total	13.6	

2) Regulations and Plans about Waste Management

For nationwide, the national development plan (2004 - 2009) indicates the improvement of waste management and its service system. The national environmental strategy explains the lack of the space for landfill.

For West Java Province, the local government controls the overall system of the waste management by the local authority in the West Java Province although the local government does not have the function of waste management itself. Due to the recent problem of securing new landfill sites, they are promoting 3R (Reduce, Reuse, Recycle) to minimize the amount of waste

to be transported to the landfill site. The waste management targets of the West Java State of Environment are as follows;

- Each disposal site is designed and operated as sanitary landfill
- 60 % of garbage is still enable to be disposed to existing disposal sites
- 20 % of garbage is treated with composting system
- Corporation System in waste management has been effectively running
- Bandung basin (Bandung City, Cimahi City, Bandung Regency), Bodebek (Bogor, Depok, Bekasi), and Ciayumajakuning (Cirebon, Indramayu, Majalengka dan Kuningan) has their own regional landfills

3) Greater Bandung Waste Management Center (P3JB)

In order to manage regional landfills, such as Leuwigajah, Greater Bandung Waste Management Corporation (GBWMC) was set up as one of the measures to reinforce the environmental management-related organizations of the local governments in the project for environmental management in West Java Province from 2002 to 2006. It entered into an agreement to set up the GBWMC in March 2005. After that, the corporation was renamed the "Greater Bandung Waste Management Center (P3JB)" under the Decree of West Java Governor No. 31/2007 through mutual discussions between the central government and the local governments, and was established in January 2008.

The supervision and management of P3JB will be conducted by the local government of West Java, but P3JB takes charge of the following functions under the control of the Department of City Spatial Planning & Housing in West Java Province:

- Planning of waste management programs
- Development of infrastructure for waste management
- Waste management (treatment and reduction in quantity)
- Application of appropriate technology and promotion of waste treatment and management
- Coordination of joint projects between private businesses and local governments and infrastructure development

The organizational form of P3JB that was approved by the local government is shown in Figure 1-2. P3JB is divided into a Secretary Group and an Expert Group and it controls waste management within the province. Within P3JB, Operational Management Units (UPO) will be organized to enable management of the disposal plants and to procure and manage operators.

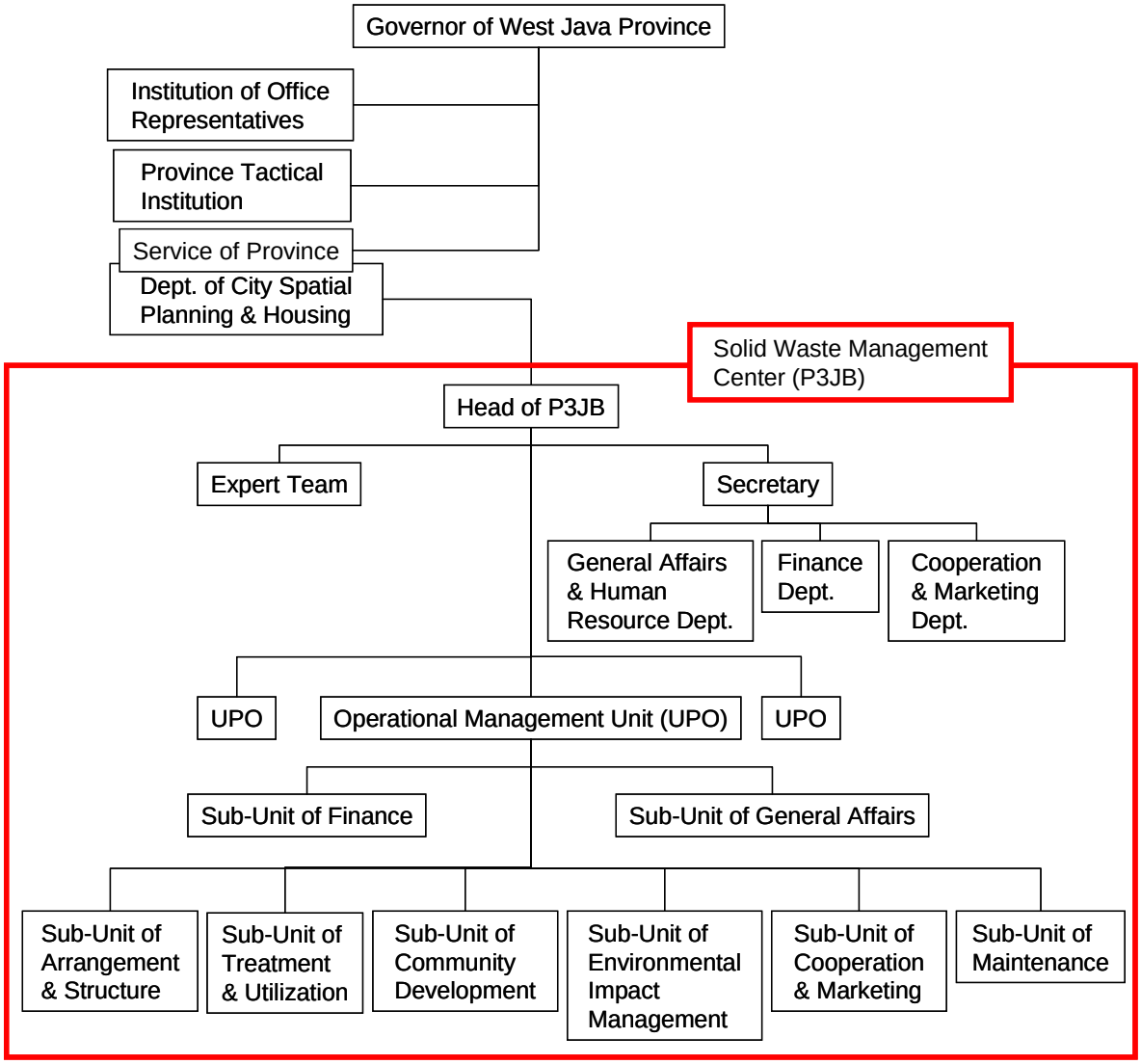

Figure 1-2 Organizational Chart of P3JB in West Java Province

1.1.2 Landfill Sites in West Jawa

Table 1-4 shows the situation of landfill in West Java in FY 2004. Total number of landfills is recognized as 55 sites. Among them, active landfills are 36 sites, closed landfills are 6 sites, landfills under planning are 6 sites and unknown landfills are 8 sites. Among active landfills, sanitary landfills are 4 sites, controlled landfills are 11 sites and open dumping sites are 21 sites.

Table 1-5 shows the results of the survey about waste generation and waste disposal into landfills implemented by BPLHD from 2002 to 2006 with the area and population of each city/regency in West Java. Total daily waste generation is 42,680m^3/day and total daily waste disposal is 14,902m^3/day.

The waste generation in Bandung Regency is the largest of all as 8,173m^3/day. The waste generation in Bandung City is the second as 5,000m^3/day and the waste generation Bekasi City is the third as 4,307m^3/day. The ratio of each generation to total generations is 19%, 12% and 10% respectively. Regarding Bandung Regency and Bandung City, there populations are the largest and the third largest of all respectively. Therefore each waste generation has a correlation with each population in these two areas.

The waste disposal in Bekasi City is the largest of all as 5,000m^3/day. The waste disposal in Bandung City is the second as 2,000 m^3/day and the waste disposal in Bogor City is the third as 1,501m^3/day. The ratio of each disposal to total disposals is 34%, 13% and 10% respectively. Regarding Bekasi City, the daily waste generation is smaller than the daily waste disposal. It means that Bekasi City seems to receive wastes from other cities. And it should be noted that all disposal sites in Bekasi City are open dumping sites as Table 1-4.

Table 1-4 Situation of Landfill in West Java (FY 2004)

No.	City/Regency	Landfill Site	Area (ha)	Operation Method	Status	
1	Bandung Regency	Leuwigajah	5.5	open dumping	closed	
		Ciparay	10.1	open dumping	active	
		Cikole	2.2	open dumping	active	
		Sarimukti*	8	open dumping	active	emergency
2	Bandung City	Leuwigajah	17.5	open dumping	closed	
		Jelekong	10	controlled landfill	closed	
		Pasir Impun	8	controlled landfill	closed	
		Sarimukti	8	open dumping	active	emergency
3	Cimahi City	Leuwigajah	1	open dumping	closed	
		Sarimukti	8	open dumping	active	emergency
4	Sumedang Regency	Cibeureum Wetan	10	open dumping	active	
		Cijeruk	2		planned	
5	Garut Regency	Pasir Bajing	8	open dumping	active	
6	Bogor Regency	Pondok Rajeg	6	sanitary landfill	active	
		Jonggol	0.5	open dumping	active	
		Galuga	9.2	controlled landfill	active	
		Nambo	5		planned	
7	Bogor City	Galuga	9.2	controlled landfill	active	
		Nambo	5		planned	
8	Bekasi Regency	Burangkeng Setu	3.7	open dumping	active	
9	Bekasi City	Bantar Gebang	10	open dumping		
		Sumur Batu				
10	Depok City	Cipayung	8.53	sanitary landfill	active	
		Nambo	5		planned	
11	Karawang Regency	Klari	3	open dumping		
		Cikampek	3	open dumping		
		Rengasdengklok	3	open dumping	active	
12	Cianjur Regency	Cilaku	4	sanitary landfill	active	
13	Cirebon Regency	Dunung Santri	4	open dumping	active	
		Cihoe	0.5	open dumping	active	
		Ciawijapura	1.5	open dumping	active	
		Gegesik	0.6	open dumping	active	
14	Cirebon City	Kopi Luhur	9	controlled landfill	active	
15	Indamayu Regency	Pecuk	4.3	controlled landfill	active	
		Kebulen	1	open dumping	active	
		Kertawinangun	1	open dumping	active	
16	Majalengka Regency	Heuleut	4.5	open dumping	active	
		Talaga	0.5	open dumping	active	
		Sindang Panon	0.5	open dumping	active	
17	Kuningan Regency	Ciniru	3.53	controlled landfill	active	
		Karang Muncang	2.8	controlled landfill	planned	
		Padarama	2.8	controlled landfill	planned	
18	Tasikmalaya Regency	Cinangsi	1.3	open dumping		
		Gurantang	3	open dumping		
		Nangkaleah	4	open dumping		
19	Tasikmalaya City	Singkup	6	open dumping	closed	
		Ciangir	5	controlled landfill	active	
20	Ciamis Regency	Handap Herang	5.8	controlled landfill	active	
		Purbahayu	1.2	controlled landfill	active	
21	Banjar City	cimiyak	4	controlled landfill	active	
22	Sukabumi Regency	Legok Nyenang	4	open dumping		
		Loji	3.08	open dumping	closed	
		Pasir Jeding	0.95	open dumping	active	
		Cikadu	5.6	open dumping	active	
23	Sukabumi City	Cikundu Ⅰ	5.6	controlled landfill	active	
		Cikundu Ⅱ	3.1	controlled landfill	active	
24	Subang Regency	Panembong	6	sanitary landfill	active	
		Purwadadi	2	open dumping	active	
25	Purwakarta Regency	Ciwareng	1.9	open dumping	closed	
		Cikolotok	2.4	open dumping	active	
		Tegalsari	1	controlled landfill	planned	

Source: BPLHD (2004) Condition of final disposal site for towns' garbage in West Java

Table 1-5 Waste Generation and Waste Disposal in Each City/Regency in West Java

No.	City/Regency	Area*1 (km2)	Population*1 (pers)	Waste Generation*2 (m3/day)	Waste Disposal*2 (m3/day)
1	Bandung Regency	1,522	4,134,504	8,173	850
2	Bandung City	1,179	2,290,464	5,000	2,000
3	Cimahi City	2,680	482,763	1,226	–
4	Sumedang Regency	3,934	1,043,340	–	–
5	Garut Regency	2,052	2,260,478	1,949	214
6	Bogor Regency	970	3,945,111	3,673	350
7	Bogor City	2,001	833,523	1,950	1,501
8	Bekasi Regency	167	1,917,248	1,686	900
9	Bekasi City	210	1,931,976	4,307	5,000
10	Depok City	3,441	1,353,249	2,996	612
11	Karawang Regency	200	1,939,674	1,299	230
12	Cianjur Regency*3	3,433	2,079,306	2,090	375
13	Cirebon Regency	988	2,084,572	2,009	850
14	Cirebon City	22	276,912	623	485
15	Indamayu Regency*4	3,065	1,749,170	958	200
16	Majalengka Regency	1,484	1,184,760	963	108
17	Kuningan Regency	2,557	1,073,172	–	201
18	Tasikmalaya Regency	1,738	1,635,661	–	–
19	Tasikmalaya City	472	579,128	1,293	386
20	Ciamis Regency	48	1,522,928	1,550	96
21	Banjar City	1,204	166,868	321	75
22	Sukabumi Regency	2,001	2,210,091	–	–
23	Sukabumi City	38	278,418	614	469
24	Subang Regency	12	1,406,976	–	–
25	Purwakarta Regency	1,136	76,022	–	–
Total		36,554	38,456,314	42,680	14,902

Note:
*1 Source: Homepage of West Java (December 2008)
http://www.jabar.go.id/jabar/public/77193/menu.htm
*2 Each value is from the results of the survey from 2002 to 2006.
Source: Homepage of BPLHD (April 2008)
http://www.bplhdjabar.go.id/
*3: Concerning about the waste disposal amount, this paper selected the central value of the original data which was180 to 220m3/day.
*4: Concerning about the waste disposal amount, this paper selected the central value of the original data which was350 to 400m3/day.

1.1.3 History of Leuwigajah Disposal Site

The start of Leuwigajah Disposal Site, which is the target site of this study, was 12ha of land Bandung City bought in 1982. The operation was started in 1987. After that, Bandung City, Bandung Regency and Cimahi city separately bought neighboring lands and separately operated. At that time, Leuwigajah Disposal Site was so called open dumping site which did not have any facilities, such as fences and liners.

Before the huge landslide accident was happened in Leuwigajah Disposal Site in 2005 as mentioned below, the similar landslide was happened in 1989. The investigations were carried out in cooperate with the team in Germany in 1990 and 1992.

The investigation in 1990[3] concluded that Leuwigajah Disposal Site was not suitable for landfill from the security point of view as follows.

＜Landslide accident in 1989＞

The landfill is established in the southern part of a hill with an abandoned andesite-quarry. The northern part of this hill was used in former times for the local people as a landfill, too. The actual site is being handled for ramp-like dumping near the steep valley-slope. There are two sites for the dumping, a northern and a southern part. In 1989, the landslide (mass movement) happened in December 1989 from the northern part of the dump. The volume is unknown and there is no clay underlining. The surface is about 8ha. The elevation over the valley bottom is about 30m. The valley bottom has been used for paddy fields before the landslide.

<Conclusion>

Because of its steep morphological position and of the failures in engineering geological stabilization measures the dump has to be classified as unsuitable for waste disposal. Similar mass movements of waste are possible on other waste disposal sites. This negative example illustrates the necessity to avoid ramp-like dumping in small valleys, without appropriate technical measures.

From another point of view, the dump is very dangerous for men's safety during operations, as sliding can occur again, most probably after heavy rains when water will reduce the friction in the waste body.

Thus Leuwigajah seems to be the most harzardous dumping site in Greater Bandung.

[3] Markus Toloczyki, February 1990, "Project Report No. 8 The Landfill Site Leuwigajah", Directorate of Environmental Geology, German Environmental Geology Advisory Team for Indonesia, Project CTA 108, Environmental Geology for Landuse and Regional Planning

The following figures show the situation of Leuwigajah Disposal Site during the investigations in 1990.

Figure 1-3 Lower Portion View from the West Side of Upper Portion

Figure 1-4 Lower Portion View from the Upper Portion

Figure 1-5 Lower Portion View from the Middle of the Landslide Portion

Figure 1-6 Landslide Wastes

Figure 1-7 Upper Portion View from the Lower Portion

Figure 1-8 Landslide Wastes Observed from the Unaffected Area of the South Side

The investigations in 1992[4] reported the following points. This report explained that Leuwigajah Disposal Site was decided to be utilized again because there were not any other options for a landfill even though this site should have been closed according to the investigation in 1990. Therefore this report suggested one rehabilitation and stabilization method shown in Figure1-9 and Figure1-10 for security and environmental protection. Figure 1-11 shows the situation of Leuwigajah Disposal Site during this investigation in 1992.

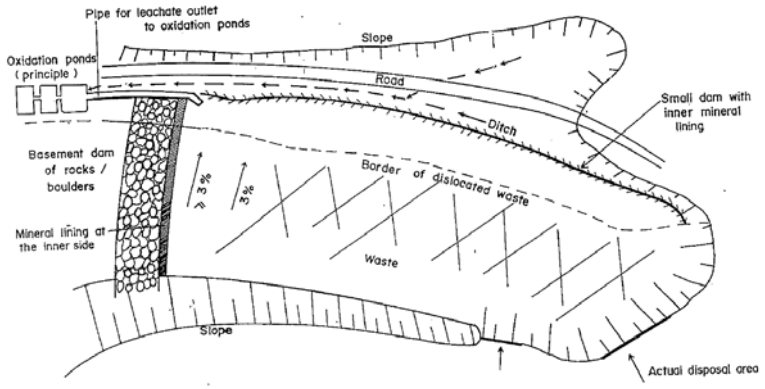

Figure 1-9 Proposal for Rehabilitation and Reclamation of Leuwigajah Dumping Site

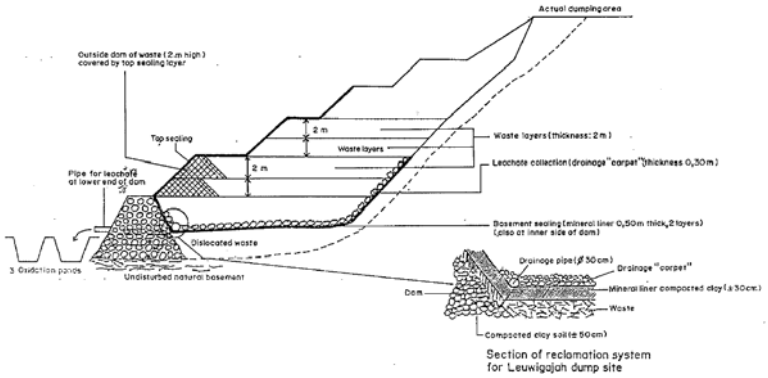

Figure 1-10 Proposal for Rehabilitation and Reclamation of Leuwigajah Dumping Site (Section)

Figure 1-11 Leuwigajah Disposal Site in April 1992

[4] H. Oeltzschener, Suprijono Wiriosudarmo, D. Zainal Abidin, May 1992, "Project Report No. 21 Comparative site rating of potential areas for waste disposal (sanitary landfilling) in the Bandung Area", Directorate of Environmental Geology, German Environmental Geology Advisory Team for Indonesia, Project CTA 108, Environmental Geology for Landuse and Regional Planning

Figure 1-11 Leuwigajah Disposal Site in April 1992

1.1.4 Landslide Accident in 2005

As mentioned above, there were no options for Leuwigajah landfill site, so Bandung City, Cimahi City and Bandung Regency had been used this site for open dumping with no features such as retaining walls, water interception layers, etc. After the landslide in 1989, it had been the largest waste disposal site, located in Cimahi City on the outskirts of Bandung City, about 12km to the west of the center of Bandung City. The total area of the disposal site became 25.1ha, the quantity of waste disposed per day was 2500m^3, 750m^3, and 450m^3 from Bandung City, Cimahi City and Bandung Regency respectively, and the maximum depth of waste was about 80m. Also, there were about 600 so-called rag pickers, who collect PET bottles and so on from the dumped waste. They have built simple tents or huts and live around the waste disposal site.

It was under these circumstances that a tremendous landslide occurred at this disposal site on 20th February 2005 after two days of heavy rain. Rather than the waste collapsing, the surface layer of the valley slope slipped like a snow avalanche, and the waste became entrained in the flow because wastes had been disposed to fill a valley. The quantity of collapsed waste was about 3.1 million m^3, the flow distance was maximum 950m, and the area covered by the waste was about 75ha. Almost all of the 141 deaths that occurred were residents, and the total amount of compensation for life, homes, fields, etc., amounted to more than Rp. 56 billion (about 800 million yen).

After the landslide, the environmental impact from the landslide wastes was serious, such as odor, vermin, scattering wastes, water pollution by leachate. And the daily household wastes had no where to be disposed and piled up around the cities. This situation was broadcasted through media and these cities' value as sightseeing spots was damaged.

The Indonesian authorities had sought a new site. However, they failed to find the site because it is very difficult to secure final disposal site in Indonesia at present. Consequently many short-lived small-scale disposal sites are found at various locations in Bandung Regency. For an emergency measure, waste from the Bandung area was brought to the existing Jelekong waste disposal site and the Cicabe waste disposal site, which had already been closed. At that time, it was still difficult to secure even a land for the temporary disposal site. In the end, on 28th May 2006, Sarimukti Landfill (disposal area 21ha) was constructed on land rented from the Ministry of Forestry on condition that organic wastes from the markets should be treated at the composting plant in the site. Sarimukti disposal site is just a temporal disposal site and scheduled to operate until 2011. Therefore, restoration and reuse of the collapsed Leuwigajah Disposal Site has been adopted as the policy for the next disposal site after Sarimukti Landfill. In parallel with the

necessity of the landfill, the necessity of intermediate treatment has been recognized. The rehabilitation program of Leuwigajah was finalized by Environmental Protection Agency of West Java Province (BPLHD), with the mention of the necessity of the intermediate treatment. However, this program was insufficient especially technical foundations because of the lack of experiences. As a result, the local government has faced several problems, such as the central government has not approved this program, the local government could not fully explain the program for residents and so on. And the rehabilitation works are still stagnant. Therefore it is required to prepare a rehabilitation plan based on the practical and precisely technical foundations. Regarding the intermediate treatment, which is a part of the rehabilitation program, Japan External Trade Organization (JETRO) implemented the study about it on economic partnership projects in development countries in FY2007. This JETRO study prepared the plan for the intermediate treatment, however, this plan had one assumption that the rehabilitation would complete by the local government. Therefore it is postponed to realize the intermediate treatment plan by JETRO study.

1.2 Objective of Study

The objective of this study is to investigate the adequacy for rehabilitation based on the strategic environmental protection measures, and to prepare the suggestions for rehabilitation and establishment of new landfill site.

1.3 Contents of Study

1.3.1 Target Area

The target wastes are wastes from Bandung City, Cimahi City and West Bandung Regency. Here, Bandung Regency was divided into West Bandung Regency and East Bandung Regency in 2008. And East Bandung Regency utilizes another landfill in West Java. Therefore this study covers three areas mentioned above. The locations of these areas are showed in Figure 1-12.

1.3.2 Target Site

The Target Site of this study is Leuwigajah Disposal Site. It is shown in Figure 1-13.

