d.8 Document 8: Plan and operation of collection system

Doc 8

Plan and Operation of Collection System

of the Workshop

for Formulation and Implementation of SWM M/P at selected provincial level based on the experience in UBC

Jun 29, 2011

Counterparts and JET of the Project for Strengthening the Capacity on SWM in UBC

Contents

1. Outline of Collection and Haulage System
2. Time and Motion Survey
3. Applicable Collection and Haulage System
4. Master Plan of Collection and Haulage System in MUB
5. Strategy for the Collection Improvement
6. Costing for Implementation of MP

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1. Outline of Collection and Haulage System

Old SWM was Easy and Simple.

SWM was just

- **collection waste**
- **carrying waste**
- **disposing of waste.**

This was enough

- **when the waste amount was little.**
- **when most waste were biodegradable**
- **when the objective was only sanitation.**

The Situation has Changed!

- Population has increased.
- People have got richer. They buy more and dispose more.
- The waste amount has been rapidly increasing.
- Packaging wastes (paper, plastic, metal, glass) have increased due to supermarkets.
- Improvement of roads has highlighted the ugly view of waste scattering.
- SWM has to target not only "Sanitation" but also "Good and Beautiful Environment".
- People have got more selfish. Less cooperation.

They have caused:

- Many waste scattering and heaps.
- Many illegal dumping of waste.
- Huge SWM expenditure.
- Serious environmental impacts by landfill.
- Many complains by people.
- Negative impacts to the tourist industry.

Privatization solve these problems?

- Private sector's objective is only maximization of profit.
- SWM's objective is sanitation, environmental protection, beautiful town, etc.
- Both parties' objectives never match.
- Unless UBC strictly control and supervise private companies, the situation become much worse.

Old Fashion Solid Waste Management

Waste collection

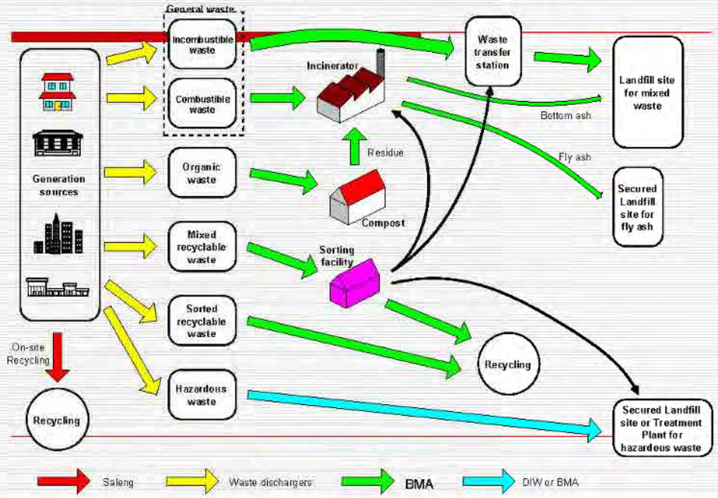
Transportation

Waste Disposal

Very Simple

Very complicated, especially collection and transportation.

Proposed SWM for Bangkok



Why Complicated? Because All Technologies Require Separate Collection.

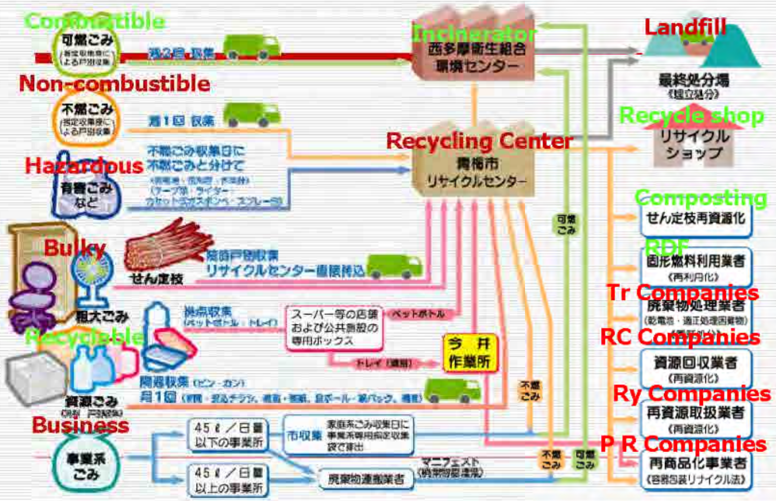
Incineration Plant accept only combustible waste.

Recycling center accept only recyclables.

Compost plant accept only bio-degradable waste.

- You have to educate people to discharge waste separately.
- Separated wastes have to be transported to the different plants and disposal sites.
- Can you force waste collection company to do so?

SWM in Ome City in Japan



2. Time and Motion Survey conducted in 2005 at UBC

Survey

- □Survey Period
  - ■From 17 January till 28 January 2005
- □Survey Sites
  - ■Byanzurukh
    - □Apartment: 2 khoroo
    - □Gel: 3 khoroo
  - ■Chingeltei
    - □Apartment: 2 khoroo
    - □Gel: 3 khoroo

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Collection System

- □Bell collection
- □Apartment with dust chute
- □Communal container collection
- □No proper collection system
- □Ger area collection

Apartment: Bell Collection

- □When the truck come, it made horn to inform of its arriving. Then people carry their garbage to the truck.
- □Cleaners and guards mainly carry garbage.
- □This system is well functioning.

Apartment: Dust Chute Collection

- □ Garbage Collection after 1 month.
- □ Nobody notice it full.
- □ Chute often clogs.
- □ Garbage often burn both in the chamber and in the chute.
- □ Very difficult to load garbage to the truck.
- □ Very unsanitary.
- □ It is very convenient system for residents, but nobody care garbage after dropping it to the chute.
- □ Dust chute should be banned!

Apartment: Communal Container Collection System

- Nobody take care public containers due to no ownership feeling.
- Garbage can't drop to the truck due to being frozen.
- Waste pickers scatter garbage to collect cans and plastic bottles.
- People burn garbage in containers for warming.
- Wheels and a cover are easily damaged.
- Using communal container for Apartment should be banned!
- This system is suitable for business waste.

Apartment: No Discharge & Collection Rule

- Waste scattered due to no garbage storage system.
- Unsanitary
- Difficult to collect garbage.

Ger Area: Fee Collection

Ger Area

- People are responsible for loading their garbage. Good public cooperation.
- Cover garbage with sheet to prevent waste scattering.
- Many people cooperate for loading garbage.

In Tokyo
Garbage Discharge System

In Tokyo: **Using plastic bags**

In Tokyo: **Plastic bag must be semitransparent to protect collection workers from accidents.**

Garbage Discharge Rule in Tokyo

The notice board showing the waste discharge rule is placed at every collection station.

Garbage Discharge Rule in Katsushika-ward, Tokyo

☐ Paper, glass, tins	on Mon.	before 8am
☐ Combustible waste	on Wed.& Sat	before 9:30am
☐ Incombustible waste	on Fri	before 8am

- ☐ Bulky waste — apply to the office by phone (disposal fee depending on items)
- ☐ Pet bottles — carry to recycle bins at shops (producers are responsible for collection)
- ☐ Nonresidential waste — pay as you throw

Recyclable Waste

Primary collection by Tricycles in Viet Nam

Container is loaded on a dump truck with a crane.

Garbage Hopper at a Local Market

Findings (1)

1. Very long working hours, from 9am until 7-9pm.
2. No authorized collection route.
3. No authorized collection schedule.
4. Residents don't know the collection days.
5. In Bayanzurukh, only one collection worker per truck. Rental contract system minimize workers and petrol but lengthen the working hours.
6. Most of collection trucks use gasoline.
7. Russian trucks consume lots of gasoline. 4 to 5 times of Japanese trucks.
8. Driver repair trucks. → Difficult for drivers to repair modern trucks.

Findings (2)

9. TUK strictly control petrol.
10. Recoding of trucks at the Ulaan Chulute landfill is not so accurate.
11. Most collection crew take no lunch due to no money.
12. In Apartment area, the Bell collection functions very well. This should be the standard collection system for Apartment.
13. In Ger area, the fee collection is the main constrain for the collection work.
14. Present condition of fee collection function well. But it creates many problems as well.
15. TUK and rental contract is the big constrain for the improvement of collection system.

3. Screening of Applicable Collection and Haulage System

Storage System

- Dust Chute
- Disposable Containers (sackcloth, paper sacks, plastic bags)
- On site waste storage
- Small containers (about 0.2 m3)
- Medium Containers (1 to 2 m3)
- Large Containers (5 to 10 m3)

Screening Results of Storage System

	Residential waste in Apartment Area	Residential waste in Ger Area	Other waste
Dust Chute	Unsuitable	Not applicable	Unsuitable
Disposable containers (Paper or plastic sacks)	Suitable	Suitable	Suitable
On-site refuse storage	Suitable	Unsuitable	
Small containers (about 0.2 m3)	Unsuitable	Suitable	Suitable
Medium containers (1 m3)	Unsuitable	Unsuitable	Suitable
Large containers (5 to 10 m3)	Unsuitable	Unsuitable	Suitable

Discharge System

- Discharge system is closely related to the storage system and collection system

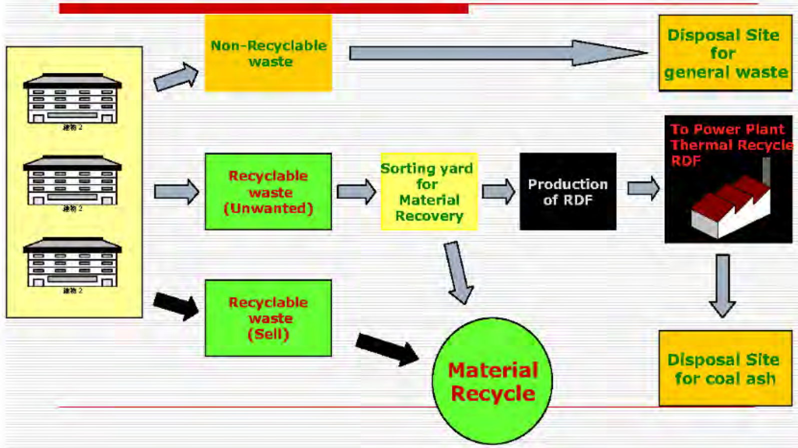
1. Mixed Discharge System
2. Separate Discharge System
3. Discharge to the drop off station
4. Bring to buy back station

Collection and Haulage System

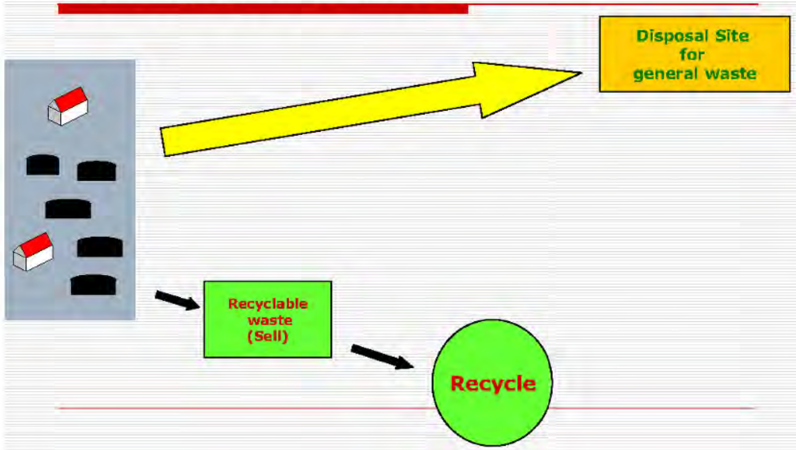
- Collection Frequency
- Mixed or Separate Collection
- Collection System
  - Door to door, Road kerb, Entrance to entrance,
- Collection Schedule
- Collection Equipment
  - Tricycle, CT, DT, Railway, Ship
- Direct Transportation or Transfer station

4. Master Plan of Collection and Haulage System in MUB

Master Plan of Waste Stream for Planned Area



Master Plan of Waste Stream for Unplanned Area



Discharge & Collection System
Planned Area

1. Separate collection
   - General waste: 2 days/week, fixed days
   - Recyclable waste: 1 day/week, fixed days
2. Compactor truck
3. Entrance collection with bell system
   - Residents discharge their waste inside of the entrance of the apartment.
   - When a compactor truck comes, it informs of its arrival by playing music.
   - Then guards and cleaners of apartments carry waste to the compactor truck for loading.

Discharge & Collection System
Unplanned Area

1. **Mixed collection**
   1 day/2 weeks, fixed days
2. **Dump truck**
3. **Door to door collection with bell system**
   - Residents store their waste inside of the Hasha.
   - When a truck come, it informs of its arrival by playing music.
   - Then residents carry waste to the truck for loading.

Or, Curb-side collection with bell system.

