



Figure 15-68: View of the new disposal site from Bakou (to North)

## 15.5 Analysis of Alternatives

### 15.5.1 Review of the Previous Report for Siting of Disposal Site

Two studies on the selection of the candidate site for the new disposal site after closure of the Stung Mean Chey disposal site were conducted. One is the “Report on searching for new landfill” (DPWT No. 634, 11 August 1995) and the other is “Dump Site Construction” in Phnom Penh (April 1997). According to the minutes of meeting on the inception report of this study signed on the 10<sup>th</sup> of March 2003, the study team reviewed the above-mentioned studies to verify the appropriateness of the site where the MPP had already acquired 11 ha of land as a part of the proposed area based on the results of these studies.

#### a. Review of “Report on searching for new landfill” (DPWT No.634, 11 August 1995)

The following four candidate sites for the new disposal site were nominated for the study.

- Candidate 1: Prey Sala Village, Sangkat Kakoy, Khan Dang Kor
- Candidate 2: Sam Rong Village, Khan Dang Kor
- Candidate 3: Pray Speu Village, Khan Dang Kor
- Candidate 4: Choeung Ek Village, Sangkat Choeung Ek, Khan Dang Kor

The characteristics are summarized in Table 15-60 and their locations are shown in Figure 15-69.

At the time of this study, it was presumed that an area of about 10 ha was to be considered as a candidate site. There are more than two landowners for three of the four sites and the fourth has only one landowner. This report only introduces the possible sites and does not conclude which is the most appropriate site.

Table 15-60: Comparison of Candidates for a New Final Disposal Site

Candidate site	Descriptions
Candidate 1	<ul style="list-style-type: none"> <li>• The land area is 6.5ha-10 hectares.</li> <li>• It is farmland (i.e. rice fields) and people are growing crops.</li> <li>• The land is sandy and far away (about 3,000 m) from any national road.</li> <li>• We have not met the landowner for price discussion.</li> <li>• We will spend money for access road construction.</li> </ul>
Candidate 2	<ul style="list-style-type: none"> <li>• The land area is about 10 hectares.</li> <li>• The villagers are already planting rice.</li> </ul>

	<ul style="list-style-type: none"> <li>• It is low-lying land and there is flooding in the rainy season. The road is not passable by vehicles.</li> <li>• We have not met the landowner for price discussion.</li> </ul>
Candidate 3	<ul style="list-style-type: none"> <li>• About 1,000 m to the village</li> <li>• It is farmland. 60% of the land is used by the villagers to grow rice.</li> <li>• There are several vacant spaces, of which the soil is sold.</li> <li>• It is sandy soil.</li> <li>• It is 17 km from Stung Mean Chey by national road No.3.</li> </ul>
Candidate 4	<ul style="list-style-type: none"> <li>• The land is not good for growing rice.</li> <li>• There is a concrete road from Stung Mean Chey to the intersection. It is about 1,000 m from the intersection.</li> <li>• The site covers about 7 hectares near the Prey Sor temple.</li> <li>• Far away from people's homes, does not impact the environment. Construction of a dike around the dumpsite is possible for waste disposal.</li> <li>• Mr. Vear Snar, the landowner, works in the port. The land is officially issue ownership by MPP.</li> <li>• Not so far from Stung Mean Chey. Will not disturb important roads, spend an appropriate amount of time for waste disposal.</li> <li>• The cost of land will be discussed next time.</li> </ul>

**b. Final Report of the Workgroup “Dump Site Construction” in Phnom Penh (April 1997) (Referred to as 1997 report)**

The report was mainly prepared by a German consultant.

The report indicates the area for the future disposal site should be 100 ha considering the waste generation amount estimated. To select the candidate site, the following were considered.

- Examination of the geological conditions of Greater Phnom Penh (height level of the site, permeability of the ground).
- Evaluation of the ground water and surface water situation with special regard to seasonal fluctuations in precipitation (flood areas, maximum water level in the rainy season)
- Estimation of the climatic situation (wind direction, amount of precipitation)
- Considering the settlement structure and other necessary exclusion criteria.

As a result of the evaluations, three out of the four sites as shown below were examined. However, the reason for excluding the fourth site is not explained in the report.

- The area northwest of Pochentong Airport (Candidate 2)
- The area south of Pochentong Airport between RT303 and RN3 (Candidate 3)
- The area in the southern extension of RT303 before the area boundary of Dang Kor, which was determined for further planning (Candidate 4)
- As a result, this report concluded that Site No.4 was the most suitable. Site No.4 is the current candidate site of PPWM.

**c. 11 ha of Land Acquired by the MPP**

Based on the conclusion of the above report, MPP purchased 11 ha of land at Site No.4 in 2001.

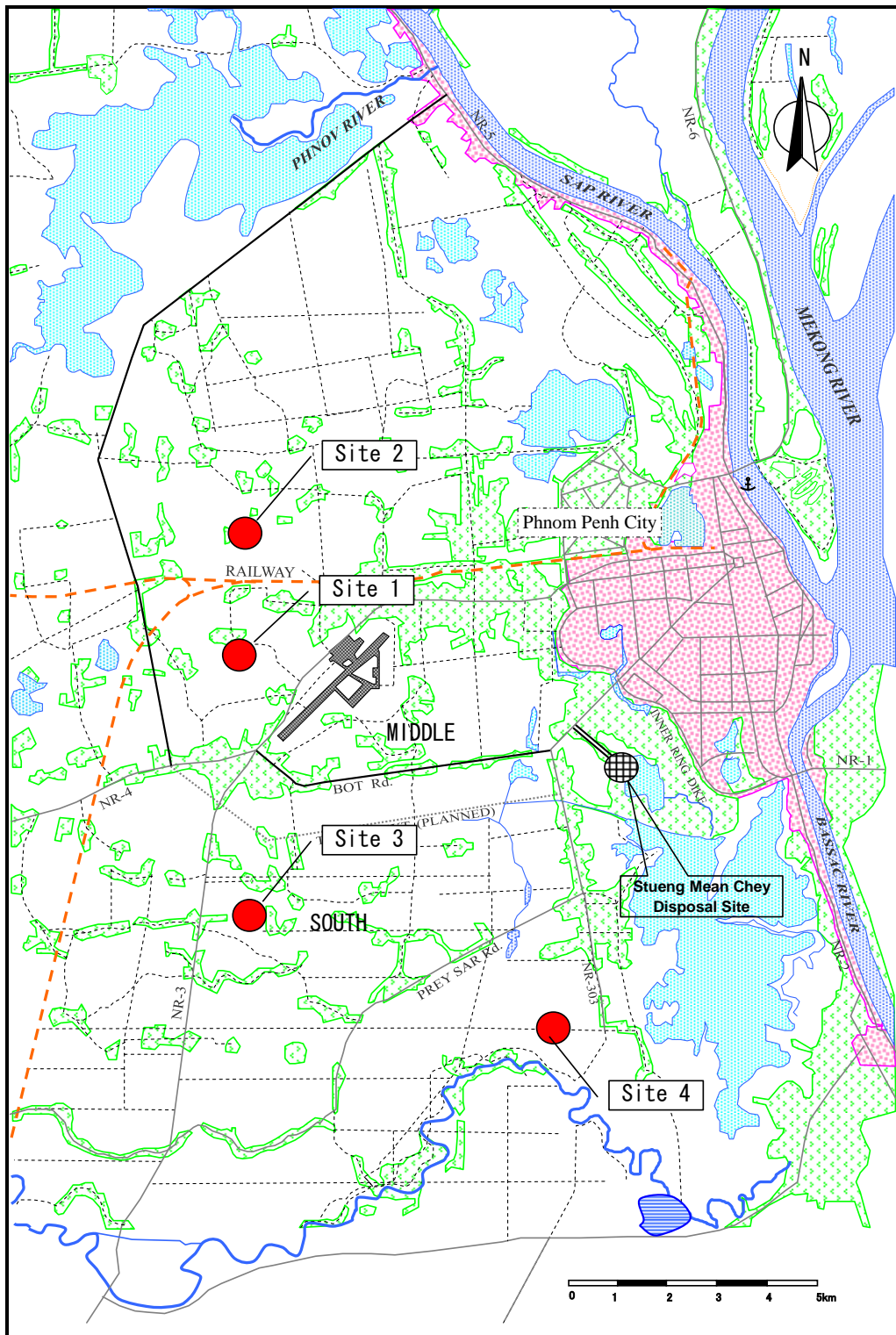


Figure 15-69: Location of Four Candidates for a New Final Disposal Site

**d. Study by the JICA Study Team**

The study team visited and observed the candidate sites with the vice governor of PPWM, Mr. Leng Simen who was one of the writers of the 1997 report, as a guide.

The team compared the four candidates for the new final disposal site by reviewing the DPWT document and the 1997 report, studying the current land use, accessibility, soil condition through visual observation and interview, surrounding environment and area size.

