CHAPTER 5 FOLLOW-UP FOR SECONDARY TRANSPORTATION AND SISDOL SHORT-TERM LANDFILL OPERATION

5.1 Follow-up for Secondary Transportation to Sisdol Landfill

5.1.1 Result of the Follow-up Survey

(1) Change of Situation for Secondary Transportation to Sisdol Landfill during Phase IV

1) Before Full Operation of Sisdol S/T-LF

The waste used to only be dumped at Bagmati Dumping Site but after Sisdol S/T-LF started partial operation on June 5, 2005 the destinations of the waste were as shown in the following figure, until full operation of Sisdol S/T-LF was started in May 2006.

In addition to the waste collected and transported from KMC to Teku Transfer Station (T/S), "flow 1", MTM also currently transports the waste there, "flow 2". This is collected at its core area and along the Arniko Highway as a continuous activity of the pilot project, though the quantity is just 1.0 to 1.5 tons per day with one trip of a rental truck.

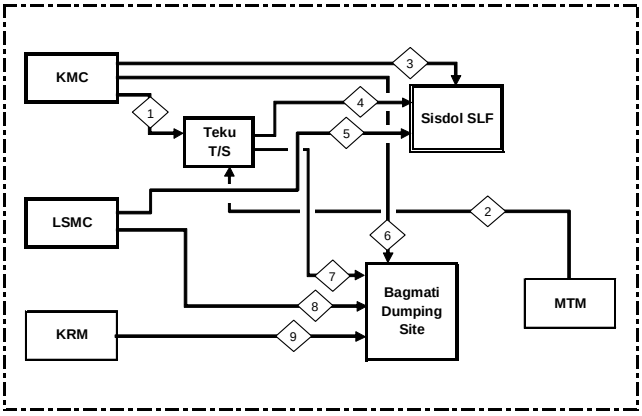


Figure 5.1-1 Waste Flow to Landfill (before Sisdol Full Operation)

Waste is directly transported to Sisdol S/T-LF from KMC "flow 3" and from LSMC "flow 5" respectively and there is also the waste transported through Teku T/S from KMC "flow 4".

After shifting Bagmati Dumping Site from the right bank to left bank on the KRM side, it was still used to accept the major proportion of the waste directly from KMC "flow 6", LSMC "flow 8" and KRM "flow 9". KMC was also disposing of its waste at the site through Teku T/S "flow 7".

In the above waste flows, the major waste flows are concerned with KMC and LSMC. According to Environmental Department of LSMC, about 180 m^3 of waste on average, which means 60 to 70 tons per day, are collected and disposed of at Bagmati Dumping Site. In addition, only one or two trips per day of tipper are made to Sisdol S/T-LF transporting about 1 to 3 tons of waste. LSMC keeps the waste collection and transportation data in the waste database management system developed by the Study.

Although KMC also records the data, because KMC currently has to manage three different waste management sites, Teku T/S, Sisdol S/T-LF and Bagmati Dumping Site, the data for each are kept in the different data sheets at the moment. Based on such existing data

records provided by KMC, the waste quantity on each waste flow above mentioned is summarized as follows:

"flow 1": Waste quantity transported to Teku T/S

Table 5.1-1 Summarized Record of Waste Transported to Teku T/S (before Sisdol Full Operation)

Unit: tons/day (monthly average)

Nepalese Calendar		Baishak	Jestha	Ahsad	Shrawon	Bhadra	Aswin	Kartik	Manshir	Poush	Magha	Falgun	Chaitra
English Calender		Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-Mar	Mar-Apr
	Day No.	31	31	31	32	31	31	31	30	29	30	15	31
Morning	Tractor	0.0	0.0	0.0	37.2	40.2	39.9	33.6	32.3	35.2	38.0	38.1	0.0
	Tipper	0.0	0.0	0.0	3.2	3.7	6.2	19.8	5.9	3.8	6.2	4.6	0.0
KMC		0.0	0.0	0.0	40.4	43.9	46.1	53.4	38.2	39.0	44.2	42.7	0.0
Private		0.0	0.0	0.0	15.3	17.9	17.4	22.8	12.6	10.2	12.7	11.3	0.0
	Sub-total	0.0	0.0	0.0	55.7	61.8	63.5	76.2	50.8	49.2	56.9	54.0	0.0
Night	Tractor	0.0	0.0	0.0	35.2	34.1	30.9	26.2	30.7	30.4	24.5	28.1	0.0
	Tipper	0.0	0.0	0.0	1.3	2.2	2.8	1.7	2.6	2.7	2.4	2.6	0.0
KMC		0.0	0.0	0.0	36.5	36.3	33.7	27.9	33.3	33.1	26.9	30.7	0.0
Private		0.0	0.0	0.0	22.0	23.1	16.9	16.9	17.9	14.9	13.3	14.8	0.0
	Sub-total	0.0	0.0	0.0	58.5	59.4	50.6	44.8	51.2	48.0	40.2	45.5	0.0
Total	Tractor	0.0	0.0	0.0	72.4	74.3	70.8	59.8	63.0	65.6	62.5	66.2	0.0
	Tipper	0.0	0.0	0.0	4.5	5.9	9.0	21.5	8.5	6.5	8.6	7.2	0.0
KMC		0.0	0.0	0.0	76.9	80.2	79.8	81.3	71.5	72.1	71.1	73.4	0.0
Private		0.0	0.0	0.0	37.3	41.0	34.3	39.7	30.5	25.1	26.0	26.1	0.0
	Total	**0.0**	**0.0**	**0.0**	**114.2**	**121.2**	**114.1**	**121.0**	**102.0**	**97.2**	**97.1**	**99.5**	**0.0**

Sourse: KMC and summized by JICA Study Team, March 2006
Note: Raw data of KMC was recorded from Shrawon 1, 2062 (July 16, 2005) to middle of Falgun 15, 2062 (Feb. 27, 2006)

The monthly average of the daily waste quantity transported to Teku T/S fluctuated from about 100 to 120 tons per day. From the average value recorded from Shrawan to Falgun, it is understood that KMC collects 70% of waste transported to Teku T/S in a day and the private sector collects 30%. It could also be observed that 54% of waste was transported by the morning shift and 46% by the night shift.

"flow 3" and "flow 4": Waste quantity transported to Sisdol LF

Table 5.1-2 Summarized Record of Waste Transported to Sisdol LF (before Sisdol Full Operation)

Unit: tons/day (monthly average)

Nepalese Calendar		Baishak	Jestha	Ashad	Shrawon	Bhadra	Aswin	Kartik	Manshir	Poush	Magha	Falgun	Chaitra
English Calender		Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-Mar	Mar-Apr
	Day No.	31	10	31	32	31	31	31	30	15	30	29	31
KMC	Compactor		22.8	39.4	42.5	38.0	49.7	28.7	42.7	25.6	0.0	0.0	0.0
	Tipper		0.0	0.0	0.0	1.1	1.2	4.5	1.3	1.8	0.0	0.0	0.0
LSMC	Tipper		0.0	1.1	1.5	0.9	0.6	0.5	0.7	0.5	0.0	0.0	0.0
JICA S/T	Dump		27.0	29.6	29.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sub-total	0.0	49.8	70.1	73.2	40.0	51.5	33.7	44.7	27.9	0.0	0.0	0.0
	Max. day		88.0	102.0	115.0	87.0	139.0	104.0	93.5	80.5			
	Min. day		18.0	0.0	27.0	0.0	0.0	0.0	0.0	0.0			

Sourse: KMC and summized by JICA Study Team, March 2006
Note: Raw data of KMC was recorded from Shrawon 1, 2062 (July 16, 2005) to Falgun 15, 2062 (Feb. 27, 2006)

Since Sisdol S/T-LF started to accept the waste in June 2005, KMC has transported part of the waste collected from the municipality to Sisdol S/T-LF. The average daily quantity was 30 to 40 tons with one or more trips of the seven existing compactor trucks after

supplementary transportation with three rental trucks arranged by the JICA Study Team. Peak transportation was recorded at more than 100 tons per day.

- "flow 6" and "flow 7": Waste quantity transported to Bagmati Dumping Site

Table 5.1-3 Summarized Record of Waste Transported to Bagumati Dump Site (before Sisdol Full Operation)

Unit: tons/day (monthly average)

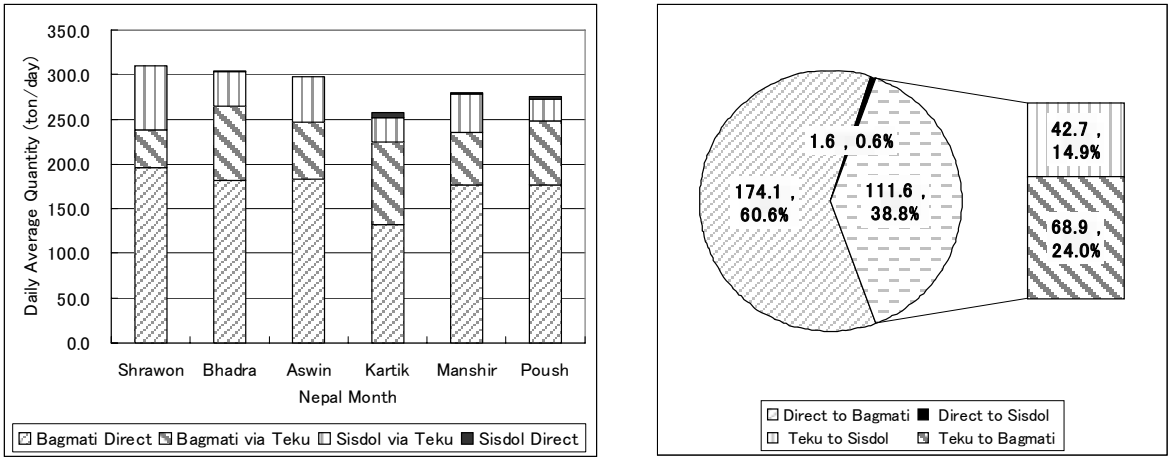
Nepalese Calendar		Baishak	Jestha	Ahsad	Shrawon	Bhadra	Aswin	Kartik	Manshir	Poush	Magha	Falgun	Chaitra
English Calender		Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-Mar	Mar-Apr
	Day No.	31	31	31	32	31	31	31	30	16.5	30	29	31
Morning	KMC	28.7	27.7	24.4	33.1	32.6	34.5	5.4	33.6	34.9	0.0	0.0	0.0
	Private	16.0	12.6	14.8	16.2	17.3	24.5	3.5	16.9	16.5	0.0	0.0	0.0
	Sub-total	44.7	40.3	39.2	49.3	49.9	59.0	8.9	50.5	51.4	0.0	0.0	0.0
Night	KMC	52.5	5.2	41.5	50.1	50.6	46.2	45.7	40.1	39.0	0.0	0.0	0.0
	Private	102.1	6.8	76.5	96.3	81.4	77.7	77.2	85.3	85.9	0.0	0.0	0.0
	Sub-total	154.6	12.0	118.0	146.4	132.0	123.9	122.9	125.4	124.9	0.0	0.0	0.0
Total	KMC	81.2	32.9	65.9	83.2	83.2	80.7	51.1	73.7	73.9	0.0	0.0	0.0
	Private	118.1	19.4	91.3	112.5	98.7	102.2	80.7	102.2	102.4	0.0	0.0	0.0
	Total	**199.3**	**52.3**	**157.2**	**195.7**	**181.9**	**182.9**	**131.8**	**175.9**	**176.3**	**0.0**	**0.0**	**0.0**

Sourse: KMC and summized by JICA Study Team, March 2006
Note: Raw data of KMC was recorded from Baishak 1, 2062 (April 13, 2005) to Poush 17, 2062 (Jan. 1, 2006)
Bulk density is assumed to be 0.4 for municipal tractor, 0.35 for other municipal trucks and 0.8 for private collection

Bagmati Dumping Site has still been used to be disposed of the waste from KMC, about 150 to 200 tons per day, since April 2005. After the start of Sisdol LF, that quantity has been decreased by 20 to 70 tons per day. From the average value recorded from Shrawan to Falgun, KMC was transporting 43% and the private sector 57%. It is also noted that 26% of waste was transported by the morning shift and 74% by the night shift. KMC collects about 40% of its waste in the morning and 60% at night but the private sector mostly collects at night, about 84%, and only 16% in the morning. The reason for this is that it is rather difficult for the private sector to execute a "Door to Door Collection" service from each house and business early in the morning.

As shown in the table, total waste transported and disposed of from KMC was about 300 tons per day from Shrawan (mid July) to Aswin (mid October), and decreased to be about 250 to 275 tons from Kartik (mid October) to Poush (mid January).

Most of collected waste, about 60%, or 174.1 tons per day on average, was still directly transported and disposed of at Bagmati Dumping Site. 40% of waste was transferred at Teku T/S, of which 62% or 68.9 tons, and 24% of total waste, was transported to Bagmati Dumping Site. 14.9% of total waste collected from KMC, or 40% of waste transferred at Teku T/S, is disposed of at Sisdol LF.



Source: KMC , March 2006

Figure 5.1-2 Waste Disposal Balance of KMC (before Sisdol Full Operation)

2) Condition of Procured Secondary Transportation Vehicles

Twenty-one (21) units of Secondary Transportation Vehicles (STVs), which are categorized as container carriers, with spare parts and 18 units of extra containers procured under programs of Japan Non-Project Grant Aid 2003 were finally delivered to Teku T/S in December 2005. Seventeen (17) units are allocated for KMC and 4 units are for LSMC. The handover ceremony was held at Teku T/S on December 21, 2005 after the completion of delivery inspection and operational training of the equipment by the supplier. The container capacity is 15 m^3 and Gross Vehicle Weight (G.V.W.) of vehicle is 16 tons, means a STV can carry about 6 tons of waste per vehicle per trip.

After trial operation and performance check, KMC and LSMC carried out their own mechanical inspections of each STV carefully to find out if any defects had developed. As the result of such self-inspection and meeting with the supplier and manufacturers, mechanical malfunctions have been solved and a mutual agreement reached. It was also agreed that for appropriate operation of STVs within their design capacity, the loaded weight should be under the 16.2 tons of G.V.W, which means about 6 tons of waste loaded into the container. Both KMC and LSMC also completed their necessary administrative procedure to use STVs such as obtaining the license plate and arrangement of drivers for those STVs.

In addition, coordination meetings between KMC, LSMC and Okharpauwa Sanitary Landfill Site Main Coordination Committee (OSLSMCC) were held to prepare such large-scale transportation to Sisdol S/T-LF.


Figure 5.1-3 Secondary Transportation Vehicles

Those administrative procedures took a longer time than that initially expected due to other urgent municipal works related to the election in February 2006 and political confusion in April 2006. Finally KMC and LSMC started to operate STVs in May 2006.

3) After Tentative Sisdol Full Operation

After the 25 days from April 6 to 30, 2006, when collected waste was not transported to either the Bagmati River Dumping site and Sisdol S/T-LF due to the confused situation in Nepal, secondary transportation was re-started. Because of strong opposition by the people near Bagmati River Dumping Site, KMC and LSMC could not dispose of the collected waste and had to transport all the waste to Sisdol S/T-LF. During the period of May 1 to 20, an approximately estimated 6,000 tons of waste was brought to the site. In addition to the daily waste collected, the waste accumulated at Teku T/S was also transported to Sisdol S/T-LF.

During that period when such unusual secondary transportation had to be made, as much as possible of the waste accumulated at Teku T/S was loaded on to the STVs and overloading sometimes occurred. The reasons for this overload was that the operators of the loader at Teku T/S and STV drivers were not always familiar with the design capacity of STV, and the bulk density of accumulated waste itself had become heavier because of self-compaction on the ground. After the meeting among KMC, LSMC, the supplier and manufacturers on May 11, 2006, all operators of Teku T/S and drivers of vehicles were notified to correct the operation.

During those days, first priority for KMC was to transport all the collected waste to Sisdol S/T-LF. KMC used almost of all 17 STVs, except a few STVs which needed repair, to transport the collected waste to Sidol S/T-LF in addition to seven units of the existing multi-compactor from Teku T/S. As recommended by the Study Team, utilization of extra containers at the waste collection points along the Ring Road or some common places in the city was identified as the future requirement.

On the other hand in LSMC, as LSMC had not proceeded with the tentative transfer station plan at Afadol yet, the small containers with 4 to 6 m^3 capacity at the public places in Sundarighat, near Industrial Estate, or Naya Basti, were replaced by new containers with $15m^3$ capacity as suggested by the Study Team. The following photos are the situations of waste collection points with $15m^3$ containers in March 2006.

Figure 5.1-4 Situations at Waste Collection Points with new $15m^3$ Containers in LSMC (Mach 2006)

Regardless of such steady step-by-step efforts by KMC and LSMC, operation of Sisdol S/T-LF had to be stopped again in July 2006. Prior to this blockade, KMC's temporary staff went on strike and all the municipal waste collection and transportation was also stopped for several days. This unexpected situation seriously disrupted the solid waste management systems of both municipalities, especially KMC had missed an opportunity to use the platform at Teku T/S for effective transferring of the waste.

Figure 5.1-5 Blockade at Teku and Temporary Use of Kura Manch (July 2006)

When KMC accumulated the collected waste at Teku T/S for several days because of lockout of Sisdol S/T-LF, the local residents surrounding Teku also forcibly blocked the use of the station. At that time, KMC had to use Kula Manch in the Ratna Park as a temporary transfer point even after the Sisdol S/T-LF started to accept waste again.

In order to solve this situation at Teku, KMC had a meeting with the local people and both agreed to re-open the transfer station with the conditions such as consideration of budget allocation to improve the road to Teku and to develop other transfer stations and/or to develop the waste collection points with new large containers like LSMC.

In July 2006, KMC took the representative of local people at Teku to Balaju and some existing waste transfer points that the private sector use along the Ring Road to explain the Action Plan that was being considered to improve the waste collection and transportation system. However, unfortunately, with the closure of all the waste destinations at Sisdol S/T-LF, Teku Transfer T/S and Kura Manch temporary waste transfer place, KMC had to stop the primary collection from the city area in August 2006. The following photo shows the situation at Tamel in August 2006.

Figure 5.1-6 Site Visit with Teku People and Waste Pile at Tamel (August 2006)

As well as KMC, LSMC also faced difficulty of full-scale transportation because of the above-mentioned Sisdol problem and the delay of tentative transfer station development at Afadole, and most of the collected waste was disposed of at the bank of Bagmati River at that time. KMC also disposed of all collected waste at another place on the bank of Bagmati River since Sisdol Landfill was again stopped from accepting the waste.

Figure 5.1-7 Waste Dumping at the Bank of Bagmati River (Left: KMC, Right: LSMC, August 2006)

(2) Result of Follow-up Survey

In the first term of Phase IV, the Study Team carried out the follow-up survey mainly focusing on the preparation of an inventory of the existing waste collection / transportation system, which includes equipment and its collection route, and trial operation of STVs.

1) Conditions of existing waste collection / transportation system

a. KMC

KMC has 134 vehicles and heavy equipment for the solid waste management. Of these, 81 vehicles, such as hydraulic tippers, dumper placers and tractors, are used for primary collection. 25 vehicles, including the multi-compactors and STVs, are used for secondary transportation from Teku T/S to the final disposal site. 14 units of heavy equipment like backhoe loaders and dozers are used for operation at Teku T/S and Sisdol S/T-LF (see Supporting Report I-1 for the detail equipment inventory).

As one of the waste collection system, KMC is collecting the waste by removal of containers with a capacity of 4 to 6 m^3 located at defined places, named "container collection". There are two types of containers provided by KMC for public collection and private collection. Public containers are provided free of charge by the municipality and are located at public common places or special sites such as Singha Darbar and Royal Palace. The container collection service, especially located at public areas can be used by any one at any time. The private containers, provided by the municipality, are set up at the premises of the clients such as hotels, institutions, hospitals and industries. Those clients have to pay KMC the usage charge of the container at a set price. In August 2006, KMC placed its containers at 42 locations, of which 7 are for public containers and 35 for private containers (see Supporting Report I-2 for the list of the container locations).

By the time when GTZ supported the solid waste management in the late 1980's to 1990's, KMC had approximately 125-130 container locations mainly to provide the municipal collection service. Since then, however, those containers have been relocated or abandoned over time due to following reasons:

- Public objections.
- Insufficient space due to rapid urbanization.
- Responsible for road accidents.
- Damage during the 1990 (pre-democracy) revolution.
- Privatization introducing the door-to-door collection system.

In terms of primary collection routes of KMC, two types of routes are assigned, one is by tippers and the other is by tractors (see Supporting Report I-3 for the collection routes).

Regarding secondary transportation of waste to Sisdol S/T-LF, it takes three hours for a multi-compactor to make a round trip from Teku T/S. The transportation starts from 5:30 in the early morning and ends in the afternoon if the vehicle makes two trips. However, sometimes but quite rarely, KMC has to stop transporting the waste to Sisdol S/T-LF due to unavoidable reasons like blockade of the main highway.

b. LSMC

LSMC has 19 vehicles for waste collection / transportation with four types, 11 units of tipper, 2 units of dumper placer, 2 units of tractor and 4 units of STVs (see Supporting Report I-4 for the list of vehicles). In addition, LSMC has 2 units of backhoe loaders for solid waste management, of which, one is allocated for operation at Sisdol S/T-LF.

As well as KMC, LSMC carries out container collection, placing containers at 13 different locations at present, 9 of public containers and 4 of private containers. The containers are of two different capacities, 4.5 m^3 and 6 m^3. The clients who use private containers such as B&B hospital and Patan hospital are paying a usage charge to the municipality (see Supporting Report I-5 for the list of container locations).

Containers used to be located at approximately 36 places during the GTZ Project period. Because the municipality has been extending bell collection system (by tippers) and open space has been urbanized, many of the container locations were abandoned, as they were also in KMC.

The solid waste is collected in two shifts one in the morning starting from 5 AM and one in the evening from 5 PM. Each driver is allocated a specific area for the collection and decides on the collection route depending on the waste discharging situation every day (see Supporting Report I-6 for the basic collection routes).

2) Preliminary trial operation of STVs

a. KMC

As the STVs were not ready to go to Sisdol S/T-LF, the preliminary trial operation, which is a loading and unloading examination, was conducted on March 2, 2006 within the Teku T/S in order to confirm the operation efficiency of STVs compared with the multi-compactors for future secondary transportation plan. Two STVs were selected for the trial operation. STVs with empty containers moved from the main gate of Teku T/S to the unloading/loading platform. The loaded tippers were taken to the upper level of the platform and its waste was directly unloaded into the STV waiting under the platform. After waste was loaded into the container, STVs with waste went to the weighbridge to measure the waste quantity loaded. Through this trial, the moving time, loading/unloading time, and total number of trips required by each vehicle for filling the container with waste and the loaded weight of waste were recorded.

The time required for loading the usual multi-compactor at ground level with use of a back hoe loader was also measured to find out the time difference between a compactor and a new STV. The unloading time of the compactor at Sisdol S/T-LF was also recorded. The average time taken in loading to two new STVs was 11 min.-22 sec. and that to load a multi-compactor was 18 min.-15 sec. If it is assumed that the loading process goes smoothly for 1 hour, then about 3 multi-compactors could be loaded whereas about 5 STVs could be loaded in the allocated time (see Supporting Report I-7 for more detail).


Figure 5.1-8 Trial Operation of STV of KMC at Teku T/S (March 2006)

The weighing of the vehicle showed that both of a new STV and a multi-compactor carry more or less the same amount of waste which is 7,060 kg or 6,585 kg for STV and 7,260kg for multi-compactor. Considering the container capacity is 15 m^3 for the STV and 12 m^3 for the multi-compactor, the waste in the multi-compactor is compacted more. However, the G.V.W. of both vehicles is same, 16 tons, and it is very crucial to manage waste loading appropriately for both to avoid overloading.

The trip time to travel from Teku T/S to Sisdol S/T-LF and back to Teku T/S for both vehicles is dependent upon the traffic conditions on the road. Usually drivers of KMC for the multi-compactor trip to Sisdol S/T-LF are taking the following two routes to Balaju.