Discharge & Collection System
Special Order

- **Waste which are not suitable for regular collection**
- **Large amount of waste**
  - Factories, Supermarkets, Hotels, Restaurants, large amount of waste from residence, etc.
- **Bulky waste**
  - Furniture, TV, Refrigerator, Washing machine, Computer, etc.
- **Request collection by telephone**
- **Special fee**

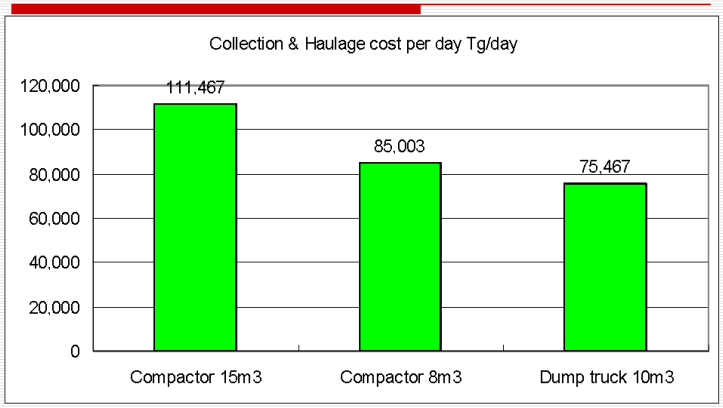
Special Collection

5. Strategy for the Collection Improvement

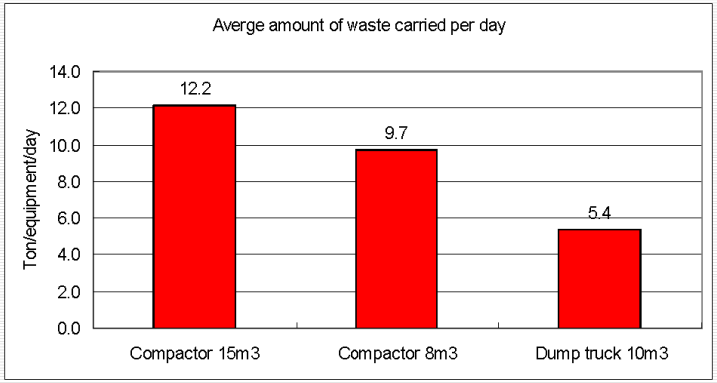
Assumed Bulk density of waste

	Area	Original condition	After compaction
Compactor 15m^3 & 8m^3	Planned	0.20 t/m^3	0.45 t/m^3
Dump truck 10m^3	Un-planned	0.30 t/m^3	-

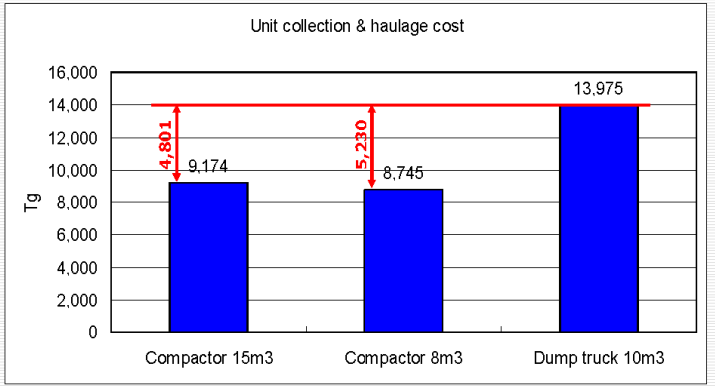
Collection & Haulage Cost per Equipment per Day



Average Amount of Waste Carried per Day



Collection & Haulage Cost per Ton of Waste

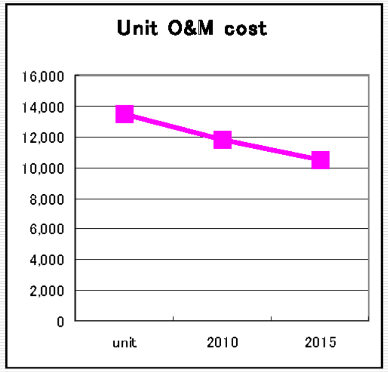


Compactor is cheaper by 5000Tg per ton of waste.

How much can Collection Cost is reduced?

- Waste amount in planned are in 2015: 133,000 ton
- The difference of unit cost between a dump truck and a compactor: 5,000Tg/ton
- Different amount in 2015:
  133,000ton x 5,000Tg/ton= 665million Tg. can be saved in 2015.

Waste Collection Amount vs Unit Collection Cost



Strategy to achieve 100% collection rate at the minimum cost.

1. To minimize the total collection cost, all waste in Planned Area is collected by compactor trucks.
2. Extra budget squeezed in Planned area is spent for un-planned area.
3. Common 6 ton dump truck is used for un-planned area because compactor is unsuitable for waste there.

6. Costing for Implementation of Master Plan

1.Caluculation of Necessary Equipment-1
(ex. Sukhbaatar District)

Waste generation amount per day

Season	Type of area	Waste source	unit	2005	2010	2015	2020
Winter	Planned area	Apartment area	t/d	11.8	18.5	27.9	40.5
		Business area	t/d	6.2	9.0	14.0	21.1
		Roads and Parks	t/d	2.4	2.7	2.9	3.0
		Sub-total Aw	**t/d**	**20.4**	**30.2**	**44.8**	**64.6**
	Unplanned area	Ger area General	t/d	10.2	10.6	10.2	8.3
		Ger area Ash	t/d	49.3	44.5	36.7	25.9
		Sub-total Bw	**t/d**	**59.5**	**55.1**	**46.9**	**34.2**
	Total		**t/d**	**79.9**	**85.3**	**91.7**	**98.8**
Summer	Planned area	Apartment area	t/d	10.5	16.5	24.8	35.9
		Business area	t/d	7.4	11.2	17.1	26.0
		Roads and Parks	t/d	4.1	4.5	4.8	5.1
		Sub-total As	**t/d**	**22.0**	**32.2**	**46.7**	**67.0**
	Unplanned area	Ger area General	t/d	12.7	13.2	12.6	10.3
		Ger area Ash	t/d	0.0	0.0	0.0	0.0
		Sub-total Bs	**t/d**	**12.7**	**13.2**	**12.6**	**10.3**
	Total		**t/d**	**34.7**	**45.4**	**59.3**	**77.3**

Waste Collection Amount per day by type of the collection vehicle

Waste collection amount per day by type of the collection vehicle

Season	Type of area	Waste source	unit	2005	2010	2015	2020
Winter	Compactor	Apartment	t/d		18.5	27.9	40.5
		Small business	t/d		4.5	7.0	10.6
		Roads and Parks	t/d		2.7	2.9	3.0
		Large business	t/d		4.5	7.0	10.6
		Sub-total Aw	**t/d**		**30.2**	**44.8**	**64.6**
	Dump truck	All waste	t/d		55.1	46.9	34.2
		Sub-total Bw	**t/d**		**55.1**	**46.9**	**34.2**
	Total		**t/d**		**85.3**	**91.7**	**98.8**
Summer	Compactor	Apartment	t/d		16.5	24.8	35.9
		Small business	t/d		5.6	8.6	13.0
		Roads and Parks	t/d		4.5	4.8	5.1
		Large business	t/d		5.6	8.6	13.0
		Sub-total As	**t/d**		**32.2**	**46.7**	**67.0**
	Dump truck	All waste	t/d		13.2	12.6	10.3
		Sub-total Bs	**t/d**		**13.2**	**12.6**	**10.3**
	Total		**t/d**		**45.4**	**59.3**	**77.3**

Waste Collection Amount per day by type of Vehicle

Waste collection amount per day by type of the collection vehicle (7days/week)

Season	Vehicle type	Waste source	unit	2005	2010	2015	2020
Winter	Compactor	Sub-total Aw	t/d		30.2	44.8	64.6
	Dump truck	Sub-total Bw	t/d		55.1	46.9	34.2
	Total		t/d		85.3	91.7	98.8
Summer	Compactor	Sub-total As	t/d		32.2	46.7	67
	Dump truck	Sub-total Bs	t/d		13.2	12.6	10.3
	Total		t/d		45.4	59.3	77.3

Waste collection amount per day by type of the collection vehicle (6days/week)

Season	Vehicle type	Waste source	unit	2005	2010	2015	2020
Winter	Compactor	Sub-total Aw	t/d		35.2	52.3	75.4
	Dump truck	Sub-total Bw	t/d		64.3	54.7	39.9
	Total		t/d		99.5	107.0	115.3
Waste co	Compactor	Sub-total As	t/d		37.6	54.5	78.2
	Dump truck	Sub-total Bs	t/d		15.4	14.7	12.0
	Total		t/d		53.0	69.2	90.2

% of Waste carried by each type of collection vehicle

% of waste carried by each type of collection vehicle

Season	Type of area	Type of vehicle	unit	2005	2010	2015	2020
Winter	Planned area	Compactor 15m3	%		80%	80%	80%
	Planned area	Compactor 8m3	%		20%	20%	20%
	Unplanned are	Dump truck 10m3	%		100%	100%	100%
Summer	Planned area	Compactor 15m3	%		80%	80%	80%
	Planned area	Compactor 8m3	%		20%	20%	20%
	Unplanned are	Dump truck 10m3	%		100%	100%	100%

% of waste carried by each type of collection vehicle

Season	Type of area	Type of vehicle	unit	2005	2010	2015	2020
Winter	Planned area	Compactor 15m3	t/day		28.2	41.8	60.3
	Planned area	Compactor 8m3	t/day		7.0	10.5	15.1
	Unplanned are	Dump truck 10m3	t/day		64.3	54.7	39.9
	Total		t/day		99.5	107.0	115.3
Summer	Planned area	Compactor 15m3	t/day		30.1	43.6	62.5
	Planned area	Compactor 8m3	t/day		7.5	10.9	15.6
	Unplanned are	Dump truck 10m3	t/day		15.4	14.7	12.0
	Total		t/day		53.0	69.2	90.2

Average trip per day by type of vehicle

			Average trip no. per day			Average haulage amount per trip		
			trips/d	trips/d	trips/d	t/trip	t/trip	t/trip
	unit	Haulage distance	Compactor 15m3	Compactor 8m3	Dump truck 10m3	Compactor 15m3	Compactor 8m3	Dump truck 10m3
Planned	km	15.5	2	3	2	6.08	3.24	2.70
Unplanned	km	18.5	1	2	2	6.08	3.24	2.70

Number of Vehicle required

Roundup required number of equipment

Season	Type of vehicle	unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Winter	Compactor 15m3	nos	3	3	3	3	4	4	4	5	5	5	5
	Compactor 8m3	nos	1	1	1	1	2	2	2	2	2	2	2
	Dump truck 10m3	nos	12	12	12	11	11	11	10	10	9	8	8
		nos	16	16	16	15	17	17	16	17	16	15	15
Summer	Compactor 15m3	nos	5	6	6	7	7	8	8	9	10	10	11
	Compactor 8m3	nos	2	2	2	2	2	2	2	2	3	3	3
	Dump truck 10m3	nos	3	3	3	3	3	3	3	3	3	3	3
		nos	10	11	11	12	12	13	13	14	16	16	17

Price of Each Equipment

	Basic price	Basic price	Life year	Salvaged value
	USD	Tg	years	Tg
Compactor truck 15m3, 10ton	95,000	114,000,000	8	11,400,000
Compactor truck 8m3, 6ton	80,000	96,000,000	8	9,600,000
Dump truck 10m3, 6ton	65,000	78,000,000	8	7,800,000
Skipper truck 5m3		0	8	0
Wheel loader	130,000	156,000,000	12	15,600,000
Wheel backhoe	100,000	120,000,000	12	12,000,000

Number of Vehicles and Amount to be Invested

Number of equipment procured

Season	Type of vehicle	unit	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Winter	Compactor 15m3	nos	3	0	0	0	1	0	0	1	3	0	0	0
	Compactor 8m3	nos	1	0	0	0	1	0	0	0	1	0	0	0
	Dump truck 10m3	nos	0	0	0	0	0	0	0	0	0	0	0	0
		nos	4	0	0	0	2	0	0	1	4	0	0	0

Investment for equipment (cash base)

Season	Type of vehicle	unit	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Winter	Compactor 15m3	1000Tg	342,000	0	0	0	114,000	0	0	114,000	342,000	0	0	0
	Compactor 8m3	1000Tg	98,000	0	0	0	96,000	0	0	0	96,000	0	0	0
	Dump truck 10m3	1000Tg	0	0	0	0	0	0	0	0	0	0	0	0
		1000Tg	440,009	0	0	0	210,000	0	0	114,000	438,000	0	0	0