According to the comparison table shown in the Table 15-61 prepared based on the site reconnaissance, the study team concluded that Site No.4 in Dang Kor is the most appropriate site for the future disposal site.

Table 15-61: Comparison of the Candidate Sites by JICA Study Team

Items	Candidate 1	Candidate 2	Candidate 3	Candidate 4
Location (Address)	Prey Sala village, Sangkat Kakoy	Choeung Ek village, Sangkan Choeung Ek	Chunlun Malou village	A land near the road to Prey Sor temple
Present land use	<ul style="list-style-type: none"> <li>Rice field</li> </ul>	<ul style="list-style-type: none"> <li>Rice field</li> </ul>	<ul style="list-style-type: none"> <li>Mainly rice field, but also ponds, trees, and probably a road to a temple near the site</li> </ul>	<ul style="list-style-type: none"> <li>Rice field</li> </ul>
Access road	<ul style="list-style-type: none"> <li>1.3 km to the north along the road that connects with a national highway running near the airport, and 1.1 km to the west.</li> <li>There are many houses along the roads.</li> </ul>	<ul style="list-style-type: none"> <li>1.8 km to the north along the road that connects with a national highway running near the airport, and 1.3 km to the west along a railway.</li> <li>The road along a railway is not wide enough and its road surface condition is poor, requiring substantial rehabilitation work.</li> </ul>	<ul style="list-style-type: none"> <li>4 km to the south along the national highway Route 3 from the point where Route 4 starts, and 1.2 km to the east.</li> <li>The access road from Route 3 should be newly constructed.</li> </ul>	<ul style="list-style-type: none"> <li>The access road is not wide enough and its road surface condition is poor at present.</li> <li>It is to be upgraded by 2007.</li> </ul>
Soil condition (interview with PPWM and visual observation)	<ul style="list-style-type: none"> <li>As the ground is principally sand, permeability is estimated as high and the bearing power small.</li> </ul>	<ul style="list-style-type: none"> <li>The ground is sandy and the groundwater table seems to be high as a water spring was found at a height of 2-3 m in a sandpit.</li> </ul>	<ul style="list-style-type: none"> <li>Permeability seems to be low as there is a pond in the site.</li> </ul>	<ul style="list-style-type: none"> <li>Permeability seems to be low as there is a pond and an irrigation canal in the site.</li> </ul>
Surrounding environment	<ul style="list-style-type: none"> <li>Only 2 km from the airport.</li> <li>The site is rice field but houses and factories are situated nearby.</li> </ul>	<ul style="list-style-type: none"> <li>Vehicles must go across the railway.</li> <li>The site is rice field but an industrial park is under construction nearby. There are also houses in the surrounding area.</li> </ul>	<ul style="list-style-type: none"> <li>There is a temple nearby leeward from the site and another at a small distance.</li> <li>There is a house on the pond.</li> <li>The areas near temples have not been studied yet.</li> </ul>	<ul style="list-style-type: none"> <li>The site is rice field. There is a residential area on the southern side including military facilities. There is a pagoda worth visiting on the north-east side.</li> <li>Rice fields spread in the other directions.</li> </ul>
Possibility to secure 100ha	<ul style="list-style-type: none"> <li>Low due to the location of houses and factories.</li> </ul>	<ul style="list-style-type: none"> <li>Low due to the location of the industrial park and houses.</li> </ul>	<ul style="list-style-type: none"> <li>High.</li> </ul>	<ul style="list-style-type: none"> <li>High</li> </ul>
Others	<ul style="list-style-type: none"> <li>There are no rivers to which treated leachate can be discharged.</li> </ul>	<ul style="list-style-type: none"> <li>There are no rivers to which treated leachate can be discharged.</li> </ul>	<ul style="list-style-type: none"> <li>Careful attention should be paid to the temples.</li> <li>There are no rivers to which treated leachate can be discharged.</li> </ul>	<ul style="list-style-type: none"> <li>Careful attention should be paid to the temple.</li> <li>There is a river to which treated leachate can be discharged.</li> </ul>
Evaluation	No good	No good	Good	Very good



Figure 15-70: View of Four Candidates

**e. Final Disposal Site**

The Study Team examined the entire site and the siting of the first area to be developed.

Based on the content of the 1997 Report, the team identified an area of 100 ha, including the 11 ha already purchased by MPP, on the aerial photo. Next, they identified an area of 25 ha within the 100 ha to secure a disposal site with a capacity for landfill operation of more the five years, as the initial development plan. The team reported the examination results to MPP and proposed that they secure the site.

In regard to the above, MPP sent a letter dated June 15, 2003 to the Resident Representative of the JICA Cambodia Office, informing that they approve of the future final disposal site of



100 ha proposed by the Study Team and agree to purchase 15 ha of land, in addition to the 11 ha already obtained, by the middle of 2004.

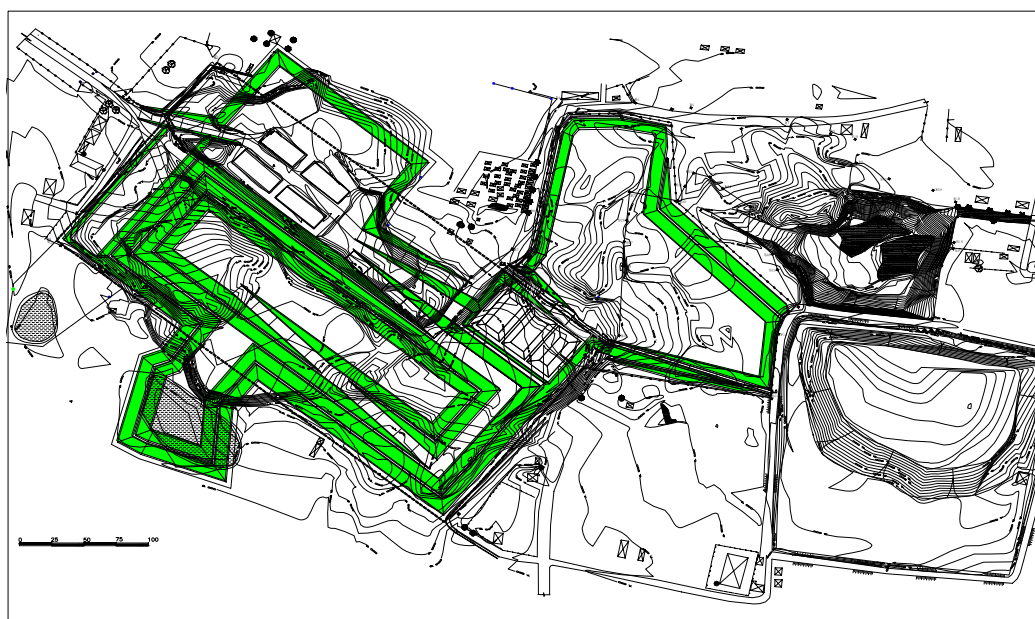
**f. Site Selection for Other Facilities**

As described later, the M/P recommends that PPWM provide waste collection services in the rural area . In order to strengthen PPWM's capability for waste collection, the provision of collection equipment is essential, and such equipment requires depots and maintenance workshops.

Therefore, the Study Team held discussions with the C/P, and MPP decided to add 1 ha to the new final disposal site of 25 ha, to be utilized for the depots and maintenance workshops.

**15.5.2 In case without the project**

If new waste disposal site development project is not carried out, the existing disposal site, SMCDS, have to be continued using. However, SMCDS will be full occupied until the end of 2007 and there will be no way to dispose waste of Phnom Penh. Therefore, this option is a feasible plan. Following figure shows the SMCDS in case waste is piled up as much as possible.



**15.6 Assessment of the Environmental Impact of the Project**

**15.6.1 Socio – cultural Characteristics**

**a. Economic activities**

This includes loss of bases for economic activities (e.g., land) and loss of income for land owners.

**a.1 Construction**

**a.1.1. Negative impact**

As the proposed site is mainly cultivated area, construction of the proposed disposal site will have no negative economic impact.

**a.1.2. Positive impact**

Workers such as laborers, drivers, equipment operators, supervisors, etc. may be employed for the construction of the disposal site, thus increasing economic activity in the study area. Therefore, construction of the site might be economically beneficial.

**a.2 Operation**

**a.2.1. Negative impact**

The proposed disposal site area is mainly rice fields and a 26 ha area in total will be lost for the disposal site. This means the land owners of this area will lose agricultural income and countermeasures are needed(see in the section of “Environmental Impact Mitigation Measures”). This impact was pointed out at the public hearing by the local residents.

Furthermore, when the existing disposal site, SMCDS, is closed, more than 2,000 waste pickers who are picking valuables in there will lose their job. Therefore, countermeasures are needed (see in the section of “Environmental Impact Mitigation Measures”).

**a.2.2. Positive impact**

Workers such as labors, drivers, equipment operators, supervisors, etc. may be employed for the operation of facilities including the disposal site, composting facility and workshop for collection and operation vehicles, thus increasing economic activity in the study area. Therefore, operation of the disposal site might be economically beneficial.