- Teku-Kalimati-Soalteemod-Ravibhawan-Kalanki-Shyambhu-Balaju-Balaju Bypass-Sisdol S/T-LF (total 25 km)
- Teku-Tripureshwor-Sahidgate-Jamal-Lainchor-Shorhakhutte-Balaju-Balaju Bypass-Sisdol S/T-LF (total 28 Km)

A multi-compacter takes 3 hours in average for a round trip from Teku T/S to Sisdol S/T-LF including driver's personal activities like lunch. The travel time for the STV could be expected to be similar to the multi-compacter trip time.

The STV has a hydraulic system only for hook lift equipment for loading/unloading of containers but the old multi-compactor has a more complicated mechanical system for a waste compaction plate and waste unloading plate. Considering these differences of the hydraulic system and the usage years of each vehicle, the operation efficiency of the STV is expected to be higher than the multi-compactor.

b. LSMC

As LSMC did not a transfer station like Teku T/S yet, a trial operation for LSMC this time on March 13, 2006, was carried out to evaluate the possibility of utilizing new containers, 15 m^3, for container collection at public places. A container was placed at the left bank of Bagmati River in Sundarighat where the existing public containers were located in the

previous day. These containers were accepting the waste collected by a NGO, NEPCEMAC, with 25 units of tricycle. For the trial operation, waste collectors of NEPCEMAC were asked to put the waste collected into a new container on the trial day.

A time and motion survey was conducted during the trial operation recording the traveling time and distance at the following seven major sections of the road. The trail route started from the LSMC garage with the final destination of the STV for waste disposal was Teku T/S in cooperation with KMC because Sisdol S/T-LF was not ready to accept the new STV at that time.

Section 1	Garage to Balkhu Bridge,
Section 2	Balkhu Bridge to Sundarighat for waste loading,
Section 3	Sundarighat back to Balkhu Bridge,
Section 4	Balkhu Bridge to Kuleshwor Chowk
Section 5	Kuleshwor to Kalimati Chowk,
Section 6	Kalimati to Teku Chowk and
Section 7	Teku Chowk to Teku T/S Gate.

The time of loading the container full of waste collected by NEPCEMAC was measured at the site. When the STV reached Teku T/S, its weight with waste was measured by the weighbridge and then the waste was unloaded on the ground. The time taken to unload the waste and the weight of the empty STV was measured too. The STV went back to the same site for public containers at Sundarighat and a record taken of the unloading/loading time for the empty container. After the trial, the STV was driven back to the LSMC garage. The distance and time was measured again for the same sections (see Supporting Report I-7 for more detail).

Figure 5.1-9 Trial Operation of STV of LSMC at Sundarighat (March 2006)

The STV for the trial, truck No. 5037, left LSMC garage at 11:35 AM without container and reached Sudarighat through the Ring Road at 11:55 AM, which means it took 20 minutes for 7.4km. Average speed was about 22 km per hour. It was founded that the STV could not function to load the container because of the mechanical problem, which was the missing of

joint rod for the loading arm. Therefore, the STV, No. 5037 was replaced by another one, No. 5036.

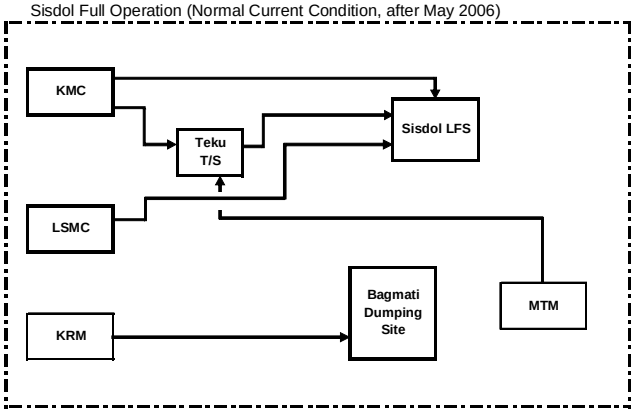
Loading test was started at 1:21 PM after the replacement of the STV. Only three minutes was taken to lift on the container with collected waste. It was observed that loading was done smoothly from the unpaved earth ground. However, since this result is from just one time trial, further trials are needed in the conditions of rain or other different circumstances in addition to more training of the drivers for the STV operation.

The STV for the trial was driven from Sundarighat to Teku T/S via Kuleshwor and Kalimati Chowk slowly along with other traffic taking about 15 minutes. 6,150 kg of waste was carried by the STV with the container 100% full by volume. This value was about the same as the design capacity of the STV, which is 6,000 kg. This suggests that one of the points to avoid overloading the STV is to obey the rule of loading waste into the container so that it is not overfilled, that is, does not exceed 100% capacity or $15m^3$. The STV went back to Sundarighat from Teku T/S taking the same road in almost the same time as that taken to Teku T/S, 14 minutes. Loading and unloading of empty container at Sundarighat was also observed and found to be done very smoothly in about 2 minutes each.

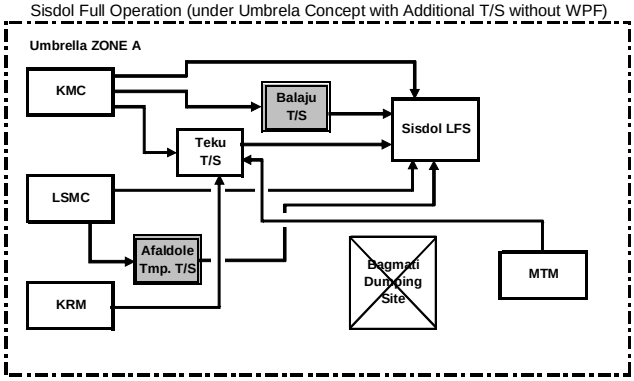
5.1.2 Suggestion for Primary Collection and Secondary Transportation Systems

Waste collection and transportation flow is depending on the availability of waste management facilities such as landfill, transfer station or waste processing facilities. A plan for such facilities was proposed as the umbrella concept including feedback to the action plan from each municipality and the SWMRMC. The figures at the right are the current and future change of waste collection and transportation flows based on the umbrella concept.

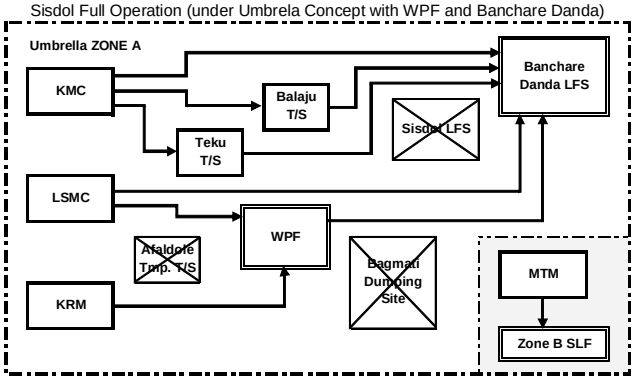
Sisdol Full Operation (Normal Current Condition, after May 2006)



Sisdol Full Operation (under Umbrela Concept with Additional T/S without WPF)



Sisdol Full Operation (under Umbrela Concept with WPF and Banchare Danda)



Currently, the waste collected from KMC goes to Sisdol S/T-LF directly or through Teku T/S. Since LSMC has not had any tentative transfer place, all the waste should be transported to Sisdol S/T-LF directly.

Considering the capacity of Teku T/S and total transportation cost, KMC needs to set up other transfer station(s). Balaju is the candidate site, even it can be used for small scale transfer. LSMC definitely needs to have a waste transfer place considering the existing transporting capacity.

It is also recommended that KRM should start to transport the collected waste to Teku T/S as per agreed between KMC and KRM. Considering the time required for development of a sanitary landfill for Zone B, MTM still needs to transport the waste collected from the core area to Teku T/S as well.

In the mean time for both KMC and LSMC to proceed with the development plan for transfer stations, the waste transfer points that LSMC has introduced by replacing old small containers with new $15m^3$ containers should be also promoted in KMC to improve the loading capacity of both Teku and Balaju Transfer Stations.

In this connection, it is recommended both KMC and LSMC should exchange information more on their waste transportation situations so that LSMC will be able to obtain information

for development and operation of the transfer station by KMC. Vice versa, KMC may learn how to operate the waste transfer point that LSMC are currently operating in cooperation with the private sector. For the introduction of waste transfer points, the following should be discussed.

- Operation Policy
- Pre-conditions for Operation Plan
  - Waste quantity to be handled at the transfer points
  - Candidate sites for waste transfer points
  - Concerned private sectors that may use the transfer points
- Operation Plan of Transfer Points
  - Waste transfer system
  - Time schedule
  - Implementation schedule to develop the transfer points
- Management Plan of Transfer Points
  - Proposed structures for transfer points
  - Environmental management plan
  - Responsibility of transfer point management

One more important facility plan, especially for LSMC, is a waste processing facility (WPF). Because the number of STVs which LSMC has at this moment were calculated based on the condition that all solid waste collected in LSMC will be transported to the WPF. As LSMC may face difficulty in transporting all the waste collected to Okharpauwa with the existing transportation capacity if the WPF is not available, development of the WPF should be proceeded.

As for the primary collection, the solid waste management policy was changed frequently. Currently, once again, the solid waste is collected during day time, not night time and early morning that has been forced since February 2005. As it may take time to settle this frequent change of collection times, it is recommended that a time and motion survey be carried out for all the waste collection routes to improve the primary collection.

5.1.3 Suggestions for Operation of Teku Transfer Station

(1) Commencement of Direct Loading

Since Balaju T/S has not been ready for the operation and also that it may take a longer time to reach an agreement between KMC and the private sector for container collection at the public places, Teku T/S may need to accept most of the waste for secondary transportation for the time being.

Teku T/S has two types of waste transfer mechanism, one is direct loading at the platform developed and the other is indirect loading on the ground. Because of frequent changes of collection systems, such as from day to nigh and again to day time collections together with

unstable political situation, as well as uncontrolled waste pickers and their demands, direct loading practices at the platform has not been in place yet. Since currently the day time collection was introduced in KMC again, it is a right time for KMC to start direct loading at the platform for quick waste transfer.

The result of trial operation of loading the waste into the multi-compactor by a back-hoe loader took about 18 min. Loading the waste to the empty containers for the STV set out on the ground takes shorter time than that for the multi-compactor. However, for loading and unloading the container on the STV also takes about 5 minutes according to the result of trial operation in LSMC. If it is assumed that indirect loading by the existing back-hoe loader take 20 minuets, total time required for loading all the waste from the ground into STVs or multi-compactors is estimated to be about 12 hours. If direct loading is conducted even for some portions of the waste brought to Teku T/S, the waste transferring time can be minimized.

At that same time, it is needed to find out the most appropriate way to receive the waste from the split level platform without over-drop and to consider the marking for stopping the STV at the ground level so that the drivers could easily understand their positioning.

(2) Appropriate Vehicle Allocation

As shown in Table 5.1-4, the quantity of waste collected by the vehicles that can unload the waste directly to the STV is about 90 tons, which is less than half of the design capacity of the platform. This is because the design capacity is based on the future condition of waste collection vehicles owned by KMC in the Action Plan that all existing tractors will be replaced to small collection trucks with tipping devices. Design capacity also includes the increase of the waste quantity collected in future. From this fact, KMC should proceed the procurement of collection trucks with tipping devices, such as tippers, when the existing old tractors are replaced as discussed in the Action Plan. In addition, KMC should allow LSMC to use the platform till another transfer station at Afadol in LSMC is developed.

Table 5.1-4 Tentative Waste Allocation at Teku T/S

Unit: Tons/day

Loading Type	Design Capacity	Collected by	Average Quantity*	Required Capacity**	
Direct loading	200	KMC Tipper	83.3	90	
Indirect loading	Depends on Loader numbers	KMC Tractor	66.8	70	210
		Private Sector	132.3	140	

Source: KMC and summarized by JICA Study Team, March 2006

Note:

*: from Table 5.1-1 and 5.1-3

**: Round-up of the average quantity to adjust total quantity to 300 tons per day.

KMC can use 17 units of the new STVs and 7 units of multi-compactor to transport the waste to Sisdol S/T-LF but the multi-compactor has to be loaded with waste by indirect loading. The following table shows a tentative estimation for the vehicle allocation based on the

condition that operation efficiency is 100%. Considering the maintenance of vehicles, total carrying capacity of secondary transportation may be decreased and more trips to Sisdol S/T-LF may be needed.

Table 5.1-5 Tentative Vehicle Allocation from Teku T/S to Sisdol LF

Loading Type	Required Capacity [tons/day]	Vehicle Type	Trip No. [time]	Capacity per vehicle [tons/trip]	Capacity per day [tons/day]	Required Number of Vehicle
Direct loading	90	STV	3	6	18	5
Indirect loading	210	STV	2	6	12	11 or 12
		Compactor	2	6	12	6 or 7

Source: Study Team

(3) Considerations to Waste Pickers

There was a provision within the concept design of Teku T/S to set aside an area within the station where the waste pickers would be able to continue their activities in a safer way and without effecting the transfer station operations. The area was to have six chambers where the sorted goods would be stacked and a space where selected trucks would unload their waste for picking activities. This area, which was isolated from the truck traffic within the station, should be secured. In parallel, a second provision called for KMC to register the waste pickers at the station in order to ensure there would be no sharp increase in the number of pickers operating there. However, since the closure of the Bagmati River dumping area, number of waste pickers has increased in Teku T/S without registration. KMC is again requested to take actions to introduce the registration system for allowing some waste picking activities without any trouble. For safety measurers to the waste pickers moved from the Bagmati River dumping area, it is also recommended for KMC to secure an appropriate sanitary environment to them such as providing regular medical checks along with the existing waste pickers. In addition, KMC should consider giving those waste pickers a preference to work at the waste processing facility to be constructed in future as operation staff.

(4) Development of Detail Operation Plan of Teku T/S

As previously mentioned, local residents at Teku T/S is quite interesting how KMC can manage the station. Their interests also included smooth operation and quick transfer of the waste at the site so that the environmental nuisances such as offensive odor from the site can be minimized. Therefore, it is recommended that KMC should have the meeting to let them participate to prepare the operation plan together. The following contents should be discussed in the detail operation plan of Teku T/S.

- Operation Policy
- Pre-conditions for Operation Plan
    - Time schedule of primary collection
    - Quantity of waste brought into the site

- Permissible operation time
- Equipment to be used for secondary transportation

- Waste Quantity handled in Teku T/S
  - Waste to be unloaded at split-level platform
  - Waste to be unloaded on the ground
- Operation Plan for Split-level Platform
- Operation Plan for Ground-level Platform
- Management Plan of Teku Transfer Station
  - Environmental management
  - Data management
  - Communication with the local people
  - Management policy for waste pickers
- Organizational Arrangement
- Information Disclosure
- Improvement of the Surrounding Environment

5.2 Follow-up for the Operation of Sisdol Short-term Landfill

5.2.1 Follow-up for the Operation of Sisdol Short-term Landfill

(1) Follow-up Process

1) Sisdol Landfill Description

Valley 1 of Sisdol S/T-LF was developed as a semi-aerobic landfill. Sisdol S/T-LF was designed as a Level Three landfill, with leachate collection and treatment by aeration and re-circulation, and application of a clay liner. The facilities constructed for Valley 1 are shown in Figure 5.2-1.

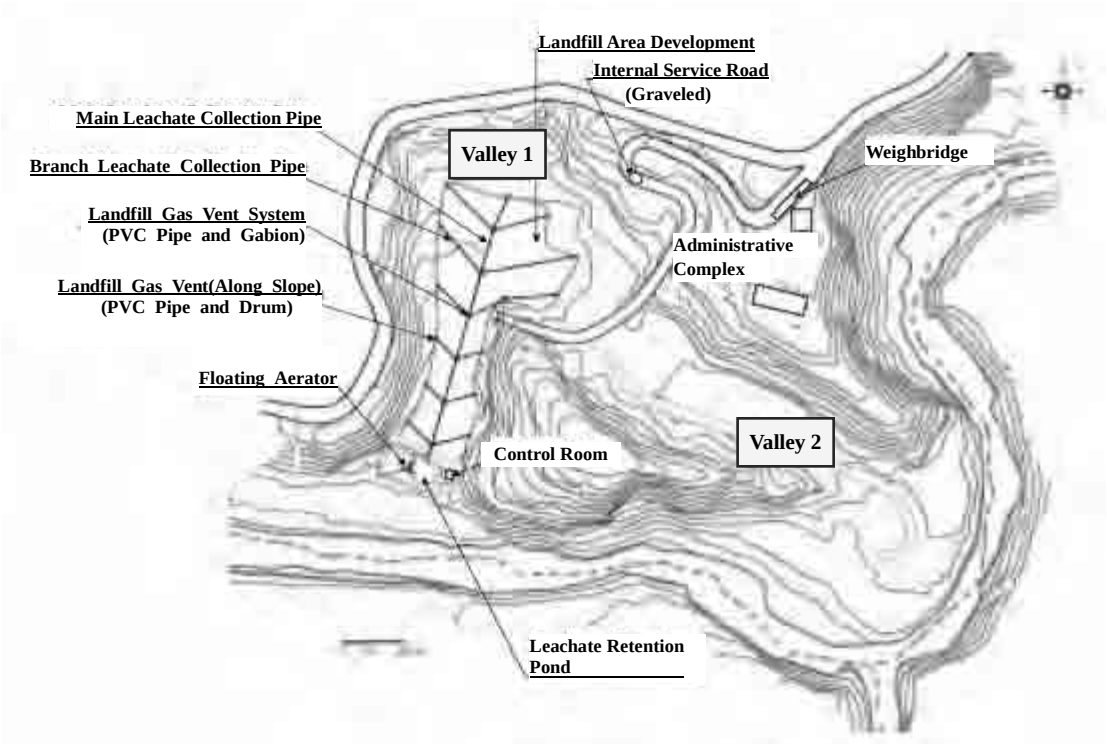


Figure 5.2-1 Sisdol LF Valley 1 Facilities

Source: JICA Study Team

The Valley 2 has been designed and developed by the SWMRMC and the site is almost ready to receive the waste as of March 2007.

2) Staging of the Activities for Capacity Development of Landfill Operation

The capacity development activities for landfill operation at Sisdol S/T-LF proceeded in five stages as shown in the Table 5.2-1.

Table 5.2-1 Staged Program for Capacity Development of Operational Aspects

Stage	Period	Remark
Stage 1 Commencement	June – Oct. 2005	Wet season
Stage 2 Monitoring system	Nov. 2005 – Jan. 2006	Dry season
Stage 3 Leachate system	Feb. – Apr. 2006	Dry season
Stage 4 Full operation	May – Aug. 2006	Wet season
Stage 5 Operation improvement	Sept. 2006 – Mar. 2007	Dry season

Source: JICA Study Team

The main activities for each stage are described hereafter, while the results of the follow-up work are described in Section (3) hereafter.

Stage 1: (June – October 2005)

The landfill operation commenced with the start of the wet season and this somewhat hampered the activities that were expected to be implemented at this stage. During this stage the focus was on placing waste, preparation of internal site road for the wet season, preparation of initial waste platform, and maintaining the site records.

Stage 2: (November 2005 – January 2006)

During this stage the focus was on the development of the monitoring systems and forms, placing waste, soil cover, and vertical vent extensions. As the landfill development works were not completed in Stage 1, these became urgent activities for Stage 2.

Stage 3: (February – April 2006)

During this stage, attention was paid to the leachate re-circulation system. As the landfill operation approached the half-year mark the outflow effluent into the pond had stronger leachate characteristics and more focus was made on aeration, re-circulation of leachate and development of additional leachate storage capacity.

Stage 4: (May – August 2006)

This stage of the follow-up coincided with the commencement of full disposal operations at the site, as well as the advent of the wet season. Activities focused upon were improvements in the application of soil cover, placing waste, internal site road system and further considerations on leachate storage capacity.

In addition to the follow-up for the landfill operation directly at the site, the study tour to Phokara Sub-Metropolitan City was conducted in August 2006. Engineers of the SWMRMC and landfill operators and mechanics of KMC and LSMC participated in this tour to see how the sanitary landfill in Phokara is managed and to share the experiences with the relating staff of Phokara Sub-Metropolitan City.

Stage 5: (Sept. 2006 – March 2007)

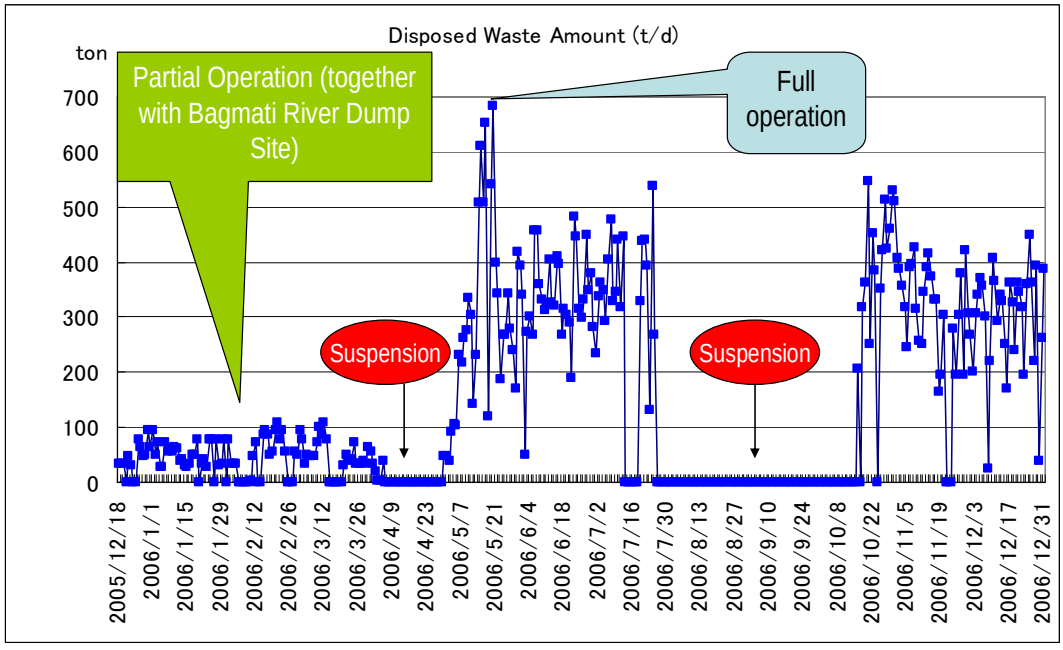
Technical capacity developed in Stage 4 was insufficient to deal with the full operation of the site, and operation was also effected by the breakdowns of the heavy equipments and frequent suspension of operations at the landfill. Activities in this stage dealt with the repair of damaged vertical gas vents, laying of additional horizontal leachate collection system, and construction of trickling filter in the waste layers, waste height control and markings, application of final cover and drainage system in the completed waste disposal area and commencement of waste disposal in Valley 2. In March 2007, the work shop at the site was organized by JICA with participation of the staffs relating landfill operation from neighboring countries.

(2) Operation Conditions

1) Chronology of the Waste Disposal

The chronology of the waste disposal to date is depicted in Figure 5.2-2.

- Oct.2004-March 2005 (6 months): Detailed design and construction
- June 2005-April 2006 (11 months): Partial operation (30-50 t/day)
- May 2006- : Full operation (300-400 t/day)



Waste amounts arriving at Sisdol LF (December 2005 – December 2006)

Figure 5.2-2 Chronology of the Waste Disposal

Source: JICA Study Team

The peak waste arrival in May 2006, as shown in the graph portion of the figure was due to transport to Sisdol S/T-LF of waste accumulated at Teku T/S for over two weeks.

Waste disposal operations were suspended at Sisdol for two long periods, in April 2006 (22 days) and from July 28 up to October 15, 2006 (80 days). In addition to these two long spells, short suspension periods occurred many times.

2) Operation System

Prior to commencement of operation, a local committee, the OSLSMCC, was formed and legally registered as a body tasked with the coordination of the landfill operation with the SWMRMC, KMC and LSMC. Agreement for operation among them was made on May 15, 2005 and the opening ceremony of Sisdol S/T-LF was held on June 5, 2005. This committee was formally dissolved on October 13, 2006, and efforts are still under way to form a new committee at this time (as of March 2007). The operation system may be summarized as follows:

a. An Operation Manual for Sisdol S/T-LF has been developed during the Pilot Project stage by the Study Team and Counterparts.

b. Up to May 2006, KMC and LSMC were operating two disposal sites; Sisdol and Bagmati River dumping site. Accordingly the manpower and equipment were allocated to both sites, causing some strain on the two municipalities.

c. From May 2006, all manpower and heavy equipment were allocated to that one site for full operation of Sisdol S/T-LF. A total staff of 20 members is allocated to the Sisdol S/T-LF as shown in Table 5.2-2 as of March 2007.