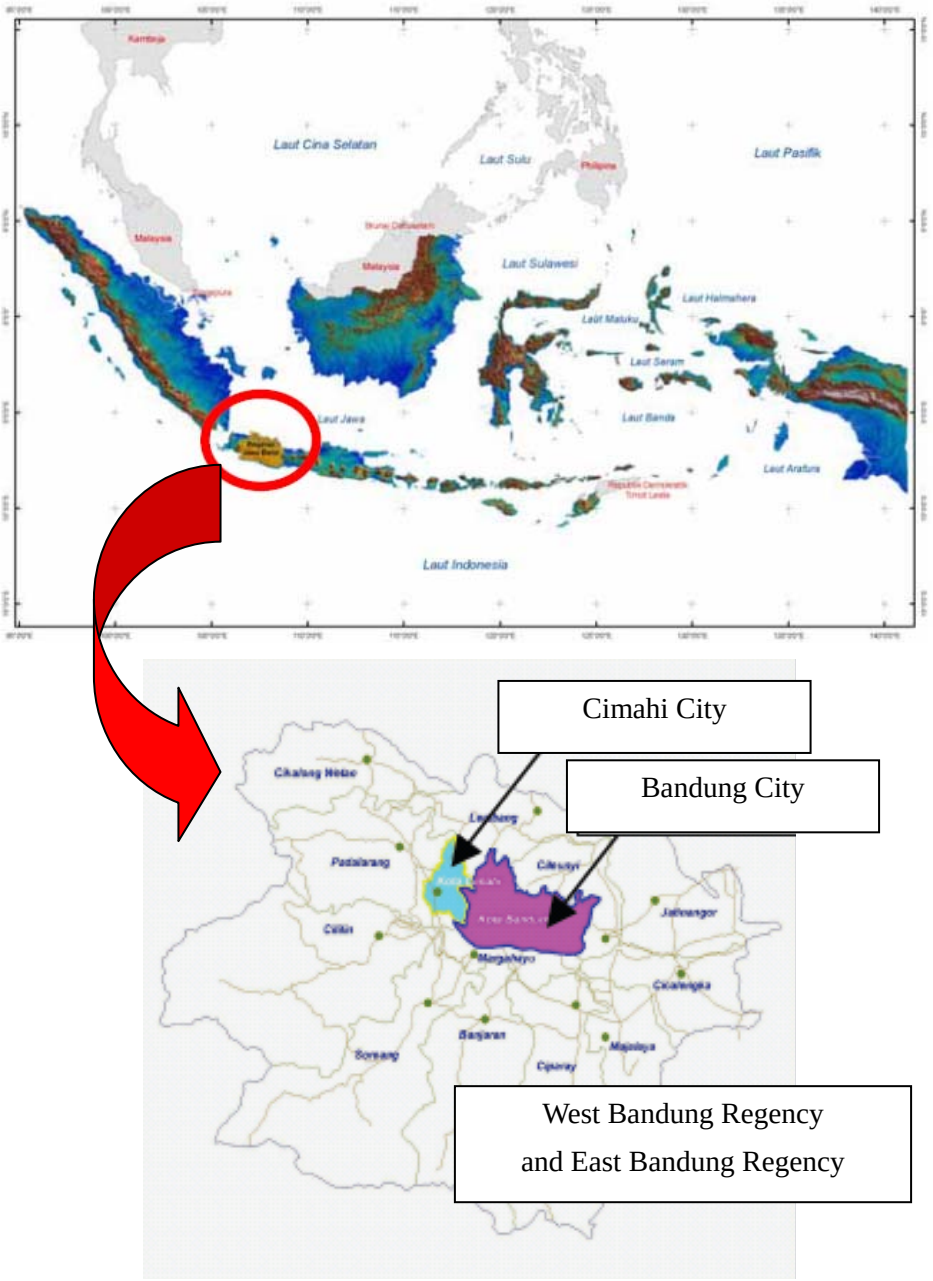

Figure 1-12 Location of Target Area

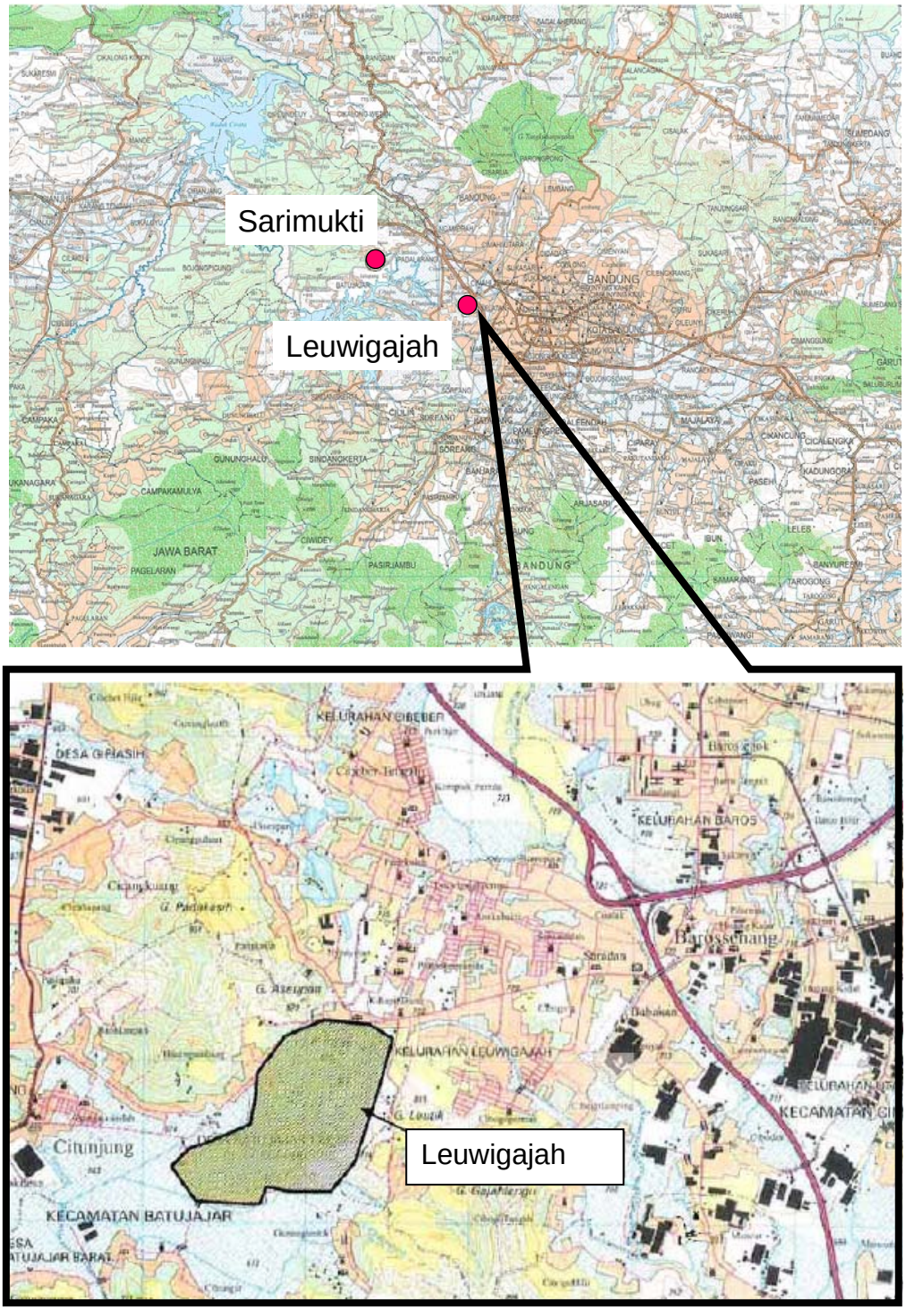

Figure 1-13 Location of Target Site

1.3.3 Contents of the study

The contents of the study are shown in Figure 1-14. Based on these contents, this study suggests Leuwigajah Solid Waste Management Center (LSWMC) including a sanitary landfill and Integrated Intermediate Waste Treatment Facilities (IIWTF). LSWMC is required to be based on the rehabilitation program of Leuwigajah. The central and local governments recognized the urgency and necessity of rehabilitation, however, they have fought desperately on the engineering technologies for rehabilitation and the sustainable method for environmental protection. On the other hand, Japanese engineering technologies for rehabilitation, environmental protection and energy utilization related to landfill are developed and take a lead in the world. Therefore, it is possible to apply these Japanese excellent technologies to the rehabilitation program, and the result of this study can contribute considerably.

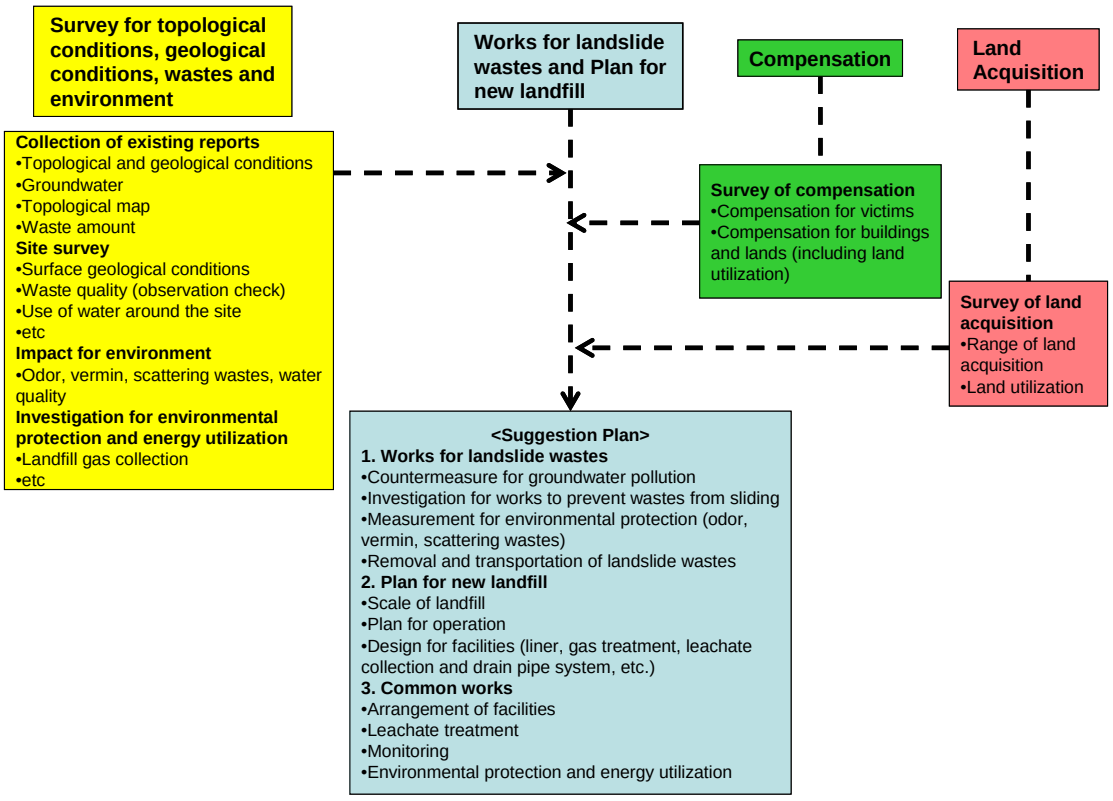

Figure 1-14 Contents of the Study

CHAPTER 2 OUTLINE OF SITE CONDITION

2.1 Location and Access

Leuwigajah Disposal Site is located in Cimahi City, which is 12km west of the center of Bandung City. Regarding to the access, waste collection vehicles of Bandung City had used Bandung High Way or Paster High Way from the center of the city to Baros interchange and used Kerkhof local road after this interchange. Waste collection vehicles of Cimahi City had used local roads and finally Kerkhof local road.

The location of Leuwigajah Disposal Site is shown in Figure 2-1.

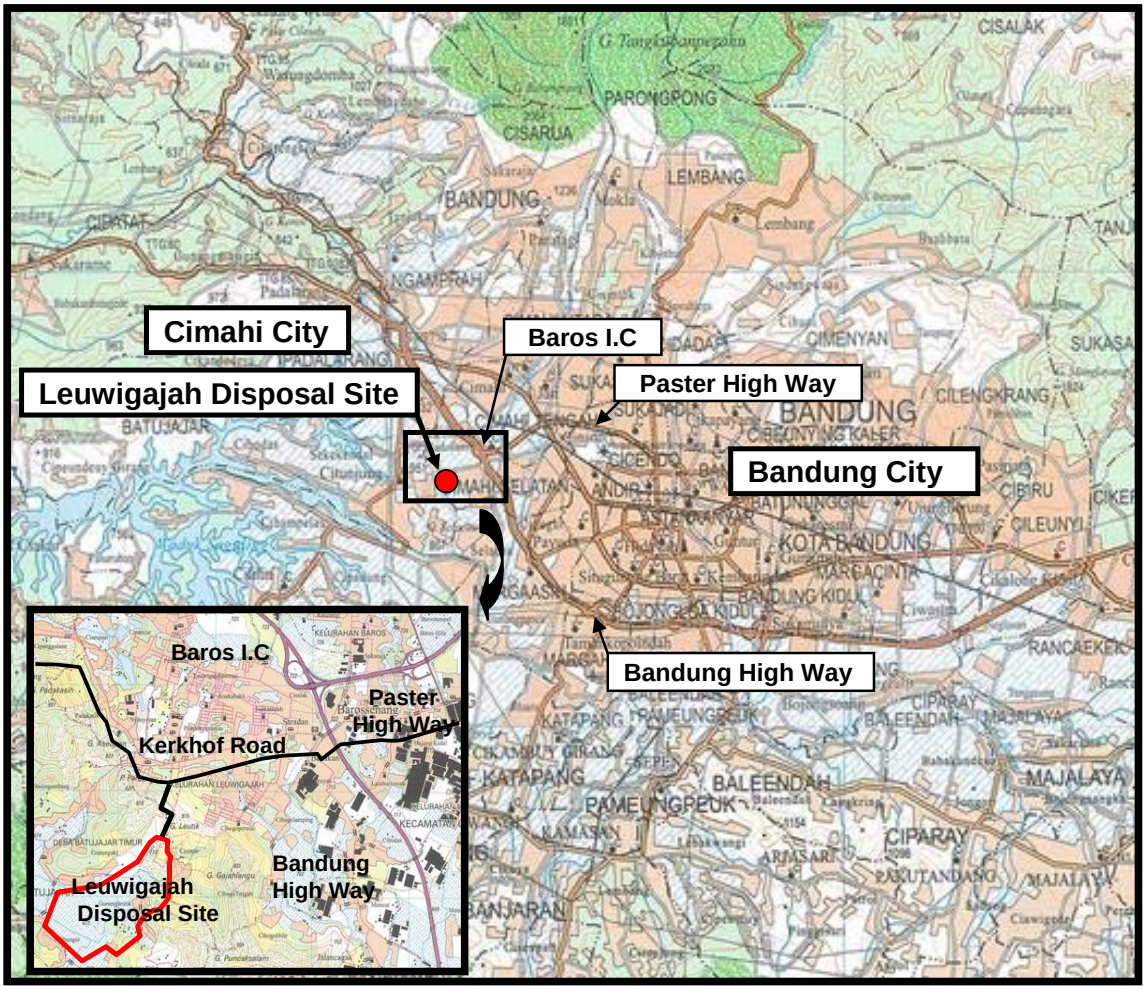

Figure 2-1 Location of Leuwigajah Disposal Site

2.2 Topographic Conditions

Before the landslide at Leuwigajah Disposal Site, people disposed wastes as filling up the valley. After the landslide, the landslide waste reached to an open (paddy) field at the foot of a mountain. The width of the valley is about 250m at maximum. The altitudes at the up stream side, the right side from the bottom and the left side from the bottom are about 770m, 815m and 770m at maximum respectively. The altitudes of the bottom after the landslide are about 725m at the up stream side and about 700m at the down stream side. The landslide waste reached about 600m ahead of the end of the valley. The altitude of the edge of the landslide waste is about 670m. Even though we could not calculate the thickness of the landslide wastes because there are not any data of boring and/or a survey map before the landslide, the thickness of the landslide wastes can be estimated as 15m to 30m by visual checking.

A topographic map of the disposal area is presented in Figure 2-2.

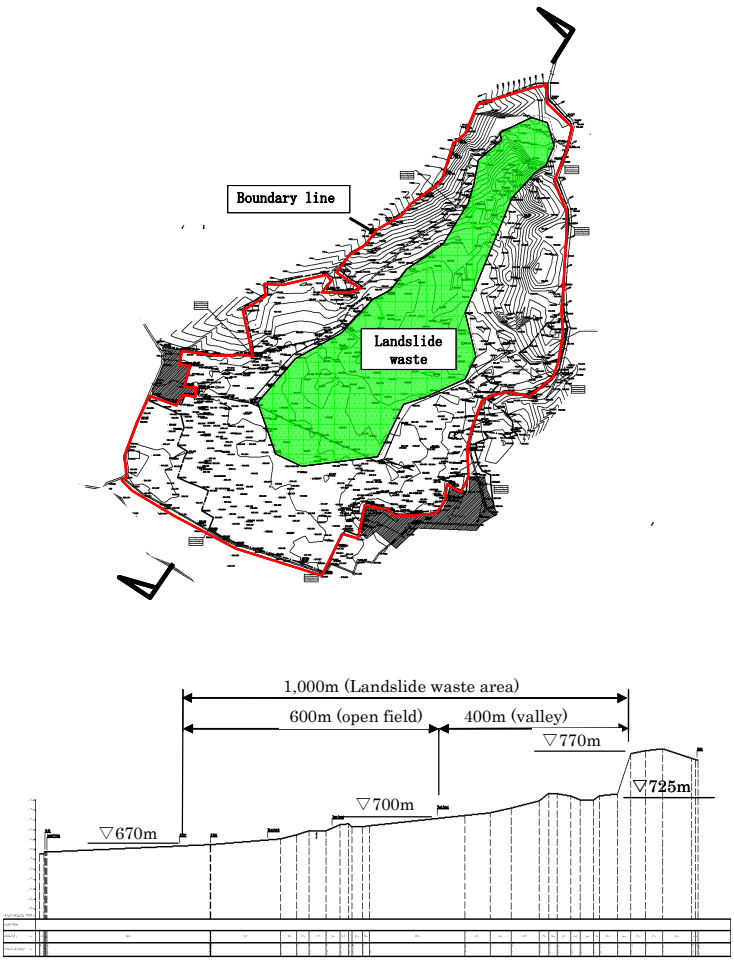

Figure 2-2 Topographic Map of Leuwigajah Disposal Site

2.3 Geological Condition

The geological map around Leuwigajah Disposal Site is shown in Figure2-3.

The stratum of the up stream side of the valley is a sandstone layer of volcano products of Tertiary-Poliocene (TPV layer). The surface of this layer is weathered and the weathered depth is about several meters. The stratum of the down stream side of the open field is an alluvial and colluvial deposits layer of Quaternary-Late Pleistocene (QH'a layer). As Figure 2-4 and Figure 2-5, there is only a little difference between the weathered soil on the up stream and alluvial and colluvial deposits layer on the down stream. Therefore, it can be said that alluvial and colluvial deposits layer formed with the weathered soil flowing out from the up stream. The open field is utilized as a paddy field, so the permeability of the soil in this layer can be low. It is possible that this layer can play a role of the liner.

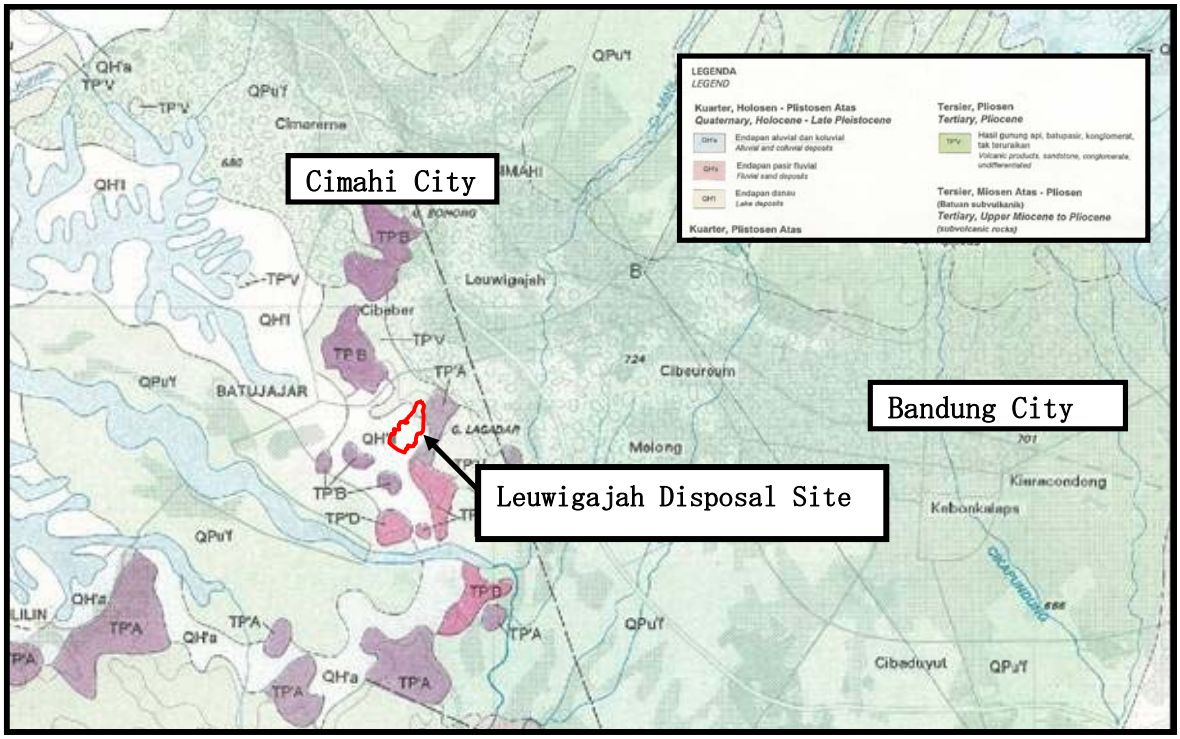

Figure 2-3 Geological Map around Leuwigajah Disposal Site

Figure 2-4 TPV Layer (up stream side)

Figure 2-5 QH'a Layer (down stream side)

2.4 Meteorological Conditions

The daily observation data of rainfall, temperature, sunshine duration and evaporation for 10 years (1999 to 2008) were collected except for each data of December 2008. The point of observation is Bandung Airport Meteorological Station which is the nearest point from Leuwigajah Disposal Site. With these daily data, the monthly averages were calculated shown as Table 2.1, 2.2, 2.3 and 2.4. As mentioned above, all annual averages in 2008 and averages in December were calculated without each data of December 2008.

(1) Rainfall

As shown in Table 2-1, the annual average is 2,006.6mm. The maximum annual average is 2,448.7mm recorded in 2001 and the minimum annual average is 1,701.6mm recorded in 2006. The maximum monthly average is 261.2mm in November and the secondary is 260.3mm in December. The monthly averages from November to April are more than 200mm. On the other hand, the monthly averages from June to September are less than 100mm.

Table 2-1 Monthly Average Rainfall

Unit:mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1999	192.3	110.3	239.2	130.4	248.3	67.4	70.5	23.0	18.7	265.7	288.7	232.8	1,887.3
2000	261.4	140.7	135.7	259.0	240.1	47.4	80.2	19.8	44.8	152.4	317.1	70.6	1,769.2
2001	219.0	248.9	208.0	244.3	82.9	87.5	187.2	52.3	107.0	409.7	526.4	75.5	2,448.7
2002	364.8	81.4	344.1	183.5	55.0	54.1	121.9	37.8	10.3	20.8	195.5	457.2	1,926.4
2003	69.1	265.6	359.0	136.0	111.7	37.4	40.5	74.7	76.3	320.2	185.6	203.2	1,879.3
2004	195.6	191.2	240.8	301.8	286.5	76.2	34.4	11.4	84.7	83.5	184.4	238.9	1,929.4
2005	168.2	416.7	307.7	213.5	201.0	201.0	76.3	64.2	145.3	114.9	225.8	204.7	2,339.3
2006	299.9	282.3	53.4	232.6	89.7	32.2	45.0	0.0	0.3	57.1	109.3	499.8	1,701.6
2007	127.5	405.7	105.4	472.0	88.6	164.1	11.0	0.0	44.1	98.4	301.7	359.7	2,178.2
2008	240.9	103.3	242.4	297.1	165.4	65.3	3.6	58.6	41.5	137.0	277.3	-	-
Ave.	213.9	224.6	223.6	247.0	156.9	83.3	67.1	34.2	57.3	166.0	261.2	260.3	2,006.6

(2) Temperature

As shown in Table 2-2, the monthly average is about 23 ºC through a year. The gap of temperature is small and the climate is mild.

Table 2-2 Monthly Average Temperature

Unit:℃

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1999	23.1	22.8	23.2	23.3	22.6	22.6	22.2	22.4	23.4	23.1	23.1	22.9
2000	22.7	22.8	23.1	23.0	23.6	22.8	22.9	23.0	24.0	23.7	23.3	23.9
2001	23.0	22.7	23.1	23.3	23.5	23.2	22.4	23.2	23.8	22.7	23.1	24.0
2002	23.2	22.9	23.5	23.8	23.9	23.4	23.2	22.9	23.7	24.9	24.3	23.6
2003	23.8	23.3	23.3	24.1	24.1	23.5	22.9	23.4	23.6	23.7	23.7	23.1
2004	23.8	23.1	23.8	23.9	23.8	23.1	22.9	22.9	23.5	24.5	23.9	22.9
2005	23.4	23.3	23.6	23.7	22.6	23.4	22.8	23.3	23.6	23.5	23.4	23.2
2006	23.1	23.5	23.9	23.5	23.3	22.7	23.0	22.6	23.6	24.4	24.8	23.2
2007	24.1	22.8	23.4	22.9	23.6	23.1	22.8	23.1	24.0	23.9	22.8	22.7
2008	23.1	22.5	22.8	22.9	23.0	22.7	22.7	23.1	24.2	24.0	23.1	-
Ave.	23.3	23.0	23.4	23.4	23.4	23.1	22.8	23.0	23.7	23.9	23.5	23.3

(3) Sunshine duration

The annual average of sunshine duration is 1,725.6hr as shown in Table 2-3. The maximum annual average is 1,962.3hr recorded in 2006 and the minimum annual average is 1,603.4hr recorded in 2003.

The maximum monthly average is 190.7hr in August and the secondary is 183.5hr in July. The monthly averages during a dry season (from June to September) are more than 160hr. Conversely the monthly averages during a rainy season (from October to May) are less than 160hr.

Table 2-3 Monthly Average Sunshine Duration

Unit:Hour

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1999	111.0	103.4	135.1	119.0	133.4	148.5	185.9	187.2	182.6	124.5	106.9	103.1	1,640.6
2000	90.6	111.3	107.2	108.7	164.2	153.4	183.0	186.8	180.8	113.7	92.1	167.7	1,659.5
2001	99.8	90.5	102.6	143.0	139.7	166.6	161.1	174.6	156.7	110.6	91.8	180.6	1,617.8
2002	117.2	94.0	147.0	139.0	135.0	178.6	179.4	208.2	183.8	198.7	121.8	129.8	1,832.5
2003	147.2	98.6	5.2	138.9	169.8	191.7	196.3	174.4	155.4	136.6	111.1	78.2	1,603.4
2004	133.8	90.2	145.7	126.9	160.3	180.0	162.9	222.6	157.3	200.5	114.0	90.4	1,784.5
2005	121.6	120.1	141.8	133.6	145.1	145.1	176.6	185.0	153.4	140.3	126.3	87.0	1,676.0
2006	116.2	150.8	141.3	144.0	165.7	181.2	190.3	221.6	199.9	190.2	157.0	104.2	1,962.3
2007	161.8	88.3	124.6	111.1	151.0	152.4	200.1	187.4	194.9	152.8	136.2	93.6	1,754.1
2008	155.5	43.8	112.4	85.0	155.7	151.7	199.5	158.9	178.3	143.5	108.7	-	-
Ave.	125.5	99.1	116.3	124.9	152.0	164.9	183.5	190.7	174.3	151.1	116.6	115.0	1,725.6

(4) Evaporation

The annual average of evaporation is 1,182.6mm as shown in Table 2-4. The maximum annual average is 1,397.0mm recorded in 2006 and the minimum annual average is 1,032.0mm recorded in 2001.

The maximum monthly average is 119.2mm in September and the secondary is 114.3mm in August. The minimum monthly average is 88.6mm in April and the secondary is 88.7mm in June.

Compared between each monthly average of rainfall and evaporation, it can be said that little leachate would generate during a dry season because the evaporation exceeds the rainfall. Contrary, it can be said that much more leachate would generate during a rainy season because the rainfall is twice as large as the evaporation.