The composting facility is to be installed at the site. It will be possible to provide urban waste compost in and around the study area. As the surrounding area is manly cultivated land, a supply of urban waste compost is beneficial.

**a.3 Closure**

**a.3.1. Negative impact**

No negative impact is expected.

**a.3.2. Positive impact**

The recommended future land use for the completed disposal site is recreational facilities such as a nature park. Citizens will get the benefit of physical and/or mental refreshment in the recreational area, which will contribute to improving the economic productivity of people.

**b. Traffic and Public facilities**

This includes the impact on traffic conditions and public facilities near the proposed disposal site and along the road connecting to the site.

**b.1 Construction**

**b.1.1. Negative impact**

There are many kinds of construction works in the development project, like the establishment of a buffer zone, earthworks for the disposal site, building of a compost plant, and construction of the maintenance workshop for heavy vehicles. However, the traffic increase caused by the construction will be small since the trucks will transport the material



for construction only once in a while. Therefore, the impact on traffic conditions will be negligible.

**b.1.2. Positive impact**

No positive impact is expected.

**b.2 Operation**

**b.2.1. Negative impact**

Based on the waste collection and transportation system in the M/P, the collection vehicles will make a total of 557 trips per day in 2015.

The traffic volume of collection vehicles in 2007-2015 is as follows:

Table 15-62: The traffic volume of collection vehicles in 2007-2015

	Urban		Rural		Total	
	Amount (tons/day)	Trips (trips/day)	Amount (tons/day)	Trips (trips/day)	Amount (tons/day)	Trips (trips/day)
2007	549	112	377	210	926	322
2008	571	116	416	233	987	349
2009	593	120	462	252	1055	372
2010	615	125	510	269	1125	394
2011	637	129	551	292	1188	421
2012	659	134	626	329	1285	463
2013	681	138	672	348	1353	486
2014	703	143	723	362	1426	505
2015	751	153	811	404	1562	557

**Trip: round trip between DKDS and waste collection site in Phnom Penh**

The number of trips made by collection vehicles is not large. However, the current road conditions are not sufficient because most roads are unpaved. Therefore, improvement of national road 303 is needed. (See the section on “Environmental Impact Mitigation Measures”)

Moreover, based on the field survey for public facilities around the study area, there are five schools and one health center along the road 303. This makes improvement of road 303 essential.

**b.2.2. Positive impact**

No positive impact is expected.

**b.3 Closure**

**b.3.1. Negative impact**

No negative impact is expected.

**b.3.2. Positive impact**

No positive impact is expected.

**c. Cultural Property**

This includes temples, shrines, archaeological remains or other cultural assets of value.

**c.1 Construction**

**c.1.1. Negative impact**

No negative impact is expected.

**c.1.2. Positive impact**

No positive impact is expected.

**c.2. Operation**

**c.2.1. Negative impact**

According to the Ministry of Cultural Affairs, there is no legal protection of pagodas so far, and there is no cultural property in the proposed disposal site area. However, the Killing Fields Memorial, which is the most important cultural property, is located near the study area. Between 20,000 and 30,000 persons per year visit this genocide memorial and this number might become bigger when road 303 is rehabilitated.

Once the disposal site is constructed, it will be visible from near the entrance to the memorial site. Therefore, countermeasures should be taken to avoid disturbing the visitors to the killing field. (See the section on “Environmental Impact Mitigation Measures”)

**c.2.2. Positive impact**

No positive impact is expected.

**c.3. Closure**

**c.3.1. Negative impact**

No negative impact is expected.

**c.3.2. Positive impact**

No positive impact is expected.

**d. Public health**

This includes the deterioration of public health and sanitary conditions in the study area due to the proposed disposal site and collection vehicles.

**d.1. Construction**

**d.1.1. Negative impact**

Construction vehicles will generate dust and exhaust fumes. However, they are considered to be negligible because the number of construction vehicles is small.

**d.1.2. Positive impact**

No positive impact is expected.

**d.2. Operation**

**d.2.1. Negative impact**

- The waste disposal site is expected to promote growth in the population of vectors and vermin which will have a negative impact on the study area.
- Leachate from the disposal site may have an impact on public health.
- Landfill fires may also have an impact on public health.

Moreover, the following was pointed out at the public hearing by the local residents.

- Litter along the national road 303 passed by waste collection vehicles.

Therefore, the above should be considered (See the section on “Environmental Impact Mitigation Measures”).

**d.2.2. Positive impact**

No positive impact is expected.

**d.3 Closure**

**d.3.1. Negative impact**

Leachate and landfill gases will continue to be produced after the site is closed although production rates and strengths will diminish with time. When the site is used as a recreational area, leachate and gases may affect public health.

**d.3.2. Positive impact**

No positive impact is expected.

**15.6.2 Environmental Characteristics**

**a. Air pollution**

**a.1 Construction**

**a.1.1. Negative impact**

Construction activities will involve a small number of earthmoving machines, dump trucks, rollers and a few light vehicles at the site, and transportation vehicles for construction materials and equipment.

The main sources of air pollution will be dust generated from the construction activities and exhaust fumes from construction vehicles at the site. Significant quantities of dust will be produced. Therefore, countermeasures are needed. (See the section on “Environmental Impact Mitigation Measures”).

The effect of exhaust fumes from construction vehicles will have a low negative impact as the number of construction vehicles is small.

**a.1.2. Positive impact**

No positive impact is expected.

**a.2 Operation**

**a.2.1. Negative impact**

**Dust from landfill operation**

Significant quantities of dust may be generated during the dry season due to the operation of landfill equipment and waste collection vehicles at the site. Therefore, it should be considered (See the section of “Environmental Impact Mitigation Measures”).

**Exhaust gas from landfill operation**

Operation vehicles such as bulldozers at the site will generate exhaust fumes. However, it is considered negligible as the number of vehicles will be small.

### **Landfill gas**

The biological decomposition processes in a disposal site with municipal solid waste result in the generation of landfill gas. Under normal conditions, landfill gas production rates reach a peak within the first two years and then slowly taper off, continuing in many cases for periods of up to 25 years or more. In most cases, over 90% of the gas volume produced is methane and carbon dioxide. If vented to the atmosphere in an uncontrolled manner, methane can accumulate in the enclosed spaces. When methane concentrations in the air are between 5-15%, it is explosive.

Carbon dioxide, being heavier than air, tends to migrate downwards, often leading to high concentrations of carbon dioxide in the lower part of a disposal site for many years. Ultimately, it can move downwards through the underlying strata, until it reaches the groundwater, where it will usually lower the pH. Therefore, it should be considered (See the section on “Environmental Impact Mitigation Measures”).

### **Landfill fire**

As with SMCDS, landfill fires may occur, causing large quantities of smoke and harmful gas. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

### **Dust from collection vehicles**

Significant quantities of dust will be generated from waste collection vehicles because road 303 is not paved. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

#### **a.2.2. Positive impact**

No positive impact is expected.

### **a.3 Closure**

#### **a.3.1. Negative impact**

Landfill gases will continue to be produced after the site is closed although production rates and strengths will diminish with time. Therefore, it should be considered (See the section on “Environmental Impact Mitigation Measures”).

#### **a.3.2. Positive impact**

No positive impact is expected.

### **b. Water quality**

This includes water pollution caused by the inflow of soil, leachate and runoff from the disposal site into rivers and groundwater.

#### **b.1 Construction**

##### **b.1.1. Negative impact**

There will be no discharge of water during construction. Therefore, a negative impact is not expected.

##### **b.1.2. Positive impact**

No positive impact is expected.

#### **b.2 Operation**

##### **b.2.1. Negative impact**

### **Final disposal site**

The disposal site will generate leachate, which may cause contamination if discharged into the river or canal or infiltrated into the groundwater. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

### **Compost plant**

In the pre-treatment stage, raw materials for compost, household and market waste etc., will generate leachate. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

### **Maintenance workshop**

The maintenance workshop will use a large volume of water for washing vehicles. This wastewater contains oils such as grease or lubricant oil. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

#### **b.2.2. Positive impact**

No positive impact is expected.

### **b.3 Closure**

#### **b.3.1. Negative impact**

While leachate from the compost plant and wastewater from the maintenance workshop will stop when the disposal site is closed, leachate will continue to be produced after the termination of operation although production rates and strengths will diminish with time. Therefore, it should be considered (See the section on “Environmental Impact Mitigation Measures”).

#### **b.3.2. Positive impact**

No positive impact is expected.

### **c. Hydrological situation**

This includes changes in surface water bodies due to the inflow of runoff from the disposal site.

#### **c.1 Construction**

##### **c.1.1. Negative impact**

No negative impact is expected.

##### **c.1.2. Positive impact**

No positive impact is expected.