Table 5.2-2 Sisdol S/T-LF Staff

No.	Position (Municipality)	Number	Comment
1	Site Manager (KMC)	1	Part time
2	Assistant Site Manager (KMC)	1	Full time
3	Overseer (KMC)	1	Full time
4	Supervisor (LSMC)	1	Full time
5	Heavy Equipment Operators	5	KMC; 4 and LSMC; 1
6	Workers, guardsmen, traffic control (KMC)	About 10	Employed from local people by KMC
7	Mechanic (KMC)	1	On demand

Source: JICA Study Team

Table 5.2-3 shows the equipment operated at the site.

Table 5.2-3 Sisdol LF Equipment

No.	Equipment (Municipality)	Number	Comment
A. Heavy Equipment			
1	Bull dozer (KMC)	1	Komatsu Dozer 8t, procured in 1996
2	Wheel loader/ excavator (LSMC)	1	JCB loader, procured in 1998
3	Bulldozer (KMC) (From May 2006)	1	Fiat Dozer 18t, procured in 1990, brought to Sisdol in May 2006 *Poor condition and frequent breakdowns*
4	Sheep foot Compactor (KMC) (From May 2006)	1	Hanomag Compactor, procured in 1988, brought to Sisdol in May 2006 *Poor condition and frequent breakdowns*

No.	Equipment (Municipality)	Number	Comment
B. Operation Equipment			
1	Weighbridge	1	40 ton
2	Aerator	1	Floating type, 10 HP
3	Re-circulation pump	1	7.5 kw
4	Generator	1	

Source: JICA Study Team

The photos of the heavy equipment are shown in Figure 5.2-3.

Figure 5.2-3 Heavy Equipments at Sisdol S/T-LF

Source: JICA Study Team

d. Sisdol S/T-LF has been operated under the following conditions:

① Operation is managed by KMC Environmental Department

② Waste collection and haulage trucks arrive in two shifts daily (on some days three shifts are operated).

③ Waste arrival records are maintained at the site manually (the weighbridge has not been not in operation due to lack of electricity at the site)

④ Two other records are maintained at the site; one for description of daily operations (such as equipment breakdowns and expenditures) and the second a visitors book

⑤ Prior to the dissolution of the OSLSMCC, bi-weekly meetings were held with the participation of KMC, LSMC and the OSLSMCC to discuss operational issues

⑥ Heavy equipment; up to April 2006, only one bulldozer and one loader were available at the site. From May 2006 and with commencement of full

operation a sheep-foot compactor and additional bulldozer were brought to the site. During the operation improvement (Stage 5) an excavator was hired and extensively used at the site.

⑦ Light equipment; a generator was used to operate the aerator and re-circulation pump, due to delay in connection of electric power

3) Monitoring System

a. Operation Monitoring Visit Report (OMVR)

The Study Team appointed a local consultant to assist in the operation monitoring. Site visits were made at least twice a week (increased to 3 times per week upon full operation) and during these visits data and information were collected, coded and input into an Operation Monitoring Visit Report (OMVR). The data and observations cover the following items:

- Visit date, time and weather
- Landfill operation
- Equipment conditions
- Manpower at the LF
- Environmental concerns
- Others, including general comments

The monitoring items are detailed as shown in Table 5.2-4, and a sample of the form is attached in Supporting Report J-1.

Table 5.2-4 OMVR Report Contents

Items		Comments
1. VISIT CONDITIONS		
1.1 Date, 1.2 Time and 1.3 Weather		Sunny, Cloudy, or Rain
2. LANDFILL OPERATION		
2.1 Waste Face	a) Zone	Zone numbers; 1 to 8
	b) Height	Approx. height from bed at time of departure
	c) Unloading	Near or far from waste face
	d) Placing	Push down, or Push up
	e) Trips	Number of waste truck trips on the visit day
	f) Amount	Total transported waste on that day, in tons
	g) Weighbridge measurement	Above amount weighed or estimated
2.2 Soil Cover	a) Active cell, b) Old cells	Sufficient or in-sufficient
	c) Source of cover materials	From Valley 2 or outside the site
2.3 Leachate pond	a) Water level	Measured in cm from invert of outlet pipe
	b) Leachate flow	From main pipe, in m^3/day
2.4 Manhole	a) Valve leak	Any leakage
	b) Water level	Below or above the pipe
	c) Odor	Detected or not detected
2.5 Outfall	a) Discharge to river	
	b) Stagnated water at outfall	
2.6 Slopes condition	a) Sliding, and b) collapse	Within the site and surroundings
2.7 Perimeter drain	a) Water flow	Any flow, and flow measurement
	b) Free flow in drain	Any blockage in the drain
2.8 Internal road	a) Pavement	Good, slippery or inaccessible
	b) Side drains	Free flow, or blocked
2.9 LP access road	a) Condition	Accessibility conditions

Items		Comments
2.10 Sprinkler system	a) In use, and b) Where?	Yes or No; and which gas vents attached to.
	c) Ponding	Does ponding exist over the land filled waste
3. EQUIPMENT CONDITIONS		
3.1 Weighbridge	a) In operation, b) hours	Yes or No, and number of hours
3.2 Aerator	a) In operation, b) hours	Yes or No, and number of hours
3.3 Re-circulation pump	a) In operation, b) hours	Yes or No, and number of hours
3.4 Generator I (PP)	a) In operation, b) hours	Yes or No, and number of hours
3.5 Generator II	a) In operation, b) hours	Yes or No, and number of hours
3.6 Bulldozer	a) In operation, b) hours	Yes or No, and number of hours
3.7 Loader/ excavator	a) In operation, b) hours	Yes or No, and number of hours
3.8 Water tanker	a) In operation, b) hours	Yes or No, and number of hours
4. MANPOWER		
	a) SWM Chief (KMC)	Present at the site
	b) Site Manger	Present at the site
	c) Asst. Site Manager	Present at the site
	d) Dozer driver	Present at the site
	e) Excavator driver	Present at the site
	f) Local Community Rep.	Present at the site
	g) Workers	Present at the site, and number
	h) Guardsmen	Present at the site, and number
5. ENVIRONMENTAL CONCERNS		
5.1 Odor	a) Waste face, b) Leachate pond, and c) Administration area	Yes or No
5.2 Flies, mosquitoes	a) Waste face, b) Leachate pond, and c) Administration area	Yes or No
5.3 Dogs	a) Waste face, b) Leachate pond, and c) Administration area	Yes or No
5.4 Birds	a) Waste face, b) Leachate pond, and c) Administration area	Yes or No
5.5 Scavengers	a) Waste face, b) Leachate pond, and c) Administration area	Yes or No
5.6 Waste scattering	a) Waste face, b) Leachate pond, and c) Administration area	Yes or No
5.7 Seepage into river	a) Detected	Yes or No
	b) If Yes; Where	Approx. meters from upstream edge of dam
5.8 Public complaints	a) Any	Yes or No
	b) If Yes; Type	Odor, Seepage, Insects, Animals, Waste scattering, Noise, Others
6. OTHERS		
6.1 Site records	a) Waste arrivals, b) Operations, and c) Visitors Records	Yes or No
6.2 Water supply	a) Available, and b) Sufficient	Yes or No
6.3 Electricity supply	a) Available, and b) Outage	Yes or No
6.4 Telephone	a) Available, and b) Outage	Yes or No
6.5 Hand phone	a) Can use?	Yes or No
6.6 Borehole conditions	a) BH1 capped, and b) Fenced	Yes or No
	a) BH2 capped, and b) Fenced	Yes or No
6.7 Visitors	a) Number, b) Names/titles	
7. COMMENTS Technical advice given to operators, necessary improvements, equipment breakdowns or repairs, access road conditions, waste types, etc.		

Source: JICA Study Team

b. Weekly Monitoring Report (WMR)

The weekly monitoring report was prepared based on the records maintained by the operator at the site and some survey works. The main components of the WMR were as follows:

- Collection truck arrivals (daily arrivals and departure times, waste amount, license number)
- Manpower at the site (daily number by staff position)
- Equipment in operation (daily number of hours of operation by equipment type)
- Waste placement progress (amounts and locations per week estimated based on measurements at the site)

(3) Follow-up Results

1) Overall Results

Findings

The main operation monitoring data are summarized in Table 5.2-5 (Details may be found in Supporting Report J-2 and J-3).

Table 5.2-5 Main Operation Monitoring Data

No.	Item	Unit	Dec. '05	Jan. '06	Feb. '06	Mar. '06	Apr. '06	May '06	Jun. '06	July '06	Oct. '06[1]	Nov. '06	Dec. '06
A	DATA												
1	Recording Period	day	21	31	28	31	30	31	30	31	31	30	31
2	Waste Arrivals												
	2.1 Operating days	day	17	28	18	25	6	31	30	19	14	27	30
	2.2 Trips	trip/m	115	234	183	221	32	1,384	1,458	1,077	901	1,341	1,381
	2.3 Waste amount[2]	ton/m	687	1,490	1,179	1,423	143	9,381	10,032	6,894	5,729	8,677	9,170
3	Staffing at LF												
	3.1 Site Manager	d/m	5	4	6	5	1	20	23	8	16	27	28
	3.2 Asst. Site Manager[3]	d/m	14	27	17	18	7	36	84	42	20	30	43
	3.3 Dozer/ compactor operator	d/m	14	28	17	25	4	58	104	29	14	30	29
	3.4 Loader/ excavator operator	d/m	13	28	17	23	6	31	30	29	17	30	30
	3.5 Workers	d/m	84	186	168	186	180	177	180	165	51	90	90
	3.6 Guardsmen	d/m	42	62	56	62	60	62	60	58	34	60	60
	3.7 Mechanic[4]	d/m	1	5	2	2	0	24	21	5	0	40	37
4	Equipment												
	4.1 Weighbridge	hr/m	0	0	0	0	0	0	0	0	0	0	0
	4.2 Aerator	hr/m	34.5	18.75	10	49	11	55	37	1	1	4	2
	4.3 Re-circulation pump	hr/m	30	73.25	38	36	36	61	64	32	60	104	55
	4.4 Generator I (pilot project)	hr/m	65	92	48	85	47	118	100	33	60	104	55
	4.5 Generator II (KMC)	hr/m	0	0	0	0	0	0	2	0	0	0	0
	4.6 Bull dozer	hr/m	42.5	90.5	81	102	15	257	262	108.5	58	153.5	248
	4.7 Loader/ excavator	hr/m	5	35	35	37	6	137	148	56.5	127	285	139
B	ANALYSIS												
1	Operating days/ month	%	81%	90%	64%	81%	20%	100%	100%	61%	45%	90%	97%
2	Ave. trips per operating day	trip/d	6.8	8.4	10.2	8.8	5.3	44.6	48.6	56.7	64.4	49.7	46.0
3	Ave. waste per operating day	t/d	40.4	53.2	65.5	56.9	23.8	302.6	334.4	362.8	409.2	321.4	305.7
4	Leachate Treatment												

[1] Sisdol LF was closed in August and September 2006
[2] Waste amounts estimated and not weighed
[3] A second assistant manager was added with the start of full operation at Sisdol
[4] Comes to LF upon request – In November and December 2006 mechanics were often at the site to change the bulldozer chain

No.	Item	Unit	Dec. '05	Jan. '06	Feb. '06	Mar. '06	Apr. '06	May '06	Jun. '06	July '06	Oct. '06[1]	Nov. '06	Dec. '06
	4.1 Aerator ave. hr/operating day	hr/d	2.0	0.7	0.6	2.0	1.8	1.8	1.2	0.1	0.1	0.1	0.1
	4.2 Pump ave. hr/op. day	hr/d	1.8	2.6	2.1	1.4	6.0	2.0	2.1	1.7	4.3	3.9	1.8
5	Waste placement with cover												
	5.1 Bull dozer ave. hr/ op. day	hr/d	2.5	3.2	4.5	4.1	2.5	8.3	8.7	5.7	4.1	5.7	8.3
	5.2 Excavator ave. hr/op. day	hr/d	0.3	1.3	1.9	1.5	1.0	4.4	4.9	3.0	9.1	10.6	4.6
6	Administration Staff												
	6.1 Site manager presence rate	%	29%	14%	33%	20%	17%	65%	77%	42%	114%	100%	93%
	6.2 Asst. Site mgr presence rate	Per/ op.d	0.8	0.96	0.94	0.7	1.2	1.2	2.8	2.2	1.4	1.1	1.4

Source: JICA Study Team

Figure 5.2-4 shows the graphs depicting the monthly waste arrivals in ton/day (left hand side vertical axis) and the number of hours the aerator and re-circulation pump were operated daily (right hand side vertical axis) for the representative months of January 2006 (partial operation) and June 2006 (full operation). The graphs for all the months from December 2005 to December 2006 are given in Supporting Report J.

Interpretation

a. Waste arrivals

- Sisdol S/T-LF was closed for short periods in January (3 days), February (10 days) and March (6 days) 2006 mainly due to security reasons. In April 2006, the site was mostly closed, except for 6 working days due to the pro-democracy movement. Full operation with all KMC and LSMC wastes coming to Sisdol S/T-LF, started in May 2006, and for both months of May and June operation was uninterrupted. On July 27 the operation was suspended due to problems with the local community over delays in commencement of promised development projects in the area. Operation was restored in mid-October 2006.
- Average waste arrival (ton/operating day) increased gradually from 40 to 66 t/d[5] during the period of December 2005 to February 2006. The peak amount during that period was around 100 t/d. With full operation, the average amounts of arriving waste were 303 t/d in May and peaking to 410 t/d in October 2006.
- As shown in the earlier Figure 5.2-4, in May 2006 the amount of arriving waste peaked to just short of 700t/d due to transport of waste stored at Teku T/S in April 2006.

b. Leachate treatment – Aeration and Re-circulation is Insufficient

- Leachate treatment is through a combination of both aeration at the leachate pond and re-circulation of the leachate back into the waste disposal area.
- The aerator should be operated for at least 6 hours daily. Obviously the average operating time is presently too low, with a maximum average operating hours of

[5] All waste amounts are estimated based on the product of number of trips arriving at the site and average waste haul weights measured at Teku T/S. The weighbridge in Sisdol LF is still not in use due to lack of electricity.

2.0 hr/d in December 2005 and falling to 1.2 hr/d in June 2006 and less than 10 minutes/d for the months of July to December 2006. The aerator should also be operated daily regardless of whether waste is arriving to the landfill or not.

- The re-circulation pump has the dual role of sending the aerated leachate back into the waste disposal area for further treatment when anaerobic conditions exist in the waste area as well as relieving the leachate pond when the leachate level rises within the pond. It is recommended that the pumping system be operated at least 2 hours daily to achieve further treatment and as required when the pond capacity becomes full.
- Due to the lack of an electricity power supply and limitations of the available generator, as the graphs show, it is difficult to operate both the aerator and re-circulation pump at the same time.
- As the graph for January 2006 shows, although high waste amounts were arriving at the site during the first week of that month, neither the aerator nor the pump were operated throughout that week. This was reportedly due to frequent breakdowns of the generator.
- In the last half of February 2006 (refer to graph in Supporting Report J-4) frequent operation of the re-circulation pump was required to re-circulate the leachate into the constructed re-circulation pond within the waste disposal area, north of the waste dam.
- In the second half of June 2006 (refer to Figure 5.2-4) the aerator was not operated at all. There was more concentration on operating the re-circulation pump to empty the leachate pond at regular intervals back into the waste and a temporary pond constructed in Valley 2. Later in December 2006 a leachate pond was constructed downstream the site and leachate has been pumped into that new pond on a regular basis.

c. Waste placement and soil cover

- The bulldozer and the loader/excavator are used for placing waste and soil cover application.
- The bulldozer spreads the waste and in the absence of a compactor is supposed to compact the waste through a number of passes over the spread waste.
- The loader/excavator is used to excavate soil cover material, basically from Valley 2, and is moving the materials to the waste placement area, or loading a tipper to take the material to the waste placement area.
- One bulldozer was operated up to April 2006 at an average 3-4 hours per operating day. Considering that the dozer was used for (1) pushing the waste to the disposal area, (2) spreading and compacting the waste, (3) pushing and spreading the cover

soil, and (4) preparing the internal site roads, it is obvious that the desired compaction could not be achieved.

- With the advent of full operation, an additional dozer and compactor were in operation from May 2006, for an average 8-9 hours/operating day. Compaction conditions started to improve.
- Efforts were made to operate the compactor during the wet season by maintaining thin layers of waste and compaction. However due to frequent breakdowns and the poor condition of the compactor, it was not possible to operate it in the wet season.
- The average operating hours of the excavator appear to be low. The excavator should be used more efficiently to stockpile materials for the cover, and not only to excavate for one day's waste.
- Placing waste continued to be a problem at the site up to April 2006, because of the lack of heavy equipment to prepare an internal road so that the waste haulage trucks could directly empty the waste at the disposal area. The practice of unloading the waste far from the waste disposal area and pushing it by dozer leads to wider disposal areas, and requires the application more cover materials.
- After May 2006, the operator began to develop the site roads and waste platform to be able to bring trucks up to the disposal areas. There was a marked improvement in placing waste in May and June 2006.
- By the first week of July 2006, it was estimated that 26,719 tons of waste had been disposed of at the site and 8,775 tons of materials had been used for the cover soil. In terms of weight the ratio of cover soil to disposed waste was around 25% (by volume and assuming it is around 20%). In the absence of a weighbridge, these figures although approximate, indicate a soil cover rate of around 25 to 30%. With better waste placement this ratio may be reduced to 20%. Figure 5.2-5 shows the accumulated waste and soil amounts by weight.

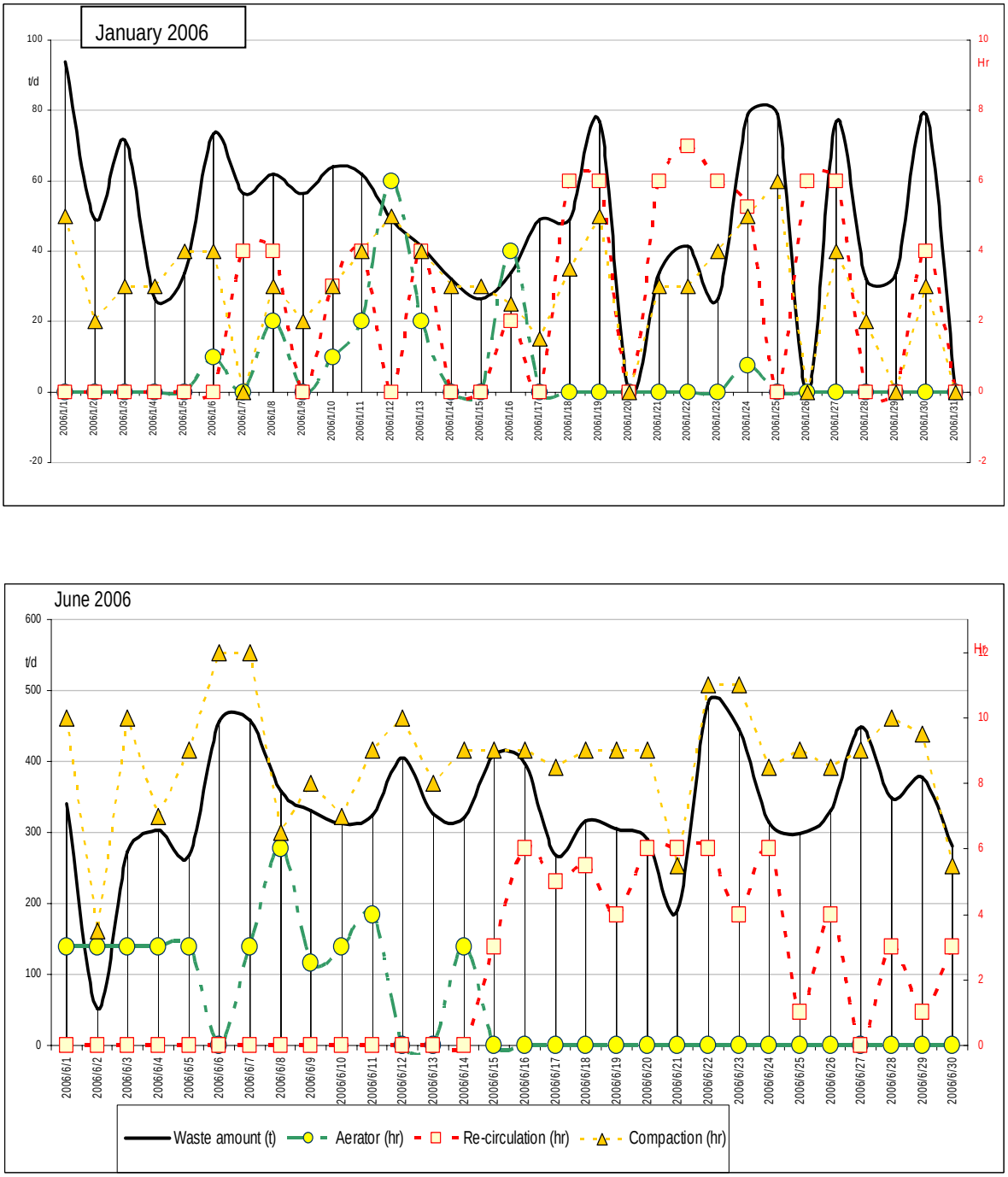


Figure 5.2-4 Waste Arrivals and Leachate Treatment Operation (January and June 2006)

Source: JICA Study Team

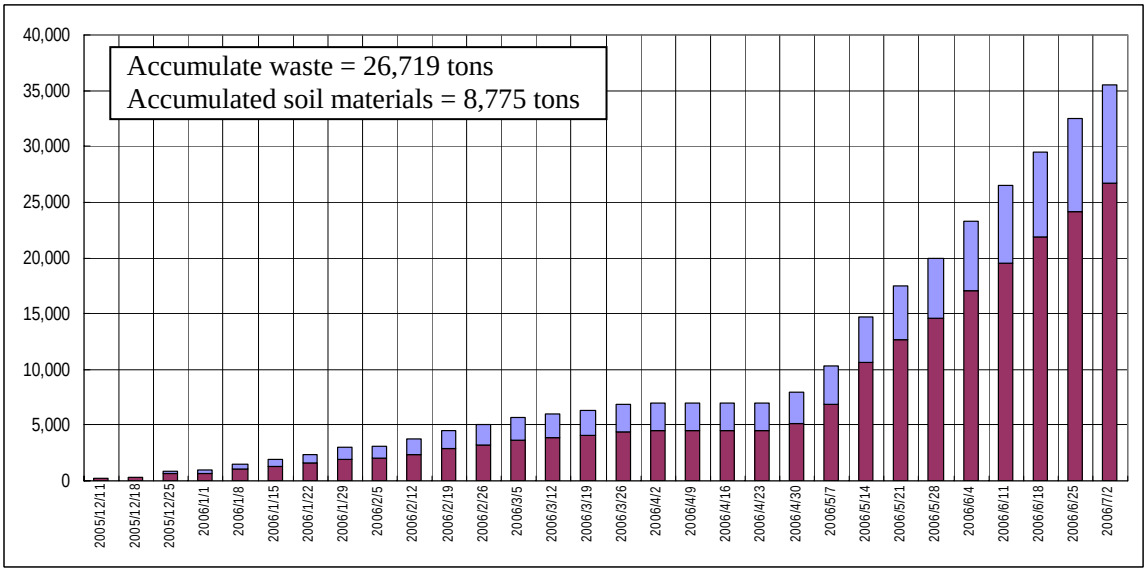


Figure 5.2-5 Waste and Soil Materials Amounts (tons)

Source: JICA Study Team

d. Site Management

- The Site Manager is at the site at least once a week.
- The Assistant Site Manager is at the site almost every operating day, as recorded from January 2006, although the frequency was lower in December 2005.
- With the start of full operation, additional staff was added to the site and the management improved.

2) Leachate Generation

Leachate is one of the main concerns of sanitary landfill operation and the quality and quantity of leachate need to be carefully monitored. The monitoring of leachate quantity is discussed hereafter (quality monitoring is discussed in the following item).

Findings

The main leachate generation data are shown in Figure 5.2-6.