Table 2-4 Monthly Average Evaporation

Unit:mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1999	89.3	98.9	89.2	82.8	63.8	74.3	89.9	102.6	104.4	98.5	83.0	87.8	1,064.5
2000	97.2	92.5	82.3	72.1	83.3	80.2	94.3	98.1	118.5	103.2	64.4	112.4	1,098.5
2001	93.6	80.4	84.2	74.6	79.1	82.1	77.9	109.2	97.4	56.8	72.4	124.3	1,032.0
2002	86.8	79.0	93.7	85.3	101.6	79.7	96.3	111.3	110.9	133.1	81.1	72.1	1,130.9
2003	105.5	75.4	63.7	79.5	105.3	93.6	108.9	109.9	108.9	98.5	74.0	81.1	1,104.3
2004	106.8	80.5	113.3	97.6	83.2	99.9	72.3	124.4	105.0	138.6	100.8	92.1	1,214.5
2005	108.7	86.8	110.1	109.0	99.7	85.9	103.3	107.3	114.8	111.4	92.3	99.6	1,228.9
2006	114.5	119.2	118.1	110.2	104.0	95.2	114.2	134.9	134.5	120.9	134.2	97.1	1,397.0
2007	134.9	87.7	110.3	88.9	101.6	95.5	109.6	132.9	155.1	136.1	121.8	98.4	1,372.8
2008	127.6	100.9	98.6	85.7	114.0	100.9	126.7	112.2	141.7	128.9	84.7	-	-
Ave.	106.5	90.1	96.4	88.6	93.6	88.7	99.3	114.3	119.1	112.6	90.9	96.1	1,182.6

2.5 Hydrological Conditions

The hydrological distribution around Leuwigajah Disposal Site is shown in Figure 2-6.

Around Leuwigajah Disposal Site, there are 3 swamps in Leuwigajah Disposal Site, Cireundeu Village and Pojok Village. From each swamp, rain water, spring water, miscellaneous wastewater and leachate are mixed together and flow through channels to the open field of down stream.

The channel from the swamp in Cireundeu Village extends from the south-east side of landslide wastes, turns to the down stream (south) side and meets the channel at the west side of landslide wastes. After 1,200m ahead to the down stream, it meets the swamp in Pojok Village. After 1,500m ahead to the down stream, it flows into Waduk Sagling Dam Lake. Leachate from landslide wastes flows into this channel. Waduk Sagling Dam Lake is utilized for surrounding agriculture and factories, and for drinking water in Jakarta.

The channel from the swamp in Pojok Village passes the south side of the landfill boundary. After 600m ahead to the down stream, it meets the channel from the swamp in Cireundeu Village.

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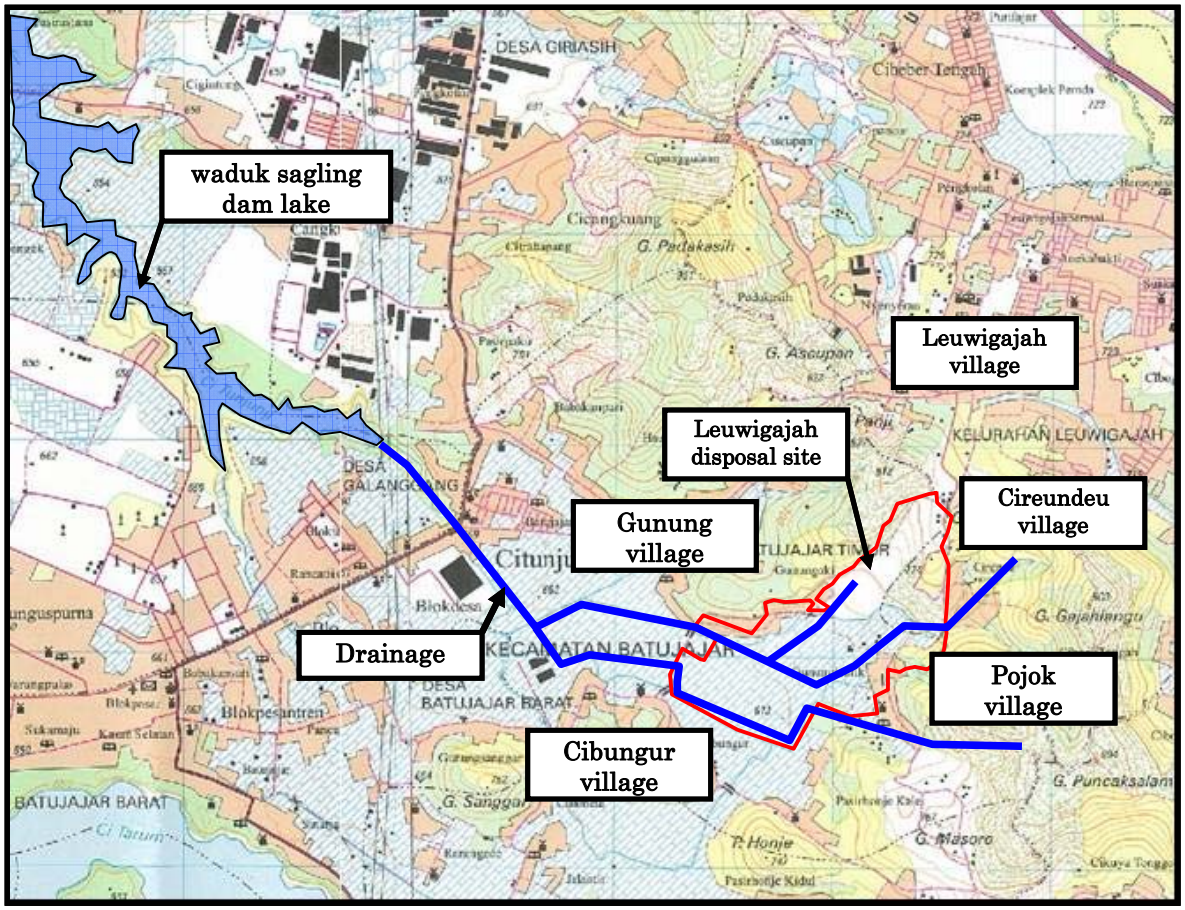


Figure 2-6 Hydrological Distribution Around Leuwigajah Disposal Site

2.6 Surrounding Land Use

The land use of surrounding Leuwigajah Disposal Site is as following;

- Leuwigajah Village at about 200m north from the north boundary
- Cireundeu Village along the north-east boundary
- Pojok Village along the south-east boundary
- Paddy fields at about 10 to 100m north from the south boundary
- Cibungur Village at the south from the paddy fields
- Gunung Aki Village and paddy fields along the south-west boundary

Among them, Cibungur Village and Gunung Aki Village receive the greatest effect of the disposal site because these areas are at the down stream of the site and at low altitudes.

Figure 2-7 shows the land use of surrounding Leuwigajah Disposal Site.

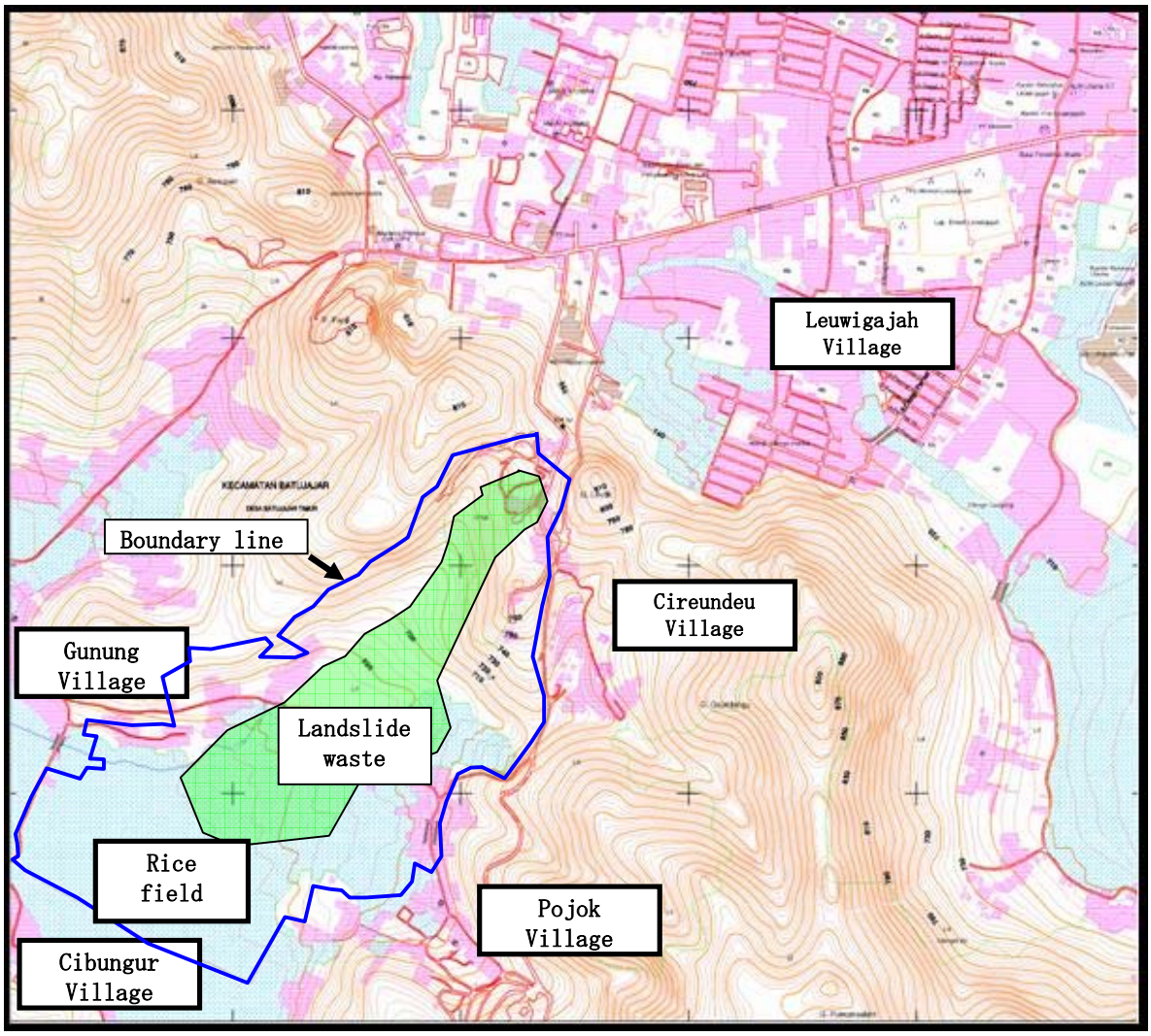


Figure 2-7 Land Use of Surrounding Leuwigajah Disposal Site

2.7 Surrounding Water Use

The water use of surrounding Leuwigajah Disposal Site is as following;

- Residents in villages at the north-east side, east side and south-east side use the shallow groundwater, which is about 2 to 3m depth, for drinking water and other domestic water.
- Residents in villages at the south side and south-west side use the deep groundwater, which is about 30m depth, for drinking water and other domestic water. It is because the shallow groundwater is used by neighboring factories and dried up at these villages
- Residents use the water of the channel from the swamp in Pojok Village for paddy fields in the south side. This water is clean apparently and not mixed with domestic wastewater so much.
- Residents use the water of the channel from the swamp in Leuwigajah Disposal Site and Cireundeu Village. This water seems not to be clean because it is a mixture of leachate and domestic wastewater from Cireundeu Village.

2.8 Compensation and Land Acquisition

West Java Province started the Rehabilitation Program just after the landslide accident in 2005. Compensation and land acquisition are one part of this program and implemented as Phase 1 and Phase 2. This compensation is both for victims and for land (including houses, other buildings, crop fields, so on). The number of victims was 167 persons including 147 of the dead (as in September 2008). Originally the Leuwigajah Disposal Site was owned by Bandung City and Bandung Regency and Cimahi City respectively. After the landslide, West Java decided to manage whole area of the site.

Phase 1 has started from February 2005 and still continued. The compensation cost Rp. 4.9 million for victims and Rp. 48.7million for land. 49.5ha of the land was acquired as Figure 2-8. 3.6ha of the land, which is at the middle of the original land of Leuwigajah, is not acquired at present (as in December 2008). West Java Province could not go through any procedure about this 3.6ha land because problems arose among 3 land owners.

Phase 2 has started from June 2007 and still continued. The land boundary was expanded because it was decided that Leuwigajah Disposal Site would be used again. The total area became 75.1ha including 25.6ha of the original and would become 81.6ha in the plan of West Java (as in June 2008). Consequently West Java Province acquired not only the land covered by wastes, but also some crop fields at the down stream. In Phase 2, 6.5ha of the land, which included 6 housing areas, is not acquired at present as Figure 2-8 (as in December 2008). West Java Province has gone through a procedure with 7 land owners regarding this 6.5ha. West Java decided to allocate the budget of FY2009 for land acquisition as Rp. 8.7 million.

The situation of compensation and land acquisition in December 2008 is summarized in Table 2-5.

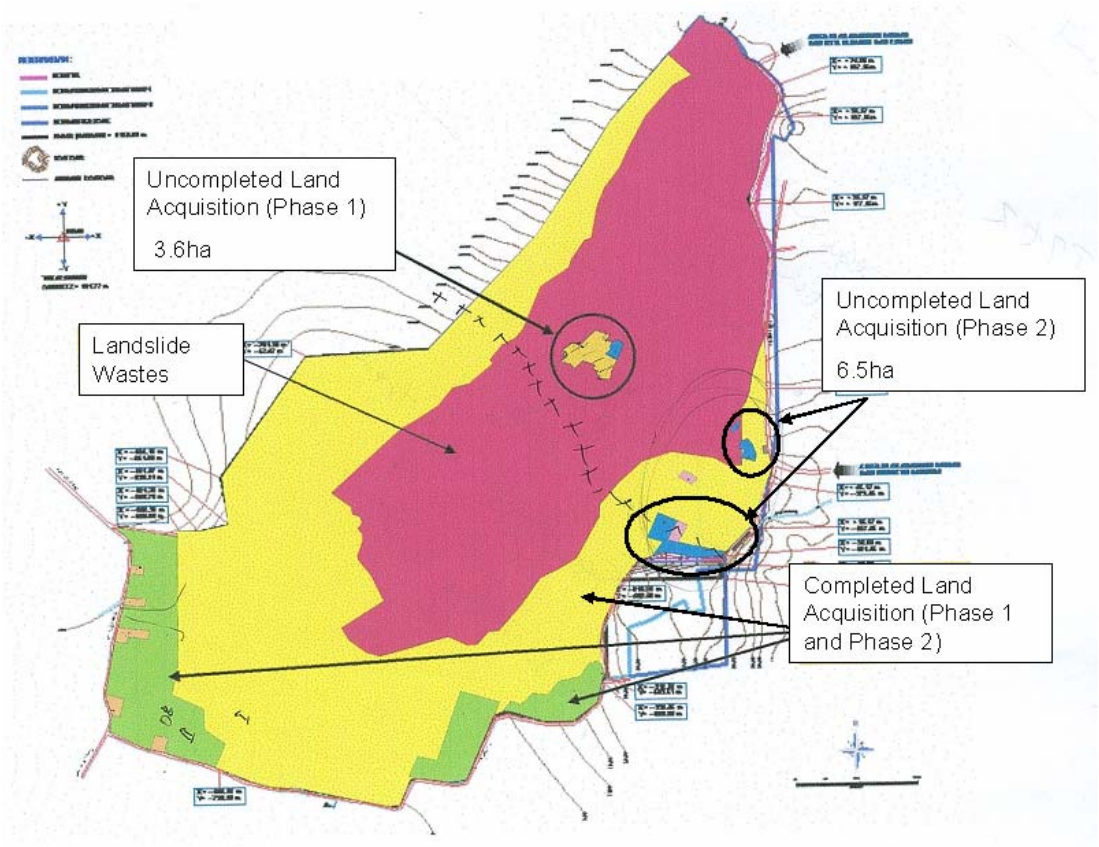


Figure 2-8 Land Acquisition Situation

Table 2-5 Compensation and Land Acquisition (December 2008)

		Phase 1	**Phase 2**	**Total**
Compensation	**For victims**	Rp. 4.9 million		Rp. 4.9 million
	For land (including houses, other buildings, crop fields, etc.)	Rp. 48.7 million	Rp. 8.7 million	Rp. 57.4 million
Land Acquisition	**Completed**	49.5ha	25.6ha	75.1ha
	Uncompleted	3.6ha	6.5ha	10.1ha

2.9 Environmental Impact Assessment (AMDAL)

In order to use Leuwigajah Disposal Site again, AMDAL (Environmental Impact Assessment) needs to be carried out. In October 2008, TARKIM explained that TARKIM already subcontracted with a local company and that preparation of AMDAL had started. The cost of implementation of AMDAL was from the budget of West Java. Finally BPLHD will evaluate this AMDAL. The field survey was finished and it was in the stage of the discussion with residents in October 2008. The local company informed about AMDAL on newspaper to call residents' comment, but any comments from residents were not submitted. In December 2008, TARKIM explained that AMDAL is still being carried out and it continues in the next fiscal year.

CHAPTER 3 EFFECT OF LANDSLIDE WASTES ON ENVIRONMENT

3.1 Characteristic of Landslide Wastes

(1) Existing data

Composition analysis of landslide wastes was carried out in the follow up investigation of JETRO study in FY2007. The analysis result is as following. The percentage by weight of soil and organic is the highest of all as 49.7%. The secondary is the percentage of stone as 15.0% and the tertiary is the percentage of plastics as 13.5%. These three components occupy about 80% of all.

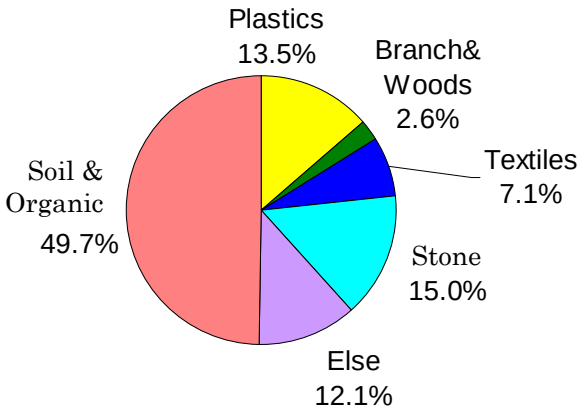


Figure 3-1 Result of composition analysis of landslide wastes

(2) Site survey of observation (visual) checking

The situation of landslide wastes was surveyed by observation (visual) checking at three points as shown in Figure 3-2.

As shown in Figure 3-3, Figure 3-4 and Figure 3-5, the surface of landslide wastes at all points were mostly covered by plastics. Fine grains of wastes on the surface seemed to be flown by wind and/or rain. Soil and organic wastes were inside of landslide wastes. As the existing data, plastics, soil and organic wastes were conspicuously.

(3) Consideration

As the following reasons, it is suitable for transportation and treatment of landslide wastes that landslide wastes would be segregated, and plastics, soil and organic wastes would be recycled.

- The ratio of plastics, soil and organic wastes is large in landslide wastes.

- Compaction of plastic wastes is difficult, but recycling of plastic wastes is possible. (Actually rag pickers recycle plastic wastes at present.)
- It is possible to use soil and organic wastes as covering soil. Utilization of these wastes as covering soil will contribute the reduction of the cost for purchasing covering soil because a lot of covering soil is necessary if a sanitary landfill is constructed

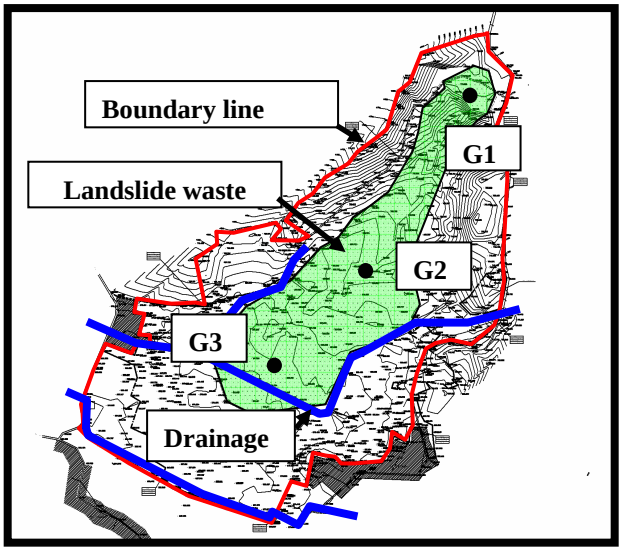


Figure 3-2 Sampling Location for Observation Checking

<Surface of landslide waste>

<Inside of landslide waste>

Figure 3-3 Observation at G1

<Surface of landslide waste>

<Inside of landslide waste>

Figure 3-4 Observation at G2

<Surface of landslide waste>

<Inside of landslide waste>

Figure 3-5 Observation at G3

3.2 Water Analysis

(1) Sampling points and measurement items

Figure 3-6 shows two sampling points for leachate, four points for groundwater (well) water and four points for canal water. EC, pH, COD and NH_4 of each sample were measured by simple measuring kits.

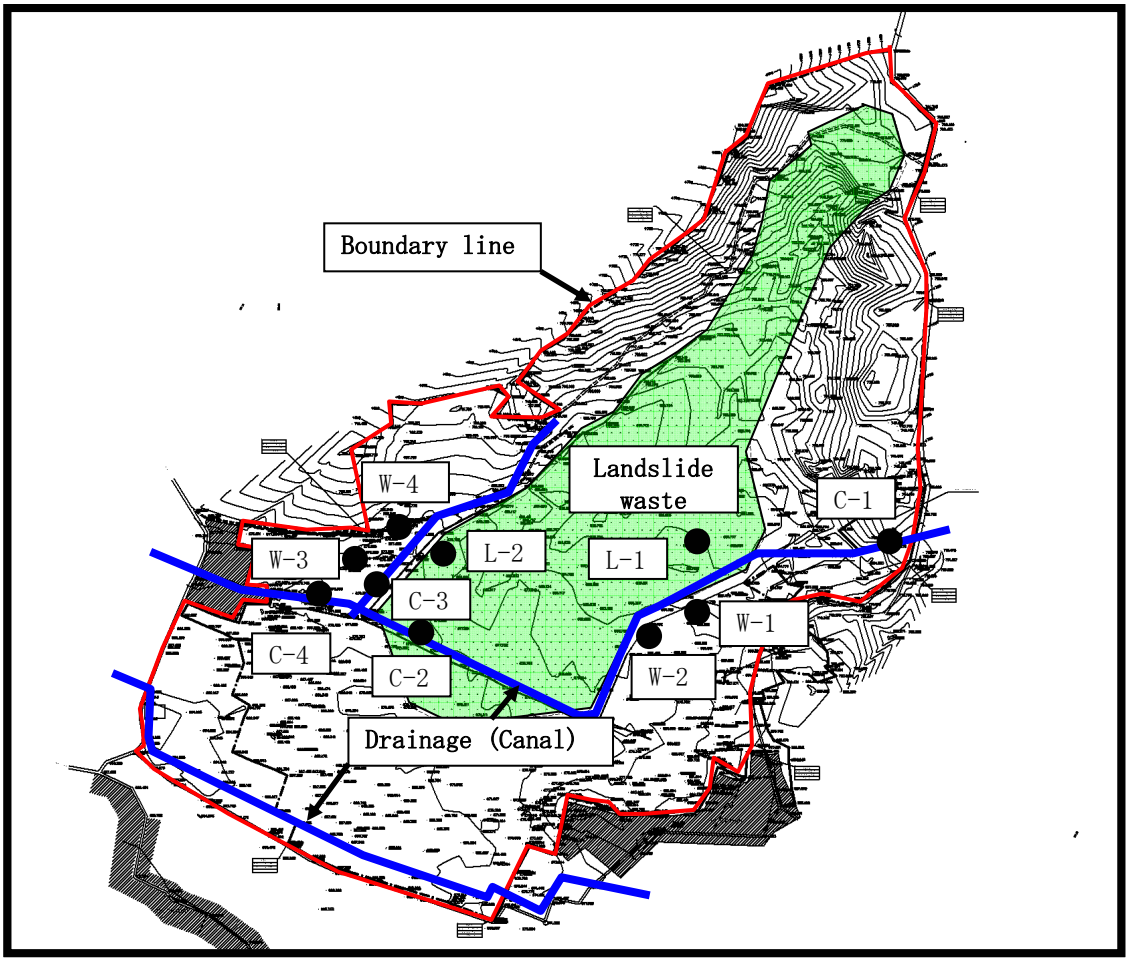


Figure 3-6 Sampling Location for Water Analysis

(2) Results of water analysis

Table 3-1 shows the results water analysis.

1) Leachate

The concentrations of COD and NH_4 of samples at L-1 and L-2 were high similar to a character of general leachate from organic wastes although about three years passed after the landslide and landfill disposal was stopped at the same time. Regarding these two samples, the values of

pH indicated alkaline, the colors were deep grey, and the values of EC were high.
Here, a high concentration of COD affects aquatic living things and a high concentration of NH_4 leads eutrophication. The leachate from Leuwigajah Disposal Site flows into drainages (canals) surrounding the site. And water from these canals is utilized for agriculture and industry. Through the canals, water flows into Waduk Sagling Dam Lake and is utilized for drinking water in Jakarta. Therefore it is necessary to establish the measurement for this leachate urgently.

2) Groundwater

Groundwater at W-1, W-2 and W-4 are not affected by landslide wastes because the groundwater levels of these points are higher than the groundwater level under the landfill. However, groundwater at W-3 has a possible to be affected by landslide wastes because the groundwater level of this point is almost the same as the groundwater level under the landfill.
According to the observation checking, color of samples at W-1, W-2 and W-4 was clear, but color of sample at W-3 was impure a little as Figure 3-8. The values of EC of samples at W-1, W-2 and W-4 were low and the values of pH of them were on the mostly same level. As a result, the pollution possibility at these points seems to be low. On the contrary, the value of EC of sample at W-3 was higher and its value of pH was in alkaline compared to other three samples. The pollution possibility at W-3 seems to be high. Therefore it is required to survey for groundwater pollution.
At present, Bandung Institute of Technology (BIT) investigates the water quality of wells surrounding Leuwigajah Disposal Site periodically and limits the utilization of wells with low water quality.