#### **c.2 Operation**

##### **c.2.1. Negative impact**

Concerning water quality, as it is mentioned in the previous section, the disposal site will generate leachate, which may cause contamination if discharged into the river or canal or infiltrated to the groundwater. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

As for change in the volume of water bodies, first, the amount of intake water is limited to car washing, administration, etc. Second, the proposed disposal site will not discharge leachate except rainwater. Therefore, it is expected that there will be little change in inflow and runoff from the disposal site, and little impact on the hydrological condition.

**c.2.2. Positive impact**

No positive impact is expected.

**c.3 Closure**

**c.3.1. Negative impact**

While leachate from the compost plant and wastewater from the maintenance workshop will stop when the disposal site is closed, leachate will continue to be produced after the termination of operation although production rates and strengths will diminish with time. Therefore, it should be considered (See the section on “Environmental Impact Mitigation Measures”)

**c.3.2. Positive impact**

No positive impact is expected.

**d. Soil contamination**

**d.1 Construction**

**d.1.1. Negative impact**

Soil contamination may occur due to possible spillage of oil from construction equipment and vehicles and leakage of fuel. However, it will be negligible because of the small number of construction equipment and vehicles.

**d.1.2. Positive impact**

No positive impact is expected.

**d.2 Operation**

**d.2.1. Negative impact**

The disposal site will generate leachate, and if it is infiltrated into the ground, soil contamination will occur. However, the geological survey for the soil of the disposal site area revealed that the permeability of the natural soil is low. Therefore, it can be said that the existing ground can be used as a natural liner to control leakage, and the contamination from the leachate will be limited.

If infectious and hazardous wastes such as medical waste and factories waste are disposed of at the site, they will contaminate the soil at the site. Therefore, it should be considered (See the section on “Environmental Impact Mitigation Measures”).

**d.2.2. Positive impact**

No positive impact is expected.

**d.3 Closure**

**d.3.1. Negative impact**

No negative impact is expected.

**d.3.2. Positive impact**



No positive impact is expected.

**e. Noise**

This includes noise generated by construction equipment, landfill site equipment and waste collection vehicles.

**e.1 Construction**

**e.1.1. Negative impact**

There are many kinds of construction works in this project like the planting of green trees in the buffer zone; earthworks for the landfill site and treatment facilities for leachate; and the building of a site office, weighbridge, compost plant and a maintenance workshop. The factors of construction which generate noise are as follows:

- ◆ Construction of a buffer zone  
Trucks for the transportation of trees and heavy machinery to dig holes for planting
- ◆ Construction of a site office, weighbridge, a compost plant and a maintenance workshop  
Trucks for the transportation of materials and equipment to build the facilities
- ◆ Construction of the final landfill site  
Heavy machinery for earthworks
- ◆ Construction of treatment facilities for leachate,  
Heavy machinery for earthworks

A certain level of noise will be generated in all construction work. However, the impact of noise will be negligible because the number of construction vehicles such as bulldozers will be limited. As for the noise from vehicles for transportation, it is negligible because the frequency of transportation of construction material and equipment will be limited.

**e.1.2. Positive impact**

No positive impact is expected.

**e.2 Operation**

**e.2.1. Negative impact**

**Landfill site**

Operational vehicles and equipment at the site will generate noise. However, it will be negligible because of the small number of operational equipment and vehicles. There is enough distance between the site and the houses around the site. Moreover, the buffer zone shall be installed to reduce the noise.

**Compost plant and maintenance workshop**

A certain level of noise will be generated from the compost plant and maintenance workshop. However, it will be negligible because the work will be light work and done indoors.

**Waste collection vehicles**

The future traffic volume of collection vehicles estimated in the section on “Traffic and Public Facilities”. Collection vehicles will generate noise because a certain amount of collection vehicles will run along national road 303, and the surface condition of this road is

very poor. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

**e.2.2. Positive impact**

No positive impact is expected.

**e.3 Closure**

**e.3.1. Negative impact**

No negative impact is expected.

**e.3.2. Positive impact**

No positive impact is expected.

**f. Offensive odor**

This includes offensive odors from the landfill site and compost plant.

**f.1 Construction**

**f.1.1. Negative impact**

Offensive odors will be generated due to exhaust fumes from construction equipment and vehicles. However, it will be negligible because of the small amount of construction equipment and vehicles.

**f.1.2. Positive impact**

No positive impact is expected.

**f.2 Operation**

**f.2.1. Negative impact**

***Landfill site***

In the landfill site, organic waste will be decomposed and offensive odors will be produced. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”). It is notable that the local residents have the most serious concern about offensive odors based on the results of the follow-up survey of the public hearing.

***Compost plant***

At the compost plant, offensive odors will be produced at the waste reception section and during the compost production process. A large proportion of the waste to be handled at the plant will be organic waste, which will be decomposed over a period of a month. In this process, offensive odors will be generated. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

**f.2.2. Positive impact**

No positive impact is expected.

**f.3 Closure**

**f.3.1. Negative impact**

No negative impact is expected.

**f.3.2. Positive impact**

No positive impact is expected.

## **g. Fauna and Flora**

This includes changes in flora and fauna leading to obstruction of breeding and extinction of species due to the disposal site.

### **g.1 Construction**

#### **g.1.1. Negative impact**

As there are very few green trees in the proposed disposal site, the natural environment of the site is typical but not abundant in flora and fauna. The majority of the site is used as agricultural land. If the land use of the proposed site is changed and the surface soil is removed, the flora on the surface will die. However, the impact is not serious because areas with similar environmental conditions can be found in the vicinity. Some fauna may move to nearby places with similar environments. Therefore, the negative impact is limited.

#### **g.1.2. Positive impact**

In the disposal site, a lot of green trees are to be planted around the site as a buffer zone. The width of the zone is 20 m to 50 m. A new habitat will be created for fauna. The site of the buffer zone may be changed into a new natural environment for flora and fauna in the future.

### **g.2 Operation**

#### **g.2.1. Negative impact**

As mentioned above, the natural environment of the site is typical but not abundant in flora and fauna. The majority of the site is used as agricultural land. When operation of the site starts, fauna will move out of the landfill site and flora will not be able to grow on the landfill surface. However, the buffer zone can create an alternative habitat. Therefore, the impact on fauna and flora is limited.

#### **g.2.2. Positive impact**

The natural environment of the proposed disposal site is not rich in flora and fauna as almost all of the site area is cultivated land. However, when operations start, the buffer zone will provide a new habitat with plenty of trees.

### **g.3 Closure**

#### **g.3.1. Negative impact**

The main impact on flora and fauna during the closure stage will be similar in nature to the impact during operation of the site as described above. After completion of disposal, leachate and landfill gases will be produced in smaller quantities. Therefore, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

#### **g.3.2. Positive impact**

After the site is closed, it will be used as a green park or recreation area for citizens. This means human activity in the area will decrease considerably and the natural environment will become richer.

## **h. Landscape**

This includes changes in topography and vegetation due to construction and operation of the disposal site.

### **h.1 Construction**

**h.1.1. Negative impact**

No negative impact is expected.

**h.1.2. Positive impact**

No positive impact is expected.

**h.2 Operation**

**h.2.1. Negative impact**

Based on the field survey for landscape, the proposed site can be seen from Bakou village, Cheung Aek village and national road 303. Moreover, the disposal site is big and the operational work is quite different from the surrounding activities which include farming. Therefore, as the operational work will be visible from outside, countermeasures are needed (See the section on “Environmental Impact Mitigation Measures”).

**h.2.2. Positive impact**

No positive impact is expected.

**h.3 Closure**

**h.3.1. Negative impact**

No negative impact is expected.

**h.3.2. Positive impact**

After the site is closed, it will be covered with soil, and may be planted with green trees and used as a recreational zone. Therefore, a positive impact is expected.

## 15.7 Public participation

### 15.7.1 First Public Hearing

**a. Objective**

A disposal site could have a huge impact on the surrounding areas, so the team conducted the EIA survey according to the laws and regulations in Cambodia. Since local residents and local authorities are concerned about the consequences of the construction of the proposed disposal site, due to the result of the SMC disposal site, the MPP and PPWM, the project owner decided to organize the 1<sup>st</sup> public hearing, inviting all the stake holders such as local residents, local authorities and NGOs, before and after the EIA survey. The first hearing was arranged on the 20th of October at Thom Matray Pagoda in Dang Kor district. The result of the first public hearing will be reflected in both the EIA survey plan and the proposed disposal site development project.

Waste management issues are not familiar topics for many public hearing participants, so it might be difficult for them to understand the explanation quickly. They may also have questions soon after the presentations finishes. Therefore, a follow-up interview survey in each village after the public hearing was conducted. Written opinions were also accepted by the MPP and PPWM.

**b. Outline of the public hearing**

**b.1 Schedule and attendants**

### b.1.1. Schedule

Date: October 20, 2003  
Time: From 8:00 a.m. to 11:00 a.m.  
Location: Thom Matray Pgoda, Commune Pray Sor

The location was decided considering the convenience of local residents.