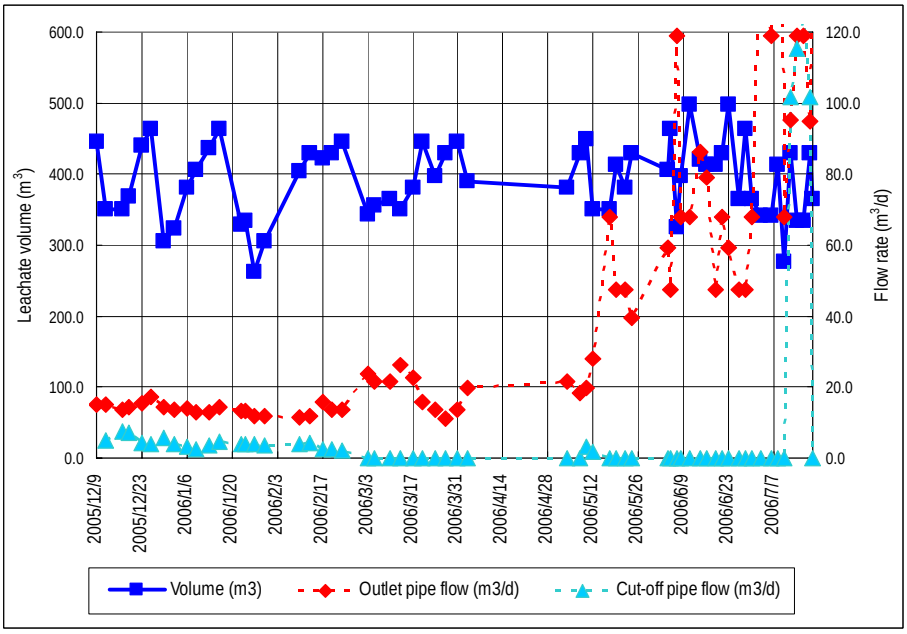


Figure 5.2-6 (1) Leachate Generation Amount

Source: JICA Study Team

The volume of leachate in the leachate pond is indicated in the left hand side vertical axis in cubic meters, while the right hand side vertical axis indicates the measured outflow from the main leachate collection pipe into the pond (outlet pipe) and the flow from the perimeter cut-off drain into the river (cut-off pipe), both in m^3/day.

The leachate flow from the outlet pipe discharging into the leachate pond continued to be measured from August 2006 to February 2007. The results are shown in the following graph.

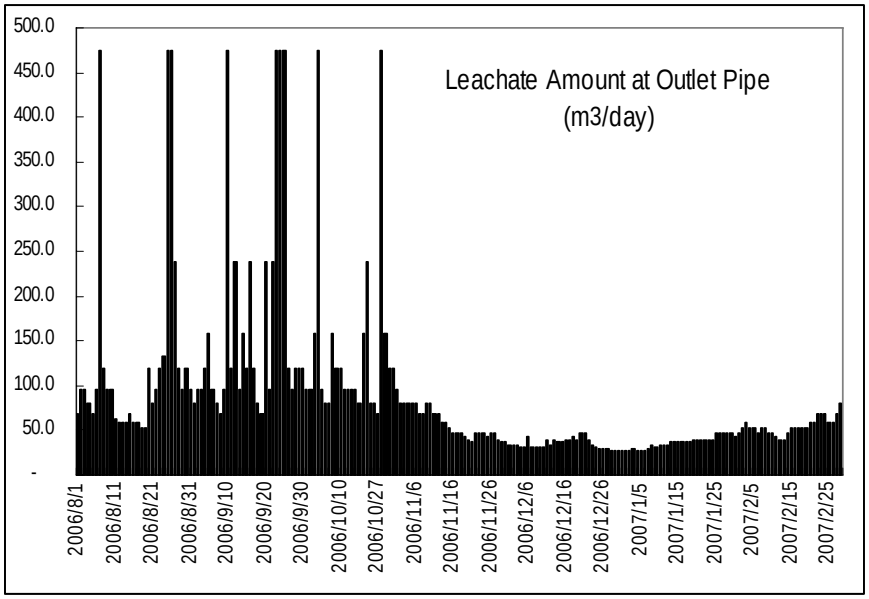


Figure 5.2-6 (2) Leachate Amount at Outlet Pipe

Source: JICA Study Team

Interpretation

a. Leachate Pond Capacity

The leachate pond had a design capacity of around 350m^3, but with the increased side heights the capacity was raised to over 500m^3. Monitoring results of December 2006 show that it took about two weeks for the leachate level to rise from 300m^3, to around 450 m^3, i.e. 150m^3, per two weeks, or about 11m^3/day. During the wet season, the leachate in the pond increased by about 100 m^3 within 2 days (50m^3/day). Due to the drought in January and February 2006 the rise in the leachate pond water was notably slower, as shown in the graph.

The fall in the volume of leachate in the pond three times in December and January was due to the opening of the outfall valve. The fall in March was due to the re-circulation pump operation and pumping the leachate back into the waste area. This is also indicated by the increased operation of the pump (refer to Supporting Report J-4), as shown in the graph for February 2006 in the previous Figure 5.2-4. The leachate was pumped into the newly excavated re-circulation pond in the landfill, just north of the waste dam, as shown in Figure 5.2-7.

Figure 5.2-7 Photo of Excavated Recirculation Pond (February 2006)

Source: JICA Study Team

As the waste disposal works progressed it became necessary in October 2006 to fill the re-circulation pond in order to develop the first waste slope and prepare for application of final cover just upstream the dam.

b. Leachate Source

The leachate quantity measured at the main collection pipe outlet peaked to 15m^3/d towards the end of December 2005 but averaged 13 to 15m^3/d during January 2006. During the wet season the quantity was 80m^3/d.

No rain was recorded at the site throughout the site visits in December 2005 and January 2006. The main source of the leachate was considered to be the seepage of mountain water from two streams that used to pass through the site. The perimeter cut-off drain that has been constructed to divert the two streams to the river, bypassing the site, is not capable of completely stopping the water from percolating under the drain and into the site. This is evident from the figures showing the quantity of water captured at the cut-off drain, which were at around $5m^3/d$.

A second source of water was considered to be the moisture content of the disposed waste. Based on the Study Team survey in 2004, during the dry season household waste, which comprises the majority of the waste content, had a moisture content of 55%. Therefore, after evaporation, water losses due to transport, and waste absorption, a portion of that moisture content also is collected in the leachate pipes and drained to the leachate pond.

Further reference to the graph shows that the outlet flow from the main leachate pipe jumped by about $10m^3/d$ to around $23m^3/d$ at the start of March 2006 (while the cut-off pipe quantity at the same time was zero). Therefore the increased water quantity flowing into the leachate pond was due to the percolation of part of the re-circulated leachate from the pond into the waste back to the pond.

In order to determine the efficiency of the newly constructed re-circulation pond to hold the pumped up leachate and relieve the lower leachate pond, it is necessary to estimate the amount of leachate pumped up to the pond.

Considering the pump capacity, head and operation hours on average during the same period of March, roughly 50 – $60m^3/d$ was pumped up. Around 15 to 20% of the pumped up leachate is returned to the pond. This indicates the efficiency of the new re-circulation pond; at least during the dry season. In the wet season, this pond was not capable of relieving the leachate pond. The SWMRMC has constructed of three ponds at Valley 2 and they intend to construct three ponds to connect Valley 1 leachate pond to these ponds, thereby reliving the pressure on the Valley 1 pond.

3) Environmental Conditions

At Sisdol S/T-LF, the daily application of soil cover is necessary in order to mitigate against odor, generation of insects, attraction of dogs and birds and waste scattering. During the site monitoring visits and based on observation, the conditions of soil cover application and the extent of the above environmental concerns were observed and recorded:

Soil cover application

The sufficiency of soil cover application is monitored at both the active waste disposal area (zone where waste is being disposed of on the day of visit) and the old areas where waste has already been dumped.

From the monitoring results it is evident that the cover for solid waste is not applied daily. *Daily application of soil cover is a fundamental operational aspect of sanitary landfill and should be implemented.*

Odor

The presence of odor depends to a great deal on the person monitoring the landfill and also the wind conditions. The table shows that odor was not detected at the waste disposal areas, except for two visits. It should be noted that this does not cover the odor of the waste transport trucks and the leachate pond.

The leachate pond generates a strong odor, especially when the aerator is operating, and there have been complaints from farmers cultivating land on the other side of the river. Also there have been complaints by the military check points leading to the Tinpiple road on the smell of the waste transport trucks. Furthermore, as ponding is observed over the northern area of the site there is a distinct leachate smell from the northern part of the road.

Vectors, dogs and birds

Although the monitoring reports indicate that there are no insects at the active disposal areas, insects may be observed at the surface of the leachate pond and the higher re-circulation pond. Dogs appeared at the site early in December 2005 and have been continuous "guests" there. In early January 2005 KMC exterminated the dogs but they reappeared. Eagles were observed at the site in December 2005 and from mid-February 2006 gulls began converging on the site.

The strict application of the daily soil cover would help very much towards diminishing the number of dogs and birds. Daily application need not be implemented at the end of the working day, but should be implemented once the waste brought during the first convoy is spread.

Waste scattering

Waste scattering is caused by strong winds, lack of soil cover and uncovered waste transport trucks. Waste scattering has not been observed at the access road leading to the site and is not a significant problem at the disposal site area.

4) Waste Placement

Findings

Basically the following items are monitored in relation to the waste placement:

- Planned waste placement
- Emptying waste near to the waste disposal area
- Spreading the waste by pushing it downwards (push down) or upwards (push up)
- Amount of wastes disposed of at the zones of the LF

Figure 5.2-8 shows the zone distribution of the site. The zones have been prepared using the vertical main and branch gas vents as border points.

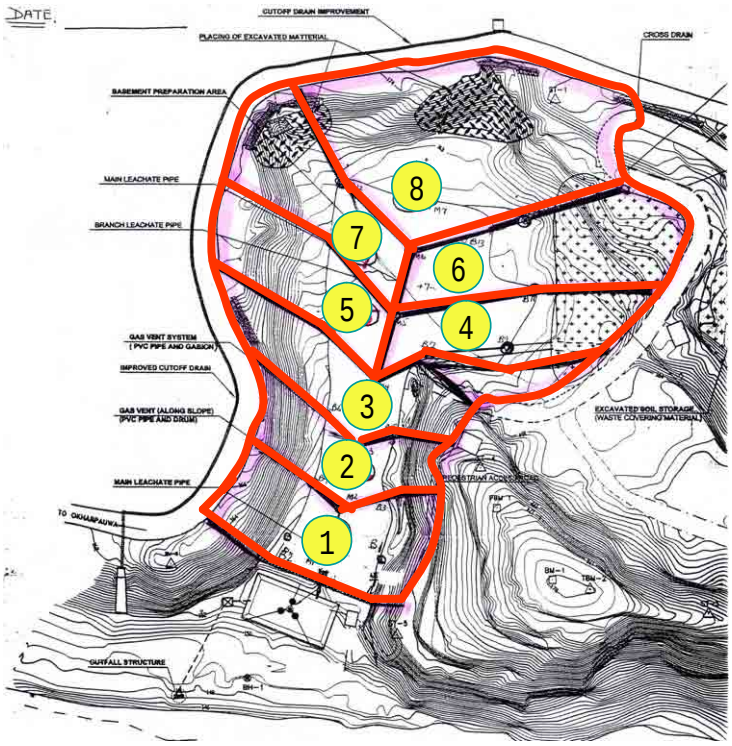


Figure 5.2-8 Waste Placement Zones

Source: JICA Study Team

Employing a theodolite, the waste levels at each zone are measured and the waste volume (+ cover soil) is estimated. This estimate is done at weekly or bi-weekly intervals. Table 5.2-6 shows the estimated volumes by zone and date of measurement.

Table 5.2-6 Waste and Soil Cover Volumes Placed (m^3)

Zone	2005		2006			2007		
	Dec. 19	Dec. 23	Jan. 6	Jan. 13	Jan. 20	Jan. 27	Feb. 17	Mar. 13
1	35	390	878	1,138	1,560	1,950	2,113	2,260
2	450	450	450	540	540	540	900	1,210
3	623	623	664	664	664	664	934	1,400
4	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,920
5	1,115	1,115	1,520	1,520	1,520	1,520	1,520	1,520
6	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,780
7	1,455	1,455	1,455	1,455	1,455	1,455	1,455	1,455
8	1,672	1,672	1,672	1,672	1,672	1,672	1,672	1,672
Total	10,372	10,727	11,662	12,012	12,434	12,824	13,617	15,217
%	6.1%	6.3%	6.9%	7.1%	7.4%	7.6%	8.1%	9.0%

Source: JICA Study Team

Presently (March 2007) the total waste and soil volume is estimated to be around 50% of the total fill volume.

Interpretation

a. Planned waste placement

It is normal practice to limit the area of the working face in order to keep the soil cover material amounts required to a minimum and decrease the leachate produced. Furthermore the waste placement should consider the overall development of the site. KMC has been trying to operate the waste disposal within such parameters but has been hampered by the lack of sufficient reliable heavy equipment. The bulldozer budgeted for by KMC over one year ago has still to be procured.

b. Waste Unloading and Spreading Operations

The waste transport trucks should unload the waste at the active waste disposal area. For this the trucks need to be able to access these areas easily.

During the wet season (summer of 2005) it was difficult for the trucks to empty at the waste disposal areas because of poor site road conditions and there were many problems. Accordingly and with the commencement of full operation KMC has been preparing a "waste platform" in Zones 4, 5 and 6 using gravel material so that when the wet season comes the waste trucks can access these zones and empty the waste for disposal in the northern area of the site. An internal access road has also been developed up to the waste dam to allow the waste trucks to reach the waste disposal areas.

Another aspect of the operation is the spreading operations; either pushing the waste downwards or upwards. Push down of the waste is commonly applied and this theoretically allows for proper compaction of the horizontal surface of the disposed wastes. The push up method would concentrate the compaction along the waste slope. However it has been noted that after emptying of the waste the dozer spreads the waste but does not make enough passes over the spread waste. In the absence of the compactor, the dozer should at least make 3-4 passes over the spread waste.

5) Landfill Gas Monitoring

Findings

Monitoring the percent of methane in the landfill gas has been implemented three times during the monitoring period. Figure 5.2-9 shows the gas vent demarcation system and Table 5.2-7 shows the methane gas percentages at each vent.

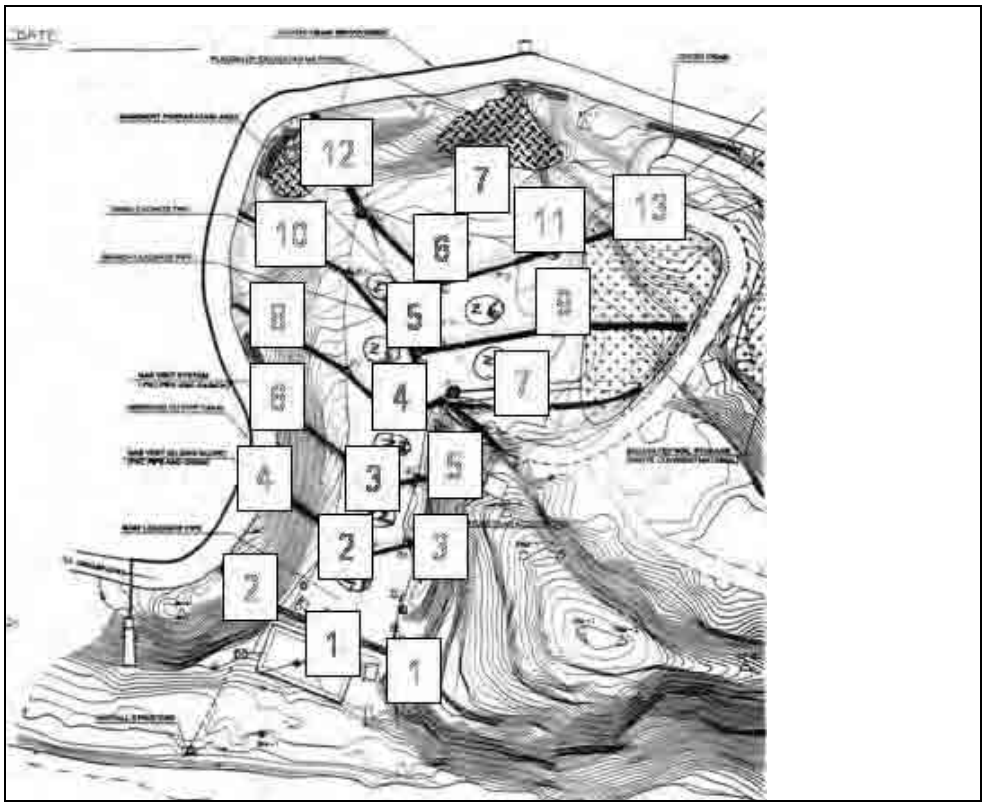


Figure 5.2-9 Gas Vents Numbering

Source: JICA Study Team

Table 5.2-7 Landfill Gas Monitoring – Methane Content

Gas Vent	2005		2006
	Dec. 4th	Dec. 21st	Feb. 22nd
M1	0.0%	0.1%	0.0%
B1	1.0%	0.0%	0.8%
B2	1.0%	0.0%	0.5%
M2	0.7%	0.9%	0.8%
B3	0.1%	0.1%	1.0%
B4	0.1%	0.3%	0.8%
M3	0.4%	0.1%	0.2%
B5	11.0%	0.9%	0.1%
B6	1.2%	0.2%	0.0%
M4	1.5%	0.9%	0.9%

Gas Vent	2005		2006
	Dec. 4th	Dec. 21st	Feb. 22nd
B7	0.2%	0.6%	0.0%
B8	0.3%	0.1%	2.8%
M5	0.0%	1.0%	1.9%
B9	0.2%	1.2%	2.0%
B10	0.1%	0.1%	1.7%
M6	3.0%	4.5%	5.0%
B11	0.8%	4.8%	3.0%
B12	2.1%	7.0%	4.5%
B13	3.0%	0.8%	24.0%
M7	1.5%	0.9%	2.0%

Source: JICA Study Team

Interpretation

a. Values Comprehension

A methane gas concentration detector has been used by to measure the concentration of methane content in the gas coming out of the vertical vents. No sampling and laboratory analysis were conducted. Therefore the values measured are only indicative of the methane content of the landfill gas mixed with surrounding atmospheric gases as it is emitted from the land filled waste.

In the case of the high methane value obtained at B13 of 24% on February 22, 2006, the measuring rod could not be inserted into the vent, which was found to be blocked. The rod was inserted in a small hole at the base of the vent. The high methane concentration could be because the gas emitted from that small hole was not diffused with the atmospheric air.

b. Effect of Waste Placement Order

Higher methane values of 2% and more were obtained from the vents located in the north part of the waste disposal area. This can be explained by the fact that waste placement started in the north in June 2005 and gradually spread southwards. Decomposition of the waste has started earlier in the northern part of the site.

6) Other Operation Monitoring Aspects

During the site visits other aspects are monitored, as described in the earlier Table 5.2-4. The main results of monitoring these other aspects were as follows:

a. Manhole Valve: This valve when opened releases the leachate from the leachate pond into the river. The valve manhole and outfall structure is always inspected to ensure that there is no leakage.

b. Slopes: The slopes have heights of 20m in some locations and are susceptible to landslide or collapse under conditions of heavy rain. Observation of the slope conditions is always carried out. To date there have been no dangerous collapse or slides.

c. Perimeter Drain: The perimeter cut-off drain is monitored to ensure that it remains clear of debris and other impediments in order to ensure free flow of water.

d. Internal Road System: The road leading into the waste area was very difficult to maintain during the rainy season and there were problems with collection trucks getting stuck on that road and having to unload waste away from the active waste areas. The road has since been improved.

e. Leachate Seepage into the River: It is necessary to always monitor for any signs of seepage of leachate directly into the river. In addition to the river water sampling and analysis, the river stretch along the south border of Valley 1 is inspected during monitoring visits. To date such seepage has not been visually detected.

f. Maintenance of Site Records: The site records maintained by the operator are monitored to ensure that they are kept up to date. Vehicle arrival records and visitors logs are kept to up to date, but daily operation records are sometimes lagging behind.

g. Boreholes: Two boreholes are fitted with piezometers in order to sample and monitor the ground water. These boreholes are fenced and capped. They are regularly monitored to ensure that both the fence and caps are maintained.

h. Utilities: The site needs to be provided with electricity, telephones and water supply utilities. Only water was found to be sufficient and is obtained from mountain streams, but electricity power finally arrived at the site in March 2007.

i. Public Complaints: During the monitoring visits the operator reports on any public complaints that are being received at the site. There have not been many complaints because of the close cooperation between the operator and the local people. Major complaints were concerning the release of leachate into the river, odor, and slaughterhouse waste being received at the site. The release of leachate into the river has been decreased through construction of the second re-circulation pond and pumping of the leachate into it, and pumping the leachate into a temporary pond in Valley 2 as well as temporary retention ponds.

5.2.2 Result of the Water Quality Test at Sisdol Landfill

To date, water samples have been taken on ten different dates from the Kalpu Khola River running south of Sisdol S/T-LF, the boreholes downstream of Valleys 1 and 2 and the leachate generated from the disposed wastes. The first four samplings were performed on dates before the operation commenced. The locations and results of these tests are respectively shown in Figure 5.2-10 and summarized in Table 5.2-8.