O&M cost per each truck

O&M Cost

	Items	Unit	Compactor 15m3	Compactor 8m3	Dump truck 10m3
A	Distance	km	15.5	15.5	18.5
B	Diesel consumption per	km/l	2	5	3
C	Collection and discharge	minutes	125	69	125
D	Effeciency for working hours		0.9	0.9	0.9
E	Diesel consumption per	min/l	15	30	30
F	Diesel quantity for trave	liter/trip	15.5	6.2	12.3333333
G	Diesel quantity for colle	liter/trip	7.5	2.07	3.75
H	Total consumption quant	liter/trip	23	8.27	16.0833333
I	Unit rate of diesel	Tg/liter	840	840	720
J	Fuel cost per trip	Tg/trip	19,320	6,947	11,580
K	Trip nos per day	Trip/day	2	3	2
L	Fuel cost per day	Tg/day	38,640	20,840	23,160
	Depreciation cost	Tg/day	0	0	24,041
	Maintenance cost	Tg/day	21,863	18,411	14,959
	Salary	Tg/day	16,667	16,667	16,667
	O&M cost per day	Tg/day	77,170	55,918	78,827
	Unit cost per ton of was	Tg/ton	6,346	5,753	14,598

O & M Cost

O&M Cost der day

Season	Type of vehicle	unit	2010	2015	2020
Winter	Compactor 15m3	Tg/d	231,509	308,679	385,848
	Compactor 8m3	Tg/d	55,918	111,836	111,836
	Dump truck 10m3	Tg/d	945,920	867,093	630,613
		Tg/d	1,233,347	1,287,608	1,128,298
Summer	Compactor 15m3	Tg/d	385,848	617,357	848,866
	Compactor 8m3	Tg/d	111,836	111,836	167,754
	Dump truck 10m3	Tg/d	236,480	236,480	236,480
		Tg/d	734,164	965,673	1,253,101

O&M Cost per year

Season	Type of vehicle	unit	2010	2015	2020
Winter	Compactor 15m3	1000Tg/y	56,257	75,009	93,761
243	Compactor 8m3	1000Tg/y	13,588	27,176	27,176
days/y	Dump truck 10m3	1000Tg/y	229,859	210,704	153,239
		1000Tg/y	299,703	312,889	274,176
Summer	Compactor 15m3	1000Tg/y	47,074	75,318	103,562
122	Compactor 8m3	1000Tg/y	13,644	13,644	20,466
days/y	Dump truck 10m3	1000Tg/y	28,851	28,851	28,851
		1000Tg/y	89,568	117,812	152,878
		1000Tg/y	**389,271**	**430,701**	**427,055**

Summary of Cost

	Investment	O&M
2009	4,296,054	0
2010	0	3,045,706
2011	228,000	3,087,680
2012	96,000	3,098,026
2013	666,000	3,065,632
2014	288,000	3,182,776
2015	342,000	3,146,114
2016	342,000	3,231,304
2017	4,125,595	3,276,581
2018	324,000	3,298,203
2019	433,200	3,337,283
2020	-3,611,625	3,364,134

Thank you for your Attention

d.9 Document 9: Site visit of 3R promotion sites, workshop, etc.

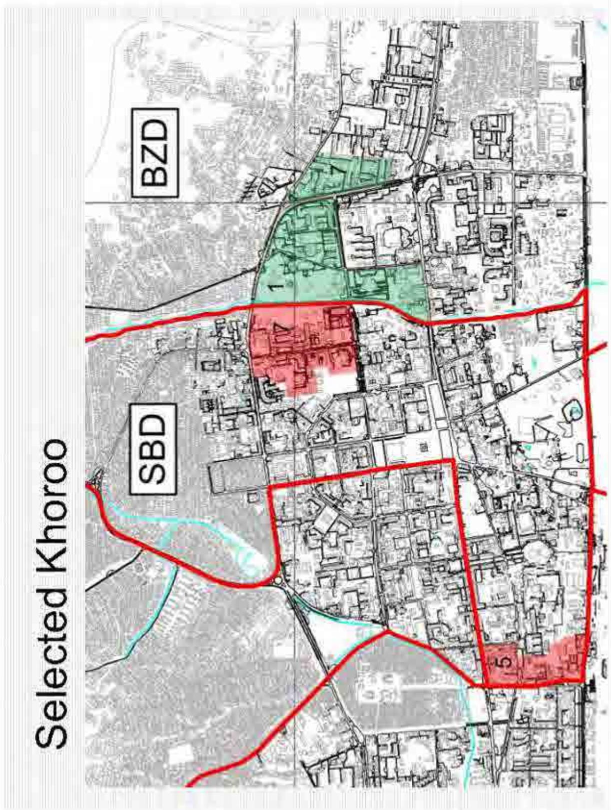
Doc 9

Site visit to SBD #7

PP1: PP of Public cooperation for improvement of waste discharging manner and waste separation

Procedure:

1. Improvement of waste discharging manner of the residents
2. Fix the waste collection schedule
3. Introduce of bell collection
4. Closure of dust chutes and ODP
5. Promoting waste separation at source and community recycling



Monitoring Results -1

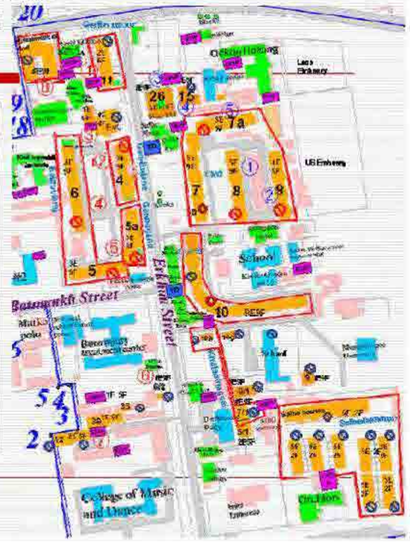
Waste collection before closure of dust chute: Wastes were not in the bags and accumulated inside. Collection worker needed to crape out the waste and load on the vehicle, it took few hours. Collection frequency was once a week

Waste collection after closure of dust chute: Watchmen take out the wastes in the bags on curbside before the collection vehicle comes. Collection worker only load those bags on the vehicle. The collection efficiency was drastically improved, it takes few minutes. Collection frequency is three times a week.

New Collection Schedule

Once/week → 3times/week with bell collection

	Odd days	Even days
Morning (9:00-12:30)	Selbe township	Selbe township
	Apart-9/1 & 5/1	Apart-9
	Apart-12 & 39	Apart-8
	Apart-4	Apart-7
	Apart-6	Apart-10
	Apart-5	
	Apart-5A	
Afternoon (14:50-18:00)	Apart-18	Apart-36
	Apart-7A	Tegsh AOU
	Apart-26	Apart-13
	Tegsh AOU	



Monitoring Results -2

Closed dust chute at Apt.6 SBD#7
Notice to inform about the closure and discharging rule was put on.

Beside the closed dust chute: The resident put out the waste only once a day by designated time, the waste shall be put into the bag, put beside the dust chute or the landing and Watchmen collect them.

Monitoring Results -3

Tegsh AOU

Before closure of ODP, not only the residents but those bars and restaurants nearby discharge the waste. Street waste pickers or stray dogs scattered the waste and make the area insanitary condition.

d.10 Document 10: Workshop (1): Preparation of framework for SWM M/P for each city

Doc 10

Workshop (1): Preparation of Framework for SWM M/P

for Formulation and Implementation of SWM Master Plan for Central Provincial Cities based on the Experience in UBC

June 29, 2011
JICA Expert Team
For the Project for Strengthening the Capacity for SWM in Ulaanbaatar City

1

Outline of the Lecture

- From this lecture participants are requested to work for the formulation of their M/P. At first how to set up the following frameworks for your M/P:

I. Site Selection for Future SWM Facilities' Sites (your case a future final disposal site)
II. Socio-economic Frame
III. Waste Amount and Composition
IV. Waste Stream without M/P

2

I. Site Selection for a Future Final Disposal Site

1. Items to be considered for site selection
2. Comparison of candidate sites
3. Preliminary selection

3

I-1. Items to be considered for site selection (1)

1. Environmental Aspects:

Avoid the following sites: Ground/surface water use in downstream, Special fauna/ flora living, Valuable landscape, Landslide area, Strong wind, etc.

2. Social Aspects:

Avoid the following sites: Area close to habited area, cultural property, public facilities, etc.

4

I-1. Items to be considered for site selection (2)

3. Technical Aspects:

Site size (available area), Current and future land use, Topography (Mining pit, valley, flat land), Geology, Distance to city center, Access road condition, Availability of utility, etc.

4. Economic Aspects:

Cost for Site development (needs of enclosing bank, leachate protection liner, etc.), Operation (availability of soil, etc.) Collection & transportation cost, etc.

5

I-2. Comparison of Candidate Sites

1. Nominate Candidate Sites:

- Current disposal site is one of the candidate if it has enough space.
- Find out some candidate site. Avoid the following sites: Ground/surface water use downstream, Special fauna/ flora living, area close to habited area, cultural property, public facilities, etc.

2. Collection of Data for each Site:

- Since new field investigation costs a lot, you need to find out existing and available data on the site.

3. Prepare a Comparison Table of Candidate Sites:

- Fill the table (Doc. 16: Comparison table of candidate sites for future disposal site).

6

I-3. Preliminary Selection

- You will evaluate each aspect of each site by using existing data.
- Then you will make score on each aspect of each site: Excellent 3, Good 2, Fair 1, Poor 0
- If you could not have enough data for evaluation of the site, you may do after workshop (3) finish.
- Site selection work should be done as open to public as possible.
- Therefore, you are requested to complete this work after you back to your city.

7

II. Socio-economic Frame

1. Population forecast
2. Economic Growth Rate
3. Financial System

8

II-1. Population Forecast (1)

- **Collection of Available Population Data:**

1. Collection of available population data
2. Data for district level is preferable for collection system planning
3. Population forecast data is highly preferable.

- **Population Forecast:**

1. If you get population forecast, you can use it.
2. If not, calculate population growth rate (P_GR) and future population by using calculation sheet (Doc 17: Calculation sheet for population forecast and future waste generation)

9

II-1. Population Forecast (2)

- **A.1 P_GR (Population Growth Rate) Calculation:**

1. Put Population Data according to the instruction of Doc 17
2. Then (P_GR + 1) is calculated by the following formula:

- $(P\_GR + 1) = Y^{(1/X)}$
- Y = B/D:
  B: Population of Latest Data,
  D: Population of Older Data
- X = A – C
  A: Year of Latest Population Data
  C: Year of Older Population Data

10

II-1. Population Forecast (3)

- **A.2 Calculation of Future Population:**

1. Put Population Data according to the instruction of Doc 17
2. Then Population in 20xx (Pxx) is calculated by the following formula:

- $Pxx = P11 * (P\_GR + 1)^{(20xx - 2011)}$
  Pxx: Population in 20xx

11

II-2. Others

- **Economic Growth Rate :**

1. You may apply average GDP growth rate (GDPav) of the nation from 2001 to 2010:
   GDPav = 6.23 % (Source: Global Finance)

- **Financial System :**

1. Sustainable financial system is essential for establishing proper MSWM.
2. Issues and problems of current financial system may be discussed in the workshop.

12

III. Waste Amount and Composition

1. Household Waste Generation Amount in Apartment Area in 20xx: HWAAxx
2. Household Ger Area Generation Amount in 20xx: HWGAxx
3. Other Waste Amount in 20xx: OWAxx

13

III-1. Household Waste Generation Amount in Apartment Area in 20xx: HWAAxx

Formula 1: HWAAxx = GR_HWAxx * Pxx_A

- GR_HWAxx: Household Waste Generation Rate in Apartment Area in 20xx

Formula 2: GR_HWAxx = GR_HWA11 * (1 + GR_GR)^(20xx - 2011)

- GR_HWA11: Household Waste Generation Rate in Apartment Area in 2011
- => Apply UBC Data => GR_HWA11 = (297 + 264)/2 = 280g/person/day
- GR_GR: Household Waste Generation Rate Growth per Year except Ash from Ger Area

Formula 3: GR_GR = 0.55 * GDPav (= 0.0623) = 0.034265 => Say 0.035

- Consequently, Formula 2 simplify as follow:

Formula 2: GR_HWAxx = 280 * (1 + 0.035)^(20xx - 2011)

14

III-2. Household Waste Generation Amount in Ger Area in 20xx: HWGAxx

Formula 4: HWGAxx = GR_HWGxx * Pxx_G

- GR_HWGxx: Household Waste Generation Rate in Ger Area in 20xx
- Ger Area Waste is divided into two categories of wastes, i.e. Ash and Other Waste
- Ash generation rate is not changed, The rate of UBC (788g/person/day) be applied to.
- Generation rate of Other waste will increase the same as HWAA.

Formula 5: GR_HWGxx = GR_HWGa11 + GR_HWGo11 * (1 + GR_GR)^(20xx - 2011)

- GR_HWGa11: Ash Generation Rate in Ger Area in 2011, i.e. 788g/person/day.
- GR_HWGoxx: Other Waste than Ash Generation Rate in Ger Area in 2011
- => Apply UBC Data => GR_HWGo11 = (188 + 234)/2 = 211g/person/day
- Consequently, Formula 5 simplify as follow:

Formula 5: GR_HWGxx = (788/2) + 211 * (1 + 0.035)^(20xx - 2011)

15

III-3. Other Waste Amount in 20xx: OWAxx

- Other MSW waste include wastes from business establishments and public area cleaning.
- But it exclude wastes from construction, factory and medical institution.