### b.1.2. Attendants

PPWM; Heng Lay Orn (governor)  
Leng Simen (vice governor)  
Mey Mon (deputy governor of district Dang kor)  
Others; Local authorities (Commune and village chiefs)  
Local residents (mainly housing group leaders)

JICA Study Team; Anai (study team leader)  
Kani and Higo (study team member)  
Makathy (Interpreter)  
and team assistants

Local residents, local authority and NGOs;  
In total 96 people from 12 villages

### Selection of attendants

Local residents that attended the first public hearing were selected by the district authority. As it is impossible to call all local residents in the three communes, which have a population of approximately 30,000 people in total, they invited Commune/Village authorities throughout the three Communes (Commune Prey Sar, Dang Kor and Cheung Aek) along with local residents. In addition, the majority of local residents were leaders of housing groups.

As for the arrangement of NGOs participation, the team directly made a contact with NGOs that are working at the Stung Mean Chey disposal site, while establishing a contact with environment a NGOs through the NGO Forum. Because the information of the first public hearing did not reach to individual environment a NGOs in advance due to a mistake of the NGO Form and the location is inconvenient for most of them, only one NGO could participate in the hearing.

The breakdown of attendants of the public hearing was as follows;

Table 15-63: attendants of the public hearing

Commune	Village	Breakdown			Remarks
		Local authority of Commune/ village	Representatives of Krom	Others	
Dang Kor	Ta ley	3	4	17	Others included farmers 14
	Thmey	4	4	0	
	Bakou	3	0	0	
	Khvar	2	0	0	
Cheung Aek	Rolous	4	5	3	Others included farmers 1
	Preak Pranak	1	2	0	
Prey Sa	Prey Sor East	3	4	7	Others were all policemen
	Anlong Kong	4	9	1	Others was a teacher
	Prey Sor West	1	0	0	
	Pra Kar	2	9	0	
	Tituy	1	0	0	
	Peam	0	0	1	Others was a policement

Others	1	0	1	Deputy governor of Commune Dang kor Khan and NGO
Total	29	37	30	96

### b.1.3. Handout

The Contents of the handout for the public hearing were as easy to follow as possible, taking into consideration that the local residents were generally unable to read. As this simple explanationone is not sufficient for NGOs, a detailed handout was also arranged.

### c. Related area for EIA

Basically, the area that may be directly affected is the area within a 1km radius from center of the proposed disposal site, which is authorized by MOE as a study area. However, the increase in traffic due to construction vehicles and waste collection vehicles, and the discharge of leachate from the disposal site into the river will also affect the area. Therefore, the total affected area and population was calculated as follows:

Affected area	Related estimated population (person)
Within 1km radius from the center of the proposed disposal site	302 household (1,299 person)
Along the national road 303 which connects the center of Pnom Penh and the Dang Kor disposal site (From the disposal site to the bridge which is located at the north end of commune Dang Kor)	3,880 person
Along the downstream area of Prek Thmot river which is located in the south of the disposal site (From the south of the site until the bridge of national road 2)	11,610 person
Total	16,789 person

Fifty two of the attendants of the public hearing were from the affected area mentioned above, which is 0.3% of the 16,789 residents. Of the 52 people, 15 were from villages in the area within a 1km radius from the center of the proposed disposal site, which is 5.0% of the 1,299 residents.

### d. Program

The 1<sup>st</sup> public hearing was done as follows;

1. Registration 7:30 – 8:00
2. Opening Remark 8:00 – 8:15  
by Mr. Mey Mon (Deputy governor of Commune Dang Kor)  
by Mr. Anai (Leader of the JICA study team)
3. Presentation of the Dong Kor disposal site development plan  
and the EIA survey plan
  - 3-1: Current situations of waste management in MPP 8:15 – 8:45  
by Ms. Kani
  - 3-2: Outline of the proposed Dang Kor new disposal site 8:45 – 9:15  
by Mr. Anai
  - 3-3: Outline of EIA survey plan 9:15 – 9:45  
by Mr. Higo
4. Q&A 9:45 – 10:15



5. Closing Remark

10:15 – 10:45

by Mr. Heng Lay Orn

by Mr. Mey Mon

Facilitator: Mr. Makathy and Ms. Kani

Interpreter: Mr. Makathy

**e. Summary of presentations**

The contents of the three presentations are summarized below. The speakers paused after each issue during their presentations to make sure the participants understood.

**e.1 Current situations of waste management in MPP**

Since waste management issues are not familiar topics for most of the participants, before the introduction of the new disposal site plan in Dang Kor and the EIA survey plan, the current situation of waste management in Phnom Penh, in particular reasons why the construction of proposed disposal site had become an urgent issue in Phnom Penh, were explained in simpler terms, so that they could get ready to listen to the following main topics carefully. On the other hand, possible problems caused by the disposal site were also presented.

In order to encourage meeting participants to participate in the discussions actively, several questions about waste management in their daily lives were asked.

**e.2 Outline of the proposed Dang Kor new disposal site**

At first, the presentation clearly pointed out the necessity of the proposed disposal site in Phnom Penh, by showing the expected future waste flow and the capacity of the existing disposal site.

Subsequently, the reasons why the area in Dang Kor was selected were explained. The planned measures to prevent or mitigate environment problems were also explained.

**e.3 Outline of the EIA survey**

Before introducing the concrete EIA survey plan, the presentation spent a considerable time to explain what an EIA survey is and its important role in preventing or mitigating possible environment problems caused by the disposal site.

Then, the detailed assessment plan was explained by the types of impact. Finally, since the cooperation from local residents is essential for the EIA survey, the presenter asked participants for their cooperation in the EIA survey.

**f. Q & A and countermeasures**

It seemed that many of attendants already knew something about problems caused by the disposal site, from the experiences of the SMCDS, and that they are concerned whether the same things happen in the proposed disposal site or not.

Questioner, a local authority, started the Q & A session by expressing his concerns about possible problems. Here is the summary.

“It is likely that collection vehicles will scatter waste on the road to the new disposal site. In addition, the construction of the disposal site could cause such problems as offensive odor and the breeding of flies, and this could result in health problems of local residents. I heard that the existing disposal site in Stung Mean Chey causes these problems.”

Though neither PPWM nor the JICA Study Team replied to this comment then, countermeasures are considered. (See the sections “Environmental Impact Analysis” and “Environmental Impact Mitigation Measures”)

He continued to make comments and ask questions. A few more people followed him. The questions and answers are summarized below.

**Q1:**

“Geographically, this area has been indeed been protected from floods since the Kob Srov dike was successfully completed under the ADB loan. Even though some parts of the dike were damaged, they are fixed now.

The main road between the center of Phnom Penh and this area (National Road 303) is narrow and not in good condition. If the new disposal site is constructed, the traffic volume will increase considerably and this could cause traffic jams, noise problems, air pollution such as dust, an increase in traffic accidents, and so on.”

**A1:**

“There is an improvement plan of National Road 303, connecting Phnom Penh and the memorial site in Chen Ek. The road improvement plan will be complete in 2007.”

This improvement plan is funded by the ADB. The details of this improvement plan are shown in the section “Conclusion”.

**Q2:**

“Local residents here use water from rivers, ponds, and wells as drinking and living water. Therefore, I am very concerned about the possibility of water contamination by leachate from the new disposal site. If water is contaminated and cannot be used as drinking water, there will be a need for a water supply system from Phnom Penh.”

**A2:**

“The JICA Study Team is now conducting a geological survey and will make a design of the disposal site based on the result of the survey. This could prevent water contamination as much as possible. As for the water supply plan, I will ask Phnom Penh Waste Supply Authority about its water supply expansion plan.”

The project owner is giving special consideration to water quality. The JICA Study Team conducted a geological survey to determine the permeability of the ground of the site and proposed countermeasures (See the sections “Environmental Impact Analysis” and “Environmental Impact Mitigation Measures”).

The World Bank will implement a Peri-urban water supply project in 2004-2005. It will extend to approximately 1 to 2 km to the north of the site.

**Q3:**

“The new disposal site is planned to be constructed in a farming area. How will farmers be able to make a living after they sell their land? How far from the disposal site can people settle?”

**A3:**

“We have a plan to construct a “Green Belt” of 50m in width to separate the disposal site from the surrounding areas, so they can settle in an area adjacent to this buffer zone.”

Based on this question, alternative jobs for the landowners will be planned. The project owner shall give priority to the landowners when hiring staff (See the sections “Environmental Impact Analysis” and “Environmental Impact Mitigation Measures”).

**Q5:**

Why you are not considering an incinerator?

**A5:**

Because an incinerator is too expensive and Cambodia cannot afford it. It costs approximately US\$ 300 per ton to incinerate waste, while at present PPWM spends only US\$ 0.6 for the landfill operation (open dumping).