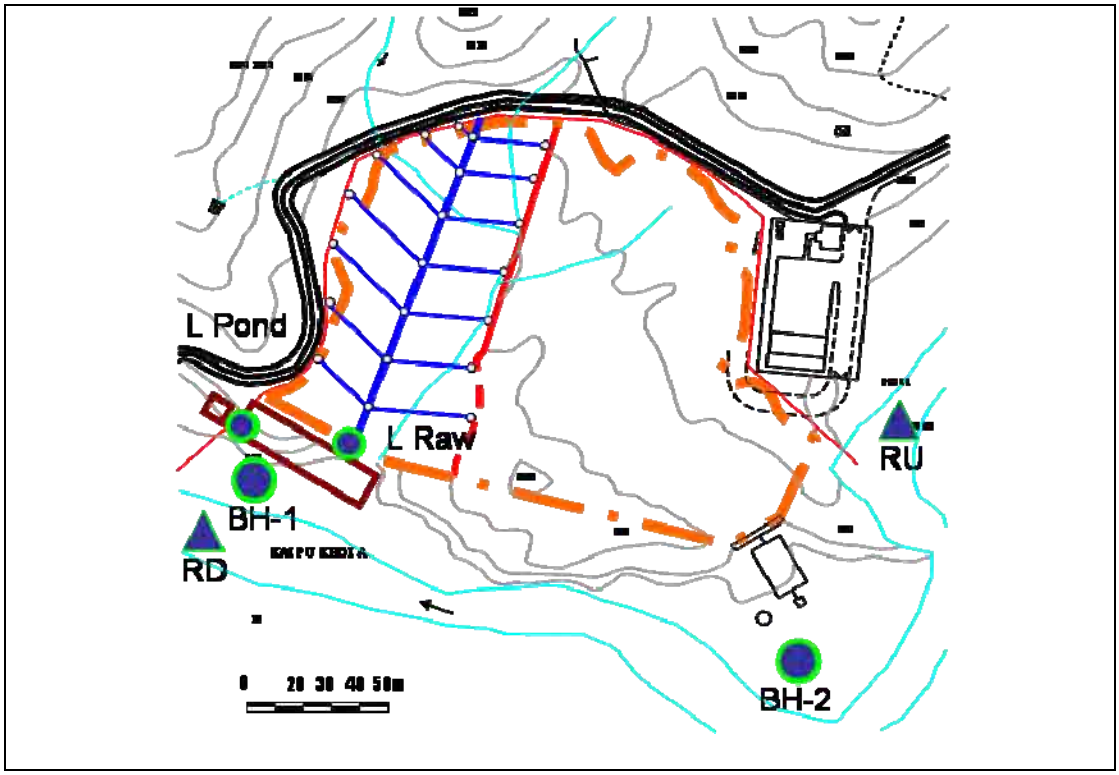


Figure 5.2-10 Locations of Water Sampling

Source: JICA Study Team

Table 5.2-8 Summarized Results of the Water Quality Analysis

1. RIVER	MOPE	2004/7/27		2005/3/1		2005/3/20		2005/5/24		2005/6/9		2005/6/28		2005/7/21		2006/1/24		2006/3/5		2006/6/8	
	Std	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD
Water temperature (°C)		23	23	17	18	20	19			29	29	26	27	24	22	8	9	13	14	24	24
pH	5.5-9.0	7.6	7.4	7.9	8.3	7.8	8.1			8.9	8.4	7.4	7.9	7.2	7.6	7.69	7.67	7.65	8.15	7.71	7.88
Dissolved Oxygen (DO; mg/L)		7.3	7.1	9.5	9.1	7.8	8.4			7.4	7.9	7.5	7.5	8.4	8.0	10.5	10.5	10.5	10.1	8.4	7.5
Tot. Suspended Solids (TSS; mg/L)	30-200	NA	NA	53	93	43	87			3	3	26	3	73	474	NA	NA	NA	NA	NA	NA
Biochemical Oxygen Demand (BOD; mg/L)	30-100	15	17	4	7.2	1.1	1			2	2	6	5	15	16	4	11	5	5	3	6
Chemical Oxygen Demand (COD; mg/L)	250	24	21.8	25	19.5	22.5	20			12	3	15	23	30	39	6	12	7	7	29	30
Ammonia-Nitrogen (NH_4-N)	50	1	3.7	0.6	0.7	1.1	1			0.2	0.3	0.4	0.4	0.4	0.5	0.77	0.49	0.81	0.75	0	0
2. GROUNDWATER		2004/7/27		2005/3/1		2005/3/20		2005/5/24		2005/6/9		2005/6/28		2005/7/21		2006/1/24		2006/3/5		2006/6/8	
		BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2
Water temperature (°C)		23	24	21	20	22	23	22	23	30	31	29	29	28	28	18	18	19	19	23	24
pH	5.5-9.0	7.3	7.4	7.6	6.7	7.5	6.5	6.3	6.2	6.3	6.3	6.7	6.4	7	6.3	7.38	6.43	6.94	6.4	6.65	6.57
Dissolved Oxygen (DO; mg/L)		4.9	6.5	4.5	1.8	4	4.1	5.2	3.4	3.6	4.6	3.7	6.8	2.3	5.6	6	4.5	7.5	5	5	5
Tot. Suspended Solids (TSS; mg/L)	30-200	465	1,936	334	27,524	213	9,079	76	484	36	145	4	87	164	40	NA	NA	NA	NA	NA	NA
Biochemical Oxygen Demand (BOD; mg/L)	30-100	25	30	17.5	420	12.5	80	3	17	10	9.4	7	11	9	25	21.5	11.5	8	35	17	31
Chemical Oxygen Demand (COD; mg/L)	250	119.9	127.7	44.5	980	43	250	18	34	12.5	20.5	20	40	70	41	107.7	109.4	25.98	62.64	58.24	166.4
Ammonia-Nitrogen (NH_4-N)	50	0.6	18	1.1	0.7	2.3	3.5	5.3	0.5	0.4	0.5	1.2	0.8	0.4	0.6	0.94	1.16	1.12	1.32	1.12	1.17
3. LEACHATE		2004/7/27		2005/3/1		2005/3/20		2005/5/24		2005/6/9		2005/6/28		2005/7/21		2006/1/24		2006/3/5		2006/6/8	
		L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond
Water temperature (°C)										23	35	24	27	26	25	15	15	22	17.5	32	29
pH	5.5-9.0									7.0	6.9	5.5	5.7	5.6	5.6	7.7	7.8	7.6	7.9	6.5	7.5
Dissolved Oxygen (DO; mg/L)										2.4	2.8	ND	ND	ND	ND	0.0	0.0	0.0	0.0	0.0	0.0
Tot. Suspended Solids (TSS; mg/L)	30-200									62	364	870	840	13,280	14,010	567	965	475	1,000	1,550	6,930
Biochemical Oxygen Demand (BOD; mg/L)	30-100									333	2,100	7,750	5,750	27,000	13,800	3,400	6,700	6,400	8,975	69,000	32,500
Chemical Oxygen Demand (COD; mg/L)	250									525	2,675	11,625	7,900	44,500	25,500	4,664	7,632	10,857	13,270	104,000	43,680
Ammonia-Nitrogen (NH_4-N)	50.0									6.9	9.6	321.4	125.7	144.7	97.3	653.4	612.3	693.6	471.6	996.3	501.1

Source: JICA Study Team

The following Table 5.2-9 shows the results of the last sampling carried out in December 2006 for the river and boreholes 1 and 2. At that time the leachate was not sampled because of the non-operation of the aerator.

Table 5.2-9 Results of the Groundwater and River Water (December 2006)

15th Dec 2006 Sisdol LFS Data

		Borehole 1	Borehole 2	Kolpu upstream	Kolpu downstream
Air Temperature	oC	16	14	14	15
Water Temperature	oC	22	19	11	11
Odor	_	Light decaying odor	Decaying odour	Muddy	Muddy
Groundwater level from surface	m	2	3.3	_	_
Color		Light grey	Light grey	yellowish brown	Yellowish brown
Turbidity	NTU	75	400	800	750
pH	-	6.80	6.61	7.68	7.78
Chloride	mg/L	34	34	65	68
Electrical Conductivity	uS/cm	797	285	91	97
Dissolved Oxygen (DO)	mg/L	0	2.00	9.00	9.70
Biochemical Oxygen Demand (BOD)	mg/L	50.00	46.00	10.00	9.60
Chemical Oxygen Demand (COD)	mg/L	85.69	69.10	34.53	35.36
Ammonia- Nitrogen (NH_4-N)	mg/L	NA	NA	1.10	0.87

Source: JICA Study Team

(1) River Water Monitoring

The results indicate that on the whole there has been no detected impact from the waste disposal activities on the river water. COD values slightly increased after operation, but remain well within the acceptable norms set by MOEST.

Total Suspended Solids (TSS) showed a high level of 474 mg/l in July 2005 downstream of the site, one month after disposal commenced, and this may be explained by the irrigation and farming activities. Results in January, March and June, 2006 showed no detected TSS.

BOD and COD parameters slightly increased in December 2006, compared to the samples taken in June 2006, during the rainy season. This may be due to the dilution and flushing by the rains. Ammonia-nitrogen (NH_4-N) was slightly lesser for the December 2006 samples.

(2) Groundwater Monitoring

Groundwater samples are obtained from two boreholes; BH-1 located south of Valley 1 waste dam (where the waste disposal operation is ongoing) and BH-2 located downstream of Valley 2. Samples from BH-3, located within the site northern area were obtained at the start of the disposal activities but were suspended once BH-3 was covered with the waste.

When compared to the respective results before the operation, only the DO result of BH-1 rose, to 6 mg/l, after the start of operation.. However, this value is not a significant problem. Other values remained within the same limits as those of the samples taken before waste disposal started.

As in the case of the river samples, BOD and COD parameters slightly increased in December 2006, compared to the samples taken in June 2006 during the rainy season.

(3) Leachate Quality

Leachate samples were taken from the main leachate collection pipe outlet (i.e. before the leachate pours into the pond) and from the leachate pond. Comparative analysis of both samples should show the effect of aeration on the quality of the leachate. However as reported earlier, aeration was not being done to the required standards due to many reasons so there was not much difference.

During the March sampling the pond was aerated for about 30 minutes, after which the pond sample was taken. For the June sampling, aeration was done for 6 hours before the pond sample was taken. BOD and COD values for samples of the raw leachate rose to 69,000 and 104,000 mg/l respectively. However with 6 hours of aeration the respective values from the pond sample fell to 32,500 and 43,680 mg/l, i.e. to less than half of the raw leachate values. NH_4-N also fell from 996 mg/l to 501 mg/l. This indicates necessity of proper aeration of the leachate for at least 6 hours daily.

5.2.3 Training for Improvement of Operation of Sisdol S/T-LF

In order to improve operation of Sisdol S/T-LF, instruction to the operators and training in situ was conducted three times, September, December 2006 and March 2007, by landfill site operation experts as show in the table below (see Supporting Report L).

Table 5.2-10 Training for Improvement of Operation of Sisdol S/T-LF

Date	Instruction and Training Items
September 16-21, 2006	- Landfill method and daily soil cover - Improvement of gas ventilation facilities - Measuring of methane gas concentration generated from landfill - Rainwater drainage planning
December 10-16, 2006	- Operation and maintenance of landfill - Maintenance of heavy equipment - Improvement of gas ventilation facilities - Landfill method (leveling and installation of landfill height makers)
March 1-14, 2007	- Operation and maintenance of landfill (Installation of a leachate re-circulation bed and drainage in Valley 1) - Improvement of gas ventilation facilities (Preparation of gabions for gas ventilation facilities) - Landfill method (leveling and installation of landfill height makers in Valley 1 and the first layer in Valley 2, leveling and final soil cover

Source: JICA Study Team

(1) First Training for Improvement of Operation of Sisdol S/T-LF (September 2006)

At first, the landfill operation expert inspected operational situation of Sisdol S/T-LF and then made recommendations for improvement of operation.

1) Results of Inspection

- According to local staff, daily soil cover had been applied by means of soil locally obtained. The soil used for the cover was cohesive soil and the permeability was supposed to be low.
- Gas ventilation facilities were formed by used tires and the perforated PVC pipe of which inner diameter was 15cm. The inner diameter of tires was about 35 to 40 cm. It was observed that some tires had been filled with about 10 cm stones and some tires had not. The lumps of clay soil, which looked like stones, had been mixed in the filled cobble stones.
- It was also observed that the some gas ventilation facilities were not functioning judging from the situation of leachate retained around the pipe. (see Figure 5.2-11).
- Gas generation was not detected at some gas ventilation pipes. The result of measurement of methane from the gas ventilation, maximum value with 28.0% and minimum value with 1.2% revealed that some pipes of gas ventilation facility had been blockaded.

Gas Ventilation Facility with Used Tire

Condition of Gas Ventilation Facility

Figure 5.2-11 Inappropriate Condition of Gas Ventilation Facility

- Except some pipes supposed to be blockaded, there was a trend that methane concentration at the monitoring points in the downstream was lower than those at upstream. It is assumed that the fresh air came into the ventilation facilities from the end of main leachate collection pipe. So, the methane concentration is diluted by fresh air. Therefore, it was concluded that function of air ventilation worked to some extent since air inflow from the leachate pipe was confirmed by this fact.
- It is said that the explosion limit of methane gas concentration is 5.3 - 14.0%. Dangers of fire as well as explosion were recognized at the site. Judging from detection of methane gas, hydrogen sulfide gas was considered to be generated at the site as well.

2) Proposal for improvement of landfill operation

The following recommendations were provided to the operator from the Study Team.

a. Improvement of gas ventilation facility

- The gas ventilation facility should be improved as shown in Figure 5.2-12 .
- Since there were some pondings that rainwater and leachate retained in the landfill area, it is necessary to remove a part of soil cover in order to eliminate leachate pondings in operation lots. The parts would become interception layer of air and leachate.

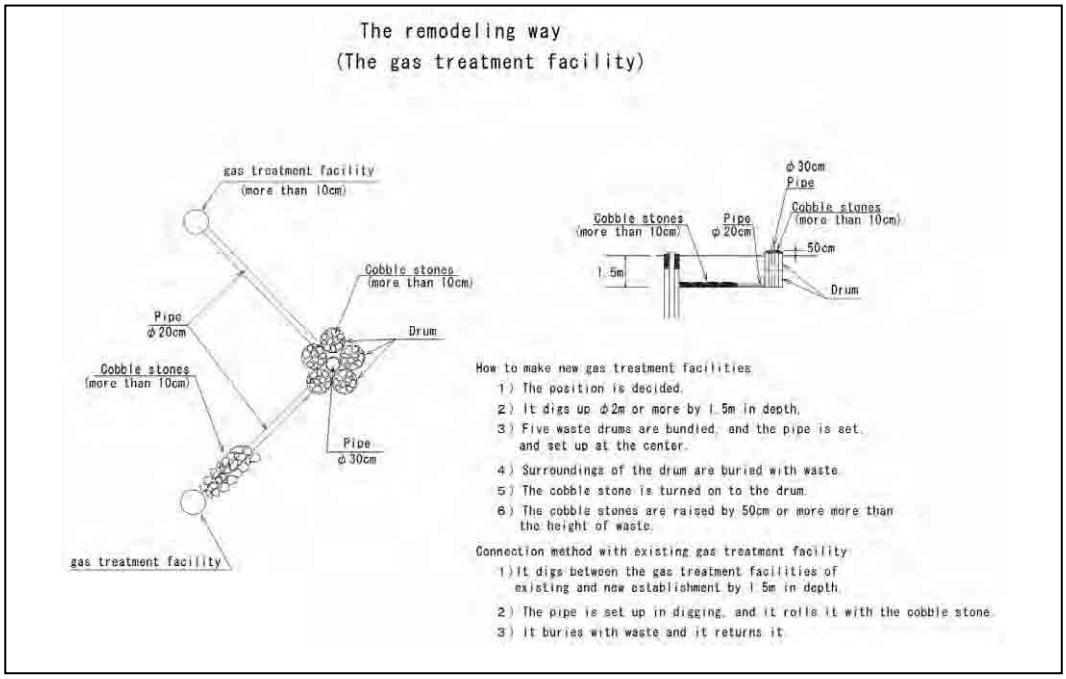


Figure 5.2-12 Improvement Method of Gas Ventilation Facility

Source: JICA Study Team

- The generation of methane gas and hydrogen sulfide was expected during the rehabilitation work of gas ventilation facilities. For implementing this work, the following should be remembered.

(i) Prohibit people from entering the dug waste absolutely

(ii) Prohibit using the fire during work

(iii) Train the staff to be involved in the work to make them understand and prepare for the danger of hazardous gas.

b. Improvement of landfilling method

- The cell method of landfill had been adopted. The relatively thick layer of soil cover adopted might inhibit penetration and distribution of the water to enhance semi-aerobic condition in the waste layer although daily soil covering had been done to control odor generation, waste scatter and annoyance of vermin generation. It should be considered to remove partial or all soil cover of the landfill area before dumping new waste there. Reusing the removed soil cover material as well as reduction of volume of soil covering should be also considered for not only for keeping semi-aerobic condition but also extension of lifetime of the landfill site.

c. Appropriate Plan of Rainwater Drainage

- Judging from the record of monthly precipitation, the rainfall intensity of Kathmandu is high that is observed in short term. It is expected that quick draining of rainwater owing to appropriate drainage plan for the high intensity rainfall in the landfill site would enable considerable reduction of leachate volume in the rainy season. The rainwater drainage plan was proposed as shown in Figure 5.2-13.

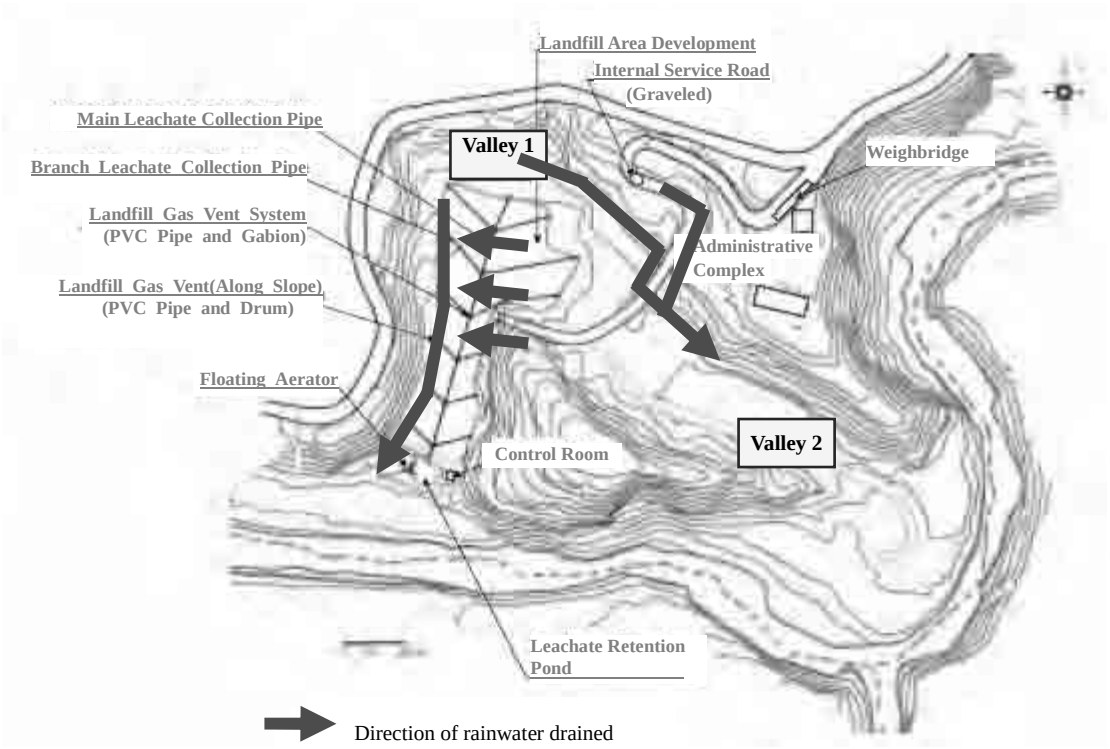


Figure 5.2-13 Proposed Plan for Rainwater Drainage

Source: JICA Study Team

(2) Second Training for Improvement of Operation of Sisdol S/T-LF (December 2006)

The second training for improvement of operation of Sisdol S/T-Lf was conducted in December 2006 as follows. At that time, three units of D-4 bulldozers whose weight were around six ton were allocated at the site. Two among three were in operation, but one was out of order. One wheel excavator was available at site. The dumped waste layer was around 2m in depth.

1) Training for Equipment Maintenance

The following significances of maintenance were highlighted to the operators at the site:

- Extend the lifespan of equipment
- Reduce total cost of repair of equipment by daily check and early detection of malfunction
- Reduce time of work suspension to be caused by equipment troubles

Daily and monthly checklists for equipment were provided and training for how to check and maintain the equipment (bulldozer) was conducted as follows;

* Maintenance at the beginning of work

- Check of conditions of engine oil, coolant water
- Detecting oil leakage in lines, external damage, and missing parts

* Maintenance at the end of work

- Cleaning of equipment
- Check of missing part or parts to be replaced

Since it was afraid that corrosion would occur in the continuous wet condition because waste sticking to underbody was not removed and cleaned in daily maintenance, it was pointed out that galling of driving sprocket would result in big expense for the repair. Swamp type of bulldozer was recommended since the body of bulldozer was sinking during landfill work.

2) Improvement of Gas Ventilation Facility

It was observed in September 2006 that some gas ventilation facilities did not function due to blockage in the pipes. Improvement tried in this training was intended not to solve current blockage in ventilation facilities but to avoid causing blockage in facilities and waste layers to be developed in future.

Improvement Option-1: Modification by foraminate drums and rocks (gas ventilation pipe B8)

The base of the pipe was excavated by 3m from the ground level (G.L.). Then, the pipe and tire existed was removed and new pipe and drums were installed to renovate the ventilation facility (see Figure 5.2-14). Although it was planed to use five drums for one vertical ventilation facility, the actual improvement was implemented by only one drum due to limitation of availability of drums and rocks. The rocks were accommodated for the circumference of vertical pipe above G.L. The diameter of the pile of rocks above G.L. was instructed more than 2 m. Option1 took rather long time to make holes of drums and man power was required to prepare foraminate drums.

Before Improvement After Improvement

Figure 5.2-14 Improvement of the Gas Ventilation Facility with Gravels

Source: JICA Study Team

Improvement Option-2: Installation of materials by excavator (gas ventilation pipe M4)

The following steps were taken for the improvement:

- Step1: The existing facility was removed and the base was excavated before trial
- Step2: Develop small dike of waste circumscribing pile of rocks to raise a pile.

- Step3: Fill rocks into the space between the dike and pipe
- Step4: Repeat above two work steps.

It was reminded that the diameter of pile of rocks to be accommodated for the circumference of vertical ventilation pipe should be more than 2m, and also that the height of rocks pile for the circumference of pipe should be higher than G.L. +50 cm when gas ventilation facility would be developed.

Improvement Option-3: Modification by means of connected drums (gas ventilation pipe B6)

The following steps were taken for the improvement:

- Step1: Removed existing tires and pipes above G.L.
- Step2: Cleaned the remained vertical pipe to be linked to new pipe by high pressure water washer
- Step3: Linked new pipe with remained vertical pipe
- Step4: Cleared the ground around the facility and prepared for installation of drums.
- Step5: Combined five drums to the vertical pipe located at the center.
- Step6: Filled rocks in drums and space between the drum and pipe

It was recommended to use 6-7 drums considering the condition observed after implementation of Improvement Option-3 although only five drums were used in this training. It is better to secure more width for rocks.

Introduction of Option-3

After Improvement

Figure 5.2-15 Improvement of the Gas Ventilation Facility with Used Drum by Landfill Operators

3) Training of leveling, installation of finishing stake showing height for landfilling

To understand the life expectancy of the landfill, progress of waste dumping in terms of landfill capacity should be predicted and monitored based on the amount of waste hauled at the site. It is responsibilities of the supervisor of landfill operation to prepare land formation for access road, appurtenant works such as intermediate and final soil cover. At the site, the height of waste burying had not been managed. Training of leveling was conducted to enhance controlling the shape of buried waste as a part of landfill operation.

Besides, waste height makers were installed so that the operators understand the planned height of waste dumped. Some workers showed concern that height sign could not keep being correct because waste layer would subside. In corresponding to this, it was explained that height sign would be referred as relative standard for operation of waste landfilling. The following training was provided by the Study Team.

- How to use and operate of the level, instructions for operating level
- How to use leveling staff.
- How to write field note.
- Actual leveling work
- Installation of finishing stakes

(3) Third Training for Improvement of Operation of Sisdol S/T-LF (March 2007)

The third training for improvement of operation of Sisdlo S/T-Lf was conducted in March 2007 as follows. As the construction of landfill area of Valley 2 had been finished, first landfilling was also conducted as OJT. During the training, field workshop as well as indoor workshop was conducted by inviting government officials who are relating to landfill operation from six countries, i.e. Mongolia, Vietnam, Pakistan, Sri Lanka, Bangladesh, and Vanuatu. During the filed workshop, Sisdol S/T-LF was introduced followed by explanation of activities for improvement of operation at Valley 1 and beginning landfilling at Valley 2.

1) Situation of Sisdol S/T-LF

The situation of Sisdol S/T-LF was summarized before improvement of the operation in March 2007.

- The gas ventilation pipes in vertical and longitudinal direction had been installed on the waste layers as the countermeasure for clogged ones.
- Bamboo and steel wire were used for the gabions with materials of cobble stones for the gas ventilation facility, which was considered by the operator.
- On-site road had been prepared so that collection vehicle can go to the dumping area for unloading effectively.
- Footage of the bulldozer has been improved based on the previous instruction.

New Gas Ventilation Facility

Bamboo Gabion

Figure 5.2-16 Continuous Improvement of the Gas Ventilation Facility

2) Improvement of Landfill Operation

a. Heavy Equipment

Driving wheels of the landfill compactor had been abraded away mainly due to slipping in the slope. Since it was difficult to carry out compaction of the waste on the slope, the maintenance of the landfill compactor was recommended. The sprocket of driving wheel of bulldozer should be carefully checked to maintain and exchange it in the early stage in order to make the life-span of bulldozer longer. It was also recommended that an excavator with flat bucket was needed for arranging the surface.

b. Landfill Operation at Valley 1

Landfill height markers for the current landfill layer and the final layer above the final soil cover were installed based on landfill operation plan (longitudinal gradient is 2%, 1:3 slope near the embankment). In the process of land height marker installation, how to operate leveling machine was trained (see Figure 5.2-17). It was recommended that waste dumping should be carried out from down stream of valley and depth of waste layer should be deep to prevent increase of ratio of soil in the layer.

Installation of Landfill Height Markers

Level Measurement

Figure 5.2-17 Training of Landfill Level Check

c. Installation of leachate re-circulation bed

In order to treat the leachate effectively, the leachate re-circulation system consisting of was installed recirculation bed (4m x 4m, depth 1m), bamboo gabion (diameter 2m), and four PVC pipes with holes (height approx. 0.2m). Infiltration of sprayed leachate on the bad through the cobble stones was expected as a trickling filter. In order to reduce the surface leachate, the drainage of leachate on the surface landfill layer was also installed into the re-circulation bed.