Formula 6: OWAxx = (HWAAxx + HWGAxx) * 0.157 (Figure from MUB Study)

!! Let calculate MSW generation in your city by using calculation sheet Doc 17

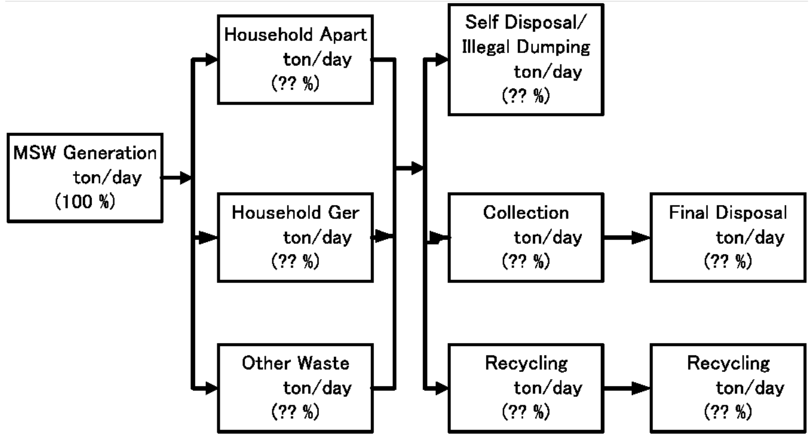
16

IV. Waste Stream without M/P

1. Waste Stream
2. Draw up waste stream in your city

17

IV-1. Waste Stream



IV-2. Draw up Waste Stream in your City (1)

1. **Fill the following figures by taking the results of calculation sheet of Doc 17-2**

- MSW Generation,
- Household Waste Generation in Apartment Area
- Household Waste Generation in Ger Area
- Other MSW than Household Waste (excluding wastes from construction, factory and medical institution

19

IV-2. Draw up Waste Stream in your City (2)

2. Calculation of Self Disposal & Illegal Dumping Waste: SDID_Axx

- Formula 1: SDID_Axx = (Non-Ca * HWAAxx) + (Non-Cg * HWGAxx) + 0.157 * ((Non-Ca * HWAAxx) + (Non-Cg * HWGAxx))
- Non-Ca: Non-collection Population Rate of Apartment Area
- Non-Cg: Non-collection Population Rate of Ger Area
- Put the Non-Ca and Non-Cg

3. Calculation of Recycling Amount: REAxx

- Formula 2: REAxx = RR * MSWxx.
- REAxx: Recycling Amout in 20xx
- RR: Recycling Rate; Apply the figure obtained in MUB study

4. Calculation of Collection and Final Disposal Amount: CFDxx

- Formula 3: CFDxx = MSWxx - (SDID¥Axx + REAxx)

20

IV-2. Draw up Waste Stream in your City (3)

5 Fill the remaining figures by taking the results of calculation sheet of Doc 17-2

6 Complete the waste flow in 2011 and 2020 without M/P

21

Thank you very much for your attention

22

d.11　Document 11: Workshop (2): Collection system planning for SWM M/P for each city

Doc 11

Collection System Planning for SWM M/P

for Formulation and Implementation of SWM Master Plan for Central Provincial Cities based on the Experience in UBC

June 29, 2011
JICA Expert Team
For the Project for Strengthening the Capacity for SWM in Ulaanbaatar City

1

Outline of the Lecture

1. **Basic Considerations for Collection System Planning**
2. **Calculation of Required Number of Collection Vehicles**

2

1. Basic Considerations for Collection System Planning

- Compactor Truck for Apartment and Business Wastes
  - 15m3 Compactor where road is wide.
  - 8m3 Compactor where road is narrow.
- Dump Truck for Ger Waste because of Ash

3

Photo for the Compactor Trucks

Photo for Dump truck

5

2. Methods of Calculation

1. Daily collection amount in each area (ton/day)
2. Allocation of type of trucks in each area
3. Adjusting daily collection amount by 6 days working in a week
4. Calculation of number of trips depends on the haulage distance to disposal site in each truck
5. Calculation of number of trucks

6

Thank you very much for your attention

7

d.12 Document 12: Workshop (3): Final disposal system planning for SWM M/P for each city

Doc 12

Final Disposal System Planning for SWM M/P

for Formulation and Implementation of SWM Master Plan for Central Provincial Cities based on the Experience in UBC

June 29, 2011

JICA Expert Team

For the Project for Strengthening the Capacity for SWM in Ulaanbaatar City

1

Outline of the Lecture

I. Advantages of Sanitary Landfill

II. Basic Considerations for Final Disposal Planning

III. Calculation of Required Landfill Volume

IV. Planning of a Final Disposal Site

V. Operational Planning

2

I. Advantages of Sanitary Landfill

The advantages of sanitary landfill are as follows.

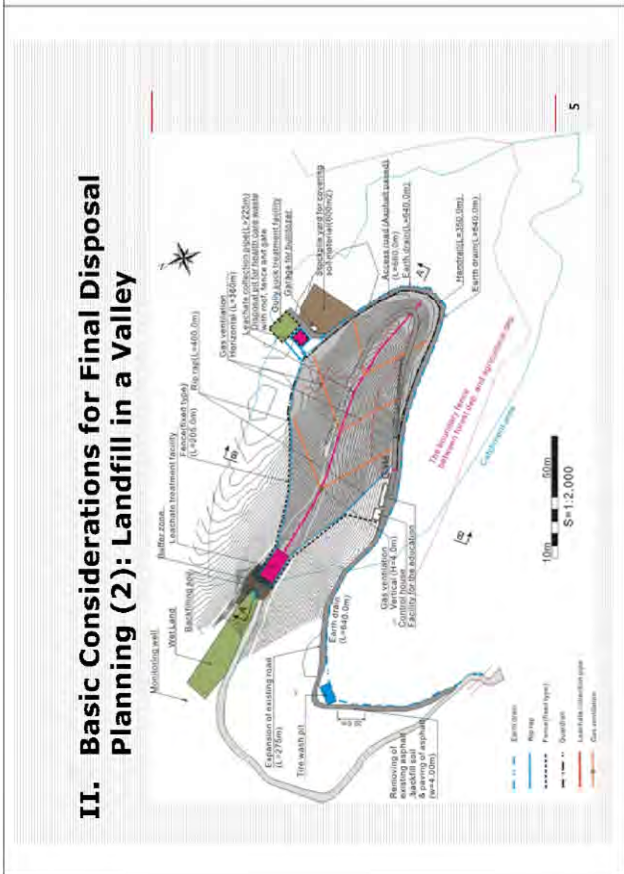
- Where land is available, sanitary landfill is usually the most economical solid waste disposal method.
- Sanitary landfill is not investment intensive compared with other disposal methods, i.e., composting and incineration.
- In contrast to incineration and composting, sanitary landfill does not require additional treatment or disposal operations for residue, etc.
- A sanitary landfill can receive all types of solid wastes, eliminating the necessity for separate collections.
- A sanitary landfill is manageable; increased quantities of solid wastes can be disposed of with a minimum number of personnel and equipment.
- Submerged land may be reclaimed for use as parking lots, playgrounds, golf courses, botanical gardens, etc.

3

II. Basic Considerations for Final Disposal Planning (1)

- **Location:** The following locations requires stricter environmental protection measure:
  1. Close to habited area: Buffer zone, etc.
  2. Water use in down stream: Leachate Protection of ground/surface water from leachate contamination
- **Topography:** The enclosing facilities differ from flat land, valley and hole/ depression.
- **Size of Site:** Area should be enough for at least ten years landfill operation.

4


II. Basic Considerations for Final Disposal Planning (2): Landfill in a Valley
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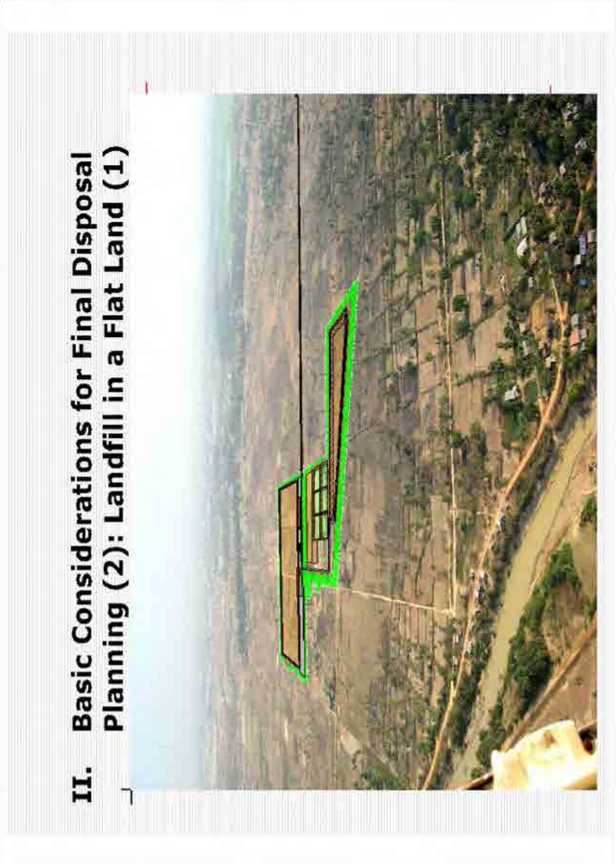
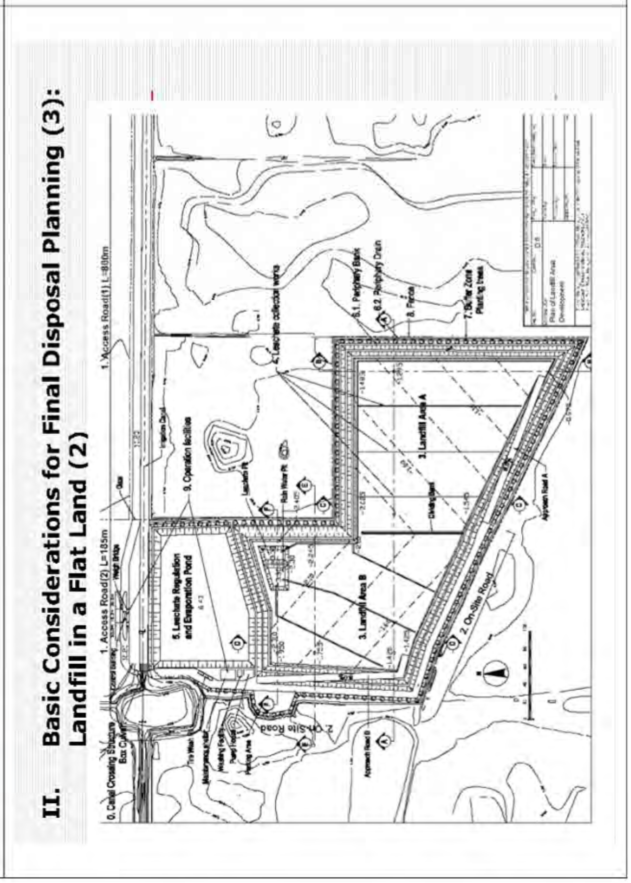
5


II. Basic Considerations for Final Disposal Planning (2): Landfill in a Flat Land (1)


II. Basic Considerations for Final Disposal Planning (3): Landfill in a Flat Land (2)


II. Basic Considerations for Final Disposal Planning (4): Landfill in a Flat Land (3)
8

II. Basic Considerations for Final Disposal Planning (5): Landfill in a Flat Land (4)

9

II. Basic Considerations for Final Disposal Planning (6): Landfill in a Hole of Soil/ Gravel Mining (1)

Landowner (a construction company) excavated the land for use of soil/ gravel for construction. After the excavation the owner started to receive MSW for filling excavated land.

10

II. Basic Considerations for Final Disposal Planning (7): Landfill in a Hole of Soil/ Gravel Mining (2)

III. Calculation of Required Landfill Volume

- Landfill volume (YRLVxx) calculation Formula:

YRLVxx = ((YFDxx/UWWL) * (1 + CSR))

YRLVxx: Yearly Required Lanfill Volume in 20xx (m^3/year)

YFDxx: Yearly Final Disposal Amount in 20xx (ton/year)

UWWL: Unit Weight of MSW at the Landfill (ton/m^3)

CSR: Cover Soil Rate to Landfilled Waste

- Calculate ARLV by using Doc 18-1.