**g. Follow Up Survey of the First Public Hearing**

**g.1 Objectives**

The first public hearing was organized on the 20<sup>th</sup> of October before the start of the EIA survey in order to explain the proposed disposal site development plan and the EIA survey plan. Since waste management issues are unfamiliar topics for local residents in Khan Dang Kor, a follow-up survey was arranged to check how much the participants of the first public hearing understood the explanations and what they thought about the new disposal site plan and the EIA survey plan.

The approach to the second public hearing was modified based on the result of the first public hearing and the follow-up survey.

**g.2 Survey Methods**

**g.2.1. Survey Method: Interview Survey**

The questionnaire is attached as an appendix.

**g.2.2. Selection of Interviewees:**

Interviewees were selected based on the attendant list of the public hearing. Residents in villages which are far away from the new disposal site were eliminated from the selection list.

**g.2.3. Implementation of the survey**

The survey was conducted from October 27 - 28.

**g.3 Survey Result**

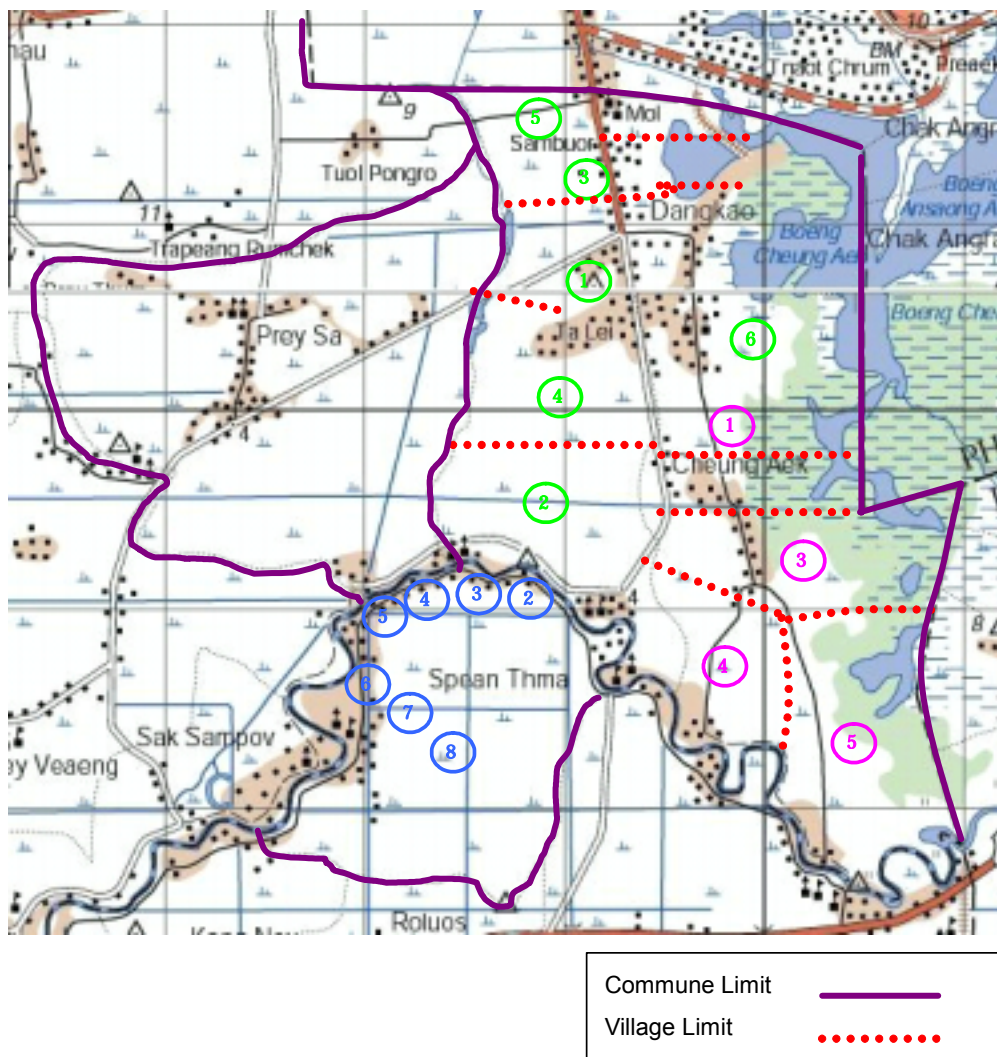
**g.3.1. Interviewees**

The residences of interviewees and their locations are shown in Table 15-64: and Figure 15-71.

Table 15-64: Villages of Interviewees

District	Commune	Village	*Village No.	Number of samples
Dang Kor	Dang Kor	Bakou	2	2
	Dang Kor	Khvar	6	1
	Dang Kor	Taley	4	6
	Dang Kor	Thmey	1	5
	Prey Sa	Annloug korng chaas	6	2
	Prey Sa	Annloug korng thmey	6	6
	Cheung Aek	Rolous	2	10
	Cheung Aek	Prey Pranak	4	3
<b>Total</b>				<b>35</b>

\* The village numbers correspond to the numbers in the following map.



Sangkat Dangkao

1: Thmey; 2: Bakou; 3: Sambour; 4: Ta Ley; 5: Mol;  
6: Khva

Commune Cheung Aek

1: Choeng Ek; 2: Rolous; 3: Sroc Chek; 4: Prey Pranak; 5: Prek Thloeng

Commune Spean Thma

1: Preak Chrey; 2: Doung; 3: Ha; 4: Svay Mean Leak; 5: Spean Thma;  
6: Meun Tra; 7: Anhchanh; 8: Kouk Ovloek

*Note:* Out of these 19 villages, only 5 villages are located in (not totally) the Study Area

Figure 15-71: Location of Villages

Most of the interviewees were local authorities or community leaders as shown in Table 15-65.

Table 15-65: Occupations of Interviewees

Occupations	
Commune and Village Authorities	15
Community Leaders (Group leader, association chief and so on)	16
Teacher	1
Police	1
Agriculture/Fisher	2
Total	35

### g.3.2. Proposed Dang Kor disposal site development project

According to the result of the interview survey, 29 respondents (82.9%) already heard about the new disposal site plan before the first public hearing. 91.4% of the respondents replied that they knew the exact location of the planned site.

About half of the respondents said that they knew a lot about the disposal site well before the first public hearing, as shown in Table 15-66. In addition, 28.6% of the respondents replied that they were well aware of what kinds of facilities would be constructed at the proposed disposal site, as shown in Table 15-67.

Table 15-66: Before the public hearing, did you know anything about the disposal site?

Yes, I knew alot.	45.7%
Yes, but only a little.	40.0%
No.	14.3%
Total	100.0%

Base: 35

Table 15-67: Do you understand what kinds of facilities are planned to be constructed?

Yes, I understand well.	28.6%
Yes, but only a little.	57.1%
No.	28.6%
Total	100.0%

Base: 35

However, it seems that these figures are too high, judging from the level of awareness of waste management issues in Phnom Penh. More detailed questions about the disposal site and its facilities could reveal how much they actually understand about a disposal site and its facilities.

### g.3.3. Possible problems caused by the disposal site and their countermeasures

Although about half of the respondents replied that they had a good understanding of the possible problems caused by the proposed disposal site, less than 10% of them showed a serious concern about the possible problems, as shown in Table 15-68.

Table 15-68: Do you understand the possible problems caused by the new disposal site?  
(Are you concerned about these problems?)

Q5 Do you understand the possible problems?	Q6 Are you concerned about these problems?			
	Yes, I'm concerned.	Yes, but only a little.	No.	Total
Yes, I understand them well.	5.7%	22.9%	20.0%	54.8%
Yes, but only a little.	2.9%	22.9%	5.7%	28.6%
No.	0.0%	0.0%	20.0%	16.7%
Total	8.6%	45.7%	45.7%	100.0%

Base: 35

During the free talk at the end of each interview survey, some of the interviewees said that they stopped worrying about the problems caused by the disposal site because the representative from the local authority insisted in the closing remark that the JICA study team would conduct a proper study to prevent problems and we had no need to worry about them. It can be said that they changed their opinions based on the vague remark by the authority, not on scientific grounds.

In practice, PPWM, not the JICA study team, is the responsible organization, and the actual impact depends on the actual operation of the disposal site by PPWM. It is necessary to make them understand clearly the role of the JICA study team and its limit. At the second hearing, the roles and responsibilities of MPP, PPWM and the study team should be clearly explained.

Among the possible problems, offensive odor was the problem people were concerned about most, followed by air pollution. During the free talk at the end of each interview survey, many people expressed their concern about bad smell.

Table 15-69: What kinds of problems concern you most? (Multiple Answers)

Problems	
Water pollution	26.3%
Air pollution	42.1%
Breeding of vermin (flies, worms, etc.)	21.1%
Increase in traffic	15.8%
Offensive odor ( bad smell)	78.9%
Others	15.8%

Base: 19

To the question about countermeasures to prevent possible problems, 42.9% of the respondents replied that they understood them well, as shown in Table 15-70. In this case, the figure seems too high, and it can be expected that the actual number might be much lower.