3) Canal water

Canal water at C-1 is not affected by landslide wastes because this point sites the upper stream of the disposal site. However, canal water at C-2, C-3 and C-4 has a possible to be affected by landslide wastes because these points site the down stream of the disposal site.
As Figure 3-9, color of sample at C-1 was impure a little and color of samples at C-2, C-3 and C-4 were red brown. The value of EC of sample at C-1 was relatively low, but its concentration of COD was relatively high and its value of pH was in alkaline. It is because domestic waste water flows into this canal from Cireundeu Village. The concentrations of COD and NH_4 and the values of EC of samples at C-2, C-3 and C-4 were high because of leachate. Their values of pH indicated in alkaline compared to the values of groundwater, so these canals were much affected by leachate from the disposal site.

Table 3-1 Results of Water Analysis

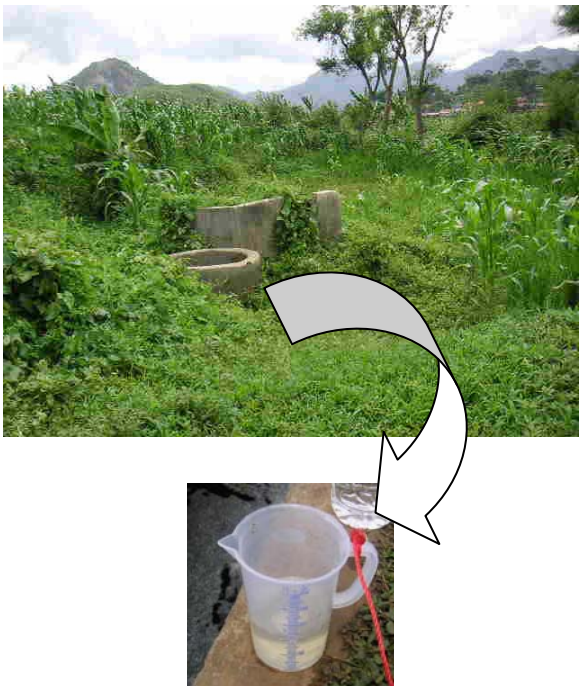
Date	Sampling Location	Type	pH	EC (ms/cm)	COD (mg/l)	NH_4 (mg/l)
08.Dec.08’	L-1	Leachate	8.1	20.00	>1,000	>100
10.Dec.08’	L-2		7.6	7.10	500	>100
08.Dec.08’	W-1	Ground water	6,2	0.50	4	0
	W-2		6.4	0.33	-	-
10.Dec.08’	W-3		7.2	8.40	60	0
	W-4		6.1	1.08	-	-
08.Dec.08’	C-1	Canal water	7.5	0.28	15	0
10.Dec.08’	C-2		7.7	11.80	500	>100
	C-3		7.7	4.20	350	>100
	C-4		7.9	5.20	500	>100

L-1 **L-2**

Figure 3-7 Sampling Points for Leachate

W-1

W-2



W-3

W-4

Figure 3-8 Sampling Points for Groundwater

C-1

C-2

C-3

C-4

Figure 3-9 Sampling Points for Canal Water

3.3 Landfill Gas Analysis

(1) Sampling points and measurement items

Figure 3-10 shows three sampling points which are at upper stream, middle, and down stream of the landslide wastes. At each point, landfill gas was measured on the surface and under 1 m from the surface as Figure 3-11. Measurement items are CH_4, O_2, CO_2 and Combination Gas.

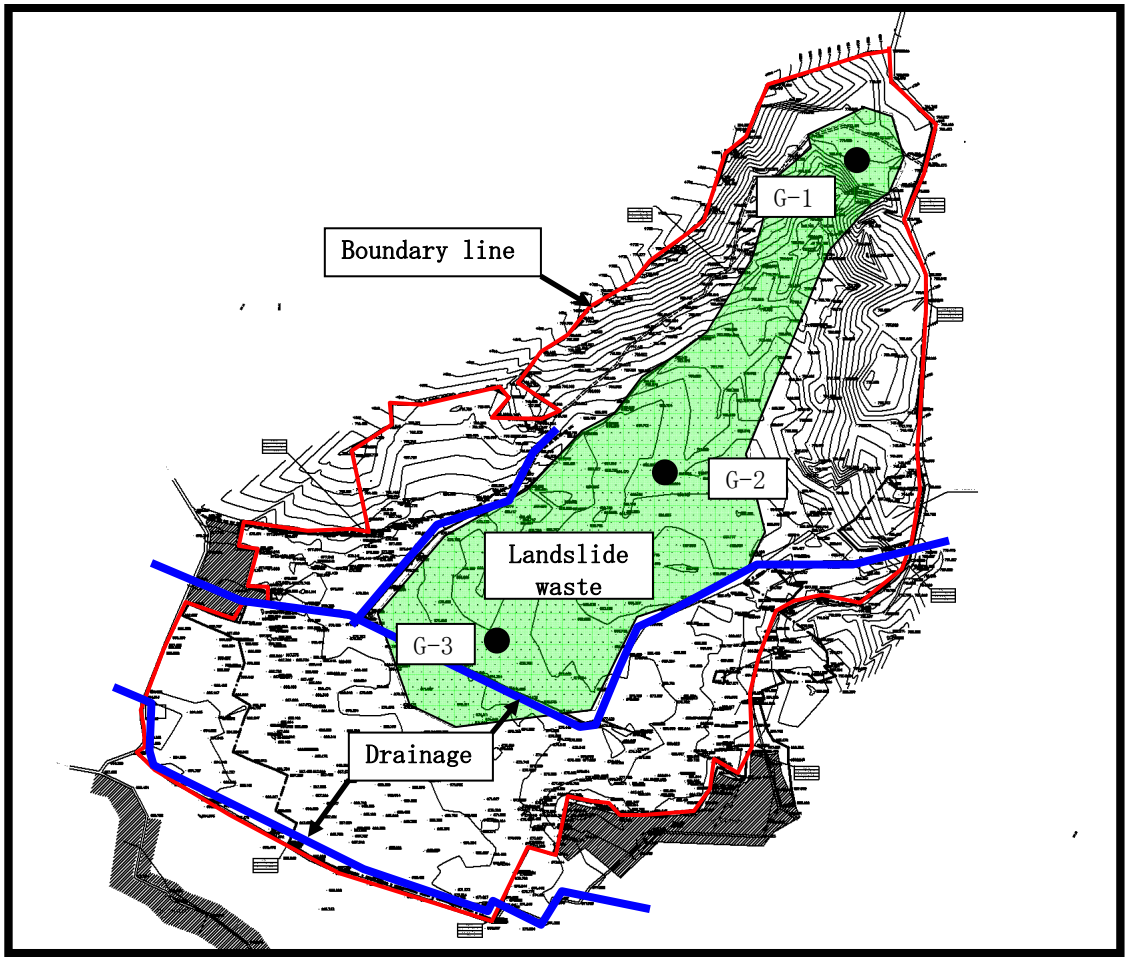


Figure 3-10 Sampling Location for Landfill Gas Analysis

(2) Results of landfill gas analysis

As Table 3-2, the values of CH_4 and CO_2 on the surface and under 1m at all points are less than 1%. It can be said that very little landfill gas would generate at all points. Decomposition of landslide wastes seems to be completed mostly during three years. This results shows that it is difficult to utilize landfill gas from landslide wastes for energy source.

G-1（ Surface）

G-1（ Under 1m）

G-2（ Surface）

G-3（ Surface）

Figure 3-11 Sampling Points for Landfill Gas

Table 3-2 Result of Gas analysis

Date	Sampling Location		CH_4 (%)	O_2 (%)	CO_2 (%)	Comb*1 (%)
08.Dec.08’	G-1	Surface	0.1	18.4	0.2	81.1
		Under 1m	0.2	18.2	0.6	81.0
10.Dec.08	G-2	Surface	0.2	18.6	0.2	81.1
		Under 1m	0.3	18.5	0.2	81.0
	G-3	Surface	0.2	18.6	0.2	81.1
		Under 1m	1.9	18.6	0.2	81.0

Comb*1: The chief ingredient of the combinations gas is nitrogen

3.4 Reconnaissance Survey

The following effects on the surrounding environment by landslide wastes were found by reconnaissance survey.

(1) Slope failures of landslide wastes along the steep slope

As shown in Figure 3-12, the slope from the top of the landslide wastes was quite steep. Slope failures can be happened again by the heavy rain.

(2) Flowing out of landslide wastes and leachate

As Figure 3-13, the leachate flew into the drainage at the edge of the down stream side of landslide wastes. At that place, landslide wastes also can flow out by heavy rain.

Figure 3-12 Steep Slope on the Top of Up Stream Side of Landslide Wastes

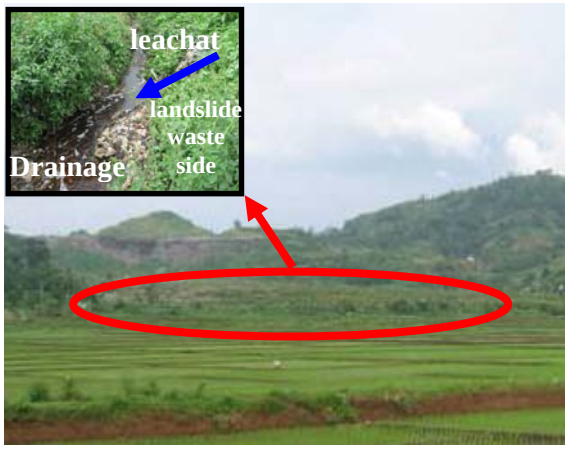


Figure 3-13 Edge of Down Stream Side of Landslide Wastes

3.5 Interview Survey for Residents around Leuwigajah Disposal Site

This study implemented the interview survey for residents around Leuwigajah Disposal Site about six items; scattering wastes, odor, vermin, smoke (fire), water utilization (drinking water) and opinion for rehabilitation. The respondent was twenty people of four villages and selected to prevent a bias. Table 3-3 shows the method of the interview survey.

Table 3-3 Method of Interview Survey

Date	7th December, 2008
Place	Villages surrounding Leuwigajah Disposal Site (9 points, 4 villages)
Survey method	Interview survey (6 items; scattering wastes, odor, vermin, smoke (fire), water utilization (drinking water) and opinion for rehabilitation)
Respondent	20 persons from 4 villages surrounding Leuwigajah Disposal Site
Gender of respondent	Man: 11 persons, Woman: 9 persons
Age of respondent	Average 46.4 year-old

The results of the interview survey are shown as follows, except for the results of water utilization because it is mentioned in Chapter 2.

3.5.1 Scattering wastes

As a result shown in Table 3-4, the number of respondents who answered as “No problem” was the largest of all. This result would be affected the date of the survey because it was in rainy season. Considering respondents who answered “Problem only in dry season” and “Problem”, scattering wastes would be a problem especially in dry season. Regarding on the relationship of the living area, all respondents in Gunung Village, next to the down stream side of the landslide wastes, answered as “Problem”.

Table 3-4 Result of Interview Survey about Scattering Wastes

Answer	No of persons
No problem	9
Problem only in dry season	8
Problem	3

3.5.2 Odor

As Table 3-5, four respondents answered as “No problem”, however, other sixteen respondents answered as “Problem” although there are some differences of extent. It is found that residents feel odor is more trouble than scattering wastes. Also the difference of seasons is little in answers, so odor is a problem through a year for residents. There is not a clear relationship with living areas.

Table 3-5 Result of Interview Survey about Scattering Odor

Answer	No of persons
Problem	8
Problem a little	6
No problem	4
Problem only in dry season	1
Problem only in rainy season	1

3.5.3 Vermin

As Table 3-6, five respondents answered as “No problem”, however, other fifteen respondents answered as “Problem” although there are some differences of extent. As same as the results about odor, vermin is a problem through a year and there is not a clear relationship with living areas.

Table 3-6 Result of Interview Survey about Vermin

Answer	No of persons
Problem	11
No problem	5
Problem a little	3
Problem only in rainy season	1

3.5.4 Smoke (fire)

As a result shown in Table 3-4-5, the number of respondents who answered as “Problem only in dry season” was the largest of all. Other than this answer, eleven respondents answered as “Problem” although there are some differences of extent. Only one person answered “No Problem”. Compared to three items mentioned above, it is clear that smoke is the most serious

problem for residents. Several respondents explained that the causes of smoke generation were both spontaneous and artificial combustion.

Table 3-7 Result of Interview Survey about Smoke (Fire)

Answer	No of persons
Problem only in dry season	11
Problem	7
Problem a little	1
No problem	1

3.5.5 Opinion for rehabilitation

The result of opinion for rehabilitation is as following table.

Table 3-8 Result of Interview Survey about Opinion for Rehabilitation

Answer	No of persons
Disagree	11
Agree	3
Agree under some conditions	3
Uninteresting	3

The number of respondent answering “Disagree” was the largest as eleven respondents. Six respondents expressed agreement although three of them explained some conditions to agree. And three respondents do not show any intentions. Reasons for each answer are as follows.

Table 3-9 Reasons for Opinions about Rehabilitation

Answer	Reasons
Disagree	The present situation is fear, but the operation of Leuwigajah Disposal Site has been unchanged for 23 years. Trauma for landslide accident (3 persons) Unfavorable effect for health (3 persons) Problem of odor Unfavorable effect for children A reliable relationship between the local government is not established

	regardless of applying technology The local government does not come to explain Management method is unclear There are not any detail data It is preferable to transfer landslide wastes to other places It is preferable to establish landfills for each city/regency Financial support is necessary
Agree	Rehabilitation will create a new chance for employment
Agree under some conditions	The condition is that the local government takes into consideration for residents, such as the countermeasure for odor
Uninteresting	Rehabilitation is up to the local government because the land of Leuwigajah Disposal Site was acquired by the local government Rehabilitation already had done for some times, but the management was not changed and open dumping style continued.

3.5.6 Consideration of the Interview Survey

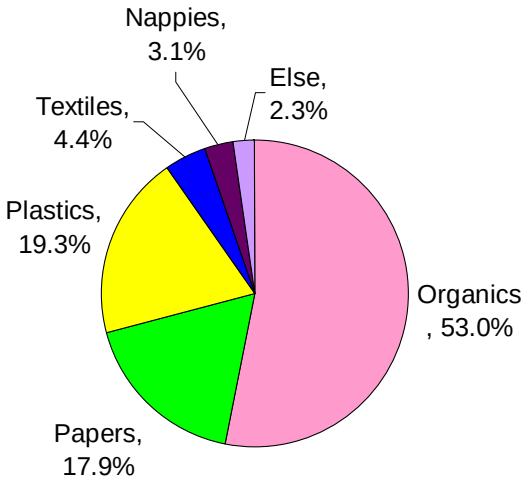
Regarding on scattering wastes, odor, vermin and smoke (fire), as a whole, respondents lived in the down stream side had a higher consciousness about these issues than respondents lived near the disposal site. It was found that odor and vermin were the problems through a year, scattering wastes and smoke (fire) were the problems especially in dry season.

Finally anxiety and distrust of residents seemed to be quite deep. It is because that the tremendous landslide has happened at least twice as mentioned in Chapter 1.

CHAPTER 4 CONDITIONS FOR WASTE MANAGEMENT IN LEUWIGAJAH SOLID WASTE MANAGEMENT CENTER

4.1 Waste Generation in Target Areas

Composition of wastes disposed in Sarimukti Landfill is as the following figure according to JETRO study report in FY2007. The specific gravity of wastes is reported as 0.35.



Else: metals, minerals, rubber, hazardous, etc.

Figure 4-1 Composition of wastes Disposed in Sarimukti Landfill

BPLHD explained the wastes, which were disposed in Leuwigajah Disposal Site before the landslide, were as the following table. These wastes are disposed in Sarimukti Landfill now.

Table 4-1 Wastes Disposed in Leuwigajah Disposal Site before Landslide

	m^3/day	t/day
Bandung City	2,500	875
Cimahi City	750	263
West Bandung Regency	400	140
Total	3,650	1,278

4.2 Waste Management Plan for Target Areas

4.2.1 Conditions for Receiving Wastes at LSWMC

In this study, the target wastes for LSWMC are two types; landslide wastes and daily household wastes.

Regarding the landslide wastes, total amount of the landslide waste is estimated as 1,860,000ton. Treatment of this landslide wastes is necessary to stabilize in order to reuse Leuwigajah Disposal Site. In this study, the daily treatment amount is set as 254t/day. Among them, plastics and other marketable items are picked up for selling, materials under 10mm and minerals are used as covering soil, and others are directly transferred into the landfill. For the future, LSWMC would include a plan of energy recovering from high calorific wastes which could not be sold or reused.

The target of the daily household wastes is a part of the wastes disposed in Sarimukti now; it means the wastes disposed in Leuwigajah before the landslide. The target amount of receiving daily household wastes is summarized as Figure 4-2.

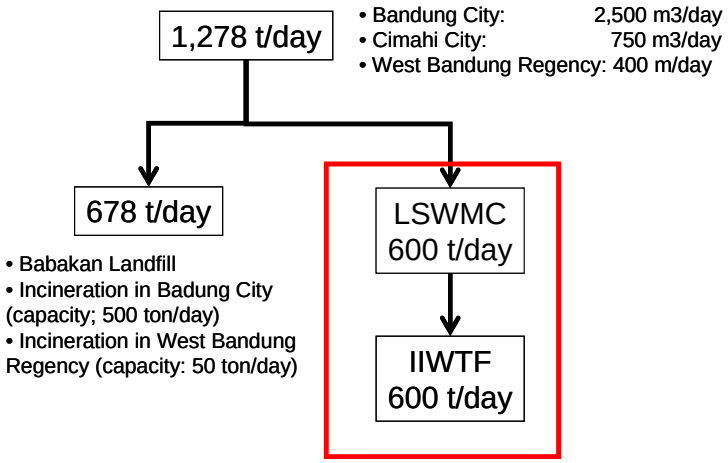


Figure 4-2 Target Amount of Receiving Daily Household Wastes

Before the landslide, wastes transferred into Leuwigajah as around 1,278t/day. In this study, the lifespan of the sanitary landfill in LSWMC is set as 10 years, therefore the amount of receiving wastes at LSWMC is set as 600t/day. The rest of them, which is 678t/day, would be managed in other facilities because Bandung City has a plan of incineration construction and Bandung Regency has plans of construction of incineration and Babakan Landfill.

At first the study team set the receiving wastes were set as that the total receiving wastes were 800t/day of which 600t/day were transported to IIWTF. And the rest of 200t/day was set to be directly disposed into the landfill. However, as a result of discussion with local authorities on 16th

December 2008, the condition of directly disposal into the landfill was deleted according to the request from local authorities for consideration of residents. Therefore the conditions of the receiving wastes at IIWTF were decided as the same amount of the total receiving wastes at LSWMC as 600t/day, that is, all of receiving wastes are transported to IIWTF.

4.2.2 Treatment flow of LSWMC

The summary of the treatment flow is showed in Figure 4-3.

IIWTF consists of the segregation and the biological treatment. The receiving landslide wastes and daily household wastes are segregated as three parts respectively as Figure 4-4. In case of the landslide wastes, fine grains less than 10mm and minerals would be reused as covering soils. Plastics, textiles, branch and woods would be sold for junk buyers. The rest of them would be disposed into the landfill. On the other hand, in case of the daily household wastes, the residue of the biological treatment (organics and papers) would be recycled as compost products. Plastics, textiles and nappies would be sold for junk buyers. The rest of them would be disposed into the landfill as same as the case of landslide wastes.

At present, the total amount of disposal into the landfill is estimated as 400t/day, which consists of residues as 145t/day and products from biological treatment 255t/day as shown in Figure 4-3. It is because the quality of these products is not secured in this plan. Therefore, the annual amount of disposal into the landfill is estimated as 146,000t/day.

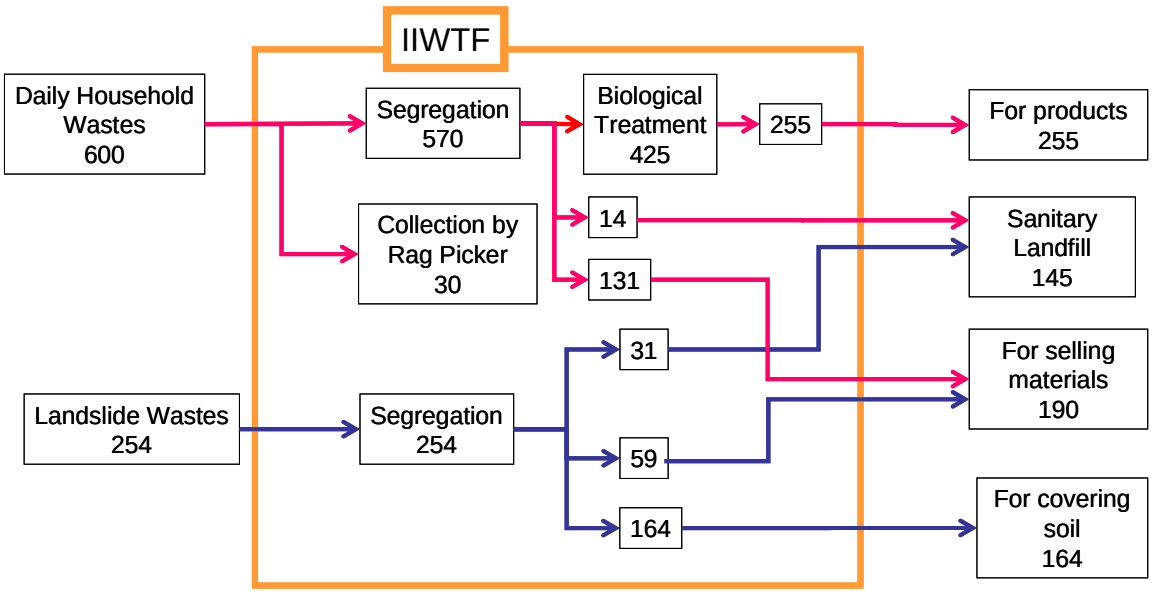


Figure 4-3 Treatment Flow of the Target Wastes (t/day)

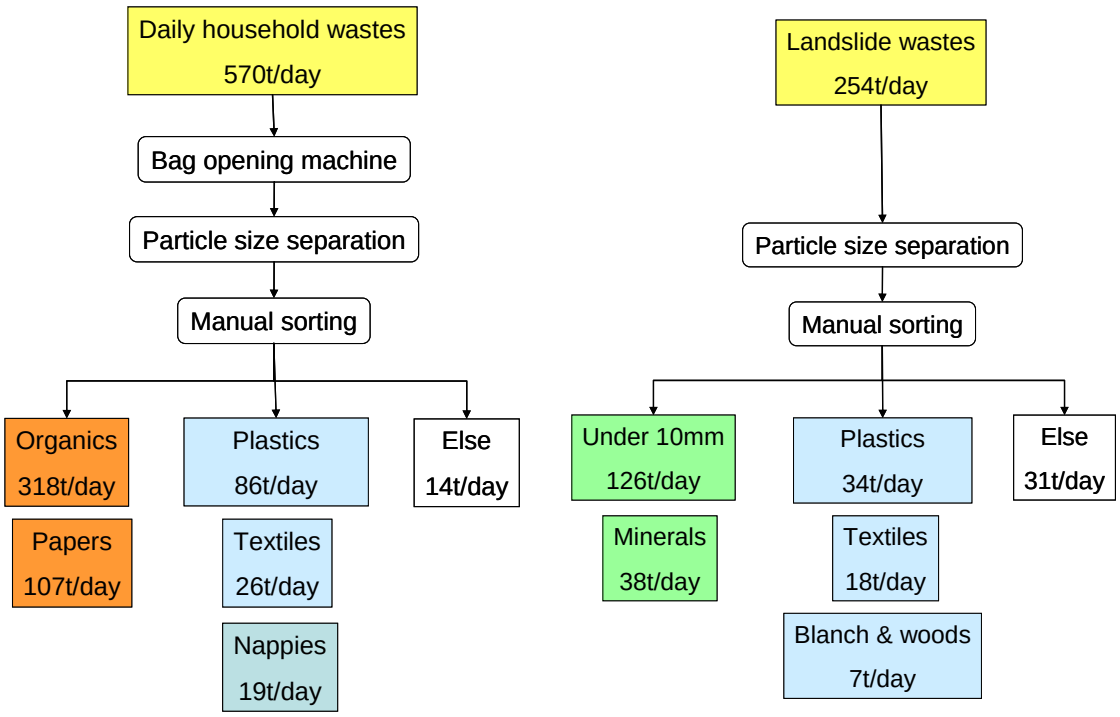


Figure 4-4 Flow of Segregation Process

CHAPTER 5 PLAN FOR REHABILITATION AND ESTABLISHMENT OF LEUWIGAJAH SOLID WASTE MANAGEMENT CENTER

5.1 Process of the West Java Rehabilitation Program

After the landslide at Leuwigajah Disposal Site in February 2005, BPLHD was in charge of implementation for “Rehabilitation Program for Leuwigajah Disposal Site”. BPLHD started this program (refer as the old program) in May 2006 and finalized it in 2007. This old program included two components;

Component 1: Construction of sanitary landfill and Treatment of landslide wastes
Component 2: Construction of intermediate treatment facilities.

However, this old program was lack of technical foundations and it has been stagnant because the central government has not approved it. Regarding on the component 2, the concrete plan was not examined in the old program and JETRO study in FY2007 implemented the survey about it. In JETRO study, the component 1 was an exception of the target because the local government would implement it by their original budget. In order to solve the stagnancy of the old program, TARKIM, which deals with construction works, started to revise the old program and have prepared the program based on the revision (refer as the new program) from October 2008. This study technically supported to prepare the new program especially component 1.
As a part of the rehabilitation, West Java Province already has implemented the compensation, land acquisition, construction of canals and village roads. Table 5-1 shows the process of the rehabilitation by West Java.