ARLV: Accumulated Required Landfill Volume (m^3)

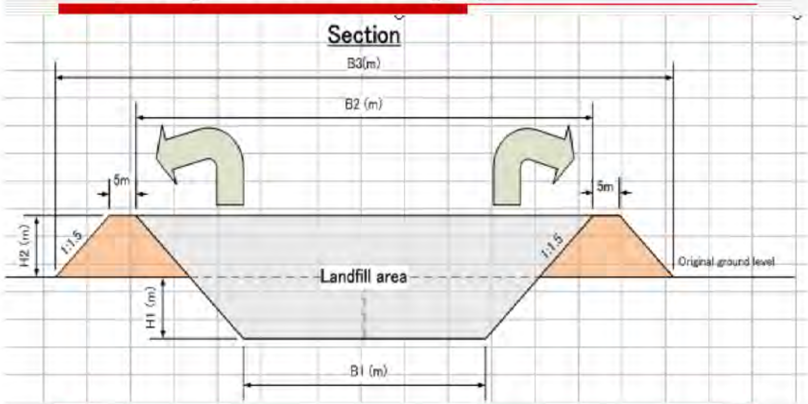
2

IV. Planning of a Final Disposal Site (1)

- Plan a disposal site of your city
- A sample design sheet for a Flat Area Landfill is provided in the Doc 18-2.

13

IV. Planning of a Final Disposal Site (2)



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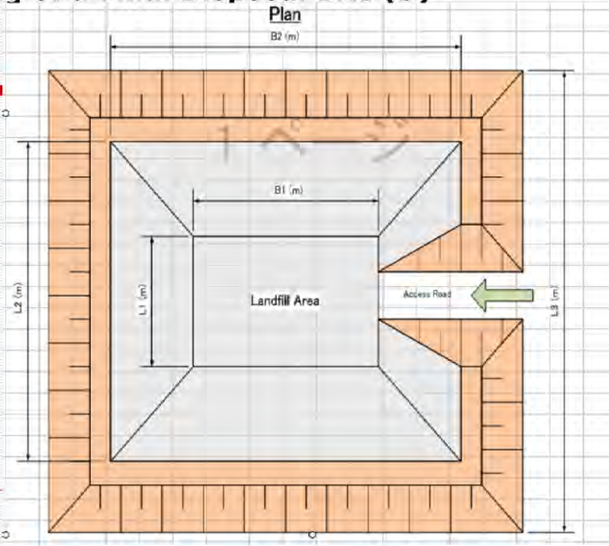
IV. Planning of a Final Disposal Site (3)



IV. Planning of a Final Disposal Site (4)

B. Calculation
B1 Landfill volume calculation

To calculate landfill site volume to match with accumulated required landfill volume (ARLV)
Step 1: Input required landfill volume
Step 2: Input approximate land area (Width and length)

					Formula
1	Required landfill volume	Vlr=	30,000	m^3	
2	Planed bottom width 1	B1=	50.0	m	
3	Planed bottom width 2	L1=	30.0	m	
4	Calculated bottom area	A1=	1,500	m^2	A1=B1xL1

Step 5: Input estimated height of landfill site

5	Proposed Height	H1+H2=	10.0	m	
6	Calculated top width 1	B2=	80.0	m	B2=B1+5x2+1.5x(H1+H2)x2
7	Calculated top width 2	L2=	60.0	m	L2=L1+5x2+1.5x(H1+H2)x2
8	Calculated top area	A2=	4,800	m^2	A2=B2xL2
9	Calculated landfill volume	Vlc=	31,500	m^3	Vlc=(A1+A2)/2x(H1+H2)
			OK		Vlr is biger than Vlc => OK If Vlr is smaller than Vlc => back to step 2

IV. Planning of a Final Disposal Site (5)

B2 Soil balance calculation

To calculate soil balance between excavation and embankment filling
Step 10: Input excavate height

10	Proposed excavate height	H1=	5.90	m	
11	Calculated embankment height	H2=	4.10	m	
12	Proposed excavate soil volume	Ves=	13,951	m^3	Ves=(A1+(B1+1.5xH1x2)x(L1+1.5xH1x2))/2xH1
13	Required embankment soil volur	Vev=	13,715	m^3	Vev=(5+5+H2x1.5x2)/2xH2x(B2+5+L2+5)x2

OK

Surplus 237 m^3

Ves−Vev=0~500 m3 => OK
Ves−Vev>501 m3 => surplus
Ves−Vev<0 m3 => Not enough

Dimension of landfill site

Required width	**B=**	**102.3**	**m**
Required length	**L=**	**82.3**	**m**
Required area	**A=**	**8,419.3**	**m^2**
Receivable volume	**Vlc=**	**31,500**	**m^3**
Bottom width 1	B1=	50.0	m
Bottom width 2	L1=	30.0	m
Top width 1	B2=	80.0	m
Top width 2	L2=	60.0	m
Excavate depth	H1=	5.9	m
Embankment height	H2=	4.1	m

17

V. Operational Planning (1)

- **Proper location** to avoid serious impacts to environment; i.e. distance from airport, not in the catchment area of drinking water source, etc.
- **Waste should be disposed at designated place.** => See UCDS in 2004 and MDDS in 2006
- **Secure the accessibility for collection vehicle.**
- **Incoming vehicles should be controlled to avoid hazardous waste disposal.**
- **To avoid adverse impacts to the surrounding; i.e. not to cause fire, water contamination, odor, etc. => Secure soil for cover, etc.**
- **Proper use of Landfill Equipment may be instructed by CMPUA operator in NEDS.**

18

V. Operational Planning (1)

UCDS in 2004

MDDS in 2006

Thank you very much for your attention

20

d.13 Document 13: Workshop (4): Recycling system planning for SWM M/P for each city

Doc 13

Recycling System Planning for SWM M/P

for Formulation and Implementation of SWM Master Plan for Central Provincial Cities based on the Experience in UBC

June 30, 2011
JICA Expert Team
For the Project for Strengthening the Capacity for SWM in Ulaanbaatar City

1

Outline of the Lecture

I. Basic Considerations for Recycling System Planning
II. Planning of a Recycling System
III. Completion of Future Waste Stream considering M/P which promotes 3Rs (Reduce, Reuse and Recycle)

2

I. Basic Considerations for Recycling System Planning (1)

- Recycling including reuse of waste is broadly divided into the following two in terms of place where it will be done;
  1. Recycling on-site (generation sources)
  2. Recycling off-site (after discharge of wastes)
- MSW includes many different materials and mixture of materials makes recycling difficult.
- Recycling on-site, therefore, is more preferable than off-site.

3

I. Basic Considerations for Recycling System Planning (2)

- Recycling off-site is broadly divided into the following two in terms of activities;
  1. Valuables waste picking by waste pickers, etc.
  2. Recycling at intermediate treatment facility such as a sorting, composting, RDF production plants.
- In Mongolia almost all of recycling activities are item 1.
- The item 2 is only being conducted in MUB, a pilot scale sorting plant and a RDF plant will be constructed this year.

4

I. Basic Considerations for Recycling System Planning (3)

- Problems of item 1 are;

1. Only a few final users of valuable waste are in MUB. In terms of country scale, i.e. population, final user is limited.
2. Most of final users of valuables are in China. => Recyclable items is very limited due to transportation costs.
3. Price of valuable waste fluctuates international market price. => Valuables are not constant.
4. Waste picking activities in a disposal site makes sanitary landfill operation difficult.

5

I. Basic Considerations for Recycling System Planning (4)

- Problems of item 2 are;

1. As far as we, JICA expert team, know, there is no facility operating without a tipping fee, i.e. not profitable.
2. For operation of a MSW recycling facility it requires a certain subsidies or tipping fee for the sake of landfill volume reduction. But if disposal system is open dumping, landfill volume reduction makes no contribution to landfill operation cost.
3. For proper operation of the intermediate facility, it requires separate collection for the waste to be treated. => It requires an additional cost for collection system.

6

II. Planning of a Recycling System(1)

- Recycling off-site is not recommended in your city due to some investment operational cost increase.
- Even if you prefer to treat and recycle plastics and paper wastes (which are problems for landfill operation, etc.), at least you have to know about the results of RDF plant operation in MUB.
- Recycling on-site is recommended but target wastes are limited.
- For valuable wastes recycling, you may inform people the price of them depends on the cleanliness and purity.
- On-site composting depends on the use of by-product such as gardening, farming, etc.

7

II. Planning of a Recycling System(2) On-site Composting Equipment in Sri Lanka

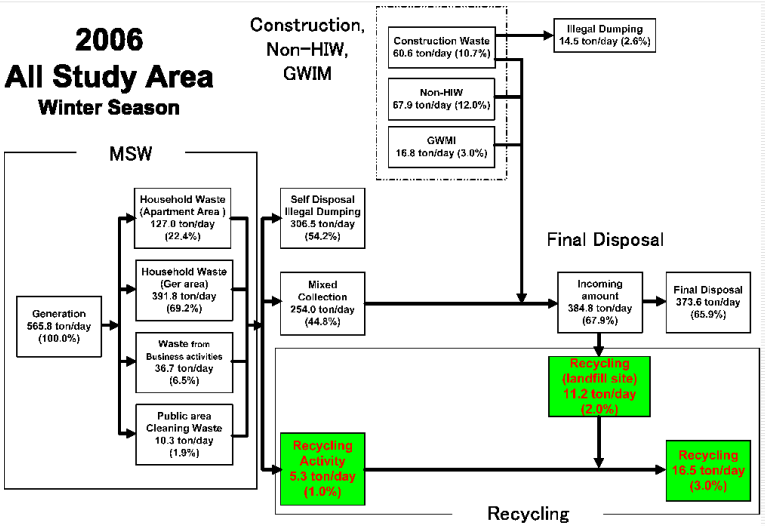
III. Completion of Future Waste Stream considering M/P which promotes 3Rs (Reduce, Reuse and Recycle) (1)

- For your reference waste streams of MUB in 2006 and 2009 is compared. The main findings are presented as follows:

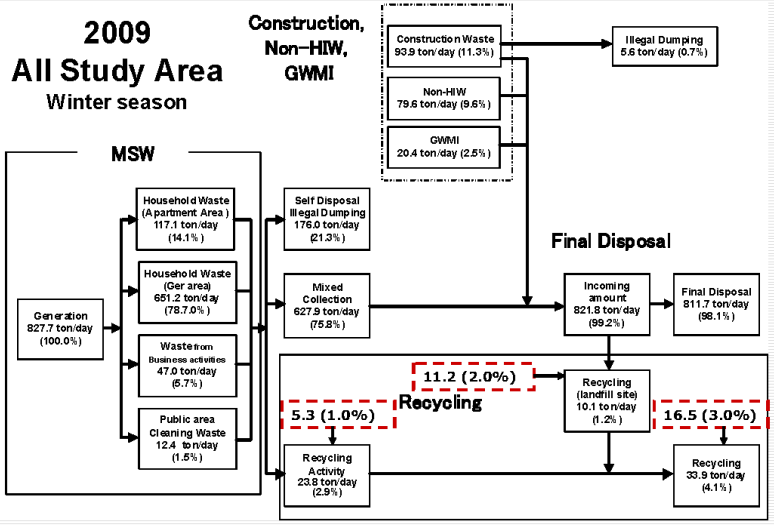
1. Both in winter and summer total recycling amount/ rate in MUB increases, i.e. 2.1 and 1.5 times in amount 1.37 and 1.15 times in rate.
2. Both in winter and summer valuable wastes recycling on-site (generation) increases significantly, i.e. 4.5 and 3.1 times in amount. => Due to public education?
3. However, valuable wastes recycling at disposal site decreases. => Active on-site recycling and Sanitary landfill operation?