Table 15-70: Did you understand the countermeasures to prevent possible problems?

Yes, I understand them well.	42.9%
Yes, but only a little.	45.7%
No.	11.4%
Total	100.0%

Base: 35

#### g.3.4. Opinions on the disposal site plan

Eighty percent of the respondents replied that they had a good understanding of the reasons why the area in the Dang Kor district was selected as a new disposal site, as shown in the table below. In addition, 88.6% of the respondents agreed with these reasons.

Table 15-71: Do you understand why the area in the Dang Kor district was selected as the new disposal site?

Yes, I understand well.	80.0%
Yes, but a little.	14.3%
No.	5.7%
Total	100.0%

Base: 35

Table 15-72: Do you agree with these reasons?

Yes.	88.6%
Yes, but a little.	11.4%
No.	0.0%
I do not know	0.0%
Total	100.0%

Base: 35

More than 80% of the respondents accepted the proposed disposal site plan in Dang Kor. The rest accepted it provided that there will be no serious environment problems.



Table 15-73: What do you think about the plan of the new disposal site?

I accept it.	82.9 %
I accept it if there will be no serious environment problems.	17.1%
I accept it if a water supply system is installed in this area.	0.0%
I do not accept the plan.	0.0%
I do not know.	0.0%
Total	100.0%

Base: 35

However, it would be better not to jump to the wrong conclusion. It is necessary to analyze these data carefully. It is likely that many of the respondents made their decisions based on limited knowledge and the inappropriate remarks by the local authority and PPWM at the end of the public hearing.

### g.3.5. EIA Survey Plan

Most of the participants had probably heard the term “EIA” for the first time, and 34.3% of the respondents replied that they understand it well.

Table 15-74: Do you understand what the EIA survey is?

Yes, I understand it well.	34.3%
Yes, but only a little.	40.0%
No.	25.7%
Total	100.0%

Base: 35

Table 15-75: Do you understand the purpose of the EIA survey?

Yes, I understand it well.	37.1%
Yes, but only a little.	34.3%
No.	28.6%
Total	100.0%

Base: 35

Table 15-76: Do you understand what kinds of items are investigated?

Yes, I understand it well.	25.7%
Yes, but only a little.	51.4%
No.	22.9%
Total	100.0%

Base: 35

### g.3.6. Project Owner

Only one respondent pointed out PPWM as the project owner of the proposed disposal site. It is necessary to make clear who the responsible organization is at the second hearing. As for the responsible organization of the EIA survey, nobody recognized the actual responsible organization. The representatives of PPWM were late for the public hearing and missed an opportunity to make an opening remark. This might have been a main factor for the participants in judging which organization was responsible for the new disposal site plan and the EIA survey.

Table 15-77: Do you know who is responsible for the construction of the new disposal site?

Yes.	57.1%
No.	42.9%
Total	100.0%

Base: 35

Table 15-78: Who is it?

JICA.	30.0%
Local Authority.	5.0%
Phnom Penh Municipality (MPP).	60.0%
Phnom Penh Waste Management (PPWM).	5.0%
Total	100.0%

Base: 20

Table 15-79: Do you know who is responsible for the EIA survey?

Yes.	42.9%
No.	57.1%
Total	100.0%

Base: 35

Table 15-80: Who is it? (Multiple Answers)

JICA.	73.3%
Local Authority.	46.7%
MPP.	13.3%
Phnom Penh Waste Management (PPWM).	0.0%
Total	100.0%

Base: 15

#### **g.4 Conclusions**

Although the majority of the respondents replied that they understand waste disposal issues, the extent of their understanding is questionable. Their limited knowledge on waste management issues may have lead them to believe that they understand these issues better than they actually do. PPWM and the team need to make more effort to ensure a greater understanding of these issues.

Moreover, all the respondents agree with the new disposal site plan, but it would be better to analyze these data carefully. They may have made their decisions based on their limited knowledge and on unscientific grounds such as the remarks of local authorities. In order to achieve a real consensus with local residents, it is necessary for MPP/PPWM to deepen the knowledge of local residents on waste management issues and to establish a mutual (two-way) relationship between MPP/PPWM and local residents.

On the other hand, few respondents recognized PPWM as either the project owner or the responsible organization of the EIA survey. Its presence at the first public hearing was not visible enough for the local residents. Therefore, it is vital for PPWM to take a leading role in the second public hearing and to guarantee that they themselves will take all the necessary measures to prevent serious environment problems as the responsible organization.

## Questionnaire

### About new disposal site plan

Q1. Before the public hearing, had you heard about the plan of the new disposal site in Dang Kor District?

1. Yes.
2. Yes, but only a little.
3. No.

Q2. Location: Do you know the location of the planned new disposal site?

1. Yes, I know the exact location.
2. Yes, I roughly know.
3. No, I did not.

Q3. Before the public hearing, did you know anything about disposal site?

1. Yes, I knew a lot
2. Yes, but only a little
3. No

Q4. Do you understand what kinds of facilities are planned to be constructed?

1. Yes, I understand it well
2. Yes, but only a little
3. No

Q5. Do you understand the possible problems caused by the new disposal site?

1. Yes, I understand them well.
2. Yes, but only a little.
3. No.

Q6. Are you concerned about possible problems?

1. Yes, I am concerned. → go to Q7
2. Yes, but only a little. → go to Q7
3. No. → skip Q7 and go to Q8

Q7. What kinds of problems concern you most?

1. Water pollution.
2. Air pollution.
3. Offensive odor (bad smell).
4. Breeding of Vermin (flies, worms, etc).
5. Increase in traffic.
6. Others (please specify \_\_\_\_\_).

Q8. Do you understand the countermeasures to prevent possible problems?

1. Yes, I understand them well.
2. Yes, but only a little.
3. No.

Q9. Do you understand why the area in the Dang Kor district was selected as the new disposal site?

1. Yes, I understand it well.
2. Yes, but only a little.
3. No.

Q10. Do you agree with these reasons?

1. Yes.
2. Yes, but only a little.
3. No.
4. I do not understand.

Q11 What do you think about the plan of the new disposal site?

1. I accept it.
2. I accept it if there are no serious environment problems.
3. I accept it if a water supply system is installed in this area.
4. I do not accept the plan.
5. I do not understand.

#### **About EIA survey**

Q12. Do you understand what the EIA survey is?

1. Yes, I understand it well.
2. Yes, but only a little.
3. No.

Q13. Do you understand the purpose of the EIA survey?

1. Yes, I understand it well.
2. Yes, but only a little.
3. No.

Q14, Do you understand what kinds of items are investigated?

1. Yes, I understand it well.
2. Yes, but only a little.
3. No.

#### **Project Owner**

Q15. Do you know who is responsible for the construction of the new disposal site?

1. Yes. → go to Q16
2. No. → go to Q17

Q16. Who is it?

1. Phnom Penh Municipality (MPP).
2. Phnom Pen Waste Management (PPWM).
3. JICA.
4. Local Authority.

Q17. Do you know who is responsible for the EIA survey?

1. Yes. → go to Q18
2. No. → go to Q19

Q18. Who is it?

1. Phnom Penh Municipality (MPP).
2. Phnom Pen Waste Management (PPWM).
3. JICA.
4. Local Authority.

Q19. What do you think about the new disposal site plan and the EIA survey plan? (free talk)

## 15.7.2 Second Public Hearing

### a. Objective

Based on the results of the EIA survey and the Dang Kor draft final development plan, which have been modified based on the results of the first public hearing, the second public hearing was arranged at the end of December 2003.

As the responsibilities of the institutions concerned were not clear to the local residents in the first public hearing, in the second hearing the roles and responsibilities of institutions were clarified. As for the local residents, the importance of their voluntary participation in the Dang kor development project was emphasized.

### b. Outline of the second public hearing

#### b.1 Schedule and attendants

##### b.1.1. Schedule

Date: December 25, 2003  
Time: From 8:00 a.m. to 11:00 a.m.  
Location: Thom Matray Pgoda, Commune Pray Sor

The location was decided considering the convenience of local residents.