PVC Pipe in Gabion

Leachate Re-circulation Bed

Figure 5.2-18 Installation of Leachate Re-circulation Bed

d. Gas Ventilation Facility

Bamboo gabion had been adopted for gas ventilation facility. The diameter of the gabion was instructed more than 2m. Drum and steel and drum gabions were also used for the improvement works (see Figure 5.2-19).

Steel Gabion Method

Drum Gabion Method

Figure 5.2-19 Alternatives for the Gas Ventilation Facility Improvement

e. Final Soil Cover

It is important to prevent of infiltration of the rainwater and to drain the rainwater outside landfill area in order to reduce the leachate amount. Final soil cover was carried out for the area near the embankment where the landfill was completed with the instruction of the Study Team as follows (see Figure 5.2-20):

- Depth of final soil cover should be more than 50 cm that is current designed value to prevent the rainwater infiltrate.
- Cell method should be adopted to prevent rain water infiltration.
- The protection sheet to prevent rain water should be installed after the final soil cover.

Final Soil Cover (No. 1)

Final Soil Cover (No. 2)

Figure 5.2-20 Final Soil Covering Practice

f. Landfill Operation at Valley2

Regarding first landfill layer, it was instructed that landfill operation should be carried out from upper stream to down stream. The first waste layer should be 2m depth. After accomplishment of the area near the embankment, the on-site road on left bank should be utilized for landfill operation for the second waste layer from downs stream to upper stream.

As the progress of landfill operation, on-site road (8m width, 30cm height) should be constructed. In addition, the soil with gravel but not only soil can help the vehicles to be easy to drive on on-site road in rainy season due to prevention of the slip.

The leachate collection pipe was concerned due to the collision with heavy equipment and to moving weight of them. To solve the problem, the depth of waste layer was secured more than 2m. Two(2) meter height of movable height markers made of bamboo were installed (see Figure 5.2-21).

Height Markers Installed

Utilization of Bulldozer

Figure 5.2-21 Stating of Landfill Operation at the Valley 2

There were one landfill compactor and one bulldozer (4t) at the site, but they were not enough for proper operation. It was instructed as temporary way that landfill compactor should be used for Valley 1 and the bulldozer should be used for Valley 2 considering the ground condition. The compaction was carried out by a landfill compactor to stabilize the ground on the landfill layer. In addition, allocation of controller for waste collection vehicle was suggested to prevent the downfall from the shoulder of on-site road.

5.3 Recommendations on Further Facility (Landfill Site) Development and Operation

Based on the experience gained from the design, construction and operation of the Sisdol S/T-LF a number of recommendations may be made, which have been considered in the concept design for Banchare Danda LF and/or other landfill sites. Main recommendations are as follows.

(1) Development

1) Leachate pond capacity

At Sisdol S/T LF it was necessary to discharge leachate from the pond into the adjacent river during the rainy season. Although the river flow is strong during the rainy season, it is recommended that a pond with enough capacity to prevent discharge be considered. Accordingly for Banchare Danda LF, the leachate quantity was estimated for 30 years continuously (20 years of operation + 10 years for post closure maintenance).

2) Site internal road system

During the rainy season the site internal road system at Sisdol was unreliable and access of the waste collection trucks to the waste disposal areas was extremely difficult. It is recommended that the internal road system should be designed with all weather roads.

3) Storm water drainage system

The storm water cutoff perimeter drain at Sisdol S/T-LF was not successful at preventing all the mountain water penetrating into the site, and also there was no perimeter drain constructed along the access road towards the site. More attention should be given in the design towards developing facilities to limit the ingress of rainwater into the waste disposal area.

4) Site access control

The Sisdol S/T-LF is still not completely fenced and there is hardly any access control. This is a rather dangerous situation for any unauthorized persons who access the site. The fence and gates must be constructed before the waste receiving commences.

5) Leachate collection system along gentle slopes

Along the northern edge of Sisdol S/T-LF, the slope is gentle. Although the leachate collection system has been installed along the landfill bed, no system is installed along the slopes. Accordingly there is marked ponding in that area. From the development stage leachate collection along the slopes should be considered.

(2) Operation

1) Waste placement to limit leachate generation

In order the operation easier and limit leachate generation, the landfilling site should be divided into sections. Accordingly, the operation guidelines for Banchare Danda have divided the site into four sections.

2) Aeration and re-circulation

Eight (8) units of blowers will be provided at the leachate pond to ensure sufficient aeration. Further the re-circulation system should be improved to include a rigid piping system.

3) Source of suitable cover materials

The cover materials applied at Sisdol S/T LF are clay based and may interfere with the semi-aerobic system. A more suitable source for materials for waste cover should be considered for Banchare Danda LF, including the possibility of mining old waste at Sisdol S/T LF for use as cover.

4) Internal road development

In addition to the road developed before the commencement of the waste disposal, service roads have to be developed periodically to give waste collection trucks easier access to the site.

5) Importance of gas vent extensions and horizontal vent (trenches) development

Much may be learnt from Sisdol S/T LF operation in this regard. The vertical vents should be extended using the gabion nets and surrounded by boulders. The boulders place should be, at minimum, 1.0 m diameter. Furthermore as the waste height increases, in the case of Banchare Danda LF, a secondary system for leachate collection should be constructed (at about 20m levels) to enhance the semi-aerobic system.

CHAPTER 6 RECOMMENDATIONS FOR FURTHER ACTIVITIES

The A/P is a long-term strategic plan to be implemented over the period starting fiscal year 2005/2006 (2062/63) to 2014/15 (2071/2072). In order to ensure implementation of the A/P in an effective and sustainable manner, there needs to be put in place a monitoring and evaluation system that binds together both individual and collective achievements of the SWMRMC and the five municipalities. Although unstable situation of Nepal has much influenced the progress of scheduled activities in the AWPs of the fiscal year 2005/2006 (2062/2063), there have been lessons learned from the fist year's experience. From those further action plans, to be tackled independently by the SWMRMC and the five municipalities, are recommended for implementation.

6.1 Lessons Learned from FY 2005/2006 (2062/2063)

At the series of monitoring sessions, lessons learned from the implementation of the scheduled activities and challenges and constrains faced by the municipalities were collected as follows:

6.1.1 SWM Planning and Budgeting

Introduction of the planning, implementation and evaluation cycle in the municipalities has been found to be useful in practice for more effective solid waste management. AWP preparation and budgeting has had a distinct impact on the municipal programs and budgets for SWM. However, so far an internal monitoring system has not been fully established in the municipalities. It may take time to enroot such an organizational culture in each of the five municipalities. It is therefore recommended that it be mandatory to continue the monitoring system. An annual work planning - budgeting - implementation - evaluation cycle should be practiced in the municipality as an official process.

The A/Ps have been formulated on the basis of present reality. However, considering the currently changeable situation in Nepal, amendments of the A/Ps based on the situation as well as progress of the scheduled activities may be necessary. Therefore, regular periodic reviews including a mid-term review of the A/Ps are recommended. A review of the A/Ps by the central government (MOLD/SWMRMC), with publication of the results, may also help with the practical implementation of the A/Ps.

Annual work planning and program based budgeting has contributed to the building of a linkage between short-term planning of the A/P and activities to be conducted in each fiscal year as a budgeted AWP. Although a small step, this has also contributed to institutionalize the planning/decision making process even though the unstable situation has delayed the process in the last fiscal year. From the experience in the last fiscal year, the daily activities,

such as regular operation (maintenance) and development, should be covered in the AWP to strengthen the institutionalization of the AWP. Before the Study, the entire SWM activities were inclined to be limited to collection and transportation, and budgeting practice was ad hock.

On the other hand, all municipalities immediately have to enhance measures to take in more revenue to make up for the LDF that is expected to fade out by the end of 2013, although the Government has started to take into consideration some financial relief for local municipalities.

The A/P was prepared in a participatory way involving relevant municipal sections and key stakeholders in Task Forces and TWGs. As the relationship of the SWM section with other sections is further enhanced by being involved in the implementation process, it is recommended that this practice be continued.

6.1.2 Remarkable Progress of Activities by Respective Municipalities

(1) KMC

The operation of Sisdol S/T-LF has provided good opportunities to learn about sanitary landfill as well as semi-aerobic landfill development, operation and management. A series of discussions and meetings, which were conducted with the local people to obtain their consensus at different stages, provided experience in involving the local community in the social considerations of landfill management. As disturbances have occurred, from time to time, on different fronts (local people, drivers and politicians) in the operation, the operation and management of SWM facilities especially a landfill site in an environmentally sound manner is a big challenge, which needs to be continuously met by KMC together with LSMC and SWMRMC.

Solid waste reduction at source has been also exercised by KMC. Household and community level composting have been encouraged, such as, through further promotion of home composting and operation of the community-based recycling center (CRC) involving NGOs and CBOs. In order to put the planned waste minimization activities into wider practice, these experiences of community participation should be verified and developed.

(2) LSMC

There has been significant progress in community participation in SWM in LSMC. Several programs on community awareness raising were conducted in the last fiscal year (2005/2006). NGOs/CBOs/Women groups and nature clubs have shown much interest in SWM and they have a good relationship with LSMC and have actively been working in SWM.

Expanding door-to-door collection by the private sector has decreased collection points and there has been an identified improvement in the solid waste collection situation. It may be good experience to proceed with activities on improvement of collection and transportation

system as well as private sector collection. The sanitation and SWM section has been strengthened structurally and technically; for example, the assignment of the environment engineer and arrangement of computers with training. Although the SWM database planning system was a new practice in the municipality, it can now be used continuously for management.

(3) BKM

The municipal authority and local people have their own bias against support from outside. But municipal people/staff have started to realize the need of new approaches and exposure to new practices for better SWM. Although it could not be extended to other areas, waste separation at source with support of organized nature clubs is the best practice, which has been continuously conducted in the last fiscal year, in BKM. Although a good deal of effort is still needed, they are pushing forward with the consultative process of landfill site development by using consultation experiences of source separated collection (and also experiences of Sisdol S/T-LFS) through joint effort and cooperation among the sections concerned and central government.

(4) MTM

MTM staff has been responsive and collective works have been done to implement the scheduled activities in the AWP. The Community Development and Sanitation Section (CDSS), where two staff are working, has been made mainly responsible for implementing the A/P. Under CDSS, efforts for waste minimization have been made at the community level and MTM has sustained promotion and cleaning campaigning. Hiring a collection vehicle has allowed solid waste collection from the city core area to be carried out as scheduled in the AWP. Continuation of these activities is recommended.

It is interesting that MTM has asked other donors, such as World Vision, udle-GTZ and UN-Habitat, to provide support to implement the A/P and AWP. As it may be useful to have collaboration from other donors for putting the scheduled activities into practice, it is also recommended that these attempts be continued.

(5) KRM

The municipality has started to regularize private operators on solid waste collection. The guideline for PPP in SWM, which was developed during the Study, has been adopted and the procurement processes initiated. As mentioned in the guideline for PPP in SWM, the tendering process for PPP was completed and it is expected that selection and agreement will be completed in the near future. Due to there not being a people's representative in the municipality, the municipal authority does not want to take a risk of deciding on this matter. However, the municipal authority has been putting forward this process in consultation meetings with political parties. After the approval, if KRM does sign an agreement with the

selected private parties, KRM will be the first municipality in the valley to complete the formal process of PPP in SWM.

6.2 Lessons Learned from FY 2005/2006 (2062/2063) for Specific Activities

The Action Plans of the SWMRMC and the five municipalities of the Kathmandu Valley have been reviewed and some recommendations regarding the short-term activities presented in their respective Action Plans are made herein.

6.2.1 Collection and Transportation

(1) Secondary Transportation

The current number of new secondary transportation vehicles (STVs) was estimated with the assumption that the future facilitation scenario would follow the umbrella concept in order to optimize the initial investment. Theoretically that number is not enough to transport all the waste collected from KMC and LSMC without proposed facilities such as the new transfer stations in addition to Teku T/S and a waste processing facility. However, in reality, KMC is transporting all of their collected waste to Sisdol S/T-LF. This is the reason why KMC, as much as possible, uses the new STVs and seven units of old multi compactor trucks for secondary transportation, conducting more than 3 trips per day with overtime works and also dispatches tipper trucks with small capacity. Estimation for the number of STVs considered operation efficiency and loading efficiency and apparently the capacity of those STVs seems to be enough.

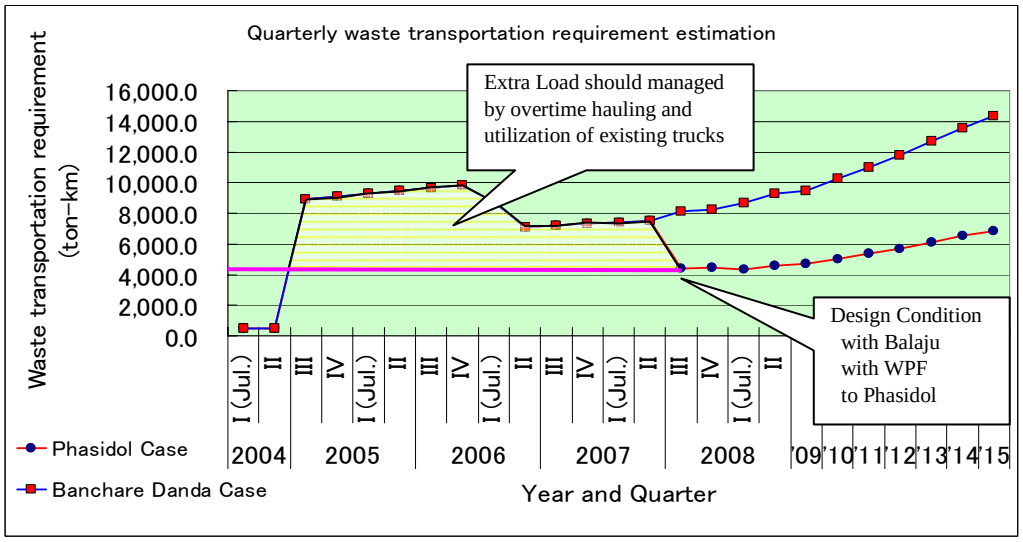


Figure 6.2-1 Design Condition for Estimation of STVs Number in 2004

In the equipment procurement plan under the umbrella concept, it was mentioned at least 25 units of STVs would be needed in the case of waste transportation to Banchare Danda landfill site. This estimation is based on the condition there will be a Balaju transfer station and waste processing facility.

It should be understood that current full-scale transportation to Sisdol LF may be at more than 100% operating efficiency and the capacity could quite easily collapse. Needless to say, the mechanical equipment needs regular maintenance and inspection to maintain this performance. Transportation by small trucks may need more fuel than required if lager ones are used because of the low transportation efficiency and utilization of such small trucks may affect the primary collection system. Therefore, it is recommended that efforts be continued to develop additional transfer stations and waste processing facilities as well as procure additional STVs, at least 4 units.

(2) Operation of Teku Transfer Station

The changes of waste management policy from nighttime collection to daytime collection definitely affect the operation of Teku T/S again. The platform has not been utilized well for waste transferring. KMC is advised to prepare the operation plan of Teku T/S with the participation of local people taking into consideration the waste and vehicle balance into and from the station. In order to operate Teku T/S more effectively, it is required that both entrances to the site are used to segregate haul trucks traffic and collection trucks traffic including utilization of the platform.

The chief of the solid waste management section of KMC, who had experience and skills for waste management planning, left his position in August 2006. Daily operation of the transfer station is required to be conducted by the field level KMC staff as well as before, but it is quite difficult to operate the site without such experienced staff. Therefore, it is recommended that KMC appoint an appropriate person to the position of Section Chief.

It should be also noted that during May, June and July 2006 when all the waste was transported to Sisdol S/T-LF and Bagmati Dump Site was closed, the number of waste pickers at Teku almost doubled. It is recommended that considerations be given to limiting and registering the waste pickers to the number that can work at Teku without hindering the operations and endangering their own safety. It is also necessary to consider options for the remaining waste pickers.

(3) Development of Other Transfer Stations

1) Balaju T/S

Concerning KMC's intention regarding Balaju T/S as shown in their short term plans; it is recommended that KMC immediately prepare a study within the Environment Department on the potential to use that site. Information on estimated costs as well as concept designs and expected environmental issues are presented in this report. If the study finds it suitable to proceed, then it is recommended that KMC proceed with the IEE for the site, and secure the budget for EIA and construction.

2) Afadole T/S

LSMC has determined that a T/S is required in order to transport its waste to Sisdol. Afadole site is conveniently located and has a large area. However the community surrounding the site is expected to object to constructing a T/S there due to the way they have suffered as a result of Balkhu dumping site.

It is recommended that LSMC start studying ways to construct the temporary transfer station at this site, through discussions with the surrounding community. Also LSMC should discuss with KMC and KRM their joint participation in constructing and using Afadole T/S to offset the costs. Also this may help KMC should their effort to construct the Balaju T/S not meet with success.

6.2.2 Waste Minimization

(1) Large-scale Waste Minimization Facility

The SWMRMC and KMC should continue with efforts to solve the issues related with site selection as well as others for development of a waste minimization facility. The authorized working group, which has been organized in the last fiscal year, should be functioning soon.

(2) Local Level Waste Minimization Activities

1) Operation of Medium-scale Vermi-composting

The following are recommended for ensuring the sustainability of the vermin-composting plant operation:

- Supply of vegetable wastes from the vegetable market to the KMC plant should be secured.
- Working environmental conditions should be improved, especially for the rainy season.
- Labor conditions also should be improved, for example salary of staffs/workers should depend on amount of produced compost to increase motivation, and working wear should be supplied.
- Marketing of vermi-compost should be done effectively with an attractive brand, product launch, and promotional activities.
- Improvement of compost quality should be studied, for example using cow-dung as a raw material.
- Entrusting the management of the vermi-composting plant to a suitable NGO or private sector should be considered.
- The plant can be utilized as a training institute for vermin-composting technology.

2) Community-based Waste Minimization Activities

a. Operation of Recycle Center

The following are recommended for sustainable CRC operation:

- A catch phrase on recycling of waste such as "Recycling solves the waste issue and changes trash to cash" should be shown on the CRC booth.
- The purchase price list for recyclable waste including household made compost should be indicated on the CRC booth and distributed with above-mentioned catch phrase.
- Opening hours also should be indicated on the CRC booth.
- The CRC should not only be recycling center, but also an information center on solid waste management at the community level.
- For the sustainability of the Center, the scope of work of the Center has to be expanded in addition to collecting recycling materials.
- KMC should arrange funds to support recycling centers, because all activities cannot be judged in economic profitability. Reduction of waste at the source and reuse of the materials is itself a great activity to reduce pollution.
- The CRCs should be established at other wards based on experience of this CRC.

b. Home Composting Activities

Community based composting is also a useful method for waste minimization. It is desirable that community based composting be expanded based on the successful operation in KMC.

For sustaining and expanding home composting, the following are recommended:

- Municipality should subsidize HCBs as appropriate as possible so that residents can acquire one easily in cheaper price, but should also motivate composting operation by sharing a certain amount of bin cost.
- Periodical monitoring and advice should be done by employing motivators. Trouble shooting for composting operation should also be done quickly and surely.
- HCBs and the operation manual should be improved according to operational experiences.
- Municipality should arrange places/opportunities, like the CRC, for those who want to sell the compost product for earning money.
- Considering the present situation that some compost products are being sold at markets/shops, the sales market of the compost products is expected to be secured. Since the result of the market survey conducted in the Study revealed that there is a potential for use of compost by farmers in and around the valley, Municipality should also monitor and encourage the sales market of the compost products continuously.
- Effectiveness of the home compost product in crop growth should be studied continuously and demonstrated to bin users.
- Information on not only home composting but also other waste minimization activities should be shared through CoMoN meeting periodically.

c. Plastic Separation Activities

Assignment of a motivator is one of reasons for successful continuous activities and remuneration of the activities of plastic separation in KRM. Thus, motivators should be continuously appointed for effective monitoring and follow-up of the activities.

6.2.3 Final Disposal

The action plans of the SWMRMC and the five municipalities of the Kathmandu Valley have been reviewed and some recommendations regarding the short-term activities presented in their respective action plans are made herein.

(1) Sisdol S/T-LF

Although Sisdol S/T-LF is operated mainly by KMC, it is recommended that LSMC and the SWMRMC become more involved in the operation of the site. It is also urgently recommended that KMC, LSMC and the SWMRMC revive the spirit of cooperation upon which the agreement was signed between the three parties and the local residents through honest discussions and mutual understanding of their needs. The OSLSMCC should not resort to closing the site through strikes and the operator, KMC, should improve the site operation.

(2) Banchare Danda LF

The SWMRMC is progressing with the EIA to develop the site. The construction schedule, and particularly the activities and duration required to implement "pre-construction" activities are vital to the commencement of construction.

The SWMRMC should carefully consider its capacity to cope with all the activities related to implementing this large project. Manpower and budget need to be allocated. As required, it is also recommended that the SWMRMC includes KMC and LSMC in the development phase in order to benefit from their strengths as well.

Finally it is recommended that the SWMRMC immediately start preparation for the detailed design of the access road to the site.

(3) Continuity of Sanitary Landfill Operation

The Sisdol S/T LF is expected to be completely filled by January 2008, assuming that all the waste collected at KMC, LSMC and KRM will be brought to the site daily from October 2006[1]. On the other hand, Banchare Danda LF is expected to be ready to receive the waste by July 2009. It is therefore necessary to consider what measures need to be taken to landfill the waste during the period of January 2008 to July 2009.

[1] If there is improved waste placement and compaction (assuming a compacted density of 1 t/m^3 and 20% soil cover) then the Sisdol S/T-LF life may be extended up to July 2008.

One alternative that could be considered is to use the Aletar land purchased by the SWMRMC west of Sisdol S/T LF for a temporary landfill. This is a terraced farmland and a trench method for waste disposal may be applied there. The clay sub-soil expected there may decrease the permeability of the leachate. Cover material may be sourced from the site when preparing the trenches for the waste disposal.

(4) Development of a long-term Landfill for Zone B

It is recommended that BKM seek more community discussion on establishing the landfill site including discussions with communities outside where the proposed site is located. A balance of opinions is needed. Also those agreeable to the project, and probably living far away from the site, need to understand their duty towards those living within the site vicinity.

The SWMRMC should play a larger role in this matter as they are the government agency responsible for development of sanitary landfill within the valley. Again this requires that the SWMRMC enhance both its manpower and budget.

(5) Closure of Bagmati Dumping Site

The action plans of the SWMRMC, KMC and LSMC called for safe closure and rehabilitation of the Bagmati dump site. Nature is kind to Kathmandu Valley as witnessed by the quick growth of green areas around the Bagmati River dumpsite. However problems of methane gas generation as well as leachate still prevail. It is recommended that, in the absence of effective safe closure, people should be warned of the dangers of tapping onto unpurified methane gas, building upon old dump sites and swimming or playing in the river near these areas.