9

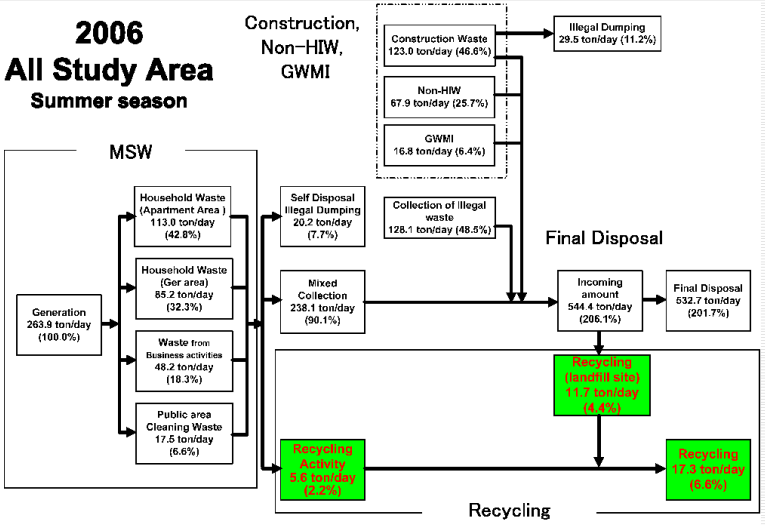
III. Completion of Future Waste Stream (2): Waste Stream of MUB in winter in 2006



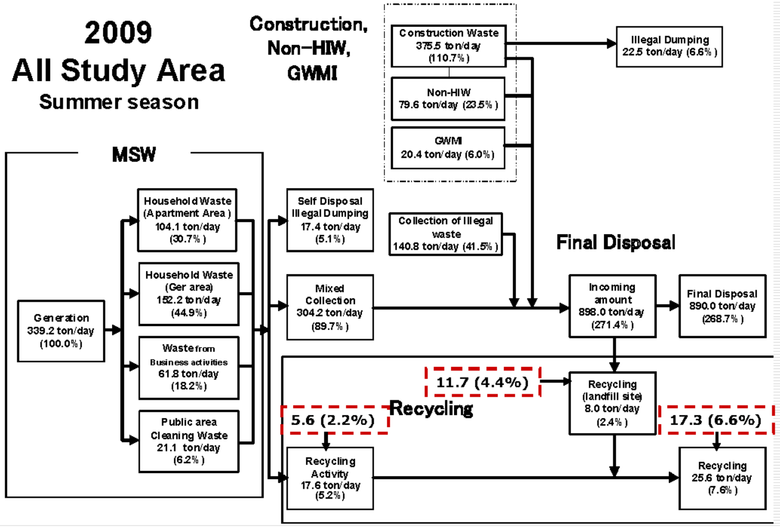
III. Completion of Future Waste Stream (3): Waste Stream of MUB in winter in 2009



III. Completion of Future Waste Stream (4): Waste Stream of MUB in summer in 2006



III. Completion of Future Waste Stream (5): Waste Stream of MUB in summer in 2009



Thank you very much for your attention

14

d.14　Document 14: Workshop (5): Formulation of concept of SWM M/P for each city and an action plan (A/P) for formulation of the M/P

Doc 14

Formulation of Concept of SWM M/P and Action Plan (A/P) for Formulation of the M/P for Formulation and Implementation of SWM Master Plan for Central Provincial Cities based on the Experience in UBC

June 30, 2011
JICA Expert Team
For the Project for Strengthening the Capacity for SWM in Ulaanbaatar City

1

Outline of the Lecture

I. Contents of SMM M/P Concept
II. Contents of A/P for Formulation of M/P

2

I. Contents of SMM M/P Concept

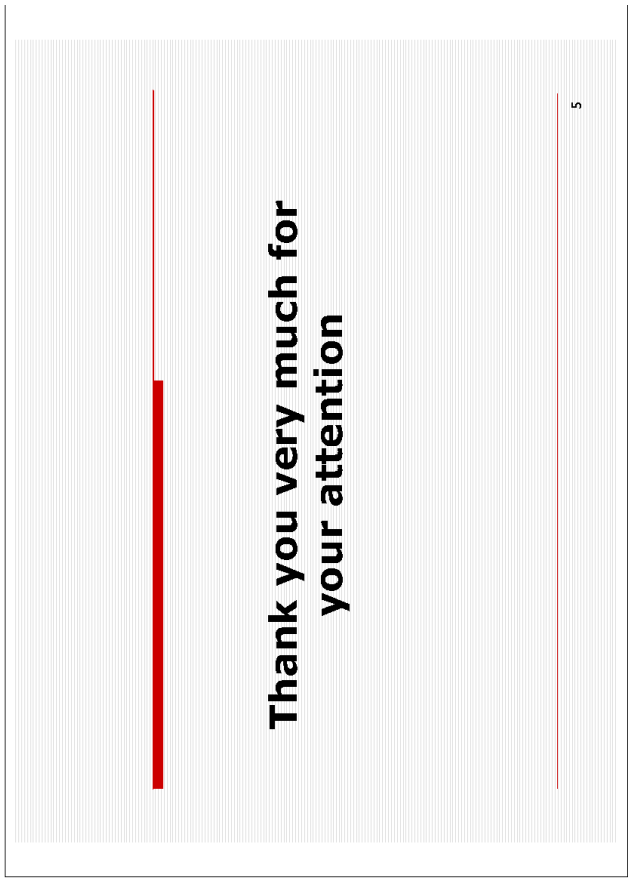
- SMM M/P Concept shall includes the following information:
1. Current SWM in the City
2. Current issues on SWM
3. Framework for SWM M/P
4. Concept of future technical system (collection, recycling and final disposal)
5. Concept of institutional requirements (financial sources, organization, regulation, etc.) for improvement of technical system.

3

II. Contents of A/P for Formulation of M/P

- The A/P shall includes the following information base on the SMM M/P Concept :
1. Who will complete the M/P?
2. How to complete the M/P?
3. Schedule for formulation and implementation of the M/P.
4. Input and supports for completion of the M/P

4


Thank you very much for
your attention
5

d.15 Document 15: Presentation of the concept of SWM M/P and the A/P for formulation of the M/P by 10 cities

Doc 15

Presentation of the Concept of SWM M/P and the A/P for Formulation of the M/P for Formulation and Implementation of SWM Master Plan for Central Provincial Cities based on the Experience in UBC

June 30, 2011
JICA Expert Team
For the Project for Strengthening the Capacity for SWM in Ulaanbaatar City

1

Outline of the Lecture

- Describe the following aspects by using Power Point File:

I. Concept of SMM M/P
II. A/P for Formulation of M/P

2

I. Framework for SWM M/P

1. Current issues on SWM
2. Framework for SWM M/P
3. Concept of future technical system (collection, recycling and final disposal)
4. Concept of institutional requirements (financial sources, organization, regulation, etc.) for improvement of technical system.

3

I-1. Current issues on SWM

- Technical system issues: for example

1. Insufficient collection service => There are many non-collection area
2. Open dumping makes serious adverse impacts on surrounding environment
3. Others

- Institutional system issues:

1. Insufficient collection service fee collection in Ger area
2. Lack of human resources
3. Others

4

I-2. Framework for SWM M/P

- Framework for SWM M/P : for example

1. Proposed future final disposal site: Name, location, area, etc.
2. Population forecast
3. Economic growth rate applied to the M/P
4. Future waste amount forecast
5. Future waste stream without M/P

5

I-3. Concept of future technical system

- Concept of proposed technical system : for example

1. Proposed collection system: Collection amount by Household waste from apartment area and Ger area and other generation sources, types and number of collection vehicles, etc.
2. Proposed recycling system: Improvement of on-site recycling by public education, etc.
3. Proposed final disposal system: Required landfill volume, sanitary landfill, etc.

6

I-4. Concept of institutional requirements for improvement of technical system

- Concept of institutional system improvement: for example

1. Strengthening organization
2. Improvement of fee and financial management system
3. Requirement of supporting regulations
4. Public education

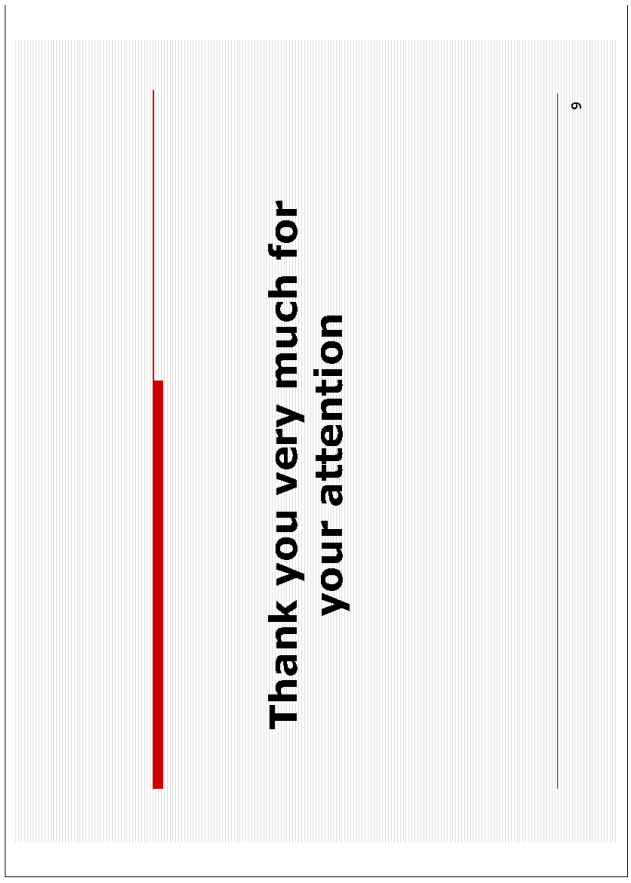
7

II. A/P for Formulation of M/P

- A/P for Formulation of M/P :

1. Responsible organization and personnel for formulation of M/P
2. Method of M/P Formulation
3. Schedule for formulation and implementation of the M/P.
4. Required input and supports for completion of the M/P

8


Thank you very much for
your attention
9

d.16 Document 16: Comparison table of candidate sites for future disposal site

Aspects	Candidate A		Candidate B		Candidate C	
1. Environmental Aspects						
1.1 Ground water use in downstream						
1.2 Surface water use in downstream						
1.3 Existence special fauna & flora						
1.4 Valuable landscape						
1.5 Landslide area						
1.6 Strong wind						
1.7 Others (specify)						
2. Social Aspects						
2.1 Area close to habited area						
2.2 Area close to cultural property						
2.3 Area close to public facilities						
2.4 Other administration						
2.5 Others (specify)						
3. Technical Aspects						
3.1 Site size						
3.2 Current landuse						
3.3 Future landuse						
3.4 Topography						
3.5 Geology						
3.6 Distance to city center						
3.7 Access road condition						
3.8 Availability of utility						
3.9 Others (specify)						
4. Economic Aspects						
4.1 Site development cost						
4.2 Operation cost						
4.3 Collection & transportation cost						
4.4 Others (specify)						

d.17 Document 17: Calculation sheet for population forecast and future waste generation

Doc 17-1

Calculation Sheet for Population Forecast and Future Waste Generation (1)

A. Population Porecast

A.1 P_GR (Population Growth Rate) Calculation

1. Year of Latest Population Data: A 2008
2. Population of Latest Data: B 15000
3. Year of Older Population Data: C 2003
4. Population of Older Data: D 12000
5. P_GR Caluculation Formula
   (Formula) P_GR + 1 = Y^(1/X)
   Y = B/D
   X = A − C

Year	Population
2008	15000
2003	12000
P_GR + 1	1.046

6. **P_GR** (Population Growth Rate) 0.046

A.2 Calculation of Future Population

1. Population in 2011: P11 17149
2. Population in 20xx: Pxx
   (Formula) Pxx = P11 * (P_GR + 1)^(20xx − 2011)
3. Apart Area Population Rate: APR 0.60
4. Ger Area Population Rate: GPR 0.40
5. Apartment Area Population in 20xx: Pxx_A
   (Formula) Pxx_A = Pxx * APR
6. Ger Area Population in 20xx: Pxx_G
   (Formula) Pxx_G = Pxx * GPR
7. Calculation of Future Population

Year	Pxx	Pxx_A	Pxx_G
2011	17149	10289	6860
2012	17932	10759	7173
2013	18750	11250	7500
2014	19606	11763	7842
2015	20501	12300	8200
2016	21436	12862	8574
2017	22415	13449	8966
2018	23438	14063	9375
2019	24507	14704	9803
2020	25626	15375	10250

Doc 17-2

Calculation Sheet for Population Forecast and Future Waste Generation (2)

B. Waste Amount Calculation

1. Household Waste Generation Amount in Apartment Area in 20xx: HWAAxx

(Formula 1) **HWAAxx = GR_HWAxx * Pxx_A**

GR_HWAxx: Household Waste Generation Rate in Apartment Area in 20xx

(Formula 2) **GR_HWAxx = GR_HWA11 * (1 + GR_GR)^(20xx – 2011)**

GR_HWA11: Household Waste Generation Rate in Apartment Area in 2011

=> Apply UBC Data => GR_HWA11 = (297 + 264)/2 = **280g/person/day**

GR_GR: Household Waste Generation Rate Growth per Year

(Formula 3) **GR_GRxx** = 0.55 * GDPav (= 0.0623) = 0.034265 => Say **0.035**

Consequently, Formula 2 simplify as follow:

(Formula 2) **GR_HWAxx = 280 * (1 + 0.035)^(20xx – 2011)**

2. Household Waste Generation Amount in Ger Area in 20xx: HWGAxx

(Formula 4) **HWGAxx = GR_HWGxx * Pxx_G**

GR_HWGxx: Household Waste Generation Rate in Ger Area in 20xx

Ger Area Waste is divided into two categories of wastes, i.e. Ash and Other Waste

Ash generation rate is not changed, The rate of UBC (788g/person/day) be applied to.

Generation rate of Other waste will increase the same as HWAA..

(Formula 5) GR_HWGxx = GR_HWGa11 + GR_HWGo11 * (1 + GR_GR)^(20xx – 2011)

GR_HWGa11: Ash Generation Rate in Ger Area in 2011, i.e. **788g/person/day.**

GR_HWGoxx: Other Waste than Ash Generation Rate in Ger Area in 2011

=> Apply UBC Data => GR_HWGo11 = (188 + 234)/2 = **211g/person/day**

Consequently, Fomula 5 simplify as follow:

(Formula 5) **GR_HWGxx = (788/2) + 211 * (1 + 0.035)^(20xx – 2011)**

3. Other Waste Amount in 20xx: OWAxx

Other MSW waste include wastes from business establishments and public area cleaning.