Table 5-1 Rehabilitation Process by West Java

Year	Item
FY2005	Landslide in Leuwigajah Disposal Site
FY2005 – FY2007	Compensation
FY2006 - FY2009	Land acquisition
FY2006 - FY2007	Preparation of the Rehabilitation program for Leuwigajah Disposal Site by BPLHD
FY2006 - FY2007	Construction of canals
FY2007	Preparation of the plan for intermediate facilities by JETRO study
FY2008	Improvement of village roads
FY2008	Revision of the Rehabilitation program for Leuwigajah Disposal Site by TARKIM
FY2009	Completion of AMDAL
FY2009	Construction of the segregation facility for landslide wastes
FY2009	Construction and improvement of access roads
FY2009 - FY2010	Construction of the fish pond and the agricultural pond
FY2009 - FY2010	Construction of the buffer zone

5.2 Requests from Residents for Rehabilitation

In addition to the lack of technical foundations in the old program, it makes the program stagnant that residents around Leuwigajah Disposal Site object to the rehabilitation. As mentioned in Chapter 3, residents have a deep anxiety and distrust against the local government. It is because the local government historically did not implement any counter measures for some landslides although it declared to do. And residents insist that they have not received any fully explanation about the rehabilitation program by the local government. Considering this situation, the local government constructed canals and improved village roads as a part of the rehabilitation. It makes the process of the program smoothly to recover the trust from residents by these continuous efforts for them. This study prepares the design of LSWMC reflecting some requests from residents because cooperation with residents is essential for promoting the rehabilitation program. The main requests are as following;

1. To secure the appropriate range of buffer zone around the landfill
2. To dispose wastes into the landfill after the intermediate treatment (Not to dispose directly into the landfill)
3. To construct a fish pond and an agricultural pond
4. To construct a meeting place in LSWMC for opinion exchange and environmental education

5.3 Layout Plan

Layout plan of LSWMC is shown in Figure 5-1. The buffer zone is secured enough for residents' request, and then the rest of the site is divided into 3 areas; 1: Rehabilitation Area, 2: Sanitary Landfill Area and 3: Facilities Area. In the old program, it was planned that the new sanitary landfill would be constructed at the down stream of the site and all landslide wastes would be transported into this landfill (Figure 5-2). However, transportation of all landslide wastes will cost a huge time and money because the volume of landslide wastes is extremely large as about 310 million m^3. Therefore this study plans not to move landslide waste as much as possible and to construct environmental protection facilities for these wastes at their original place.

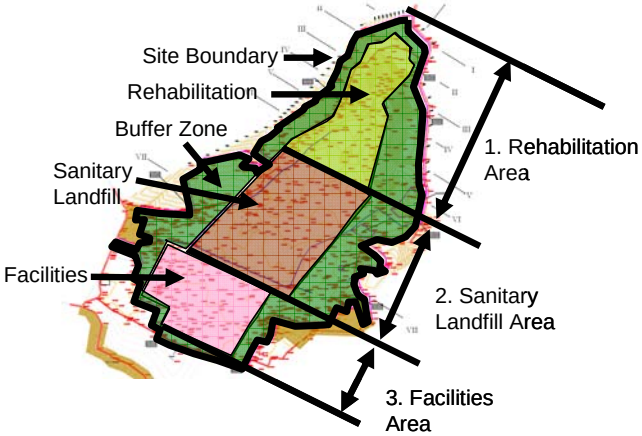


Figure 5-1 Layout Plan of The Study

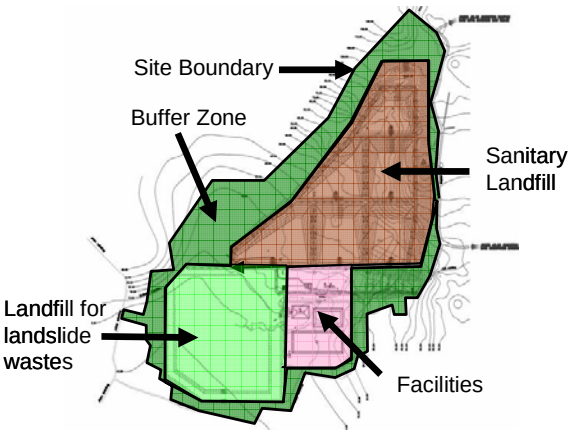


Figure 5-2 Original Layout Plan

5.4 Rehabilitation Concept Design

5.4.1 Protection of Landslides and Effects for Environment

According to the results of the site survey mentioned in Chapter 3, the following items need to be included into the design.

a. Protection of slope failures of landslide wastes

b. Protection of landslide wastes flowing out

c. Offensive odor prevention

d. Scattering of waste prevention

e. Vectors prevention

f. Fire prevention

g. Protection of leachate penetration into the groundwater and flowing into the river

5.4.2 Environmental Measures

Environmental measures for the surrounding residents are summarized as Table 5-2. And Figure 5-3 shows the position to apply each measure.

Table 5-2 Environmental Measures

Item	Position	Measure
a. Protection of slope failures of landslide wastes l	1-B	The steep slope (cliff) of landslide wastes will be gentle.
b. Protection of landslide wastes flowing out	1-C, 2	Embankment will be applied.
c. Offensive odor prevention	1-A, 1-B, 1-C, 2	Soil cover with sufficient thickness will be applied.
d. Scattering of waste prevention	1-A, 1-B, 1-C, 2	Soil cover with sufficient thickness will be applied.
e. Vectors prevention	1-A, 1-B, 1-C, 2	Soil cover with sufficient thickness will be applied.
f. Fire prevention	1-A, 1-B, 1-C, 2	Soil cover with sufficient thickness will be applied.
g. Protection of leachate penetration into the groundwater and flowing into the river	1-A, 1-B, 1-C, 2	Low permeability clay soil with sufficient thickness and surface water drainage will be applied.

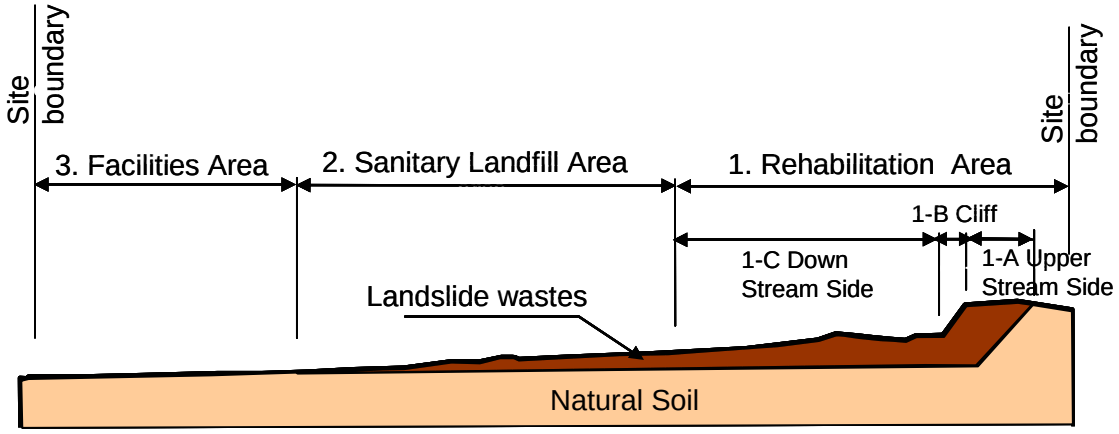


Figure 5-3 Longitudial Section (as in December 2008)

Detail explanation of environmental measures at each position is as follows.

1-A: Upper stream side of Rehabilitation Area (Refer to Figure 5-11)

i. Landslide wastes are leveled.

ii. Covering soil is set up as 1m onto the landslide wastes with some gradient in the direction of the valley side for rainwater drainage.

iii. Rainwater drainages are set up at the valley side to collect rainwater onto the soil covering area and at the boundary side to prevent outside rainwater to flow into the site.

1-B: Cliff of Rehabilitation Area (Refer to Figure 5-11)

i. The cliff of Rehabilitation Area, shown in Figure 5-4, is cut down and a gently slope is made.

ii. Wastes from cutting down are segregated. Plastics, soil and organic wastes are recycled and others is disposed into 1-C.

Figure 5-4 Cliff of Rehabilitation Area

1-C: Down stream side of Rehabilitation Area (Refer to Figure 5-11)

i. Embankment is established at the edge of the down stream as the longitudinal section in Figure 5-12 in order to prevent landslide wastes from flowing out

ii. Residue from cutting the cliff and wastes from leveling for Sanitary Landfill Area are disposed in the upper side of embankment. Its slope is 1:3.

iii. Covering soil is set up as 1m onto the transferred landslide wastes with some gradient in the direction of the down stream for rainwater drainage

iv. Rainwater drainages are set up every 50m on the soil covering area to collect rainwater and at the surrounding of the soil covering area to keep rainwater from the slope side away.

2: Sanitary Landfill Area (Refer to Figure 5-11)

i. Embankment is established at the edge of the down stream as the longitudinal section in Figure 5-12 in order to prevent landslide wastes from flowing out

ii. As a land preparation for construction of sanitary landfill, land leveling is implemented with 2 to 3 % of gradient in the direction of the down stream. Wastes from leveling are segregated. Plastics, soil and organic wastes are recycled and others is disposed into 1-C.

iii. Covering soil is set up as 1m. The permeability of this covering soil needs to be low because this covering soil is a liner layer of sanitary landfill.

5.5 Sanitary Landfill Concept Design

5.5.1 Design Conditions

i. A new landfill is a sanitary landfill

ii. A lifespan of the landfill is set as about 10 years (the capacity of landfill is about 200 million m^3).

iii. Requests from residents are reflected on the design as much as possible.

- Fish pond and agricultural pond
- Meeting place in LSWMC for opinion exchange

5.5.2 Selection of Semi-aerobic System

(1) Anaerobic Sanitary Landfill Systems

Anaerobic Sanitary Landfill is a structure in which leachate collecting pipe is installed for drainage at the bottom. The pipe ends are not exposed to air (the main leachate pipe outlet is immersed in the leachate pond). There is no conveyance of air into the waste disposal area and the wastes decomposition is mainly in anaerobic condition. An anaerobic Sanitary Land Fill is presented in Figure 5-5.

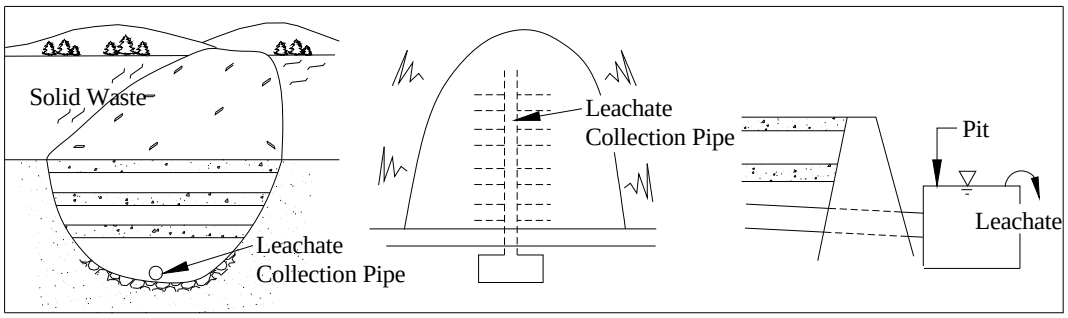


Figure 5-5 Improved Anaerobic Sanitary Landfill

(2) Semi-aerobic Landfill Site

In a Semi-aerobic Sanitary Landfill leachate is collected in a leachate collection pond through properly sized perforated pipes embedded in graded gravels/ boulders. As the outlet of the main leachate collection pipe is always open to air, fresh air is drawn into the waste layers, thereby introducing an aerobic condition around the pipes. Since leachate is removed as quickly as it is formed, the internal waste layers have lower water content. A Semi-aerobic Sanitary Landfill System is presented in Figure 5-6 and Schematic Diagram in Figure 5-7.

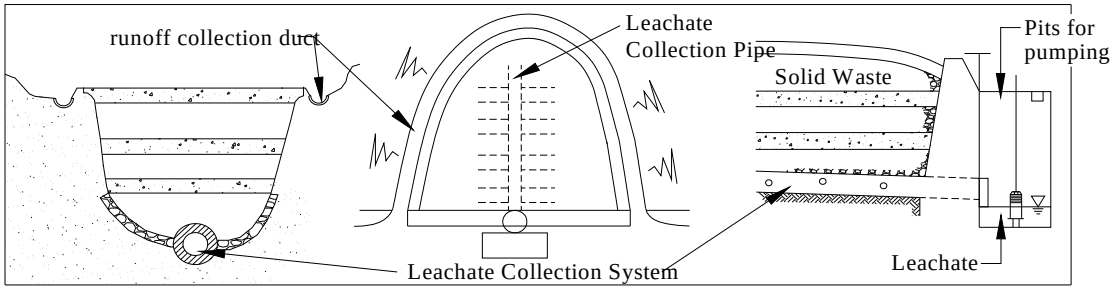


Figure 5-6 Semi-aerobic Landfill System

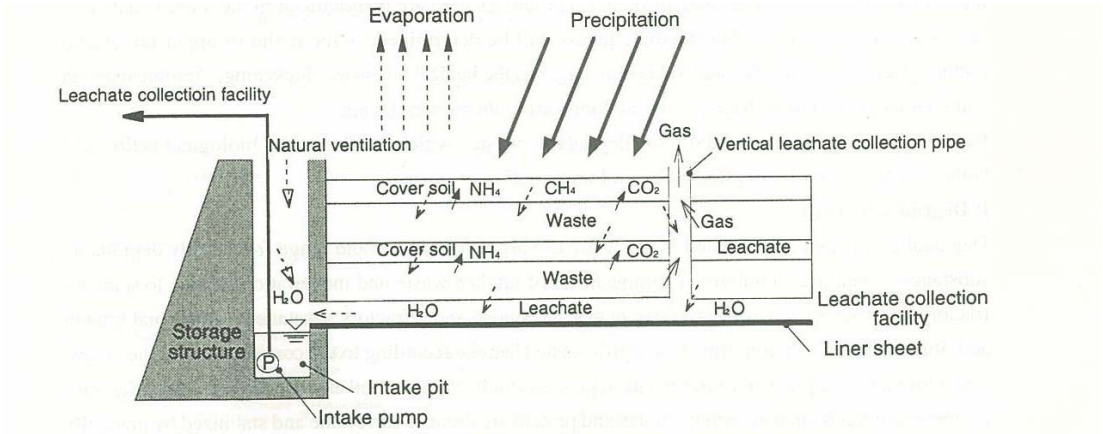


Figure 5-7 Schematic Diagram of Semi-aerobic Landfill System (Fukuoka University)

(3) Comparison of Anaerobic and Semi aerobic Landfill System

A comparison of the two landfill systems in different technical aspects are elaborated in the Table 5-3.

Table 5-3 Comparison of Anaerobic and Semi-aerobic Landfill Systems

Particular	Anaerobic Landfill	Semi-aerobic Landfill
Objective	• Landfill gas recovery	• Waste stabilization by natural ventilation • Reduction of leachate toxicity
Condition of waste layers	• Anaerobic condition prevails	• Partially anaerobic • Layers surrounding leachate and gas collection pipes are semi-aerobic
Leachate collection pipes	• Pipe outlet immersed	• Open to air at pipe outlet • Connected with gas vents • Large pipe diameters
Gases produced	• Mainly methane with some carbondioxide about 60% : 40%	• Roughly divided into methane and carbondioxide about 40% : 60%
Leachate quality	• Higher BOD and COD • Slower decrease in volume	• Lower BOD and COD • Rapid decrease in volume

Special Features / Advantages of Semi-aerobic Landfill System Compared to Anaerobic Landfill System are as follows.

- Rapid stabilization of the input (i.e. landfilled waste) through better aerobic conditions,
- Better quality of the outputs (i.e. landfill gas and leachate), which saves the treatment cost, and
- Low water pressure on the liner layer and reduction in possibility of leachate seepage.

(4) Reason for Selection of Semi-aerobic System

Semi-aerobic Landfill System is an appropriate system of sanitary land filling with the control of input (i.e. the incoming waste) and of outputs (i.e. leachate and the landfill gas). This system is scientific and expected to be appropriate for Indonesia context, as it is technically simple and cost-effective. One of the main benefits of this system is to hasten biodegrading. And this system has the gas collection pipes through which rain water in the landfill runs out quickly. This character is also effective for our landfill site because this site has a heavy rain season. Therefore the Semi-aerobic Landfill System is effective for our target landfill site.

5.5.3 Solid Waste Disposal System

In the solid waste disposal plan of the site, following elements shall be considered:

(1) Landfill System

1) Landfill operation

Landfill method: Cell method is applied. In this method, wastes will be covered with soil at the end of daily operation hours, to form a waste disposal cell. The height of cell should be 2 to 3 m.

- Thickness of each waste layer: within 1m
- The gradient of the slope is smaller than 1:3. A small step with 2m width is established on every 5m height.

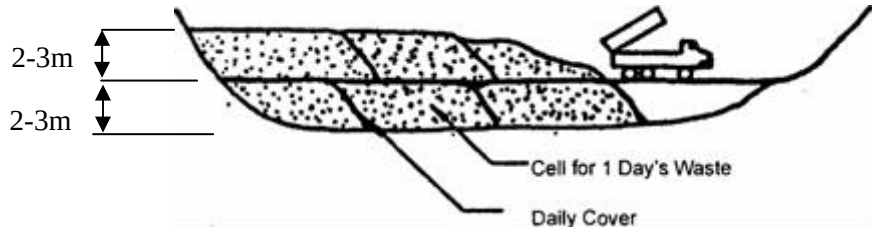


Figure 5-8 Waste Disposal by Cell Method

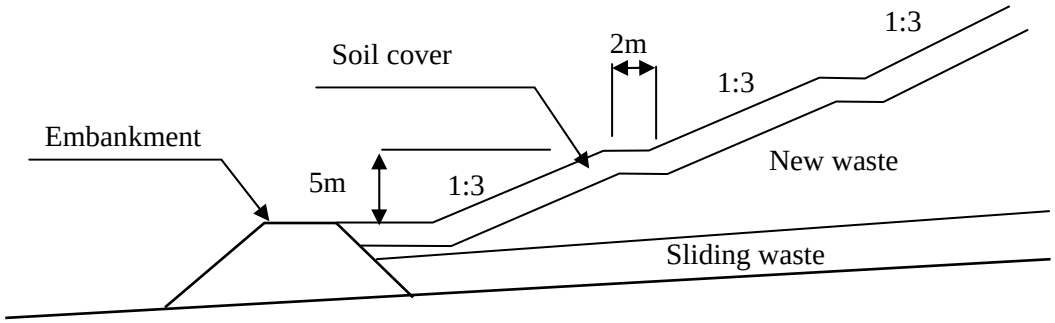


Figure 5-9 Typical Slope of Wastes

2) Soil covering

Application of the cover material is one of the most important countermeasures to mitigate a number of environmental concerns, e.g. reducing rainwater penetration, bad smell, littering of waste etc. The disposal layers shall be 2 to 3 m thick and a daily cover soil shall be applied. The thickness of daily cover shall be min.15cm. Intermediate cover will be placed over disposed

waste in areas where further waste placement will not occur for at least 6 months. The intermediate cover will be spread and well compacted. The intermediate cover will be graded to allow for surface water run-off and reduce ponding and infiltration. The thickness of intermediate cover shall be 50cm. The final cover will be placed once waste disposal operation is completed. The final cover will be included layers of soil to reduce infiltration, prevent erosion and support vegetation. The final landfill cover will be re-seeded with native vegetation to minimize the visual impact of the final landfill surface and to provide a natural habitat consistent with the surrounding environment.

It should be noted that the cover material shall be obtained from the surrounding areas, as suitable material is not available within the site. Application of the cover material is one of the most important countermeasures to mitigate a number of environmental concerns, e.g. reducing rainwater penetration, bad smell, littering of waste etc.

(2) Facility Plan

Facilities for landfill site are classified into three as shown in Figure5-10; i.e. main facilities, administrative facilities, and related facilities.

Key facilities required for the sanitary landfill site are summarized in Table 5-4.

Facility layout plan and section plan are shown in Figure 5-11 and Figure 5-12.

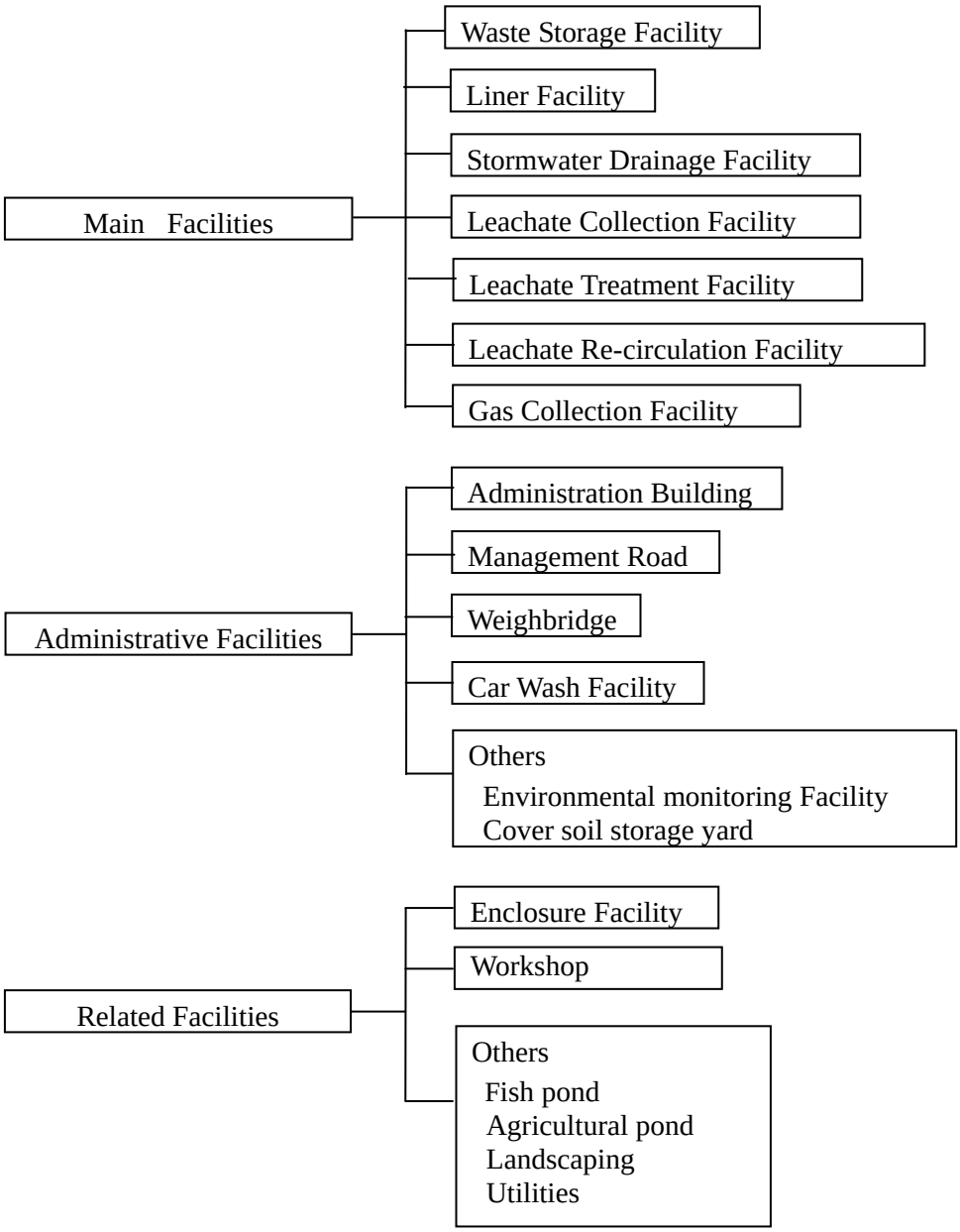


Figure 5-10 Composition of Sanitary Landfill Site Facilities

Table 5-4 Function and Structure of Facilities

Items	Function	Structural
Main Facilities		
1. Waste storage facility (Embankment)	In order to prevent the sliding and new waste out-flowing from the landfill site and maintain the waste accumulation at a certain height during landfill operation, embankment shall be constructed around the landfill site. A road for receiving wastes shall be constructed on the top of embankment.	Construction of embankment with soil. Shape is a trapezoid, upper base is 10m and height is 5 – 10m.
2.Liner facility	Impermeable facility within the landfill for preventing leachate from infiltrating into ground and flowing into a river.	Impermeable layer of clay soil(t=100cm)
3.Stormwater drainage facility	It is necessary to drain rainwater to outside of the site. And drainages are set up also at the surrounding of the soil covering area to keep rainwater from outside away.	Pre-cast or Reinforced concrete U-shaped gutter
4.Leachate collection	A facility installed above the liner facility to collect leachate and convey it to a leachate treatment facility. The leachate collection system, in combination with the landfill gas collection vents will serve to convey air into the waste layers to enhance semi-aerobic conditions.	Main pipe: Installation of perforated pipes of minimum dia. 600mm at spacing 100m and surrounded by gravel. Branch pipe: Installation of perforated pipes of minimum dia. 200mm at spacing 20m and surrounded by gravel. Gravel layer : Natural stone(size:30-50mm)
5.Leachate treatment	Leachate shall be treated until the treatment water shall not have any effects on the environment.	Leachate treatment system is composed of aerated lagoon and sedimentarion pond(or Wetlands). Aerator shall be installed in the aerated lagoon. The Pond is constructed with Reinforced concrete, geo-membrane, etc.
6.Leachate re-circulation facility	This facility will re-circulate leachate back to disposal site, contributing to reduction of the leachate amount, and providing further treatment of leachate under anaerobic conditions.	Installation of re-circulation pump, sprinkler and portable flexible hose pipes.
7.Gas collection facility	In order to prevent the fire and/or explosion hazards, impact on ecological system, and offensive odor to surrounding areas caused by produced gases; i.e. methane carbonic acid, nitrogen, ammonia, etc., gas removal facilities shall be installed.	Install perforated pipes of dia. 200mm vertically at 40m spacings and surrounded by stone boulders inserted within encircled wire mesh (of tot. 300mm dia) to heights of 2.0m.
Administrative Facilities		
1.Administration building	The administration building provides accommodation for the manager, an engineer and a clerk for management and operation of the Landfill site. The administration building is also proposed to be established to maintain communication with neighboring residents, invite	One-story Reinforced concrete with area of 500m2

	public officials from other Indonesia municipalities to visit and inspect the landfill operations and conduct educational campaigns on waste management.	
2.Management road	Management roads shall be constructed around the landfill to maintain the landfill and to transport wastes into the landfill.	The flat part will be asphalt pavement and the slope part will be concrete pavement. The road width will be 7m.
3.Weighbridge	Measures the gross weight of trucks loaded with waste and measures the tare weight again after they dump the waste to control the landfill volume.	Installation of weighbridge. The specification for maximum capacity of 30 tons. The foundation has concrete pits.
4.Car wash facility	A facility for washing the tires of waste trucks before they exit the site.	Installation of car wash pool and High-pressure washing machine by two sets. The specification of High-pressure washing machine ; Motor:3.7kw, and Discharge pressure: more than 50kgf/cm2
5.Monitorimg facility	Monitoring wells are set up as the monitoring facility to observe leakage of leachate into groundwater. Four monitoring wells are set at each side; the north, south, east and west side.	Diameter of monitoring wells is more than 100mm. Monitoring wells should equip with strainers at aquifer, and covers on the top to seal up in order to prevent inflow of soil and foreign substances.
Related Facilities		
1.Enclosure facility	Enclosure facility is built along the boundary of landfill site premises and the outer circumference of the landfill to provide access control and prevent waste scattering.	Structure of the fence will concrete block and reinforce concrete pillar. The hgight of the fence will be 2m.
2.Workshop	The workshop will be well equipped with necessary spare parts for the maintenance of the equipment like loader, bulldozer and dump trucks.	One-story Reinforced concrete with area of 300m2
3. Fish pond	Residents will utilize for fishery.	The Pond is constructed with Reinforced concrete and its area is 500m2,
4.Agricultural pond	Residents will utilize for agriculture in dry season.	The Pond is constructed with Reinforced concrete and its area is 500m2,