APPENDICES

APPENDIX 1

Members of the CKV Study And Committee

APPENDIX 1 MEMBERS OF THE STUDY AND COMMITTEES

CKV Study Team

Technical Working Group (Total 18 members) *As of March 12, 2007*

Organizations	Name	Designation / Organizational Position
MOLD	Mr. Babu Ram Gautam	Under Secretary
SWMRMC	Mr. Guna Raj Ghimire (Chairperson)	General Manager
	Mr. Ashok Shahi	Civil Engineer
	Mr. Ram Sharan Maharjan	Civil Engineer
KMC	Mr. Rabin Man Shrestha	Head, Environment Department
	Mr. Deepak Ratna Kansakar	Engineer, Solid Waste Management Section
	Mr. Purusotam Shakya	Chief, Mechanical Section
LSMC	Mr. Rudra Prasad Gautam	Chief, Public Works Division
	Mr. Pradeep Amatya	Chief, Environment and Sanitation Section
	Ms. Sabina Maharjan	Staff, Community Development Section
BKM	Mr. Laxman Kisiju	Chief, Physical Planning and Works Section
	Mr. Moti Bhakta Shrestha	Chief, Social Welfare Section
	Mr. Dinesh Rajbhandari	Sanitation Engineer, Physical Planning and Works Section
MTM	Mr. Satya Narayan Shah	Chief, Planning and Technical Section
	Ms. Krishna Kumari Shrestha	Assistant, Community Development and Sanitation Section
	Mr. Keshav Silwal	Legal Officer
	Mr. Surendra Shrestha	Junior Engineer, Planning and Technical Section
KRM	Mr. Anuj Pradhan	Chief, Solid Waste Management Unit
	Mr. Gyan Bazra Maharjan	Assistant, Solid Waste Management Unit/Accounting

Task Force (Total 52 members) *As of March 12, 2007*

Organizations	Name	Designation / Organizational Position
SWMRMC (8)	Mr. Surya Man Shakya	Act. Dean of SchEMS (Former General Manager)
	Mr. Guna Raj Ghimire	General Manager
	Mr. Ashok Shahi	Civil Engineer
	Mr. Ram Sharan Maharajan	Civil Engineer
	Mr. Lal Bahadur Karki	Account Officer
	Mr. Topa Ram Acharya	Administration Officer
	Mr. Ashok Ratna Tuladhar	Consultant Engineer
	Dr. Nawa Raj Khatiwada	Environmental Engineer, SchEMS
KMC (13)	Mr. Rabin Man Shrestha	Head, Environment Department
	Mr. Purusotam Shakya	Chief, Mechanical Section
	Ms. Shriju Pradhan	Community Mobilization Unit
	Ms. Sanu Maiya Maharjan	Community Mobilization Unit
	Mr. Deepak Ratna Kansakar	Engineer, Solid Waste Management Section
	Mr. Krishna P. Kafle	Department of Mines and Geology
	Mr. Puskar L. Shrestha	LIUD (NGO)
	Mr. Basu Upreti	Kathmandu Mahanagar SWM Services
	Mr. Padma S. Joshi	IOE/TU
	Mr. Shirish Singh	ENPHO (NGO)
	Mr. Prakash M. Sharma	PROPUBLIC (NGO)
	Mr. Drona Raj Ghimire	Nefeej
	Mr. Shankar Raj Kandel	Head, International Cooperation and Coordination Department
LSMC (8)	Mr. Prem Raj Joshi	CEO
	Mr. Rudra Prasad Gautam	Chief, Public Works Division
	Mr. Pradeep Amatya	Chief, Environment and Sanitation Section

Organizations	Name	Designation / Organizational Position
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	Mr. Mukunda Ranjit	Overseer, Environment Section
	Mr. Ashok Shrestha	Division Chief, Administrative Division
	Ms. Laxmi Prasad Rajbhandari	Chief, Community Development Section
	Ms. Sabina Maharjan	Staff, Community Development Section
BKM (9)	Mr. Indra P. Karki	CEO
	Mr. Laxman Kisiju	Chief, Planning and Technical Section
	Mr. Moti Bhakta Shrestha	Chief, Social Welfare & Sanitation Section
	Mr. Dinesh Rajbhandari	Sanitation Engineer, Planning and Technical Section
	Mr. Dilip Kumar Suwal	Chief, Sanitation Sub-section
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	Mr. Revid Kusma	Chief, Store Sub-section
	Ms. Ambika Dhauvadel	Chief, Administration Section
	Ms. Ratnamaya Shrestha	Chief, Financial Section
MTM (8)	Mr. Satya Narayan Shah	Chief, Planning and Technical Section
	Ms. Krishna Kumari Shrestha	Assistant, Community Development and Sanitation Section
	Mr. Tulsi Bhakta Tako	Section Chief, Community Development and Sanitation Section
	Mr. Surendra Shrestha	Junior Engineer, Planning and Technical Section
	Mr. Shiva Man Shrestha	Policy Management / Lawyer
	Mr. Kai Prashad Waije	Architect/ Urban Planner
	Ms. Shanti Karanjit	Environmentalist
	Mr. Krishna Sundar Thapamagar	Sub Accountant, Account Section
KRM (6)	Mr. Bal Krishna Maharajan	Chief, Planning and Technical Section
	Mr. Anuj Pradhan	Assistant, Planning and Technical Section
	Mr. Gyan Bazra Maharjan	Assistant, Solid Waste Management/Accounting
	Mr. Krishna Bhola Maharjan	Junior Engineer, Planning and Technical Section
	Mr. Sanu Babu Pariyar	Account Officer, Administration Section
	Mr. Swodesh Maharjan	Unique Group (NGO)

JICA Study Team (Total 12 members) *As of March 12, 2007*

Name	Assignment
Mr. Toshiyuki Ujiie	Team Leader/ Solid Waste Management Policy/ Environmental and Social Considerations
Mr. Shungo Soeda	Deputy Team Leader/ Collection and Transportation/ Recycling System Analysis
Mr. Mahmoud Riad	Waste Management Facility Plan and Operation
Mr. Shigeru Kawanabe/ Mr. Kenichi Yokota	Waste Management Facility Plan and Operation (2)
Mr. Masahiro Saito	Landfill Design
Mr. Kiyoshi Shimizu	Waste Minimization Facility Plan and Design
Mr. Hideo Tsuta	Environmental and Social Considerations (River Engineering/Hydrology)
Mr. Yasuishi Momose	Environmental and Social Considerations (Geology/ Disaster Prevention)
Mr. Satoshi Higashinakagawa	Environmental and Social Considerations (Field Workshop)
Ms. Minako Nakatani	Organization and Institution /Human Resources Development
Mr. Noboru Osakabe	Financial Analysis
Mr. Takahiro Kamishita	Coordinator / Public Relations

Committee

Steering Committee Members *As of March 12, 2007*

Organizations	Name	Position
MOLD (as chairperson)	Mr. Som Lal Subedi	Joint Secretary
MOLD, Environmental Management Section of Municipal Management Division (as member secretary)	Mr. Babu Ram Gautam	Under Secretary, Chief of Environmental Management Section
SWMRMC	Mr. Guna Raj Ghimire	General Manager
KMC	Mr. Dinesh Kumar Thapalia	CEO
LSMC	Mr. Prem Raj Joshi	CEO
BKM	Mr. Indra Prasad Karki	CEO
MTM	Mr. Bishnu Dutta Gautam	CEO
KRM	Mr. Sarjo Guragain	CEO
Ministry of Environment, Science and Technology	Ms. Meera Joshi	Civil Engineer/EIA Expert, Environmental Assessment Section, Environment Division
Ministry of Physical Planning and Works	Mr. Hari Ram Koirala	Joint Secretary
Ministry of Industry, Commerce and Supplies	Mr. Baikuntha Bd. Adhikari	Department of Industry, Director
Ministry of Education and Sports	Mr. Narayan Pd. Kafle	Under Secretary
Ministry of Agriculture and Cooperative	Ms. Bidya Panndey	Horticulture Development Officer
Ministry of Health and Population	Dr. Bishnu Prasad Pandit	Chief Specialist, Curative Division

APPENDIX 2

Action Plans
of Five Municipalities and SWMRMC

Table A 2-1 Strategies and Necessary Activities (KMC)

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08)	**Mid-term (2008/09-2010/11)**	**Long-term (2011/12 – 2014/15)**
		(2062 Shrawan – 2065 Ashadh)	**(2065 Shrawan – 2068 Ashadh)**	**(2068 Shrawan – 2072 Ashadh)**
A: Improvement of Collection and Transportation	A-1: Establishment of efficient solid waste collection system (by private sector participation, and by KMC itself)	A-1-S1: Establishment of rules for private sector collection and its monitoring system A-1-S2: Promotion of private sector participation in door to door collection for 25% of households	A-1-M1: Revision of rules for private sector collection and its monitoring system A-1-M2: Promotion of private sector participation in door to door collection 40% of households	A-1-L1: Revision of rules for private sector collection and its monitoring system A-1-L2: Promotion of private sector participation in door to door collection for 60% of households
		A-1-S3: Preparation of equipment replacement plan and pilot test for a few types of collection vehicles, and commencement of replacement of tractors (for 25% collection)	A-1-M3: Procurement of collection vehicle for replacing tractors (for 50% collection)	A-1-L3: Procurement of collection vehicle for replacing tractors (for 100% collection)
		A-1-S4: Preparation of source separation and collection plan for introduction of waste processing facility	A-1-M4: Introduction of source separate collection for operation of waste processing facility	A-1-L4: Extension of source separate collection areas
		A-1-S5: Introduction of recycling garbage bins to public/tourism areas (1,000 bins per year)	A-1-M5: Monitoring and maintenance of recycling garbage bins at public/tourism areas and extension them if necessary	A-1-L5: Monitoring and maintenance of recycling garbage bins at public/tourism areas and extension them if necessary.
		A-1-S6: Introduction of GIS system for development of a ward and rout-wise collection plan A-1-S7: Improvement of collection and transportation system taking into consideration waste transportation to Sisdol landfill site	A-1-M6: Continuous improvement of collection and transportation system based on the ward and rout-wise collection plan	A-1-L6: Continuous improvement of collection and transportation system based on the ward and rout-wise collection plan
	A-2: Establishment of efficient waste transportation system (by transfer station, by direct transportation)	A-2-S1: Establishment of effective operation system for Teku transfer station A-2-S2: Plan (design), construction and operation of Balaju transfer station (including necessary revision of primary collection route)	A-2-M1: Preparation of a few other transfer points (spots) and their land acquisition	A-2-L1: Commencement of operation of a few other transfer points (spots).
		A-2-S3: Procurement of new direct and secondary transportation vehicles	A-2-M2: Procurement of new direct and secondary transportation vehicles	A-2-L2: Procurement/replacement of direct and secondary transportation vehicles.
		A-2-S4: Establishment of rules and system for transportation of waste from VDCs		
	A-3: Establishment of appropriate maintenance system of equipment and facilities	A-3-S1: Renovation of existing mechanical workshop including replacement of old equipment and establishment of efficient parts stock system A-3-S2: Preparation of new separated workshop for regular service in Teku	A-3-M1: Procurement of necessary equipment for new types of collection and transportation vehicles including training	A-3-L1: Upgrading of mechanical workshops and extension of their service to the private sector.
	A-4: Minimization of illegal open dumping activity	A-4-S1: Clean-up of illegal dumping areas with improvement of primary collection system (along the Bishnumati River)	A-4-M1: Clean-up of illegal dumping areas with improvement of primary collection system (along the Bishnumati River and other Rivers)	A-4-L1: Clean-up of illegal dumping areas with improvement of primary collection system (other areas).
B. Promotion of Waste Minimization	B-1: Development of a central level waste processing facility (WPF) which can receive mixed waste (by private sector participation)	B-1-S1: Cooperation with SWMRMC to proceed development of a central level WPF (50-100 t/d) at appropriate place - Final site selection - Site surveys - Concept design - Feasibility study including market study - Land acquisition - EIA - Detail design - Construction - Others B-1-S2: Cooperation with SWMRMC for commencement of operation of WPF B-1-S3: Monitoring and evaluation of the operation of WPF by the private sector	B-1-M1: Expansion of WPF up to 200-300 t/d B-1-M2: Monitoring and evaluation of the operation of WPF by the private sector B-1-M3: Assistance to private sector for necessary marketing and establishment of a national policy	B-1-L1: Implementation of study on another WPF B-1-L2: Examination of the possible recycling technologies

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08) (2062 Shrawan – 2065 Ashadh)	**Mid-term (2008/09-2010/11) (2065 Shrawan – 2068 Ashadh)**	**Long-term (2011/12 – 2014/15) (2068 Shrawan – 2072 Ashadh)**
	B-2: Promotion of home and community composting and recycling	B-2-S1: Review of the existing home and community composting and recycling activities B-2-S2: Production of home compost bins and home vermi-compost kits and their distribution B-2-S3: Operation of Community Recycling Center (CRC) in Ward 21 and its extension to other Wards (with support from NEREPA)	B-2-M1: Promotion of home bin or vermi-composting to reach total of 5,000 households B-2-M2: Operation of community compost bins in several wards B-2-M3: Operation of CRCs in 18 Wards (50% of wards)	B-2-L1: Promotion of home bin or vermi-composting to reach total of 10,000 households B-2-L2: Operation of at least one community compost bin in each ward B-2-L3: Operation of CRCs in all 35 Wards
	B-3: Operation and expansion of medium-scale vermi-composting	B-3-S1: Operation and expansion of medium-scale vermi-composting B-3-S2: Implementation of a sales campaign together with a marketing study	B-3-M1: Expansion of medium-scale vermi-composting B-3-M2: Marketing of compost as a salable product.	B-3-L1: Establishment of another medium-scale vemi composting facility B-3-L2: Marketing of compost as a salable product.
C. Improvement of Final Disposal System	C-1: Operation of sanitary landfill site	C-1-S1: Operation of Sisdol sanitary landfill site	C-1-M1: Operation of Sisdol sanitary landfill site including receive of rejects from WPF (30-40 t/day)	
	C-2: Development of long-term landfill site	C-2-S1: Conducting of survey for possible long-term landfill sites C-2-S2: Cooperation with SWMRMC to proceed establishment of a long-term landfill site - Site surveys - Concept design - Feasibility study - Land acquisition - EIA - Detail design - Construction - Others	C-2-M1: Continuous cooperation with SWMRMC to proceed establishment of the long-term landfill site C-2-M2: Cooperation with SWMRMC for commencement of operation of the long-term landfill site C-2-M3: Procurement of necessary heavy equipment for landfilling	C-2-L1: Operation of the long-term landfill site
	C-3: Appropriate closure of used landfill site	C-3-S1: Rehabilitation and landscaping works of the Bagmati (Balkhu) dumping site	C-3-M1: Continuous rehabilitation and landscaping works of the Bagmati (Balkhu) dumping site C-3-M2: Cooperation with SWMRMC for closure of Sisdol landfill site	C-3-L1: Cooperation with SWMRMC for closure of Sisdole Landfill site
D. Promotion of Public Participation and Behavior Change	D-1: Expansion of "BABA Program-children as effective agents of social changes"	D-1-S1: Establishment of 50 more Nature Clubs D-1-S2: Development of training packages on - Solid Waste Management - Greenery Promotion - Culture and Heritage Conservation - Communication - Nature club management D-1-S3: Training for Nature Clubs members on the above five areas D-1-S4: Regular interaction between Nature Clubs and local communities to reach out to society as a whole	D-1-M1: Establishment of 100 more Nature Clubs D-1-M2: Training for Nature Club members on the five areas of work D-1-M3: Regular interaction between Nature Clubs and surrounding communities to reach out to the society as a whole	D-1-L1: Establishment of 200 more Nature Clubs and reach 400 in total D-1-L2: Training for Nature Club members on the five areas of work D-1-L3: Regular interaction between Nature Clubs and surrounding communities to reach out to the society as a whole
	D-2: Support of community initiatives working with community groups, NGOs/CBOs and private sector	D-2-S1: Development of a database of community groups, NGOs/CBOs and private sector, and selection of the best ones for long term works D-2-S2: Review and evaluation of the existing Ward Environmental Committee (WEC) and formation of active WECs in 10 Wards D-2-S3: Provision of training on SWM and community mobilization for WECs D-2-S4: Provision of technical and financial assistance to best community initiatives of WECs D-2-S5: Provision of annual award to best WEC	D-2-M1: Formation of WECs in 20 more Wards D-2-M2: Implementation of regular interaction and exchange visits among WECs D-2-M3: Provision of technical and financial assistance to best community initiatives of WECs D-2-M4: Regular follow-up of WECs	D-2-L1: Provision of technical and financial assistance to best community initiatives of WECs D-2-L2: Implementation of regular interaction and exchange visits among WECs D-2-L3: Regular follow-up of the WECs

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08) (2062 Shrawan – 2065 Ashadh)	**Mid-term (2008/09-2010/11) (2065 Shrawan – 2068 Ashadh)**	**Long-term (2011/12 – 2014/15) (2068 Shrawan – 2072 Ashadh)**
	D-3: Mobilization of City Volunteers (CVs) as a linkage between KMC and citizen	D-3-S1: Mobilization of City Volunteers (CVs) to support BABA program D-3-S2: Implementation of closed camps for capability building and raising team spirit of each batch D-3-S3: Mobilization of CVs in other programs such as promotion of household composting, research, and WEC activities D-3-S4: Recruiting and training of new batch of CVs every year	D-3-M1: Mobilization of CVs in other programs such as promotion of household composting, research, recycling, and WEC activities D-3-M2: Review the past batch and if demand is higher two batches can be managed	D-3-L1: Recruit new batch of 100 CVs every year from different academic backgrounds D-3-L2: Review the past batch and if demand is higher two batches can be managed
	D-4: Implementation of mass communication education programs	D-4-S1: Production of CMU's promotional materials (flyers, brochures, posters, stickers, etc.) D-4-S2: Setting up of hoarding boards on SWM in prime locations of the city D-4-S3: Setting up of self-explanatory displays on SWM at CMU, and other key locations for wider publicity D-4-S4: Regular featuring and reporting on SWM on TV program "Hamro Kathmandu" D-4-S5: Design and maintenance of the web page on SWM D-4-S6: Implementation of community exhibition and event regularly	D-4-M1: Setting up of displays and information on SWM as an environmental park in Teku transfer station D-4-M2: Hosting Web Site on SWM and update the site D-4-M3: Review and continuation of the other media campaign programs (same as short-term activities)	D-4-L1: Review and continue the media campaign programs
	D-5: Strengthening of Community Mobilization Unit (CMU)	D-5-S1: Recruiting of a BABA coordinator D-5-S2: Recruiting of assistant level staff for administration D-5-S3: Provision of adequate office space, equipment and financial resources	D-5-M1: Upgrading of CMU with Environmental Information, Education and Communication Section D-5-M2: Provision of specialists' service in community mobilization, children's program, waste management, mass education, etc.	D-5-L1: Well established section in the department providing public services on environment management as a whole.
E Organizational and Institutional Arrangement	E-1: Rationalize organization and institution arrangements	E-1-S1: Implementation of the reorganization plan of the Environment Department	E-1-M-2: Transfer of PPP administrative matters to PPP Specialized Department within the Municipality.	E-1-L1: Monitor and regularly review organizational arrangements to correspond with changing institutional needs.
	E-2: Strengthening of management practices	E-2-S1: Establishment of a monitoring and evaluation system in alignment with the Action Plan E-2-S2: Mainstreaming of program-based budgeting system and expenditure monitoring for a more efficient use of resources E-2-S3: Improvement of information flow and management by encouraging regular coordination meetings and sharing of experiences	E-2-M1: Implementation of a mid-term evaluation on the progress of the Action Plan implementation E-2-M2: Continuous implementation of program-based budgeting system and expenditure monitoring E-2-M3: Continuous implementation of information flow and management by regular coordination meetings and sharing of experiences	E-2-L1: Implementation of a final evaluation on the results achieved from the Action Plan implementation E-2-L2: Continuous implementation of program-based budgeting system and expenditure monitoring E-2-L3: Continuous implementation of information flow and management by regular coordination meetings and sharing of experiences
		E-2-S4: Introduction of systematic collection and analysis of SW data by database	E-2-M4: Continuous collection and analysis of SW data by database	E-2-L4: Continuous collection and analysis of SW data by database
	E-3: Appropriate staffing arrangement	E-3-S1: Preparation of TORs for each unit delineating tasks and responsibilities to be undertaken during Action Plan implementation E-3-S2: Reassignment of necessary staff (Taking into consideration future human resource demands such as for facilities development)	E-3-M1: Establishment of a more effective staff performance evaluation system E-3-M2: Establishment of staffing system based to "assign the right person to the right position" using objective criteria such as staff performance evaluation. E-3-M3: Reassignment of necessary staff. (Taking into consideration future human resource demands such as for facilities development)	E-3-L1: Continuation of mid-term activities E-3-L2: Continuation of mid-term activities E-3-L3: Continuation of mid-term activities

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08) (2062 Shrawan – 2065 Ashadh)	**Mid-term (2008/09-2010/11) (2065 Shrawan – 2068 Ashadh)**	**Long-term (2011/12 – 2014/15) (2068 Shrawan – 2072 Ashadh)**
	E-4: Strengthening institution to be systematic and sustainable	E-4-S1: Development of a staffing plan based on HRD program and its application E-4-S2: Assignment of a Learning Manager for HRD, and maintain an inventory of staff skills knowledge, and training history E-4-S3: Strengthening of knowledge-sharing mechanism and peer-training sessions for full utilization of existing human resources.	E-4-M1: Development of mid to long-term HRD program and its application in line with HRD program E-4-M2: Implementation of in-house training modules systematically designed for staff development E-4-M3: Appointment of full time human resource management staff within Environment Department	E-4-L1: HRD program regularized and opened to external partners for resource mobilization.
F. Others	F-1: Development of a medical waste management system	F-1-S1: Dissemination of Medical Waste Management Guidelines F-1-S2: Operation of a medical waste treatment facility at Teku F-1-S3: Procurement of additional equipment (auto clave) F-1-S4: Training for staff of KMC, private sector and medical institutions F-1-S5: Handing over the responsibility to the private sector for the operation F-1-S6: Monitoring & evaluation of the system	F-1-M1: Establishment of a central level medical waste treatment facility F-1-M2: Continue awareness programs F-1-M3: Continue monitoring & evaluation	F-1-L1: Continuous treatment of medical waste
	F-2: Development of a hazardous waste management system		F-2-M1: Implementation of study on hazardous waste management	F-2-L1: Development of hazardous waste management system (Computers, Batteries, Industrial waste, etc.)
	F-3. Gradual and effective privatization with special consideration to the sweeper population.	F-3-S1: Review of working conditions of the sweeper population and provision of measures to improve their performance. F-3-S2: Regularize privatization procedures applying open bidding process F-2-S3: Establishment of regular coordination mechanisms with various private operators	F-3-M1:Increased coverage by private sector (Up to 50% of collection coverage, without any drastic decrease of sweeper population)	F-3-L1: Increased coverage by private sector. (Up to 60% of collection coverage, without drastic decrease of sweeper population)

Source: KMC Task Force

Table A 2-2 Strategies and Necessary Activities (LSMC)

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08)	**Mid-term (2008/09-2010/11)**	**Long-term (2011/12 – 2014/15)**
		(2062 Shrawan – 2065 Ashadh)	**(2065 Shrawan – 2068 Ashadh)**	**(2068 Shrawan – 2072 Ashadh)**
A. Improvement of Collection and Transportation	A-1: Promotion of private sector collection	A-1-S1: Review of existing policy of LSMC and establishment of strong bylaws (and rules) interacting with all stakeholders and its publication (focus on private sector involvement, paying system and assurance of municipal sweeper's job guarantee while handing over to private sector) A-1-S2: Preparation of standard TOR and agreement for PPP concept A-1-S3: Introduction of a new pilot project for waste collection from shops by private sector A-1-S4: Newly introduction of door to door collection for 25% houses at the outside the city core area by private sector (by the end of 2007)	A-1-M1: Revision of rules for private sector based on the short-term activities (from pilot projects). A-1-M2: Development of effective account system to control revenue from private sector to office A-1-M3: Expansion of pilot projects in other areas of city with correction of weakness. A-1-M4: 50 % door to door collection by private sector (Some municipal old vehicles to be handed over to private sector under leased TOR) A-1-M5: Preparation of a plan for private sector transportation (PPP as an alternative)	A-1-L1: Revision of rules for private sector based on the mid-term activities. A-1-L2: 70 % door to door collection by private sector A-1-L3: Initiation of transportation of collection points to transfer station by private sector
	A-2: Improvement of collection and transportation system	A-2-S1: Implementation of Time and Motion study A-2-S2: Introduction of new collection routes. A-2-S3: Implementation of transportation and maintenance cost analysis A-2-S4: Implementation of vehicle capacity analysis and plan for procurement of new vehicles	A-2-M1: Continuous review and improvement of collection and transportation system	A-2-L1: Continuous review and improvement of collection and transportation system
	A-3: Arrangement of a temporary transfer station	A-3-S1: Arrangement of a temporary transfer station (in Afadole) and commencement of temporary transferring	A-3-M1: Closure of the temporary transfer station	
B. Promotion of Waste Minimization	B-1: Development of a waste processing facility (WPF)	B-1-S1: Cooperation with SWMRMC and KMC for development of WPF (development, commencement of operation)	B-1-M1: Transportation of waste to WPF	
	B-2: Promotion of home composting activities	B-2-S1: Distribution of 1,200 home compost bins	B-2-M2: Distribution of 1,200 home compost bins	B-2-L1: Distribution of 1,200 home compost bins
	B-3 Promotion of 3Rs practices	B-3-S1: Promotion of 3Rs practices by local people	B-3-M1: Promotion of recycle centers at community level and individual level for minimization of waste at source. B-3-M2: Establishment of bulky waste recycling system by promoting establishment of second hand shops	B-3-L1: Establishment of recycle centers for 3Rs with PPP concept for waste pickers and promotion of plastic bag and paper recycling B-3-L2: Establishment of a medium-scale recycle centre near T/S.
C. Improvement of Final Disposal System	C-1: Operation of sanitary landfill site	C-1-S1: Operation of Sisdol LF with KMC C-1-S2: Cooperation with SWMRMC and KMC for development of long term landfill site C-1-S3: Closure of Bagmati dumping site	C-1-M1: Operation of Sisdol sanitary landfill site with KMC C-1-M2: Continuous coordination with SWMRC and KMC for development of long term landfill site	C-1-L1: Operation of long term landfill site
D. Promotion of Public Participation and Behavior Change	D-1:Implementation of mass communication and education	D-1-S1: Implementation of public awareness/education activities - Regular mechanism for awareness materials. Journal publication, drama, community interactions, reward, prize, visit, observation, establishment of SWM day.	D-1-M1: Continuous implementation of public awareness/education activities - Regular mechanism for awareness materials. Journal publication, drama, community interactions, reward, prize, visit, observation, establishment of SWM day.	D-1-L1: Continuous implementation of public awareness/education activities - Regular mechanism for awareness materials. Journal publication, drama, community interactions, reward, prize, visit, observation, establishment of SWM day.
	D-2: Formulation and mobilization of various groups for SWM	D-2-S1: Formation and mobilization of Ward Environment Conservation Committee (WECC) on a pilot basis D-2-S2: Formation and mobilization of Nature/Eco Clubs among children D-2-S3: Mobilization of youth as City Volunteers (CVs) D-2-S4: Strengthening of women groups for SWM	D-2-M1: Formation of 44 community groups in some wards for awareness raising and composting focusing on child education involving retired persons. Community development section will handle these groups	D-2-L1: Formation of 100 community groups in all wards for awareness raising and composting focusing on child education involving retired persons