But it exclude wastes from construction, factory and medical institution.

(Formula 6) **OWAxx = (HWAAxx + HWGAxx) * 0.157** (Figure from MUB Study)

Year	Pxx	Pxx_A	Pxx_G	HWAAxx (kg/day)	HWGAxx (kg/day)	OWAxx (kg/day)	MSWxx (ton/day)
2011	17149	10289	6860	2881	4150	1104	8.1
2012	17932	10759	7173	3118	4392	1179	8.7
2013	18750	11250	7500	3374	4650	1260	9.3
2014	19606	11763	7842	3652	4924	1346	9.9
2015	20501	12300	8200	3952	5216	1439	10.6
2016	21436	12862	8574	4277	5527	1539	11.3
2017	22415	13449	8966	4629	5858	1646	12.1
2018	23438	14063	9375	5010	6210	1762	13.0
2019	24507	14704	9803	5422	6586	1885	13.9
2020	25626	15375	10250	5867	6986	2018	14.9

Doc 17-3

Calculation Sheet for Population Forecast and Future Waste Generation (2)

C. Waste Stream

1. Calculation of Self Disposal & Illegal Dumping Waste: SDID_Axx

(Formula 1) SDID_Axx = (Non-Ca * HWAAxx) + (Non-Cg * HWGAxx) + 0.157 * ((Non-Ca * HWAAxx) + (Non-Cg * HWGAxx))

Non-Ca: Non-collection Population Rate of Apartment Area

Non-Cg: Non-collection Population Rate of Ger Area

Put the Non-Ca and Non-Cg

Non-Ca: 0.05

Non-Cg: 0.5

2. Calculation of Recycling Amount: REAxx

(Formula 2) REAxx = RR * MSWxx

REAxx: Recycling Amount in 20xx

RR: Recycling Rate; Apply the figure obtained in MUB study

RR: 0.03

3. Calculation of Collection and Final Disposal Amount: CFDxx

(Formula 3) CFDxx = MSWxx - (SDID_Axx + REAxx)

Year	Pxx	Pxx_A	Pxx_G	HWAAxx (kg/day)	HWGAxx (kg/day)	OWAxx (kg/day)	MSWxx (ton/day)	SDID_Axx (ton/day)	REAxx (ton/day)	CFDAxx (ton/day)
2011	17149	10289	6860	2881	4150	1104	8.1	2.6	0.2	5.3
2012	17932	10759	7173	3118	4392	1179	8.7	2.7	0.3	5.7
2013	18750	11250	7500	3374	4650	1260	9.3	2.9	0.3	6.1
2014	19606	11763	7842	3652	4924	1346	9.9	3.1	0.3	6.6
2015	20501	12300	8200	3952	5216	1439	10.6	3.2	0.3	7.0
2016	21436	12862	8574	4277	5527	1539	11.3	3.4	0.3	7.6
2017	22415	13449	8966	4629	5858	1646	12.1	3.7	0.4	8.1
2018	23438	14063	9375	5010	6210	1762	13.0	3.9	0.4	8.7
2019	24507	14704	9803	5422	6586	1885	13.9	4.1	0.4	9.4
2020	25626	15375	10250	5867	6986	2018	14.9	4.4	0.4	10.0

d.18 Document 18-1: Calculation Sheet for Required Landfill Volume

Doc 18-1

Calculation Sheet for Required Landfill Volume

Formula

YRLVxx = ((YFDxx/UWWL) * (1 + CSR))

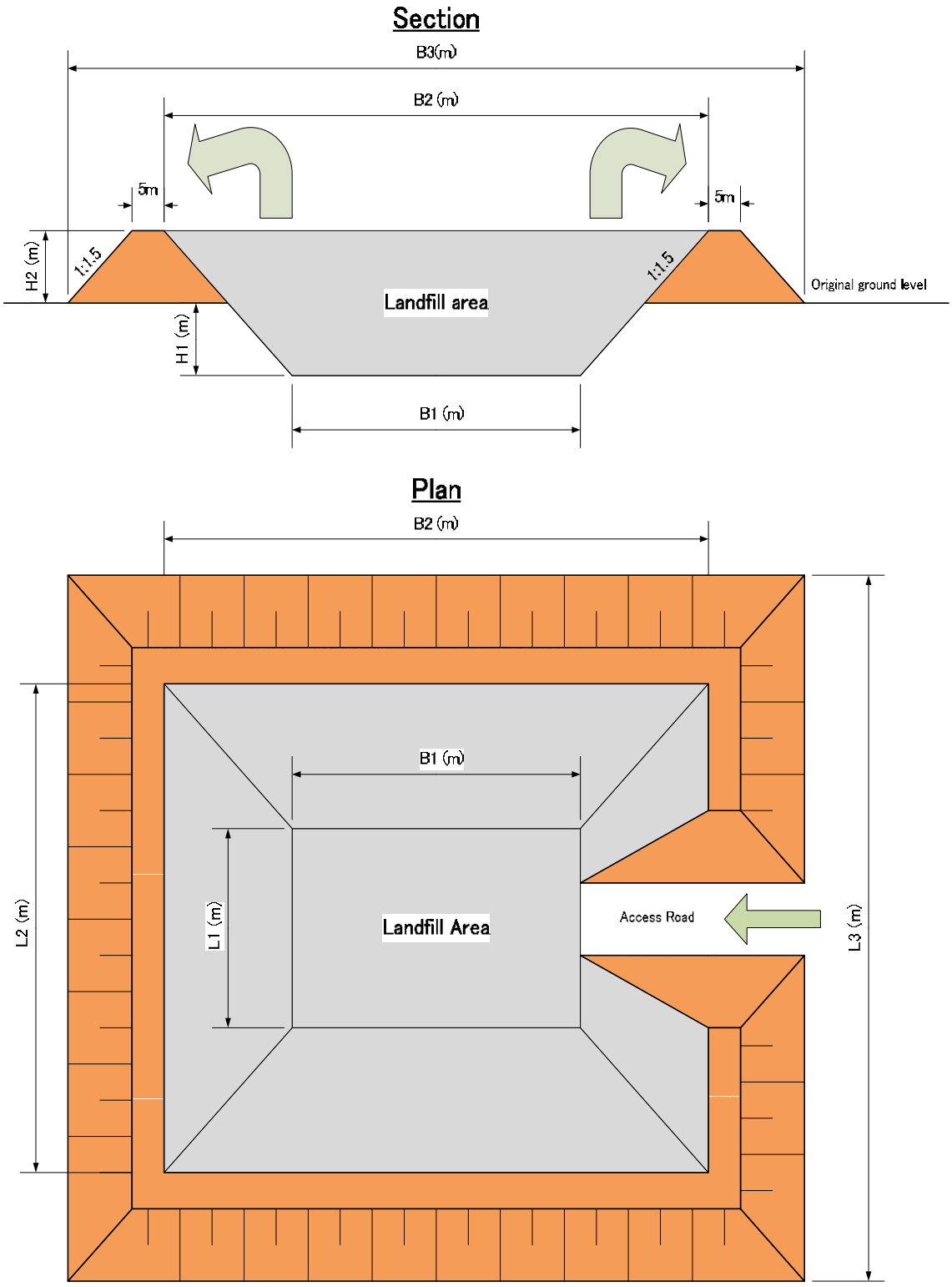
YRLVxx: Yearly Required Lanfill Volume in 20xx (m3/year)
CFDxx: Collection and Final Disposal Amount in 20xx (ton/day)
YFDxx: Yearly Final Disposal Amount in 20xx (ton/year)
UWWL: Unit Weight of MSW at the Landfill (ton/m3) 1.1
CSR: Cover Soil Rate to Landfilled Waste 0.2
ARLV: Accumulated Required Landfill Volume (m3)

Year	CFDAxx (ton/day)	YFDxx (ton/year)	YRLVxx (m3/year)	ARLV (m3)
2011	5.3	1943.1	2119.7	2119.7
2012	5.7	2083.2	2272.6	4392.3
2013	6.1	2234.0	2437.1	6829.4
2014	6.6	2396.2	2614.1	9443.5
2015	7.0	2570.9	2804.6	12248.0
2016	7.6	2758.8	3009.6	15257.7
2017	8.1	2961.2	3230.3	18488.0
2018	8.7	3179.0	3468.0	21956.0
2019	9.4	3413.6	3723.9	25680.0
2020	10.0	3666.3	3999.6	29679.5

d.19 Document 18-2: Calculation Sheet for Disposal Site Volume

Doc 18-2 Calculation Sheet for Disposal Site Volume

A. Plan drawing



B. Calculation

B1 Landfill volume calculation

To calculate landfill site volume to match with accumulated required landfill volume (ARLV)
Step 1: Accumulated required landfill volume (ARLV)
Step 2: Input approximate land area (Width and length)

					Formula
1	Required landfill volume	Vlr=	30,000	m^3	
2	Planed bottom length	B1=	50.0	m	
3	Planed bottom width	L1=	30.0	m	
4	Calculated bottom area	A1=	1,500	m^2	A1=B1xL1

Step 5: Input estimated height of landfill site

5	Proposed Height	H1+H2=	10.0	m	
6	Calculated top length	B2=	80.0	m	B2=B1+5x2+1.5x(H1+H2)x2
7	Calculated top width	L2=	60.0	m	L2=L1+5x2+1.5x(H1+H2)x2
8	Calculated top area	A2=	4,800	m^2	A2=B2xL2
9	Calculated landfill volume	Vlc=	31,500	m^3	Vlc=(A1+A2)/2x(H1+H2)
			OK		Vlr is biger than Vlc => OK If Vlr is smaller than Vlc => back to step 2

B2 Soil balance calculation

To calculate soil balance between excavation and embankment filling
Step 10: Input excavate height

10	Proposed excavate height	H1=	5.90	m	
11	Calculated embankment height	H2=	4.10	m	
12	Proposed excavate soil volume	Ves=	13,951	m^3	Ves=(A1+(B1+1.5xH1x2) x(L1+1.5xH1x2))/2xH1
13	Required embankment soil volum	Vev=	13,715	m^3	Vev=(5+5+H2x1.5x2)/2xH2 x(B2+5+L2+5)x2
			OK		Ves-Vev=0~500 m3 => OK
		Surplus	237	m^3	Ves-Vev>501 m3 => surplus Ves-Vev<0 m3 => Not enough

Dimension of landfill site

Required width	**B=**	**102.3**	**m**
Required length	**L=**	**82.3**	**m**
Required area	**A=**	**8,419.3**	**m^2**
Receivable volume	**Vlc=**	**31,500**	**m^3**
Bottom length	B1=	50.0	m
Bottom width	L1=	30.0	m
Top length	B2=	80.0	m
Top width	L2=	60.0	m
Excavate depth	H1=	5.9	m
Embankment height	H2=	4.1	m

d.20 Document 19: Calculation Sheet for Collection System Planning

Productivity

Compactor truck

	Description	Unit	Compactor 15 m3			Compactor 8 m3			
A	Capacity in weight	t	10.00	10.00	10.00	6.00	6.00	6.00	6.00
B	Capacity in volume	m3	15.00	15.00	15.00	8.00	8.00	8.00	8.00
C	Half way distance	km	*0.50*	*18.80*	*15.00*	*7.40*	*16.60*	*35.00*	*15.00*
D=C*2	One trip distance	km	1.00	37.60	30.00	14.80	33.20	70.00	30.00
E	Velocity of vehicle	km/h	35.00	35.00	35.00	35.00	35.00	35.00	35.00
F	Spesific gravity of waste	t/m3	0.20	0.20	0.20	0.20	0.20	0.20	0.20
G	Density of waste when hauled	t/m3	0.45	0.45	0.45	0.45	0.45	0.45	0.45
H	t1:Working hour	h	7.50	7.50	7.50	7.50	7.50	7.50	7.50
I	t2:Daily service time	min	30.00	30.00	30.00	30.00	30.00	30.00	30.00
J	t3:Loading time per trip	min	120.00	120.00	120.00	64.00	64.00	64.00	64.00
K	t4:Unloading time	min	5.00	5.00	5.00	5.00	5.00	5.00	5.00
L	E: Efficiency of loading capacity	−	0.90	0.90	0.90	0.90	0.90	0.90	0.90
M	f: Efficiency of working time	−	0.90	0.90	0.90	0.90	0.90	0.90	0.90
N	Nos of trips per day	times	2.98	2.00	2.14	4.01	3.00	2.00	3.14
O	Adjusted Nos of trips per day	times	*3.00*	*2.00*	*2.00*	*4.00*	*3.00*	*2.00*	*3.00*
P=BxOxL	Waste carried per trip	t/trip	6.08	6.08	6.08	3.24	3.24	3.24	3.24
Q=PxO	Waste carried per day	t/d	18.23	12.15	12.15	12.96	9.72	6.48	9.72