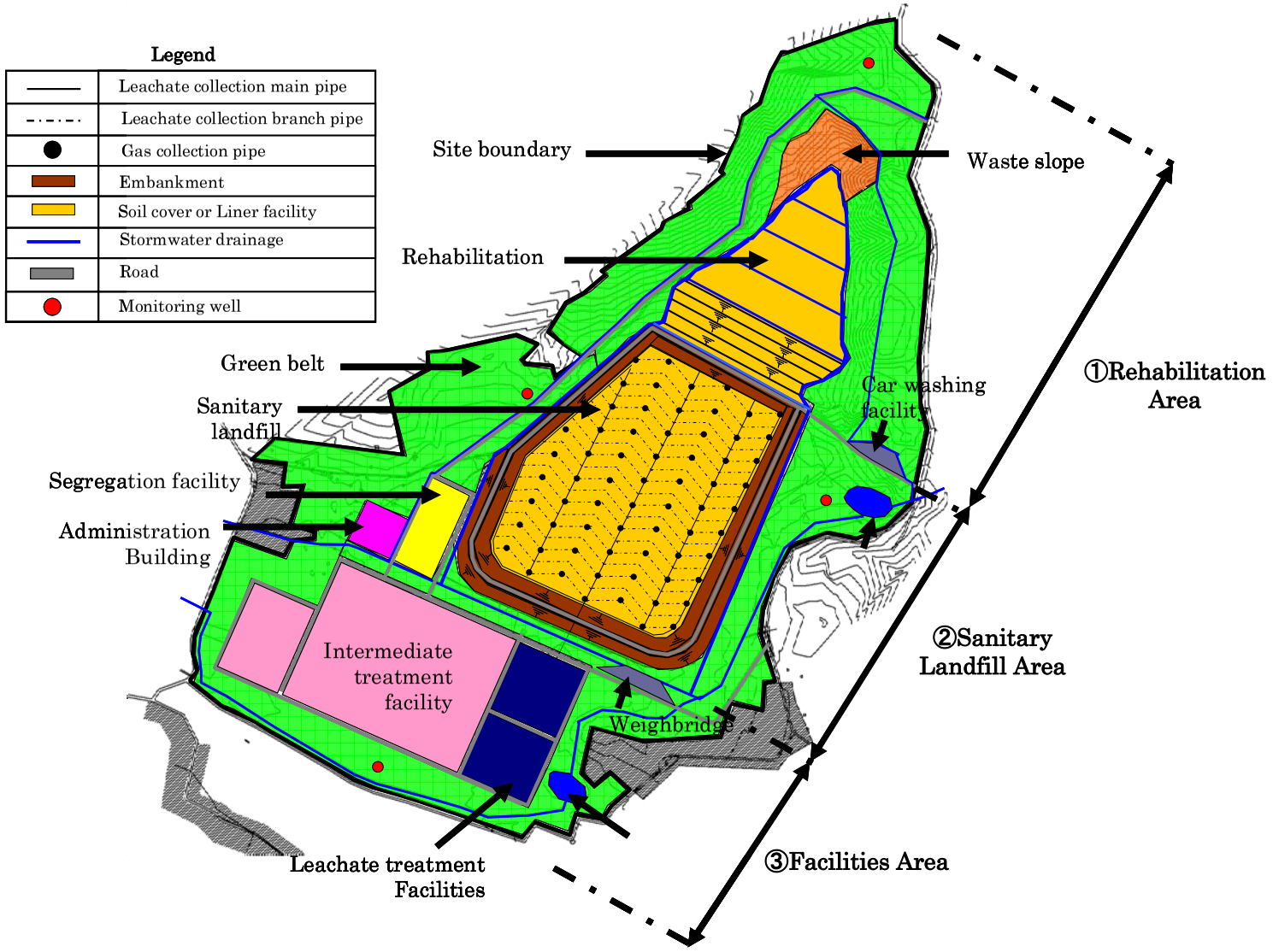


Figure 5-11 Layout Plan of LSWMC

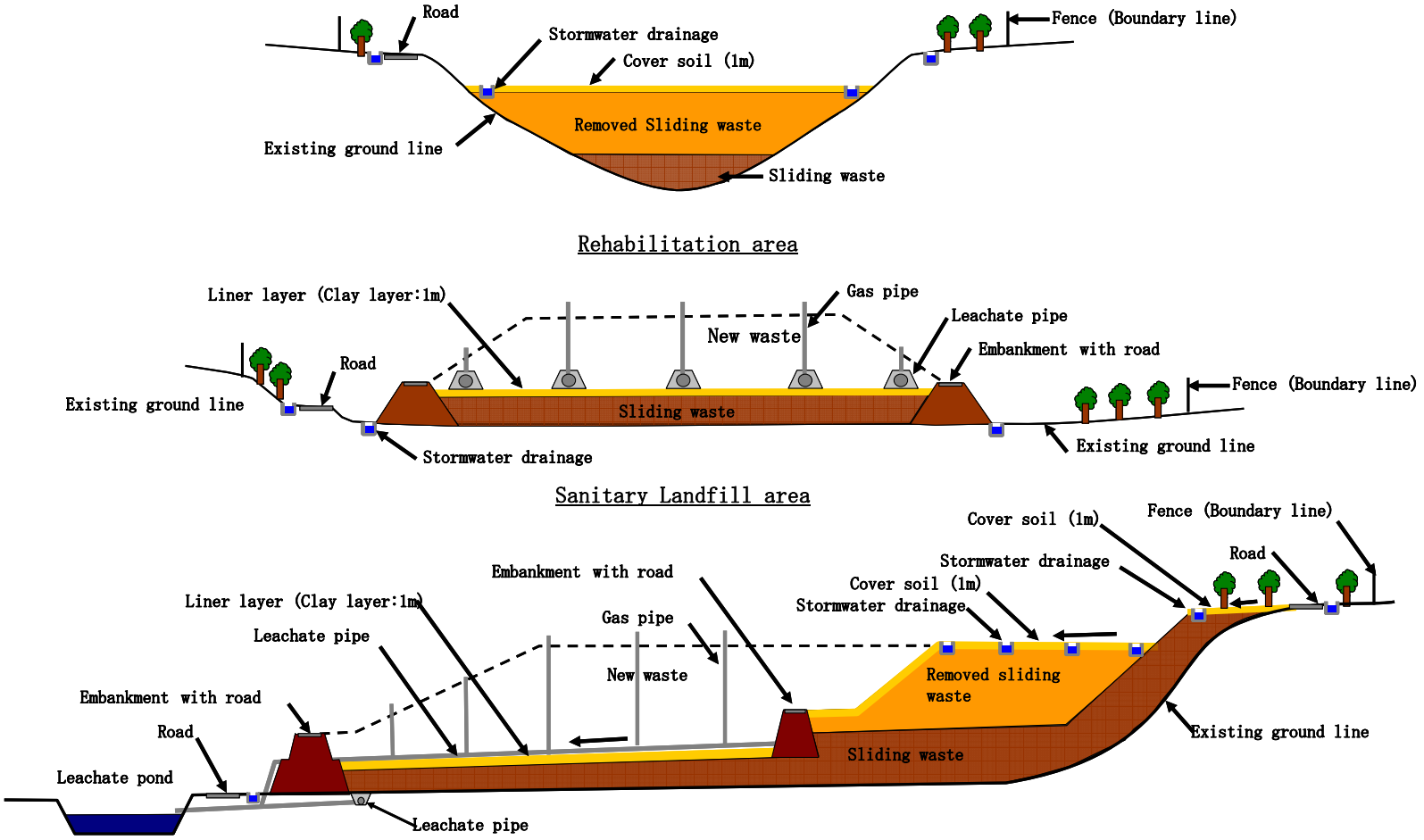


Figure 5-12 Section Plan of LSWMC

5.5.4 Operation and Maintenance

Operational aspects in this design have been described in the following sections:

1) Administration building

Administrative control is required during the operation of wastes management in landfill system. For this purpose, administration offices and related services are necessary to be incorporated in the landfill system. Wastes after intermediate treatment will be transported through the access road to the gate of the landfill site. Duties of the administration are such as the maintenance of the landfill infrastructure and the control of operators, environmental control and assistance to the landfill system.

2) Entrance control to the landfill site

There is a gate to control the entrance of vehicles and unauthorized persons. Only authorized and related with landfill operation will be allowed to enter the site.

3) Quality of wastes

The quality of wastes is checked at the entrance to the landfill site. Only municipal wastes are allowed to enter. The hospital, industries and harzardous wastes will not be allowed in the landfill site.

4) Record keeping

After the inspection of the suitability in quality, the vehicles are allowed to go to the Weigh Bridge for recording the weight. The wastes recording is fully computerized which bears the registration number of vehicles, name of the operator and the weight of wastes, time of arrival, time of departure etc.

5) Management road

From the entrance at the main gate to the waste unloading site, a management road is constructed and maintained during the operation. This road is equipped with the drainage facilities.

6) Configuration of cells

The configuration of cells is planned in advance. Location of unloading of wastes, thickness of wastes spreading, necessary soil cover and access to the site are decided during the planning stage. A working area is selected for each day and its basement will be prepared.

7) Unloading and spreading of wastes

The operator unloads wastes at a designated place only. Necessary equipment for wastes spreading and compaction such as wheel loader and compactor are in the operational condition.

8) Workshop

The mechanical workshop is well equipped with necessary spare parts for the maintenance of the equipment like wheel loader, bulldozer and dump trucks.

9) Cover soil for wastes

Large quantity of covering soil is required for the landfill operation. The appropriate quality of covering soil is secured. Required quantity for the daily covering soil is transported to the site and stored at the designated location in advance.

10) Aeration of leachate ponds

The leachate is collected in leachate pond. A system of blowers circulates oxygen in the aeration pond to aerate the leachate for purification.

11) Sedimentation pond

The sedimentation pond stores the leachate and reduces the total suspended solids. The sludge formed in the bottom of the sedimentation pond is spread on the wastes in the landfill.

12) Re-circulation system

The treated leachate from the aeration pond is sprayed on the wastes for further treatment towards purification. This process reduces the quantity and purifies it for transfer to the sedimentation pond. The quantity is further reduced by evaporation in these ponds.

13) Management of gas vent pipes

The gas produced by the wastes is allowed to escape in the atmosphere by a system of vent pipes. The vertical part of these pipes is extended as the height of waste thickness rises up. This is required to control the odor of the leachate. Gas vent pipes are lengthened along with the progress of the piling up the wastes.

14) Operation during rainy season

Special attention and requirements is needed during operation in the rainy season. The temporary leachate drainage, surface of the roads, and platform are maintained.

15) Departing vehicle control

All types of departing vehicles are washed in the car washing facilities before their departure.

16) Environmental Control and Monitoring

Environmental measures for the surrounding residents are as follows.

Table 5-5 Environmental Measures

Item	Measure
Groundwater pollution Prevention	Low permeability clay soil with sufficient thickness and leachate collection pipes.
Surface water pollution prevention	The leachate will be appropriate treated, then it will be discharged into surface water drainage.
Scattering of waste prevention	Daily soil cover will be applied with sufficient waste compaction.
Offensive odor prevention	Daily soil cover will be applied and the buffer zone will be secured.
Fire prevention	Daily soil cover will be applied with installation of gas vent pipe
Vectors prevention	Daily soil cover will be applied
Stabilization of waste	Adoption of Semi-aerobic Landfill system where stabilization of waste will be early
Noise and Vibration prevention	The buffer zone will be secured Operation hours will be set considering minimum disruptions
Waste adhering to collection trucks tires	Truck tire wash basins are located at the site exit to clean the tires
Interaction with surrounding residents	Public comments will be collected and analyzed. Visiting hours and site inspection tours will be regularly arranged
Environmental monitoring	Ground water, surface water, leachate, landfill gas, Incoming vehicle, public complain samples will be collected and analyzed or a pre-determined schedule.

5.5.5 Operation and Maintenance Structure

In order to provide the necessary operation and maintenance as described above, sufficient staff and heavy equipments should be allocated to the site.

The following table shows the proposed site staff and the role of each member, as well as the heavy equipments requirements.

Table 5-6 Staff and Equipment Requirements

	Item	No.	Function
A. Landfill O&M Staff			
1)	Manager/ Engineer	1	Overall site operation management
2)	Clerk/ Secretary	1	Manage petty cash, maintain site operation records, spare parts inventories, etc.
3)	Weighbridge operator	2	Operate weighbridge facility and keep record of amounts of incoming wastes
4)	Heavy equipment operators	4	Operate heavy equipment used at the site
5)	Environment Enginner	1	Environmental monitoring management
6)	Mechanic	2	Maintain and repair landfill equipments and heavy equipments
7)	Landfill Workers	6	Undertake miscellaneous works in connection with the operations.
8)	Leachate treatment operator	2	Operate leachate treatment facilities
9)	Vehicle drivers	6	Drive the Dump trucks, sprinkler tanker and patrol car
10)	Guards	2	Maintain site security
	Total STAFF	27	
B. Heavy Equipments			
1)	Bulldozer	3	Description: 220 HP, 24 t, Track height 550 mm Function: Waste spreading and compacting, Soil cover
2)	Wheel loader	1	Description: 3.5m^3, 200-230HP, 18t Function: Push waste to the disposal area, and spreading, transport soil cover materials to the waste operating cell, etc.
3)	Excavator	1	Description: 0.8m^3, 18 t, 125-130HP Function: Excavate in soil and waste to clear ditches, prepare cells, and dig materials for cover
4)	Dump truck	5	Description:8m^3 class Transport waste and soil cover, other functions as equipment and labor transport, etc.
5)	Sprinkler tanker	1	Description:10t class Sprinkle water on the waste as countermeasure against scattering, road maintenance, and fire prevention
6)	Patrol car	1	Description:4WD Pick-up TYPE For patrol, maintenance and staff transport purposes

5.5.6 Environmental Management Plan

There shall be regular environmental monitoring is required regularly to maintain the quality of the landfill operation.

Environmental monitoring plan are as follows:

Table 5-7 Plan for Environmental Monitoring

To be monitored	Monitoring Parameters	Monitoring Frequency	Sampling location
Surface water	(1) pH, Electrical Conductivity (2) Category A of Governmental Regulation of ROI No. 82/2001 on Management of Water Quality and Control of Water Pollution	(1): Once a month (2): Twice a year (Rainy season and Dry season)	Two places; the upper stream side and down stream side (Dankuni Khal(Canal) at upstream and downstream)
Ground water	(1) pH, Electrical , Ground water level, Conductivity, (2) Category A of Governmental Regulation of ROI No. 82/2001 on Management of Water Quality and Control of Water Pollution	(1): Once a month (2): Twice a year (Rainy season and Dry season)	For places (each side; the north, south, east and west side in landfill site)
Landfill Gas	CH_4,CO_2,O2,CO, H_2S	Once a month	For places (each side; the north, south, east and west side at gas vent pipes)
Leachate	(1) pH, Electrical Conductivity (2) Group 1 of Minister of. Environmental Decree of ROI KEP-51/ MENLH/10/1995 on Quality Standards of Liquid Waste for Industry Activities	(1): Once a month (2): Twice a year (Rainy season and Dry season)	Leachate collection pit, Aeration Pond and Sedimentation Pond
Incoming waste	hazardous materials or liquid wastes	Every waste carrying vehicle	In landfill site
Public Complaints Analysis	Analysis of all complaints arriving to the site		

5.6 Estimation of Construction Cost

Construction cost for LSWMC is estimated in cooperation with the local consultant company on the basis of Rehabilitation Concept Design (5.4) and Sanitary Landfill Concept Design (5.5) mentioned above. The estimation is shown in Table 5-8 and the total cost is calculated as about Rp. 213 billion.

Table 5-8 Construction Cost of LSWMC

	Items	Unit	Q'ty	Unit Cost Rp.	Cost Rp.
1	Site preparation	LS	1		10,241,920,000
2	Land reclamation	LS	1		37,972,443,500
3	Embankment (Earth bund) construction	m^3	1		18,768,750,000
4	Storm water drainage system	LS	1		11,707,557,950
5	Liner system	LS	1		22,277,000,000
6	Leachate collection	LS	1		24,616,000,000
7	Leachate treatment	LS	1		4,574,022,638
8	Leachate Re-circulation System	LS	1		379,500,000
9	Gas collection system	LS	1		34,000,000
10	Roads	LS	1		13,716,000,000
11	Weighbridge	LS	1		1,489,420,988
12	Car wash facility	LS	1		200,100,854
14	Control building	LS	1		73,505,801
15	Workshop/Garage	LS	1		210,713,136
16	Fence and Gate	LS	1		4,510,000,000
17	Landscaping	LS	1		2,592,000,000
18	Guardhouse	LS	1		32,411,096
19	Utilities	LS	1		1,548,231,121
20	Environmental impact assessment	LS	1		500,000,000
21	Environmental monitoring facility	LS	1		800,000,000
22	Others	LS	1		3,218,849,400
23	Heavy equipment	LS	1		34,300,000,000
Sub-Total					193,762,426,484
Miscellaneous		%	10	193,762,426,484	19,376,242,648
Total					213,138,669,132

5.7 Preliminary Works

The following items are preliminary works necessary for construction of LSWMC.

(1) Geological survey

(2) Detail design

(3) AMDAL

5.7.1 Geological Survey

Geological survey is required for design and construction of each facility in order to comprehend composition, structure and status of soil quality, distribution of soft ground layer, impermeable layer and groundwater, and the direction of groundwater. The components of geological survey are explained as follows.

(1) Field Investigation

The field investigation shall comprise the following tests.

1) 9 borings shall be carried out at site to conduct the Standard Penetration Tests (SPT) and to collect samples of soils. The depths and locations of the each borehole are shown in Figure 5-14 attached herein.
2) SPT shall be carried out at interval of 1m depth for all boreholes in accordance with JIS A 1219, ASTM D 1586-84, BS 1377, or equivalent.
3) The groundwater level shall be identified three times in each borehole during the survey period.
4) Thin-walled tube (Undisturbed) samples shall be collected at each soil stratum for the laboratory tests
5) 4 boreholes out of 9 boreholes shall be used as a permanent groundwater monitoring well, in line with the Indonesian standards. Measures shall be taken so that no rainwater will get into the boreholes in rainy season.
6) The possible capacity of pumping up the ground water for tube well shall be measured using monitoring well mentioned above in 5). And the quality of the groundwater shall be analyzed whether it can be used as drinking water or not.
7) 2 soil samples shall be taken from the 3 sampling pits shown in Figure 5-14 for the soil compaction test described in the laboratory test to find out the characteristic of the soil as embankment/ liner layer/ filling materials. The sample samples shall be taken at depth around 1m and 2m below the ground level.
8) 2 landslide waste samples shall be taken from 3 sampling pits shown in Figure 5-14 for the composition analysis test. The sample samples shall be taken at depth around 1m the surface of landslide waste.

9) 2 samples of soil from 3 sampling pits for CBR test shall be taken at depth not less than 1m below the ground level from the location shown in Figure 5-14 to conduct the CBR test for the design of road pavement.

(2) Laboratory Soil Test

The laboratory tests shall comprise the following tests.

1) Density Test
2) Water Content Test
3) Grain Size Analysis
4) Consistency Limit (Liquid Limit & Plastic Limit) Test
5) Permeability Test
6) Unconfined Compression Test
7) Consolidation Test
8) Compaction Test
9) CBR (California Bearing Ratio) Test
10) Composition analysis test of the landslide waste: Composition analysis is to measure the weight of the following 8 compositions.
    i. paper and clothes,
    ii. plastics, rubber, leather,
    iii. wood, bamboos,
    iv. organic waste,
    v. metals,
    vi. glasses,
    vii. concrete, asphalt, stones,
    viii. other small waste (putting through 5mm sieve)

(3) Soil Investigation Report

The soil investigation report shall cover at least the followings:

1) General
2) Map showing the location of boreholes and sampling pits (locations shall be plotted on the topographic maps)
3) Methodology of the soil investigation
4) Borelogs of each borehole including the depth and classification of soil stratum, the results of SPT N-values and the groundwater level, etc.
5) Results of each soil test
6) Establishment of design constant of each soil layer

7) Analysis of the survey results and comments on the geological and hydro-geological features of the site. Comment especially on water permeability of the ground slab of the site.

8) Estimation of soil bearing capacity for the foundations of structures.

9) The slip circle calculation due to landfill of solid wastes regarding the following

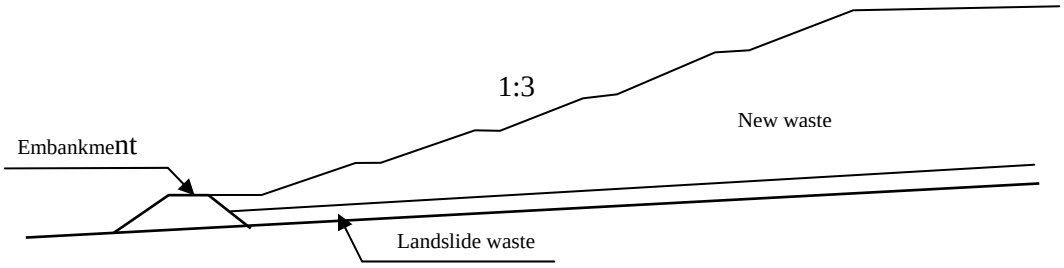


Figure 5-13 Cross Section View for Slip Circle Calculation

10) Geological profiles in longitudinal and transverse sections shall be drawn showing the borelogs and soil stratum in accordance with the investigation results.

11) All data sheets and work sheets of soil test

12) Photographs showing the survey activities

13) Maintaining the core boxes on site and for a time to be agreed upon at the laboratory

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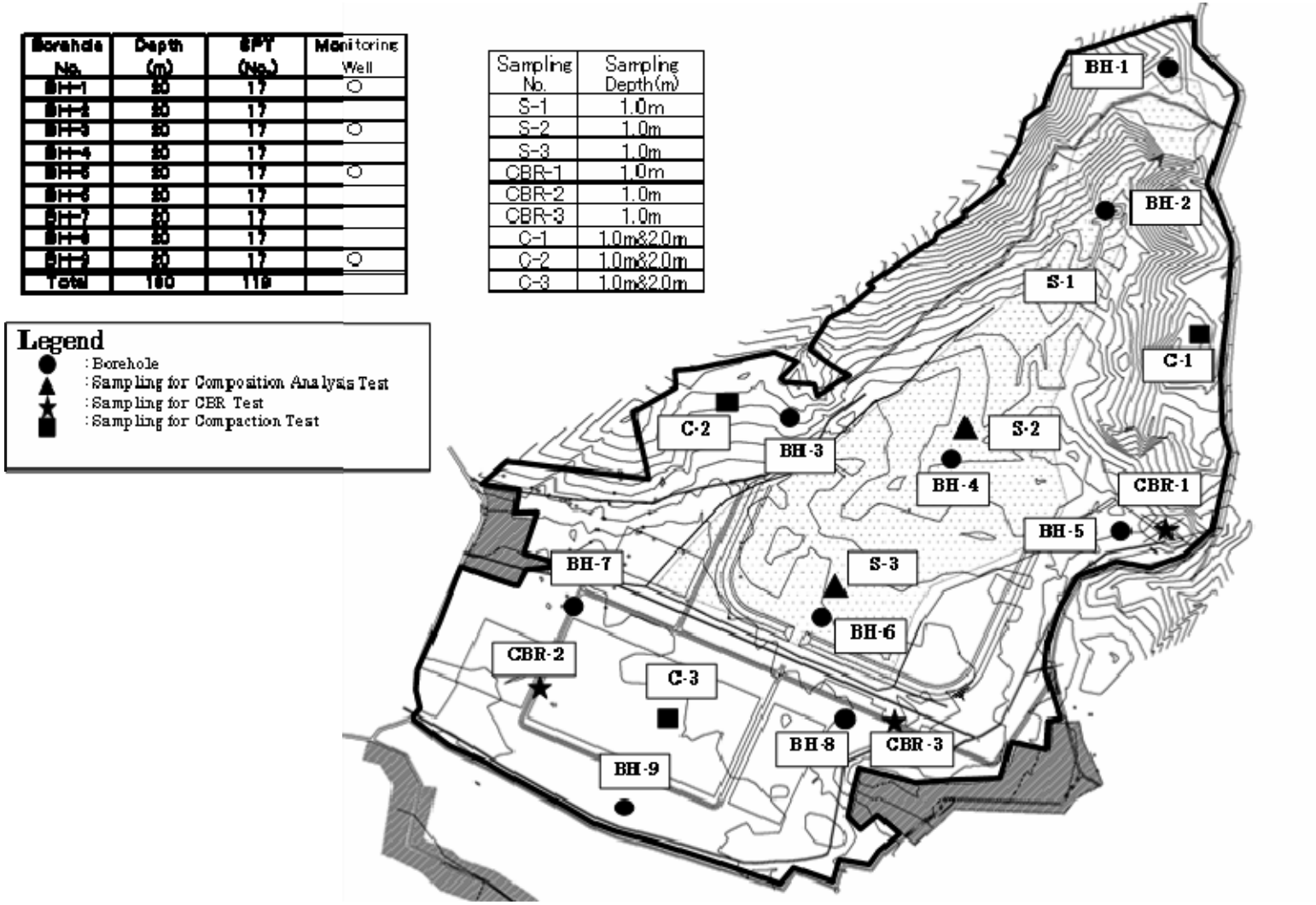


Figure 5-14 Location Plan of Field Soil Investigation on Site

5.7.2 Detail Design

Based on the contents of concept design, detail design for each facility aims to fulfill the function of each facility. The contents of detail design are as follows.