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08) (2062 Shrawan – 2065 Ashadh)	**Mid-term (2008/09-2010/11) (2065 Shrawan – 2068 Ashadh)**	**Long-term (2011/12 – 2014/15) (2068 Shrawan – 2072 Ashadh)**
E. Organizational and Institutional Arrangement	E-1: Implementation of HRD program	E-1-S1: Plan for HRD and monitoring including municipal staff/NGOs/CBOs/TLOs	E-1-M1: Proper available HRD management and monitoring. Establishment of motivating working environment.	E-1-L1: Establishment of HRD and Database Section in SWM division
	E-2-Preparation of annual work plan on SWM	E-2-S1: Announcement of SWM overall yearly plan of LSMC at beginning of each fiscal year.	E-2-M1: Announcement of SWM overall yearly plan of LSMC at beginning of each fiscal year.	E-2-L1: Announcement of SWM overall yearly plan of LSMC at beginning of each fiscal year.
	E-3: Clarification of responsibility and promotion of coordination between SWM relating divisions and sections	E-3-S1: Review of SWM organization (Environment Dept.) and appoint responsible persons as a focal point to coordinate all dimensions of SWM with motivating environment	E-3-M1: Review of responsibility overlaps and decision-making simplification. E-3-M2: Establishment of 24 hr hot line for receiving complains	
	E-4: Setting up tariff system	E-4-S1: Implementation of study on tariff system to introduce paying system	E-4-M1: Revision of effectiveness of paying system. Review of tariff. Make punishment system.	E-4-L1: "Enact Municipal SWM law" from national government. E-4-L2: Preparation of municipal ordinance E-4-L3: Dissemination of those laws and ordinance to public, TLOs and NGOs
	E-5: Management of solid waste database system	E-5-S1: Collection and arrangement of solid waste data in database E-5-S2: Implementation of waste quantity and quality survey twice a year (wet and dry seasons)	E-5-M1: Continuous arrangement of solid waste data by database system E-5-M2: Continuation of implementation of waste quantity and quality surveys twice a year (wet and dry seasons)	E-5-L1: Continuous arrangement of solid waste data by database system E-5-L2: Continuity of waste quantity and quality surveys twice a year (wet and dry seasons).
F. Others	F-1: Promotion of special waste management system	F-1-S1: Examination of medical waste treatment system	F-1-M1: Establishment of a common and centre level medical waste treatment facility (incinerator)	F-1-L1: Effective use of medical waste treatment system.

Source: LSMC Task Force

Table A 2-3 Strategies and Necessary Activities (BKM)

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08) (2062 Shrawan – 2065 Ashadh)	**Mid-term (2008/09-2010/11) (2065 Shrawan – 2068 Ashadh)**	**Long-term (2011/12 – 2014/15) (2068 Shrawan – 2072 Ashadh)**
A: Improvement of Collection and Transportation	A-1: Revision of collection system	A-1-S1: Procurement of a garbage tipper and tricycles	A-1-M1: Revision of waste collection route and extension of collection service areas to new urban settlements out of the core area	A-1-L1: Continuation of mid-term activities A-1-L2: Operation of transfer station
	A-2: Promotion of source separated collection (by community mobilization)	A-2-S1: Promotion of source separation and collection of organic kitchen waste by formulating users groups at local household level A-2-S2: Promotion of source separation and collection from hotels and restaurants	A-2-M1: Promotion of source separation and collection of organic kitchen waste at source by formulating users groups at local level and facilitated, bound with terms and conditions by the Municipality	A-2-L1: Continuation of mid-term activities
B. Promotion of Waste Minimization	B-1: Improvement and extension of existing composting facility (inclusive of transfer station)	B-1-S1: Procurement of a 10 t/d capacity excavator or backhoe loader, and waste sorting device B-1-S2: Land acquisition of extension area B-1-S3: Infrastructure development (open trussed shade, garage, parking area, weighbridge, sorting area, screening area, etc.)	B-1-M1: Commencement of operation of extended municipal composting facility (Phase I) along with marketing of compost produced with informative packing system	B-1-L1: Commencement of operation of extended municipal composting facility (Phase II) along with marketing of compost produced with informative packing system
	B-2: Waste minimization by community mobilization (community based solutions towards SWM)	B-2-S1: Promotion of waste minimization by making people well known with various methods of waste reduction at sources (e.g. home compost bins and vermi-composting, gift and educational training tools for school children from waste) B-2-S2: Installation of small scale bins/container at or nearby open waste collection spots or nearby ward office for keeping unusable broken glass, bulbs, tube lights etc. which are nuisance to municipal compost, and monitoring and operation by the local people	B-2-M1: Continuation of short-term activities	B-2-L1: Continuation of mid-term activities
	B-3: Trial of community level composting	-	B-3-M1: Introduction of closed chamber composting in new urban settlements out of the core area on pilot basis (Tole/Ward Basis) by formulating users groups at local level	B-3-L1: Continuation of mid-term activities
C. Improvement of Final Disposal System	C-1: Development of sanitary landfill site	C-1-S1: Topographical survey and soil investigation C-1-S2: Completion of EIA procedure C-1-S3: Detail design of the site with mitigation measures as recommended by EIA study - including waste processing facility within the landfill site along with leachate treatment facility and buffer zone C-1-S4: Land acquisition and resettlement of the directly affected dwellers in and nearby the site C-1-S5: Construction of the access road	C-1-M1: Completion of the access road construction C-1-M2: Completion of the site construction (Phase I area) C-1-M3: Formulation of the Environmental Monitoring Committee for the regular/periodic monitoring of the site C-1-M4: Commencement of Operation & Management of the site (Phase I area) along with waste processing facility	C-1-L1: Completion of the site construction (Phase II area) C-2-L2: Commencement of Operation & Management of the site (Phase II area) along with waste processing facility C-1-L3: Follow up of the Environmental Monitoring Committee's Activities regularly and periodically for proper Operation & Management of the site
	C-2: Procurement of equipment and vehicles for the operation of the site		C-2-M1: Procurement of heavy equipment (Garbage Tipper, Backhoe Loader, Roller, Mini -excavator, waste-sorting device, weighbridge, etc.)	
	C-3: Involvement of affected people in the development works of the site	C-3-S1: Establishment of local committee for social consensus for the development of the site C-3-S2: Consideration of community development works	C-3-M1: Implementation of community development works	C-3-L1: Continuous implementation of community development works

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08) (2062 Shrawan – 2065 Ashadh)	**Mid-term (2008/09-2010/11) (2065 Shrawan – 2068 Ashadh)**	**Long-term (2011/12 – 2014/15) (2068 Shrawan – 2072 Ashadh)**
	C-4: Implementation of research study	C-4-S1: Implementation of research study to define the leachate quality of the dumped waste at the current dumping site & the past dumping site for comparative analysis (on contamination of natural water body by solid waste disposal & liquid waste)	C-4-M1: Continuation of short-term activities	
D. Raising of Public Participation and Behavior Change	D-1: Implementation of public awareness and education on SWM	D-1-S1: Development of training tools/materials for community participation	D-1-M1: Continuation of short-term activities	D-1-L1: Continuation of short-term activities
		D-1-S2: Dissemination of information regarding SWM inclusive collection system (leaflets, brochures, calendars, advertisements in halls before starting of film show)	D-1-M2: Continuation of short-term activities	D-1-L2: Continuation of mid-term activities
		D-1-S3: Implementation of mass communication and education program (distribution of stickers, posters, drama play, competition among children group-drama, original stage drama during Gaijatra festival, drawing wall paintings, cleansing at the local communities)	D-1-M3: Continuation of short-term activities	D-1-L3: Continuation of mid-term activities
			D-1-M4: Periodic orientation classes on community based SWM in various schools in BKM D-1-M5: Mass meeting and procession at least once a year on Environment Day (June 5)	D-1-L4: Periodic orientation classes on community based SWM in various schools in BKM D-1-L5: Mass meeting, procession at least once a year on Environment Day (June 5)
	D-2: Promotion of interpersonal communication and education on SWM	D-2-S1: Promotion of Interpersonal Communication and Education program with arrangement of agreement with NGO such as selection of target communities, orientation workshop, baseline information survey in regard to existing knowledge, attitude, practices on SWM, counselor training camp for youth, teachers who support children's activities on SWM at the targeted communities	D-2-M1: Continuation of short-term activities	D-2-L1: Continuation of mid-term activities
E. Organizational and Institutional Arrangement	E-1. Organizational restructuring and strengthening	E-1-S1: Implementation of training on SWM based on the TNA E-1-S2: Finalization of organizational restructuring for SWM	E-1-M1: Recruit desired manpower for long-term SLF for proper management & operation E-1-M2: Establishment of Mechanical Section (MS)/Subsection (MSS)	E-1-L1: Extension of Mechanical Workshop Facilities
	E-2: Management of solid waste data by database	E-2-S1: Collection of relating data for SWM E-2-S2: Arrangement of the collected data in the database	E-2-M1: Establishment of data collection system E-2-M2: Continuous solid waste data arrangement in the database	E-2-L1: Continuous solid waste data arrangement by database
F. Others	F-1: Delegation of authority to communities and private sector	F-1-S1: Involvement of CBOs in collection and transportation of organic waste from households, hotels & restaurants on pilot basis (on Tole/Ward basis)	F-1-M1: Involvement of CBOs in collection and transportation of organic waste from households, hotels and restaurants (on Tole/Ward basis)	F-1-L1: Involvement of CBOs in collection and transportation of organic waste from households, hotels and restaurants (on Tole/Ward basis)
	F-2: Optimization of management efficiency and establishment of cost-effective SWM	F-2-S1: Commencement of private sector participation in SWM on pilot basis with different approaches - Case I: Only street sweeping by community level workers - Case II: Door to Door service - Case III: Both I &II - Case IV: Collection of Organic Waste from Hotels & Restaurants - Case V: Collection, transportation & Sale of Recyclable/Reusable Waste	F-2-M1: Expansion of private sector participation in SWM	F-2-L1: Expansion of private sector participation in SWM with different approaches

Tale A.2-4 Strategies and Necessary Activities (MTM)

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08)	**Mid-term (2008/09-2010/11)**	**Long-term (2011/12 – 2014/15)**
		(2062 Shrawan – 2065 Ashadh)	**(2065 Shrawan – 2068 Ashadh)**	**(2068 Shrawan – 2072 Ashadh)**
A. Improvement of Collection and Transportation System	A-1: Procurement of collection vehicles	A-1-S1: Procurement of collection vehicle(s) and assignment of a driver, collectors and loaders	A-1-M1: Procurement of collection vehicle(s)	A-1-L1: Procurement of collection vehicle(s)
	A-2: Extension of collection area	A-2-S1: Setting “depo (s)” at new collection areas	A-2-M1: Setting “depo (s)” at new collection areas	A-2-L1: Setting “depo (s)” at new collection areas
	A-3:Introduction of systematic private sector collection	A-3-S1: Preparation of guidelines for private sector collection	A-3-M1: Introduction of privatized collection system (Wards 15, 16 and 17) as pilot project	A-3-L1: Extension of privatized collection system to other Wards
B. Promotion of Waste Minimization	B-1: Promotion of separation at source	B-1-S1: Training of local people for separation at source	B-1-M1: Continuous training of local people for separation at source	B-1-L1: Continuous training of local people for separation at source
	B-2: Promotion of plastic recycling	B-2-S1: Providing of bags and metal strings (suiros) for separation at source	B-2-M1: Continuous provision of bags and metal strings (suiros) for separation at source	B-2-L1: Continuous providing of bags and metal strings (suiros) for separation at source
	B-3: Promotion of community (tole) composting	B-3-S1: Providing 25 compost drums for communities (toles) B-3-S2: Operating community composting	B-3-M1: Providing additional 25 compost drums for communities (toles) B-3-M2: Operating community composting	B-3-L1: Providing additional 25 compost drums for communities (toles) B-3-L2: Operating community composting
C. Improvement of Final Disposal System	C-1: Discourage of current dumping practices	C-1-S1: Identification and arrangement of a temporary landfill site	C-1-M1: Closure of the temporary landfill site	-
	C-2: Transportation of waste to Taikabu LF	C-2-S1: Conclusion of agreement with BKM for development and utilization of Taikabu LF	C-2-M1: Commencement of transportation of waste to Taikabu LF	C-2-L1: Continuous transportation of waste to Taikabu LF
D. Promotion of Public Participation and Behavior Change	D-1: Promotion of public awareness and education on SWM through mass communication and education	D-1-S1: Raising of public awareness through local radio (FM) and miking D-1-S2: Implementation of public events	D-1-M1: Raising of public awareness through local radio (FM) and miking D-1-M2: Implementation of public events	D-1-L1: Raising of public awareness through local radio (FM) and miking D-1-L2: Implementation of public events
	D-2: Promotion of public awareness and education on SWM through local level activities such as woman’s club and CBOs.	D-2-S1: Development of training tools and promotion materials for community participation D-2-S2: Formation and mobilization of Eco/Nature Clubs at schools. D-2-S3: Formation and mobilization and skills development of community groups for SWM D-2-S4: Implementation of community-based clean up program D-2-S5: Mobilization of youth as city volunteers for SWM	D-2-M1: Development of training tools and materials for community participation D-2-M2: Providing tools and package programs (e.g. incentives) for school children and clubs D-2-M3: Implementation of community-based clean up program	D-2-L1: Development of training tools and materials for community participation D-2-L2: Providing tools and package programs (e.g. incentives) for school children and clubs D-2-L3: Implementation of community-based clean up program
E. Organizational and Institutional Arrangement	E-1: Organizational and institutional restructuring, and strengthening	E-1-S1: Strengthening of SWM Sub-section	E-1-M1:Setting up separate Environment and Sanitation Section	
	E-2: Management of solid waste data by database	E-2-S1: Collection of relating data for SWM E-2-S2: Arrangement of the collected data in the database	E-2-M1: Continuous data arrangement in the database	E-2-L1: Continuous data arrangement in the database

Source: MTM Task Force

Table A2-5 Strategies and Necessary Activities (KRM)

Approaches	Strategies	Necessary Activities		
		Short-term (2005/06-2007/08)	**Mid-term (2008/09-2010/11)**	**Long-term (2011/12 – 2014/15)**
		(2062 Shrawan – 2065 Ashadh)	**(2065 Shrawan – 2068 Ashadh)**	**(2068 Shrawan – 2072 Ashadh)**
A. Improvement of Collection and Transportation System	A-1: Involvement of private sector for extension of collection area	A-1-S1: Preparation of agreements with private sector (NGOs/CBOs) and conclusion of the contracts (up to two parties)	A-1-M1: Increase of involvement of private sector (up to four parties)	A-1-L1: Continuation of mid-term activities
B. Promotion of Waste Minimization	B-1: Establishment of a community composting facility	B-1-S1: Selection and arrangement of land for a community composting facility	B-1-M1: Development of a community composting facility	B-1-L1: Expansion of the established community composting facility
	B-2: Promotion of home composting	B-2-S1: Promotion of home composting program (by providing bins, bags)	B-2-M1: Promotion of home composting program (by providing bins, bags)	B-2-L1: Continuation of mid-term activities
	B-3: Promotion of proper management of plastics	B-3-S1: Continuous implementation pilot bases separated collection of plastic bags (by providing wires (suiros), etc.)	B-3-M1: Expansion of target areas for separated collection of plastic bags	B-3-L1: Continuation of mid-term activities
C. Improvement of Final Disposal System	C-1: Transportation of the waste to the nearest transfer station	C-1-S1: Coordination with KMC for utilization of Teku transfer station	C-1-M1: Procurement of a vehicle for transportation of the collected waste C-1-M2: Transportation of the collected waste to the nearest transfer station	C-1-L1: Transportation of the collected waste to the nearest transfer station
D. Promotion of Public Participation and Behavior Change	D-1: Dissemination about SWM by education program	D-1-S1: Implementation of education program on SWM for school children and households (by promoting home composting, plastic bag separation, etc.)	D-1-M1: Continuation of short-term activities	D-1-L1 Continuation of midterm activities
E. Organizational and Institutional Arrangement	E-1: Establishment of SWM unit/section	E-1-S1: Establishment of a section (unit) on SWM	E-1-M1: Strengthening of SWM unit	E-1-L1: Establishment of SWM Section
	E-2: Implementation of HRD program	E-2-S1: Implementation of staff training on SWM and other related skills	E-2-M1: Implementation of staff training on SWM and other related skills	E-2-L1: Implementation of staff training on SWM and other related skills
	E-3: Management of solid waste data by database	E-3-S1: Collection of related data for SWM from private sector E-3-S2: Arrangement of the collected data in the database	E-3-M1: Establishment of data collection system from private sector E-3-M2: Continuous data arrangement in the database	E-3-L1: Continuous data arrangement in the database
F. Others	F-1: Coordination among all SWM stakeholders	F-1-S1: Coordination with SWMRMC, neighboring municipalities and NGOs/CBOs	F-1-M1: Continuation of short-term activities	F-1-L1: Continuation of mid-term activities

Table A2-6a Action Plan of SWMRMC (for Organizational and Institutional Development)

Related main issues to be tackled	Necessary Activities		
	Short-term (2005/06-2007/08) **(2062 Shrawan -2065 Ashadh)**	**Mid-term (2008/09-2010/11)** **(2065 Shrawan -2068 Ashadh)**	**Long-term (2011/12-2014/15)** **(2068 Shrawan -2072 Ashadh)**
- Unclear demarcation of responsibilities between SWMRMC and Local Bodies (LBs) - Unclear relation with MOLD (status of SWMRMC) - Limited jurisdictional area (inside the Kathmandu Valley) - Lack of skilled manpower - Lack of equipment and facility	S1: Clarification of demarcation between SWMRMC and Local Bodies by issuing a new policy and amendment of the Solid Waste Act S2: Clarification of legal status and change of jurisdictional area by amendment of the Act S3: Establishment of a strategic plan for SWMRMC (future organizational and institutional development plan) S4: Chang of name and organization (such as setting up environmental section, training section, etc.) S5: Recruitment of skilled personnel and reservation of resource persons (inc. training) S6: Procurement of basic equipment (computer, software, etc.) and facility (including arrangement of office building, training room) S7: Implementation of Public Relations (PRs) activities (development of web-site and issues of newsletter, etc.) S8: Implementation of studies and research (waste minimization technology, final disposal sites selection) as part of training	M1: Continuous recruitment of skilled personnel and reservation of resource person (inc. training) M2: Continuous procurement of equipment and facility (mainly for training implementation) M3: Implementation of PRs activities (usage of web-site and issues of newsletter, etc.) M4: Starting training program to LBs and NGOs/CBOs M5: Preparation of a subsidy system to LBs (including setting up relevant section) M6: Preparation of public participation/community mobilization (including setting up relevant section) M7: Preparation of establishment of information network for SWM (including setting up relevant section) M8: Continuous implementation of study and research on waste minimization (as part of training) M9: Implementation of necessary support to LBs	L1: Continuous recruitment of skilled personnel and reservation of resource person (inc. training) L2: Continuous procurement of equipment and facility (mainly for information network) L3: Implementation of PRs activities (usage of web-site and issues of newsletter, etc.) L4: Implementation of training program to LBs and NGOs/CBOs L5: Implementation of a subsidy system L6: Implementation of public participation/community mobilization activities L7: Utilization of information network of SWM L8: Continuous implementation of study and research on waste minimization and final disposal L9: Implementation of necessary support to LBs

Table A 2–6b Action Plan of SWMRMC (for SWM Facilities' Development)

Related main issues to be tackled	Necessary Activities		
	Short-term (2005/06-2007/08)	**Mid-term (2008/09-2010/11)**	**Long-term (2011/12-2014/15)**
	(2062 Shrawan -2065 Ashadh)	**(2065 Shrawan -2068 Ashadh)**	**(2068 Shrawan -2072 Ashadh)**
- Need of long-term sanitary landfill sites - Need of large scale waste processing plant - Safety closure of existing dumping sites and used landfill site	S1: Development of Sisdol Short-term LF S1-1: Development of Sisdol LF Valley II (2005/06) S1-2: Handover Valley II to operator S1-3: Periodic environmental monitoring S2: Development of Waste Processing Plant (KMC. LSMC, KRM) S2-3: Land selection and assessment S2-4: Site investigation works S2-5: Land acquisition S2-6: Concept design and Feasibility study S2-7: EIA process S2-8: Detailed design S2-9: Landfill development of Phase I S2-10: Handover site to operator S2-11: Periodic environmental monitoring S3: Development of Long-term LF (KMC, LSMC, KRM) S3-1: Construction of access road S3-2: Identification of the capacity and service areas S3-3: Site investigation works S3-4: Land acquisition S3-5: Concept design S3-6: EIA process S3-7: Detailed design S3-8: Landfill development of Phase 1 S3-9: Handover site to operator S3-10: Periodic environmental monitoring	M1-1: Receiving Sisdol site from operators M1-2: Regular environmental monitoring of closed Sisdol site M1-3: Maintenance and repairs for closed Sisdol site M2-1: Periodic environmental monitoring M2-2: Development of Phase II M3-1: Periodic environmental monitoring M3-2: Development of Phase II M4-1: Regular environmental monitoring	L1-1: Regular environmental monitoring L1-2: Maintenance and repairs for closed Sisdol site L2-1: Periodic environmental monitoring L2-2: Development of Phase III L3-1: Periodic environmental monitoring L3-2: Development of Phase III L4-1: Regular environmental monitoring

Related main issues to be tackled	Necessary Activities		
	Short-term (2005/06-2007/08) (2062 Shrawan -2065 Ashadh)	Mid-term (2008/09-2010/11) (2065 Shrawan -2068 Ashadh)	Long-term (2011/12-2014/15) (2068 Shrawan -2072 Ashadh)
	S4: Development of Long-term LF (BKM, MTM) S4-1: Site investigation works (EIA, Topography survey, Soil investigation) S4-2: Land acquisition S4-3: Detailed design S4-4: Development of Phase I S4-5: Handover Phase I to operator S4-6: Periodic environmental monitoring S5: Closure of Bagmati River dumping site S5-1: Design of Bagmati River dumping site closure plan S5-2: Implementation of Bagmati closure plan S5-3: Regular environmental monitoring		