Dump Truck

A	Description	Unit	Dump truck				Skipper
B	Capacity in weight	t	6.00	6.00	6.00	6.00	6.00
C	Capacity in volume	m3	10.00	10.00	10.00	10.00	5.50
D=C*2	Half way distance	km	*0.40*	*18.50*	*74.00*	*10.00*	*15.00*
E	One trip distance	km	0.80	37.00	148.00	20.00	30.00
F	Velocity of vehicle	km/h	35.00	35.00	35.00	35.00	35.00
G	Spesific gravity of waste	t/m3	0.30	0.30	0.30	0.30	0.30
H	Density of waste when hauled	t/m3	0.30	0.30	0.30	0.30	0.30
I	t1:Working hour	h	7.50	7.50	7.50	7.50	7.50
J	t2:Daily service time	min	30.00	30.00	30.00	30.00	30.00
K	t3:Loading time per trip	min	120.00	120.00	120.00	120.00	5.00
L	t4:Unloading time	min	5.00	5.00	5.00	5.00	5.00
M	E: Efficiency of loading capacity	−	0.90	0.90	0.90	0.90	0.90
N	f: Efficiency of working time	−	0.90	0.90	0.90	0.90	0.90
O	Nos of trips per day	times	2.99	2.01	1.00	2.37	6.15
P=BxOxL	Adjusted Nos of trips per day	times	*3.00*	*2.00*	*1.00*	*2.00*	*6.00*
Q=PxO	Waste carried per trip	t/trip	2.70	2.70	2.70	2.70	1.49
	Waste carried per day	t/d	8.10	5.40	2.70	5.40	8.91

N=(60 x H − I) x M / (D / E x 60 +J + K)

Equipment cost

Exchange rate
1$ 1300 Tg

	Basic price	Basic price	Life year	Salvaged value	Depriciation	Depriciation	Maintenance cost rate	Mantenance cost	Mantenance cost
	USD	Tg	years	Tg	Tg/year	Tg/day	%	Tg/year	Tg/day
Compactor truck 15m3, 10to	95,000	123,500,000	8	12,350,000	13,893,750	38,065	6%	7,410,000	23,685
Compactor truck 8m3, 6ton	80,000	104,000,000	8	10,400,000	11,700,000	32,055	6%	6,240,000	19,945
Dump truck 10m3, 6ton	65,000	84,500,000	8	8,450,000	9,506,250	26,045	6%	5,070,000	16,205
Skipper truck 5m3		0	8	0	0		6%	0	0
Wheel loader	130,000	169,000,000	12	16,900,000	12,675,000	34,726	6%	10,140,000	32,411
Wheel backhoe	100,000	130,000,000	12	13,000,000	9,750,000	26,712	6%	7,800,000	24,932

Salary & Fuel cost

Salary

	Nos of persons	Salary	Salary	Salary	Salary
	persons	Tg/person/month	Tg/month	Tg/day	Tg/year
Driver	1	200,000	200,000	6,667	2,400,000
Collection worker	2	150,000	300,000	10,000	3,600,000
Total				16,667	6,000,000

Note: The above condition is applied to all types of collection equipment used.

Fuel

	Unit	Rate
Diesel	Tg/l	1400
Gasoline	Tg/l	1300

O&M Cost

		Items	Unit	Compactor 15m3	Compactor 8m3	Dump truck
A	T&M Survey	Distance to Disposal Site	km	15.0	15.0	10.0
B	Catalogue	Diesel consumption per km for travelling	km/l	2	5	3
C	T&M Survey	Collection and discharge time	minutes	125	69	125
D	T&M Survey	Effeciency for working hours		0.9	0.9	0.9
E	Catalogue	Diesel consumption per minutes for collection	min/l	15	30	30
F	A*2/B	Diesel consumption for traveling	liter/trip	15	6	6.7
G	C*D/E	Diesel consumption for collection	liter/trip	7.5	2.07	3.75
H	F+G	Total consumption of diesel	liter/trip	22.5	8.07	10.4
I	Fuel Tab	Unit rate of diesel	Tg/liter	1400	1400	1300
J	H*I	Fuel cost per trip	Tg/trip	31,500	11,298	13,542
K	Productivity tab	Trip nos per day	Trip/day	2	3	2
L	J*K	Fuel cost per day	Tg/day	63,000	33,894	27,083
		Depreciation cost	Tg/day	38,065	32,055	26,045
		Maintenance cost	Tg/day	23,685	19,945	16,205
		Salary	Tg/day	16,667	16,667	16,667
		O&M cost per day	Tg/day	141,417	102,561	86,000
		Unit cost per ton of waste	Tg/ton	11,630	10,552	15,926

Collection Truck

1Waste Collection Amount per day

Type of area	Waste source	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Apartment	Apartment	t/day										
	Business	t/day										
Ger	Ger	t/day										
	Total	t/day										

2. Waste Collection Amount per day by type of collection trucks

Type of Waste	Type of Truck	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Apartment	Compactor	t/day										
Business	Compactor	t/day										
	CT Total	t/day										
Ger	Dump truck	t/day										
	DT Total	t/day										

3. Waste Collection Amount per day by type of trucks in case 1 day off in a week

	Type of Truck	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Compactor	t/day										
	Dump truck	t/day										
	Total	t/day										

4. Selection of Capacity of Compactor

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	%	80%									
Compactor	8m3	%	20%									
Dump truck	10m3	%	100%									

5. Waste Collection Amount by Type and Capacity of Trucks

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	t/day										
Compactor	8m3	t/day										
Dump truck	10m3	t/day										

6. Average Trip per day by type of trucks　　Refer to "Productivity" Tab

			Average trip no. per day			Average haulage amount per trip			Waste amount carried per day		
			trips/d	trips/d	trips/d	t/trip	t/trip	t/trip	t/v/d	t/v/d	t/v/d
	unit	Haulage distance	Compactor 15m3	Compactor 8m3	Dump truck	Compactor 15m3	Compactor 8m3	Dump truck	Compactor 15m3	Compactor 8m3	Dump truck
Apartment Area	km					6.08	3.24	2.70	0.0	0.0	0.0
Ger Area	km					6.08	3.24	2.70	0.0	0.0	0.0

7. Number of Trucks Required

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Nos										
Compactor	8m3	Nos										
Dump truck	10m3	Nos										

8 Roundup number of trucks required

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Nos										
Compactor	8m3	Nos										
Dump truck	10m3	Nos										
	Total	Nos										

9. Number of trucks to be Procured in each year

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Nos										
Compactor	8m3	Nos										
Dump truck	10m3	Nos										
	Total	Nos										

10. Investment Amount in each year　refer to "Equipment Cost" tab

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Tg										
Compactor	8m3	Tg										
Dump truck	10m3	Tg										
	Total	Tg										

11.Dayly Operation and Maintenance Costs in each year　refer to O&M tab

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Tg										
Compactor	8m3	Tg										
Dump truck	10m3	Tg										
	Total	Tg										

12. Annual Operation and Maintenance Costs in each year.

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Tg										
Compactor	8m3	Tg										
Dump truck	10m3	Tg										
	Total	Tg										

Sample Calculation

1Waste Collection Amount per day

Type of area	Waste source	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Apartment	Apartment	t/day	12.0	12.6	13.2	13.9	14.6	15.3	16.1	16.9	17.7	18.6
	Business	t/day	6.0	6.3	6.6	6.9	7.3	7.7	8.0	8.4	8.9	9.3
Ger	Ger	t/day	30.0	31.5	33.1	34.7	36.5	38.3	40.2	42.2	44.3	46.5
	Total	t/day	48	50.4	52.9	55.6	58.3	61.3	64.3	67.5	70.9	74.5

2. Waste Collection Amount per day by type of collection trucks

Type of Waste	Type of Truck	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Apartment	Compactor	t/day	12.0	12.6	13.2	13.9	14.6	15.3	16.1	16.9	17.7	18.6
Business	Compactor	t/day	6.0	6.3	6.6	6.9	7.3	7.7	8.0	8.4	8.9	9.3
	CT Total	t/day	18.0	18.9	19.8	20.8	21.9	23.0	24.1	25.3	26.6	27.9
Ger	Dump truck	t/day	30.0	31.5	33.1	34.7	36.5	38.3	40.2	42.2	44.3	46.5
	DT Total	t/day	30.0	31.5	33.1	34.7	36.5	38.3	40.2	42.2	44.3	46.5

3. Waste Collection Amount per day by type of trucks in case 1 day off in a week

	Type of Truck	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Compactor	t/day	21.0	22.1	23.2	24.3	25.5	26.8	28.1	29.5	31.0	32.6
	Dump truck	t/day	35.0	36.8	38.6	40.5	42.5	44.7	46.9	49.2	51.7	54.3
	Total	t/day	56.0	58.8	61.7	64.8	68.1	71.5	75.0	78.8	82.7	86.9

4. Selection of Capacity of Compactor

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	%	80.0%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Compactor	8m3	%	20.0%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Dump truck	10m3	%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%

5. Waste Collection Amount by Type and Capacity of Trucks

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	t/day	16.8	17.6	18.5	19.4	20.4	21.4	22.5	23.6	24.8	26.1
Compactor	8m3	t/day	4.2	4.4	4.6	4.9	5.1	5.4	5.6	5.9	6.2	6.5
Dump truck	10m3	t/day	56.0	58.8	61.7	64.8	68.1	71.5	75.0	78.8	82.7	86.9

6. Average Trip per day by type of trucks　Refer to "Productivity" Tab

			Average trip no. per day			Average haulage amount per trip			Waste amount carried per day		
			trips/d	trips/d	trips/d	t/trip	t/trip	t/trip	t/v/d	t/v/d	t/v/d
	unit	Haulage distance	Compactor 15m3	Compactor 8m3	Dump truck	Compactor 15m3	Compactor 8m3	Dump truck	Compactor 15m3	Compactor 8m3	Dump truck
Apartment Area	km	15.0	2	3		6.08	3.24	2.70	12.2	9.7	0.0
Ger Area	km	10.0			2	6.08	3.24	2.70	0.0	0.0	5.4

7. Number of Trucks Required

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Nos	1.4	1.5	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.1
Compactor	8m3	Nos	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7
Dump truck	10m3	Nos	10.4	10.9	11.4	12.0	12.6	13.2	13.9	14.6	15.3	16.1

8 Roundup number of trucks required

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Nos	2	2	2	2	2	2	2	2	3	3
Compactor	8m3	Nos	1	1	1	1	1	1	1	1	1	1
Dump truck	10m3	Nos	11	11	12	13	13	14	14	15	16	17
	Total	Nos	14	14	15	16	16	17	17	18	20	21

9. Number of trucks to be Procured in each year

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Nos	2	0	0	0	0	0	0	0	1	0
Compactor	8m3	Nos	1	0	0	0	0	0	0	0	0	0
Dump truck	10m3	Nos	11	0	1	1	0	1	0	1	1	1
	Total	Nos	14	0	1	1	0	1	0	1	2	1

10. Investment Amount in each year refer to "Equipment Cost" tab

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	1000Tg	247,000	0	0	0	0	0	0	0	123,500	0
Compactor	8m3	1000Tg	104,000	0	0	0	0	0	0	0	0	0
Dump truck	10m3	1000Tg	929,500	0	84,500	84,500	0	84,500	0	84,500	84,500	84,500
	Total	1000Tg	1,280,500	0	84,500	84,500	0	84,500	0	84,500	208,000	84,500

11.Dayly Operation and Maintenance Costs in each year refer to "O&M Cost" tab

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	Tg	282,833	282,833	282,833	282,833	282,833	282,833	282,833	282,833	424,250	424,250
Compactor	8m3	Tg	102,561	102,561	102,561	102,561	102,561	102,561	102,561	102,561	102,561	102,561
Dump truck	10m3	Tg	1,128,167	1,128,167	1,230,728	1,333,289	1,333,289	1,435,849	1,435,849	1,538,410	1,640,971	1,743,531
	Total	Tg	1,513,561	1,513,561	1,616,122	1,718,683	1,718,683	1,821,243	1,821,243	1,923,804	2,167,781	2,270,342

12. Annual Operation and Maintenance Costs in each year.

Type of Truck	Capacity	unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compactor	15m3	1000Tg	103,234	103,234	103,234	103,234	103,234	103,234	103,234	103,234	154,851	154,851
Compactor	8m3	1000Tg	37,435	37,435	37,435	37,435	37,435	37,435	37,435	37,435	37,435	37,435
Dump truck	10m3	1000Tg	411,781	411,781	449,216	486,650	486,650	524,085	524,085	561,520	598,954	636,389
	Total	1000Tg	552,450	552,450	589,885	627,319	627,319	664,754	664,754	702,188	791,240	828,675