(1) Planning

1) Facility Layout plan

2) Waste filling plan

・Estimate of landfill capacity

・Estimate of incoming waste volume to the landfill site

・Estimate of cover material volume require

・Estimate of Life –span of the Landfill

3) Landfill operation and maintenance plan

4) Environmental management plan

(2) Designing (Calculations)

Regarding each facility as following, it is necessary to examine layout, system, structure, capacity and other items and to implement structure and stability calculation.

1) Rehabilitation facilities

a. Facility for protection of slope failures of landslide wastes

b. Facility for protection of landslide wastes flowing out

c. Facility for offensive odor prevention

d. Facility for scattering of waste prevention

e. Facility for vectors prevention

f. Facility for fire prevention

g. Facility for protection of leachate penetration into the groundwater and flowing into the river

Note) Facility b is the same as embankment of sanitary landfill, and facility g is the same as liner facility of sanitary landfill.

2) Sanitary landfill facilities

a. Ground improvement (Banking and Cutting)

b. Embankment

c. Liner facility

d. Stormwater drainage facility

e. Leachate collection facility

f. Leachate treatment facility
g. Leachate re-circulation facility
h. Gas collection facility
i. Administration building
j. Management road
k. Weighbridge facility
l. Car wash facility
m. Environmental monitoring facility
n. Cover soil storage yard
o. Gate and fence
p. Workshop
q. Parking
r. Fish and agricultural pond
s. Utilities
t. Others

3) Making design drawings

Design drawings are made for implementation of construction. Design drawings for Rehabilitation facilities and Sanitary landfill facilities as mentioned above are indispensable at least.

4) Bill of Quantities

Based on the above design drawings, it is necessary to make bill of quantities of works for calculation of the construction cost.

5) Cost estimates

· Calculation of the construction cost with bill of quantities
· Calculation of the cost of heavy equipments for operation
· Estimation of the cost of the annual operation and maintenance

6) Making design report

Design report is a summary of 1) to 5) as mentioned above.

7) Tender documents for the construction

Tender Documents should cover all the documents in accordance with the Indonesia standard.

a. Prequalification documents

b. Invitation for bid

c. Instruction to Bidders

d. Conditions of contract

e. Technical specifications

f. Detailed design drawings

g. Bill of quantities

h. Other necessary documents

8) Work schedule

The work schedule should be detailed and its period should be from the start of design and to the finish of all construction.

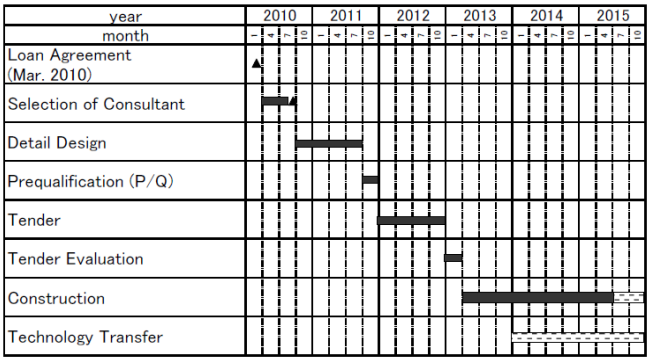
5.7.3 AMDAL

The situation of AMDAL is mentioned in Chapter 2 and works on AMDAL is being implemented and continues in FY 2009. It is desirable to include the situation of ground water pollution by landslide wastes.

5.8 Project Implementation Schedule

Table 5-9 shows the project implementation schedule in case of applying JICA loan into the implementation cost. The pre-conditions to realize this schedule are to press this project on Blue Book in FY 2009, to conclude the loan agreement in March 2010, to implement detail design in FY 2011, and to start construction in 2013. Start to use of landfill will be from the middle of 2015.

Table 5-9 Project Implementation Schedule



CHAPTER 6 RECOMMENDATIONS

6.1 Discussions for Rehabilitation and Establishment of Leuwigajah Solid Waste Management Center

On 16th December 2008, the director of TARKIM held a meeting with the study team, the related local authorities, and a representative of the central government in order to prepare the comprehensive project of Leuwigaja Disposal Site for rehabilitation, construction of sanitary landfill and treatment facilities. At the first of the meeting, the study team recommended to establish the project of Leuwigajah Solid Waste Management Center (LSWMC) including rehabilitation, and construction of new landfill and treatment facilities to receive wastes from Bandung City, West Bandung Regency and Cimahi City (see Appendix 4).The main points of recommendation were as follows.

(1) The site of LSWMC is divided as 3 parts; Rehabilitation Area, Sanitary Landfill Area and Facilities Area. Buffer zone is secured surrounding these areas. Also roads and canals around the site are improved and/or constructed.
(2) LSWMC project will be a large-scale, so it is necessary to implement with support of the central government and Japanese Government.
(3) LSWMC project will be implemented as the main components of this project will start in 2010.
(4) TARKIM will be in charge of construction of LSWMC, P3JB will be in charge of operation and management. BPLHD will implement AMDAL.

Corresponding to these suggestions, the local authorities made opinions and requests as follows.

(1) After the landslide accident in 2005, several activities were completed with the budgets of both the local and the central government, such as compensation, land acquisition of the former disposal site and surroundings, construction of infrastructure around the site and construction of Sarimukti Landfill for temporal use. It was decided that Leuwigajah Disposal Site would be used again, but the budget for rehabilitation and construction of facilities are not secured.
(2) AMDAL is being implemented by the subcontracted local consultant company.
(3) The site of Sarimukti Landfill was owned by Ministry of the Forestry. West Java has just rented the site until 2010. Actually a new landfill should be utilized from 2011. So there is a time lag between the start of LSWMC project and the actual situation. It is necessary to make a countermeasure to fill this gap.

(4) Rehabilitation and Construction of facilities in Leuwigajah are implemented on the assumption of residents' understanding. It is required to proceed step by step for promoting residents' understanding.
(5) Several private companies are interested in rehabilitation and construction of facilities in Leuwigajah. West Java will collect the proposals from these companies and expect they would be acceptable and practical. Now the conditions for the proposal are examined.
(6) In order to make a comprehensive project, West Java would like follow the suggested method to divide the site into 3 parts; Rehabilitation Area, Sanitary Landfill Area and Facilities Area.
(7) The receiving amount of wastes needs to be as 1,000t/day. Intermediate treatment should be done for all receiving wastes, that is, the disposal wastes into the landfill should be only residue from intermediate treatment.

Among these opinions and requests, it is not easy to start operation of a new landfill in Leuwigajah from 2011 because the matters of budget and residents' understanding are under examination at present. Therefore another countermeasure needs to be examined at the same time, such as extension of the use period of Sarimukti Landfill. Also it is effective to implement several works in advance for starting operation of LSWMC earlier than expected. Moreover, entry of private companies is desirable for waste management, so the methodology needs to be prepared to promote it.

In order to reflect these opinions and requests, it should be necessary to negotiate with residents, related authorities and private companies. Regarding the contents and the schedule of LSWMC project, the study team and the local consultant subcontracted with TARKIM worked together.

6.2 Recommendations for Rehabilitation and Establishment of Leuwigajah Solid Waste Management Center

6.2.1 Components of LSWMC Project

Actually it is quite difficult to construct facilities until 2011 for receiving a large amount of wastes because of the objection by residents. As a proverb "Hurry too much and it will end up taking more time", the project should be implemented under the appropriate concept and it is natural to take some time for success. The suggested project starts 4 years after the finish of the contract period of Sarimukti Landfill. Some measurements need to be prepared for start of receiving wastes earlier than expected and for waste management during the construction in Leuwigajah.
As mentioned in Chapter 5, West Java already implemented some works as a part of rehabilitation shown in Table 6-1. West Java plans to construct segregation facilities for landslide wastes and other works in FY 2009. Like these works, it is necessary to continue efforts aggressively in

order to make the whole project in advance.

Table 6-1 Rehabilitation Works by West Java in Leuwigajah Disposal Site

	Item	Year	Note
Completed and on-going	Construction of fence and others	FY2005 FY2006 FY2007	Cost: Rp. 56,000 million Additional Cost: Rp. 12,000 million
	Land Acquisition	FY2006 FY2007 FY2008 FY2009	
	Construction of canals	FY2006 FY2007	
	Improvement of roads	FY2008	
Plan from FY 2009	Construction of treatment facilities for landslide wastes	FY2009	Small-scale segregation facilities
	Construction of access roads	FY2009	West side of landfill
	Construction of leachate pond	FY2009 FY2010	East side of landfill
	Construction of buffer zone	FY2009 FY2010	

These works in Table 6-1 are being implemented with the budget of the local and central government. Therefore it makes LSWMC project smoothly to put these works into the project concept.

West Java province and the local consultants subcontracted with TARKIM should examine and decide the contents and schedule of LSWM based on the result of negotiation. If possible, the wastes, which are the rest of the target wastes of LSWMC, would be expected to be treated by private sectors. In order to promote this idea, the project needs to include the land preparation for them.

However, LSWMC should be established as a facility for long-term utilization. LSWMC should fulfill the functions such as to treat all received wastes, to recycle and reduce disposal amount into the landfill, to contribute to the global warming by establishing sanitary landfill, to recycle the stabilized wastes for land preparation after confirmation of safety and so on.

Therefore, it is recommended to divide the whole project into 4 components centering LSMWC as following order. West Java needs to secure the budget for each component in order to tasks mentioned before and to advance the project comprehensively. Also it is required for West Java

to examine each component in accordance with the policy of West Java.

1. Temporary measure for waste management in the West Greater Bandung Area

Recommended Action

- To reinforce the necessary facilities for SWM until the establishment of LSWMC, such as extension of use of Sarimukti Landfill

Financial Source

- To secure the budget by the local and central governments certainly in order to implement this reinforcement continuously

2. Rehabilitation and construction of infrastructure

Recommended Action

- To complete the compensation, land acquisition, construction of roads and drainages around the landfill (several portions had been already finished by West Java.)
- To construct the buffer zone and the intermediate treatment facilities for landslide wastes (These facilities are easy to start construction.)

Financial Source

- To secure the budget by the local and the central governments certainly in order to implement this completion and construction continuously

3. Rehabilitation and establishment of LSWMC

This component is a main part of the project.

Recommended Action

- To rehabilitate landslide wastes and to construct the buffer zone
- To construct the treatment facility for landslide wastes and daily household wastes (segregation and biological treatment)
- To construct the sanitary landfill
- To prepare the land for promoting waste management by private sector

Financial Source

- To receive the financial support by Japanese ODA and so on

4. Waste management by private sector

Recommended Action

- To secure the land in LSWMC for private sector
- To support waste management (waste reduction, recycling and environmental improvement) by private sector

Financial Source

- To implement the construction and operation by private sector’s budget

Finally the components of LSWMC project are summarized as Table 6-2.

Table 6-2 Components of LSWMC Project

No.	Component	Recommended Action	Financial Source
1	Temporary measure for waste management in the West Greater Bandung Area	Reinforcement of facilities in Sarimukti Landfill	Budget of the local and the central government
2	Rehabilitation and construction of infrastructure	1. Compensation and land acquisition	Budget of the local and the central government
		2. Rehabilitation and construction of infrastructure	
3	Rehabilitation and establishment of LSWMC	1. Rehabilitation of landslide wastes and construction of buffer zone	Budget of the local government
		2. Construction of treatment facility for landslide wastes and daily household wastes (segregation and biological treatment)	Japanese ODA and other financial support
		3. Construction of sanitary landfill and management of equipments	
		4. Land preparation for facilities by private sector	
4	Waste management by private sector	Construction and operation of other intermediate treatment facilities by private sector	Budget of private sector

6.2.2 Proposed Rehabilitation and Establishment of LSWMC

As mentioned above, the site will be divided as three parts.

On the upper stream side (Rehabilitation Area), collected landslide wastes should be capped with covering soil and prepared for buffer zone and recreation zone.

On the middle side (Sanitary Landfill Area), the area should be prepared and covered with clay soil. Leachate collection and drainage pipes, and gas vent pipes should be installed. This area should be a sanitary landfill.

On the down stream side (Facilities Area), control building and intermediate facilities should be constructed. Also a part of this area should be prepared for private sector's works. IIWTF in LSWMC should accept 600t/day mentioned in Chapter 4.

P3JB should operate and manage LSWMC with the budget of West Java and tipping fee, and subcontract with private company for each facility's operation.

Appendix

APPENDIX 1 SCHEDULE OF SITE SURVEY

No.	Date		Time	Activity	Place
1	Nov-30	Sun		Travel (Narita, Japan - Bandung, Indonesia)	Bandung
2	Dec-01	Mon	9:00-12:00 14:30-16:00	Site Survey (Leuwigajah Disposal Site) Meething（BPLHD, TARKIM, BAPEDA, P3JB）	Bandung
3	Dec-02	Tue	10:00-11:30 13:30-16:00	Revision of design with TARKIM Site Survey (Sarimkuti Landfill)	Bandung
4	Dec-03	Wed	9:00-12:00 14:00-16:00	Team meeting Meeting (TARKIM, P3JB)	Bandung
5	Dec-04	Thu	10:00-12:00 12:00-14:00	Meeting (BIT) Data collection of geological map and groundwater map (Geology Society Bandung)	Bandung
6	Dec-05	Fri	10:00-12:00 13:00-16:00	Revision of design with local consultant company Site survey (Leuwigajah Disposal Site)	Bandung
7	Dec-06	Sat		Team meeting, Data collection	Bandung
8	Dec-07	Sun		Team meeting, Data collection	Bandung
9	Dec-08 (National Holiday)	Mon	10:00-11:30 12:00-18:00	Preparation for the suggestion plan Water and gas analysis (Leuwigajah Disposal Site)	Bandung
10	Dec-09	Tue	9:45-11:30 12:00-12:30 14:00-17:00	Meeting (TARKIM) Meeting (BPLHD) Meeting (local consultant company)	Bandung
11	Dec-10	Wed	10:00-11:30 12:00-15:00	Meeting (local consultant company) Water and gas analysis (Leuwigajah Disposal Site) Interview survey (Leuwigajah Disposal Site)	Jakarta
12	Dec-11	Thu	whole day	Team meeting Preparation for the suggestion plan	Jakarta
13	Dec-12	Fri	8:00-9:00 13:00-14:00 18:00-19:00	Meeting (PU) Meeting (JICA Adviser, Ministry of Environment) Meeting (JICA)	Jakarta
14	Dec-13	Sat		Team meeting, Data collection	Jakarta
15	Dec-14	Sun		Team meeting, Data collection	Bandung
16	Dec-15	Mon	8:00-9:00 9:00-10:00 11:30-13:30 14:00-15:00	Meeting (TARKIM) Meeting (P3JB) Meeting (local consultant company) Site survey (Leuwigajah Disposal Site)	Bandung
17	Dec-16	Tue	10:00-14:00	Joint Meeting (TARKIM) Meeting (BPLHD)	Bandung
18	Dec-17	Wed	9:00-9:30 10:00-11:00	Data collection of hydorology (Geology Society Bandung) Meeting (local consultant company)	Jakarta
19	Dec-18	Thu	whole day	Team meeting Preparation for the suggestion plan	-
20	Dec-19	Fri		Travel (Jakarta, Indonesia - Narita, Japan)	

APPENDIX 2 LIST OF MEETING

Date	2008/12/01
Time	14:30-16:00
Place	Meeting room on the first floor of BAPEDA
Attendants	BAPEDA, BPLHD (Section Manager), TARKIM and P3JB (Total 4 persons)

Date	2008/12/02
Time	10:00-11:30
Place	Meeting room on the second floor of TARKIM
Attendants	TARKIM, P3JB (Director) and other related persons (Total 5 persons)

Date	2008/12/03
Time	14:00-16:00
Place	Office of P3JB in TARKIM
Attendants	TARKIM, P3JB (Director) and other related persons (Total 6 persons)

Date	2008/12/04
Time	10:00-12:00
Place	Meeting room on the first floor of BIT
Attendants	BIT (Dr. Damanhuri and research assistant)

Date	2008/12/09
Time	9:45-11:30
Place	Meeting room on the second floor of TARKIM
Attendants	TARKIM, P3JB (Director) and other related persons (Total 3 persons)

Date	2008/12/09
Time	12:00-12:30
Place	Meeting room on the sixth floor of BPLHD
Attendants	BPLHD (Section Manager) and P3JB (Director)

Date	2008/12/12
Time	8:00-9:00
Place	Meeting room on the seventh floor of PU
Attendants	PU (head of sub directorate for drainage and solid waste division)

Date	2008/12/12
Time	13:00-14:00
Place	Meeting room on the third floor of Ministry of Environment
Attendants	JICA Adviser for Environmental Policy

Date	2008/12/12
Time	18:00-19:00
Place	Meeting room of JICA
Attendants	JICA (Assistant Resident Representative)

Date	2008/12/15
Time	8:00-9:00
Place	CEO office room on the second floor of TARKIM
Attendants	TARKIM (CEO, COO, General Manager), P3JB (Director) and other related persons (Total 5 persons)

Date	2008/12/15
Time	9:00-10:00
Place	Meeting room on the second floor of TARKIM
Attendants	TARKIM (General Manager), P3JB (Director) and other related persons (Total 6 persons)

Date	2008/12/16
Time	10:00-14:00
Place	Conference room on the second floor of TARKIM
Attendants	PU, TARKIM (CEO, COO, General Manager), P3JB (Director) and other related persons (Total 12persons)

APPENDIX 3 PHOTOS OF SITE SURVEY

<Leuwigajah Disposal Site>

Lower potion view from the east side of upper portion

Lower potion view from the center of upper portion

Cliff view from the east side

Cliff view from the west side

Upper potion view from the west side of middle portion

Upper potion view from the center of lower portion

Paddy filed at the south edge of the site

Rag picker's activity

<Sarimukti Landfill>

Lower potion view from the east side of upper portion

Lower potion view from the middle portion

Upper potion view from the middle portion

Disposal of wastes

<Meetings>

Meeting with BAPEDA, BPLHD, TARKIM and P3JB on 1st December

Meeting with TARKIM and P3JB on 3rd December

Meeting with JICA Adviser on 12th December

Meeting with PU on 12th December

Meeting with TARKIM on 15th December

Joint Meeting on 16th December

APPENDIX 4 MATERIALS FOR PRESENTATION ON 16th DECEMBER 2008

Presentation material for the Joint Meeting on 16th December 2008

IMPLEMENTATION PROGRAM FOR REHABILITATION AND ESTABLISHMENT OF LEUWIGAJAH SOLID WASTE MANAGEMENT CENTER

(Rehabilitation and Integrated Solid Waste Treatment Center)

December 2008

Yachiyo Engineering Co., Ltd.

Table of Contents

1. Purpose of the Program

1. Rehabilitation and environmental protection of the site
   - 1.1 Arrangement of Infrastructure
     Green belt and buffer zone, Water resourvor and drainage
   - 1.2 Relocation and treatment of old waste
2. Integrated solid waste management center in Leuwigajah
   - 2.1 Receive and treatment of waste from west side of Bandung
   - 2.2 Promotion of 3 R (reduction, reuse and recycling)
   - 2.3 Reduce and pre-treatment of wastes into the landfill
   - 2.4 Creation of the stable land
   - 2.5 Environmental protection
   - 2.6 Reduction of green house gas

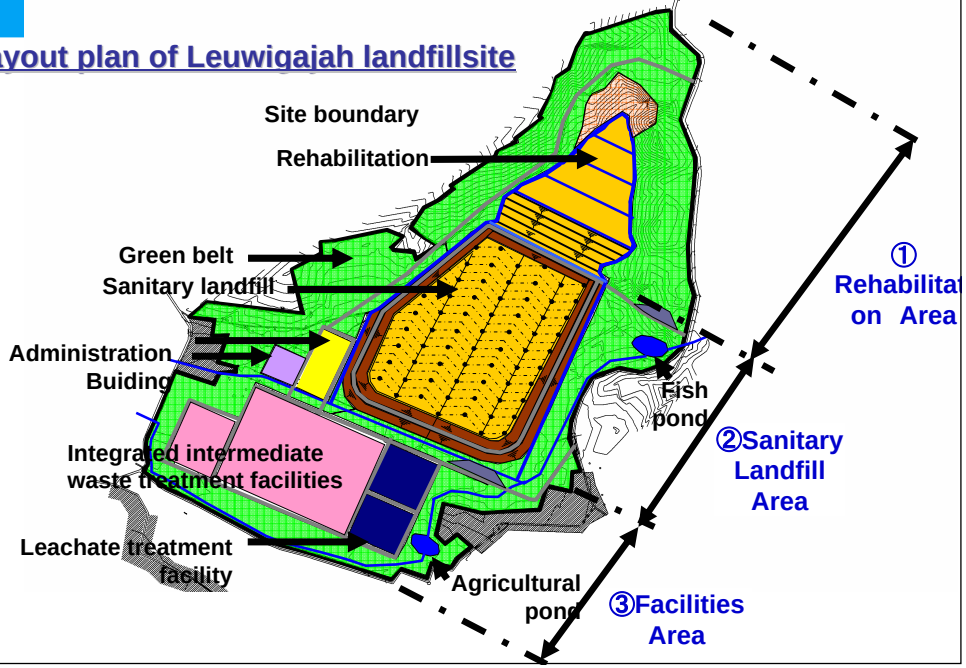
2. Component of solid waste management center

1. Arrangement of Infrastructure
   Green belt and buffer zone, Water resourvor and drainage
2. Rehabilitation
   Replacement, compaction and capping
   Segregation (Organic, Plastic & recyclable, and residue)
3. Integrated solid waste treatment

(Complex of Integrated treatment center of old waste and new waste)

- Treatment of old waste (segregation)
- Treatment of waste to be disposed
  - Segregation to Organic, Plastic & recyclable, and residue
  - Biological Treatment (Farmentation and composting)
  - Sanitary landfill (residue and biological treated waste)
  - Storage of plastic and recyclabel
  - Environmental protection

Layout plan of Leuwigajah landfillsite

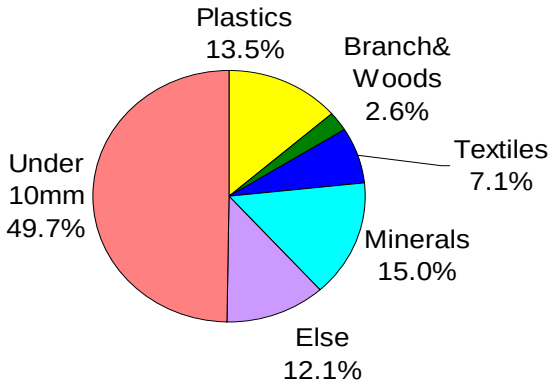


4. Target Waste

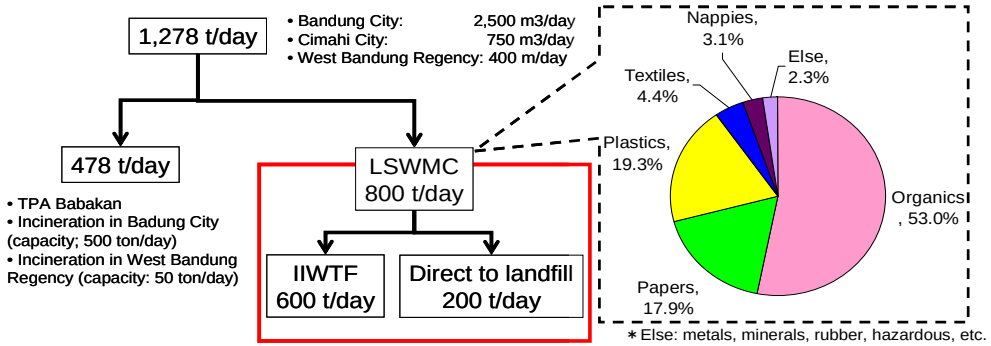
4.1 Old waste (Landslide Wastes)

- Total Amount: 1,860,000 ton
- Wet Density: 0.6

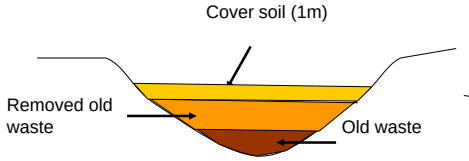
(Relocation 25 %, Segregation 25 %, Compaction and capping 50%)



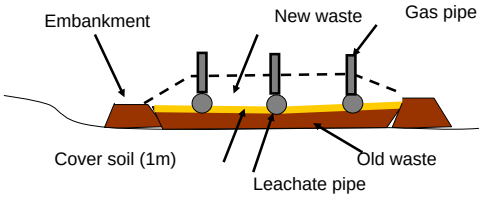
4-2 New waste (Household Wastes)



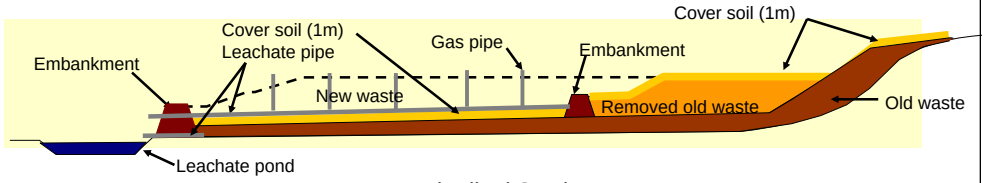
5. Section Plan of Rehabilitation Area and Sanitary landfill Area



Rehabilitation area



Sanitary Landfill area



Longitudinal Section

Cost for Rehabilitation and Landfill

	Item	Amount Rp Million	Yen Million
1	Site preparation	10,242	123.4
2	Land reclamation	37,972	457.6
3	Embankment	18,769	226.2
4	Storm water drainage	11,708	141.1
5	Liner system	22,277	268.4
6	Lecahte collection	24,616	296.6
7	Leachate treatmetn & recirculation	4,954	59.7
8	Gas collection	34	0.4
9	Road	13,716	165.3
10	Administration Facilities	4,053	48.8
11	Fence, landscape and pond	10,343	124.6
12	Miscellenious	15,868	191.2
	Total	174,552	2,103.4

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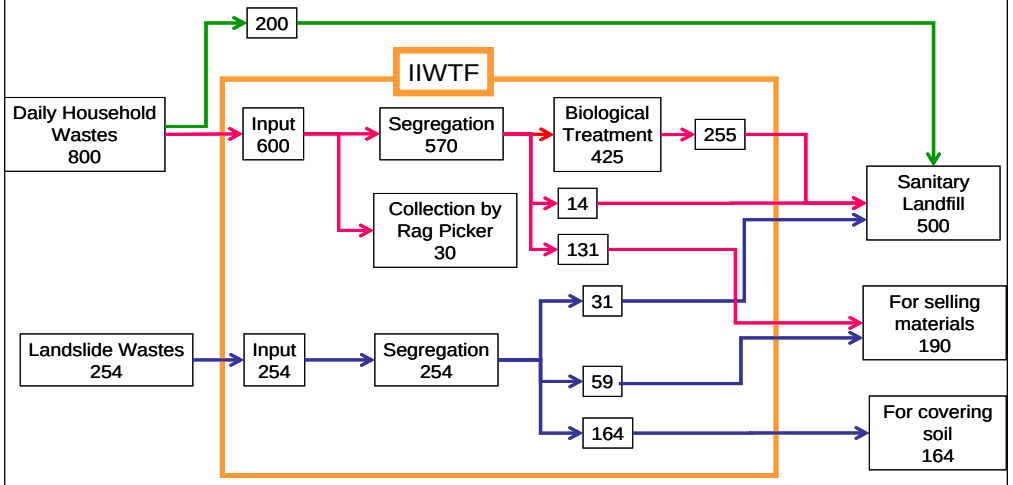
6. Process Flow



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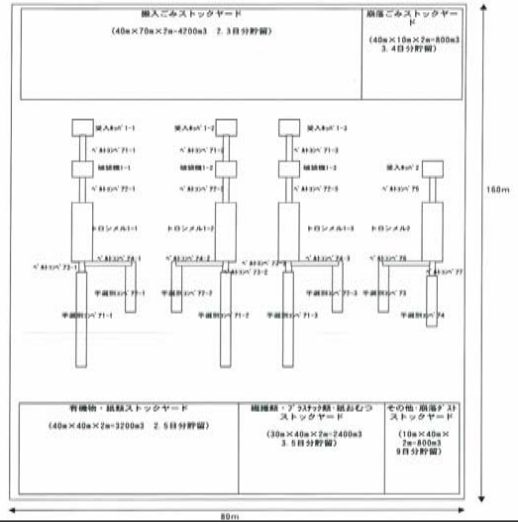
7 Integrated Waste Treatment Facilities

7-1 Segregation

(Old waste and new waste)



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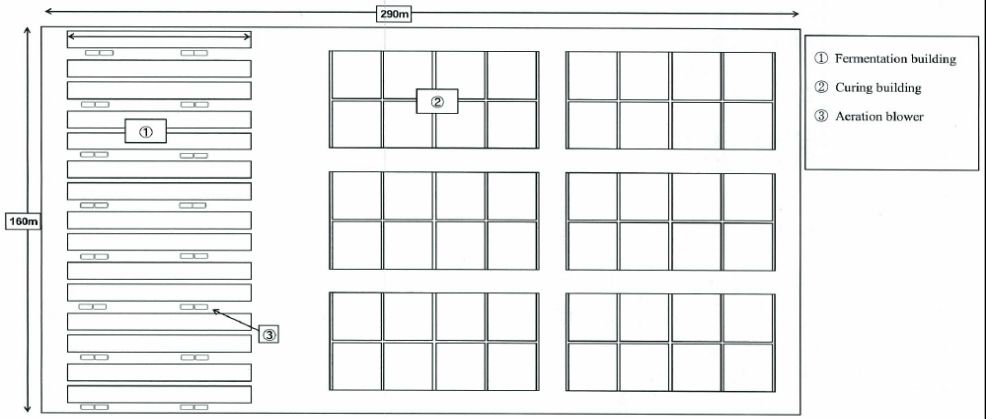
7-2 Biological Treatment



8. Cost for Project (Construction cost)

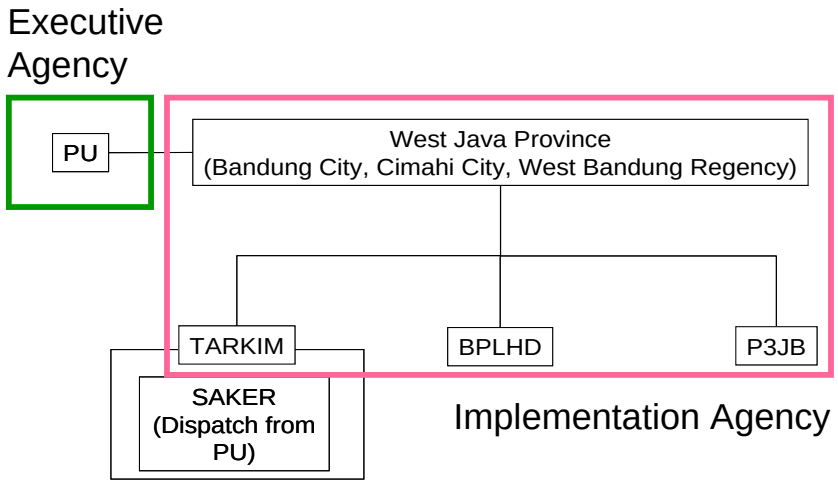
No.	Item		Cost	
			Rp. Million	Yen million
1	**Construction**		**326,338**	**3,932**
1)	Civil Works (earth work and road pavement)		5,975	72
2)	Segregation Facility	Civil and Building Work	21,079	254
		Machine and Equipment	35,270	425
3)	Biological Treatment Facility	Civil and Building Work	68,050	820
		Machine and Equipment	21,411	258
4)	Sanitary Landfill		174,553	2,163
2	**Administration (5%)**		**16,317**	**197**
3	**Consulting Services (10%)**		**32,634**	**393**
4	**Contingency (5%)**		**16,317**	**197**
5	**VAT**		**39,161**	**472**
Total			**430,766**	**5,191**

8.2 O&M Cost and Income

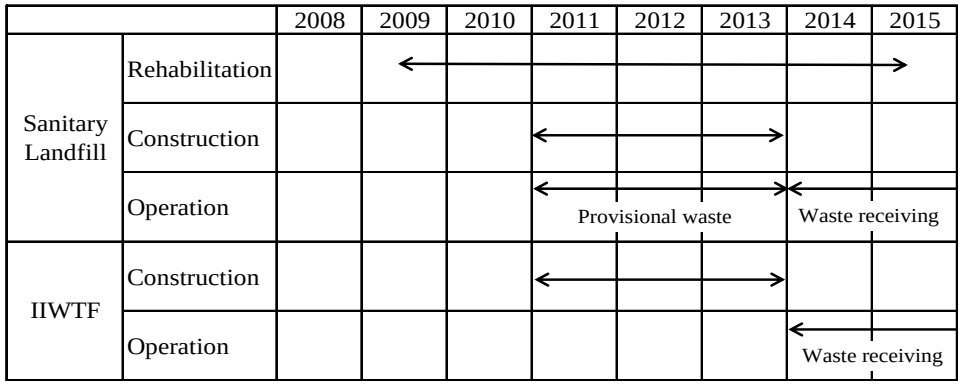
Item		Amount	
		Rp. Million	Yen million
Cost/year	Segregation Facility	8,797	106
	Biological Treatment Facility	5,477	66
	Sanitary Landfill	10,850	131
	Total	25,124	303
Income	Receiving Charge	54,312	654
	Total	54,312	654
Grand total (Balance)		29,188	351

Note: Tipping Fee Rp. 186,000/ton
Waste amount to be received: 800 ton/day

9. Implementation Agency



10. Schedule
10-1 Construction and Operation



10-2 Project Implementation

year	0–Year	1–Year	2–Year	3–Year	4–Year	5–Year
	2010	2011	2012	2013	2014	2015
month	1 4 7 10	1 4 7 10	1 4 7 10	1 4 7 10	1 4 7 10	1 4 7 10
Loan Agreement (Mar. 2010)	▲					
Selection of Consultant	■▲					
Detail Design	■	■				
Prequalification (P/Q)		■				
Tender			■			
Tender Evaluation				■		
Construction				■	■	■
Technology Transfer					■	■

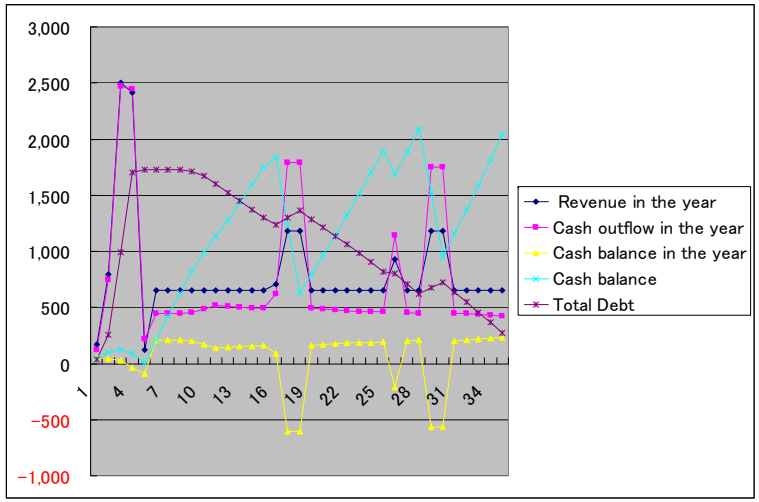
Economic Evaluation (Draft)

1. Benefit
   (1) Saving of disposal cost
   (2) Saving of disposal cost through reduction of waste
   (3) Reduction of greenhouse gas
2. Effect of the project
   EIRR 7.41% (to be re-estimated)
   Benefit/Cost without discount: 1.41

11. Financial Consideration

1. Invest cost
   Central government 70 %
   Local government 30 % (local loan)
2. Income of the Project
   Tipping fee (Assuming Rp. 186,000/ton)
3. OM cost and repayment of above local loan will be born by Tipping fee
4. Renewal cost of disposal site and facilities
   70% will be born by tipping fee
   30 % will be subsidy from central and/or local government

Cash Flow (draft)



APPENDIX 5 ARTICLE IN TEMPO INTERAKTIF.COM (2nd FEBRUARY 2009)

Garbage in Bandung to be Managed by Local Governments

Monday, 02 February, 2009 | 14:58 WIB

TEMPO *Interactive*, Bandung: Starting from next week, all garbage in Bandung and its surrounding areas will be managed and processed by local governments in Leuwigajah and Legok Nangka.

The agreement between provincial, regency, and city governments throughout Bandung will be signed this week.

The MoU will be approved soon,‧said West Java Governor, Ahmad Heryawan, in Bandung, on Saturday last week (31/1).

Heryawan explained that the provincial government has invited city and regency governments to run their own garbage management, including the setting up of power plants from the garbage in Gedebage.

Heryawan went on to say that although this is managed by local governments, they still can include provincial government in their garbage management.

Currently, garbage in Bandung is stored on the land owned by state-owned forestry company Perhutani, in Cigedig block, Sarimukti Village, Cipatat.

填 p until the year 2018,‧said head of the regional settlement and housing office, Yerry Yanuar.

Yerry said that the capacity of this location would be full by 2010.

However, since the location can still be used until 2018, the garbage there will be processed into compost.

Heryawan said that by having garbage joint management, more environmentally friendly technology can be used.

AHMAD FIKRI

インドネシア国ルイガジャ処分場
複合環境改善事業調査

和文要約

インドネシア国ルイガジャ処分場複合環境改善事業調査

和文要約

I. 背景

インドネシア国西ジャワ州にあるルイガジャ処分場はバンドン都市圏（バンドン市、バンドン県、チマヒ市）における最大の処分場であり、発生する都市ごみの内、約 4,000m3/日を処分していた。処分場面積は約 25.1ha、投棄されたごみの最大厚さは約 80m であった。当処分場は、ごみを谷間に投棄するだけのいわゆるオープンダンピングの処分場であった。

こうした状況の中、2005 年 2 月 20 日、2 日間の大雨の後に同処分場が大崩壊を起こした。崩壊ごみ量は 310 万m^3で、最も遠いところで 950m先まで流れ落ち、ごみの広がりは約 75haになった。死者 141 名のほとんどは住民であり、人命、家屋、田畑などに対する補償総額は 560 億ルピア（約 8 億円）に及んだ。崩壊したごみによる悪臭・害虫の発生・ごみの飛散及び浸出水による河川・地下水汚染など周辺環境へ多大な影響を与えていること、また当処分場にごみを投棄することができなくなったため街中にごみがあふれ出てしまったことがあり、早急に崩壊ごみの対策が必要となった。西ジャワ州は臨時サリムクティ処分場を建設し、2010 年までの供用期間中に新規処分場の建設用地を確保することとした。

サリムクティの供用の間に新規処分場の用地確保が困難であることが決定的となり、西ジャワ州は崩壊したルイガジャを復旧・再利用する方針を立て、西ジャワ州環境保護局（BPLHD）が「ルイガジャ復旧計画」策定した。この復旧計画の中には、処分場の復旧のみならず、復旧後のごみ処理計画（埋立方法、中間処理等）も含まれている。しかしながら BPLHD が策定した復旧計画は経験不足等から、技術的な根拠に乏しい計画となってしまった。その結果、中央政府による事業の承認が得られておらず、加えて周辺住民へ十分な説明ができないなどの問題に直面し、復旧作業はいまだに停滞している。

II. 調査の目的

本調査の目的は上述の復旧事業に関して戦略的な環境保全対策を踏まえた妥当性を調べ、事業調査計画書を作成し提案することである。

III. 調査内容

本調査の対象地はルイガジャ処分場である。調査概要を Figure 1 に示す。各種調査結果を踏まえ、先述のルイガジャ復旧計画を元に、衛生処分場と中間処理場の整備を含んだ「ルイガジャ復旧・廃棄物処理センター整備事業案」を策定する。

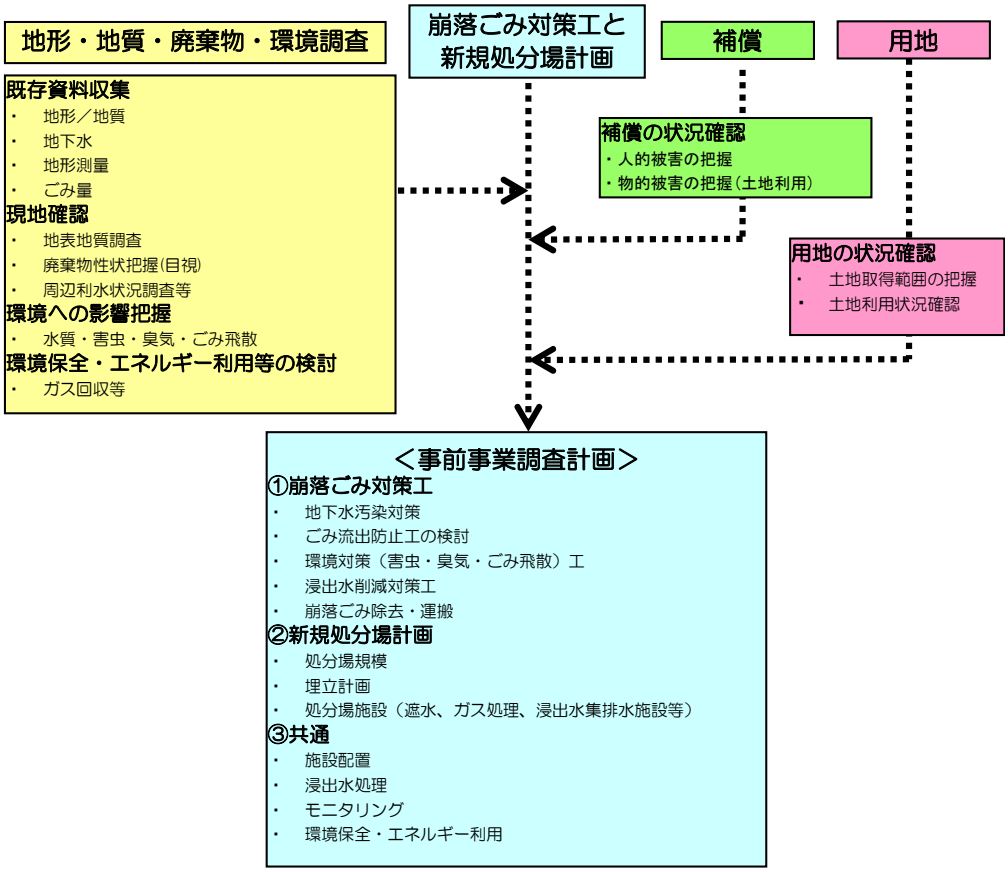


Figure 1 Contents of Study

IV. 結果

本調査では、目視による崩落ごみの調査、ガス・水質調査及び住民への聞き取り調査を実施した。これらの調査に加え、ルイガジャ処分場の位置とアクセス、地形・地質、気象、水象、周辺土地利用状況、周辺水利用状況、人的・物的補償、環境影響評価の実施状況についての調査を実施した。

これらの調査結果を元に、本調査では可能な限り住民の要望を考慮した「ルイガジャ復旧・廃棄物処理センター整備事業案」を作成した。Figure 2 にそのレイアウト案を示す。レイアウトはまず住民の要望通りに十分な範囲のバッファーゾーンを確保し、次に残ったエリアを①Rehabilitation area，②Sanitary landfill area及び③facilities areaの 3 つに分割することとした。提案した衛生処分場については、埋立期間を 10 年程度（埋立容量：200 万m^3）とした。

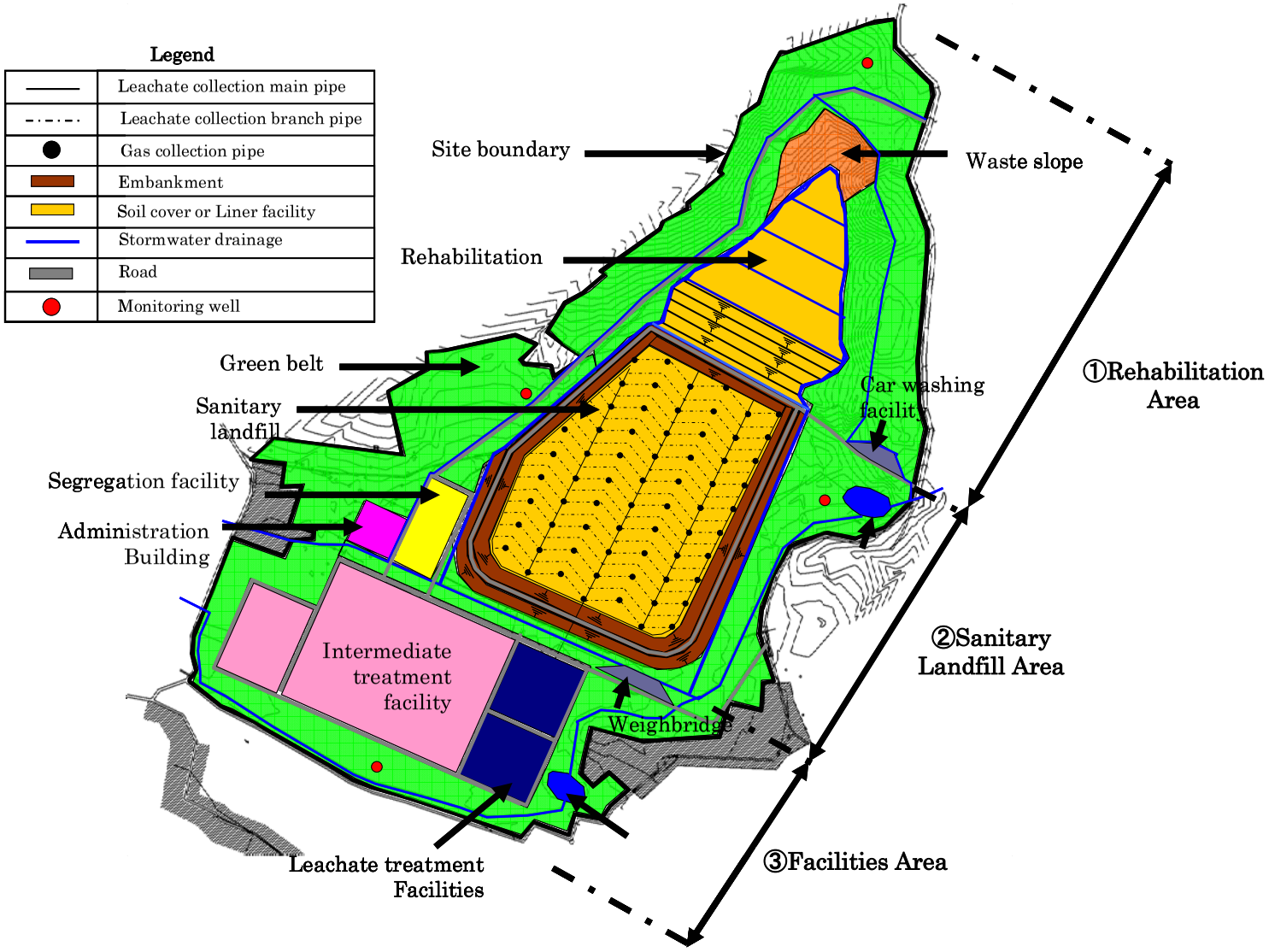
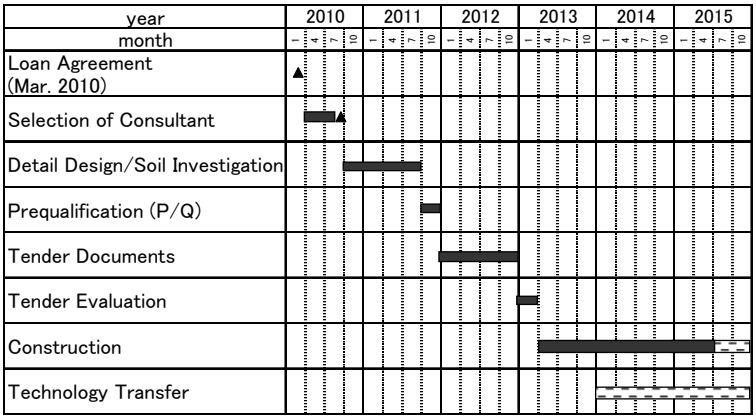


Figure 2 Layout Plan of LSWMC

さらに Rehabilitation concept design 及び Sanitary landfill concept design を計画し、それらを元に事業案の建設コストを試算した結果、約 213 billion Rp となった。また JICA ローンを適用した場合の事業実施スケジュールを Table 1 に示す。

Table 1 Project Implementation Schedule



V. 提言

最後に、「ルイガジャ復旧・廃棄物処理センター整備事業案」の全体の事業構想は Table 2 に示す様になるものと考えられる。この事業を進めて行くためには、それぞれについて西ジャワ州が事業の方針を整理し、各事業を調整しながら推進していくことが必要である。

Table 2 Components of LSWMC Project

事業区分	項　　目	備　　考
1. バンドン市西部等地域の廃棄物処理暫定対策事業	サリムクティの施設増強など	インドネシア国および西ジャワ州予算で実施
2. ルイガジャ復旧工事および周辺整備事業	1.補償および用地取得	インドネシア国および西ジャワ州予算で実施
	2.リハビリテーションとインフラ整備	
3. ルイガジャ復旧および廃棄物処理センター整備事業	1.崩壊ごみリハビリテーションおよびバッファーゾーン整備事業	地元負担分
	2.崩壊ごみ処理施設および搬入廃棄物前処理施設整備事業(選別・生物処理事業)	ローン事業
	3.衛生埋立処分場および機材整備事業	
	5.廃棄物処理施設用地整備事業	
4.民間による廃棄物処理事業	民間による廃棄物処理施設整備および運営事業	民間事業として実施