##### b.1.2. Attendants

MPP; Mr. Sok Leakhena (Deputy chief of Cabinet)  
MOE; Mr. Sarun Smbo (Department of Pollution Control)  
PPWM; Heng Lay Orn (governor)  
Ms. Nay Ratha (Staff)  
Ms. Hem Visal (Staff)  
Local residents, local authority and NGOs;  
In total 219 people  
JICA Mr. Koizumu and Ms. Tamagake (Observers)  
JICA Study Mr. Shimura (Vice team leader)  
Team; Ms. Kani and Mr. Higo (Study team members)  
Mr. Makathy (Interpreter)  
Team assistants

### Selection of attendants

Basically, the area that may be directly affected is the area within a 1km radius from center of the proposed disposal site, which has been authorized by MOE as a study area. However, the increase in traffic due to construction vehicles and waste collection vehicles, and the discharge of leachate from the disposal site into the river will also affect the area. Therefore, the total affected area, the estimated population, the invited attendants, and the number of actual attendants were as follows:

Table 15-81: The Number of local residents

Affected area	Estimated population (person)	People and parties to be invited (person)	Actual number of attendants
An area within a 1km radius from the center of the proposed disposal site (A part of Bakou, Cheung Aek, Rolous, Ha and Doung)	1,509 (351 households)	Representatives of all households (approx. 350, a household list will be prepared)	214

Residents of the 5 villages mentioned above but living outside of the study area	----	----	34
Along National Road 303 which connects the center of Phnom Penh and the proposed disposal site (from the proposed disposal site until the bridge which is located at the north edge of Dang Kor Commune)	3,880	All village chiefs and vice village chiefs of the 9 villages in the area (18, see Annex)	6
Along the downstream area of the Prek Thnot river which is located to the south of the proposed disposal site (from the south of the proposed disposal site until the bridge of National Road 2)	11,610	All village chiefs and vice village chiefs of the 14 villages in the area (28, see Annex)	5
Other villages	----	----	114
Others	----	NGO Approx. 5 groups	6
Total	16,999	Approximately 400 persons	379

In total, 379 persons attended the public hearing, which is 2.2% of the 16,999 residents in the affected area. There were 214 attendants from the area within a 1km radius from the center of the proposed disposal site, which represent 61.0% of the 351 households. Based on the list of houseowners in this area, the ratio of females is about 30%. However, the female ratio of actual attendants was estimated to be about 70%.

### c. Program

The second public hearing was done as follows:

1. Registration 7:30 – 8:00
2. Opening Remark 8:00 – 8:15  
by Heng Lay Orn (governor)
3. Presentation of the draft final development plan for the Dong Kor disposal site and the EIA survey results
  - 3-1: Background of the proposed disposal site development plan 8:15 – 8:45  
by Mr. Sok Leakhena (Deputy chief of Cabinet)
  - 3-2: Outline of EIA survey results 8:45 – 9:15  
by Mr. Higo (JICA Study Team)
  - 3-3: Draft final plan of  
the Dang Kor disposal site development project 9:15 – 10:30  
by Mr. Shimura (Vice team leader of JICA Study Team)
4. Q&A 10:30 – 10:45  
Facilitator: Mr. Makathy

### d. Summary of presentation

#### d.1 Background of the proposed disposal site development plan

Since only one respondent pointed out PPWM as the project owner of the proposed disposal site based on the follow-up survey for the first public hearing, MPP first presented the background of the proposed disposal site development plan to make clear who the responsible organization is. The speaker presented the roles and responsibilities of MPP/PPWM and JICA, and the roles, responsibilities and rights of local residents.

## **d.2 Outline of EIA survey results**

The summarized EIA results were presented. Here, the speaker explained all the environmental items and possible impacts. As for mitigation measures, the next speaker, Mr. Shimura gave a simple explanation of the disposal site development plan, which was easy for the audience to understand.

## **d.3 Draft final plan of the Dang Kor disposal site development project**

First, the presentation clearly pointed out the necessity of the proposed disposal site in Phnom Penh by showing the expected future waste flow and the capacity of the existing disposal site. The reasons why the area in Dang Kor was selected were explained. The planned measures to prevent or mitigate environment problems were also explained.

Subsequently, the development plan and operational plan were also explained. Finally, based on the EIA survey results, mitigation measures and a monitoring committee for Dong Kor disposal site were proposed.

## **e. Q & A**

It seemed that many of the attendants already knew something about the problems caused by the disposal site from their experience with the SMCDS, and that they are concerned that the same things will happen in the proposed disposal site.

An attendant started the Q & A session by expressing his concerns about possible problems. Here is the summary.

“SMCDS and the disposal site in Kandal province had a good management plan. However, once they opened, the actual disposal operation was not managed well and there were lots of environmental problems such as offensive odor, problems from waste collection vehicles, the generation of vermin and landfill fires. When there was flooding, waste washed into the rice fields in the vicinity. I understand the Dang Kor disposal site development project has a technically good management and operational plan. However, I’m afraid that it is only good on paper. The actual operation does not always proceed as planned. I would like to request the following.”

Question 1-1

Complete all the construction work before starting waste disposal at the proposed site.

Question 1-2

According to the explanation today, the MOE is responsible for controlling and monitoring the operation. It must be carried out in accordance with the plan. If it is not, we will take action to oppose the project.

Another participant also made a comment and asked the following questions.

“Today we understand there are many things to be considered when a waste disposal site is constructed and operated. However, we also understand the mitigation measures have already been considered for them.”

Question 2-1

When will the disposal site start operation?

Question 2-2

Complete all the construction work before starting waste disposal at the proposed site because we live 400m away from the disposal site. (The questioner was a resident of Ha village and the actual distance is 500m from the disposal site.)

Answer for questions 1-1 and 2-2 (by PPWM)

This is a matter of course. We will complete all the construction work before starting waste disposal at the proposed site.

Answer for question 1-2 (by the JICA Study Team)

Monitoring is essential to ensure proper operation of the disposal site. All the people and parties concerned must check whether it causes problems or not. Furthermore, we would like you to keep watch of the site to make sure it is being properly operated.

Answer for question 2-1 (by the JICA Study Team)

Operation of the site is to start from 2008. However, it may change depending on the schedule of the request or implementation.

## **f. Result of the Follow-up Survey of the Second Public Hearing**

### **f.1 Purpose**

The main purpose of the follow-up survey was to know how much the public hearing participants understood the explanation of the development project and the result of the Environment Impact Assessment survey and what kinds of opinion they had on the development project.

### **f.2 Targets of the survey**

The main targets of the follow-up survey were narrowed down to those who live in the areas most affected by the planned new disposal site. The samples of the survey were selected according to the following criteria.

#### **f.2.1. Commune and Village chiefs**

All the Commune and Village chiefs that attended the public hearing were the targets of the follow-up survey. In the survey, they were divided into two groups; (1) 5 villages within a radius of 1 km from the proposed disposal site and (2) villages along R303 and the Prek Thnot river. The questionnaire for the Chief of Commune Dang Kor was analyzed along with that of the group 1.

#### **f.2.2. Ordinal people**

At the second public hearing, all the villagers living within a radius of 1 km from the planned disposal site were invited. In addition, more than hundred villagers from other villages attended on their own wills. The targets of the interview survey were only the former.

The housing Group was used as a basic sampling unit. From each housing group, one housing group leader and 1 or 2 ordinary people were selected as samples. Ordinary people were selected randomly by interviewers at the time of the interview survey, considering the balance in terms of sex and age. In the case that the housing group leader did not attend the hearing, 2-3 ordinary people were selected as samples.

#### **f.2.3. NGOs**

All the NGOs that attended the hearing were the targets of the survey.

### **f.3 Survey Methods**

#### **Survey Methods**

- Local Authorities and Villagers  
Interview Survey at the house of interviewees



- NGOs  
Questionnaire survey by mail

According to the result of the other interview surveys, Cambodian people tend to think they understand the issues well even though their knowledge is limited. In this survey, the survey team increased the number of free answer questions along with questions with a limited number of choices, so that it is possible to estimate the level of understanding to some extent.

#### f.4 Result of the interview survey

##### f.4.1. Samples

The total number of samples was 75. Samples were summarized based on the location of residence.

#### (1) 5 villages within a radius of 1 km from the planned disposal site

##### 1) Commune and Village Chief

Commune and Village chiefs that attended the hearing are shown below.

Position	Name of Commune	Number of Official
Commune Office	Dang Kor	1
	Bakou	1
	Cheung Aek	0
	Rolous	2
	Ha	1
	Doung	1
	total	6

##### 2) Other people including Commune officials such as vice Village chiefs

The number of samples and the hearing attendances from 5 target villages is shown below. 3 Vice village chiefs were selected as samples.

Province	Commune	Village	Number of Samples	Number of attendants
MPP	Dang Kor Cheung Aek	Bakou	17	89
		Cheung Aek	11	22
		Rolous	19	82
sub-total			47	193
Kandal	Spean Thma	Ha	11	17
		Doung	6	4 <sup>*1</sup>
sub-total			17	21
Total			64	214

\*1: It seems that some participants did not inform their name at the reception desk. Therefore, the number of actual participants might be more than 214.

The total number of samples from 5 villages was 70. The breakdown of these samples is shown below. Vice Village chiefs are classified as local officials.

Table 15-82: Breakdown of samples

Commune or Village	Local Officials	Housing Group Leader	Ordinal people
Commune Dang Kor	1		
Bakou	2	5	11
Cheung Aek	1	4	6
Rolous	1	2	18
Ha	3	0	9
Doung	1	1	5
total	9	12	49

The distribution of samples in terms of sex and age is shown below.

Distribution of Sex

Sex	Count
Female	26
Male	44
Total	70

Distribution of Age

Age	Count
10-19	1
20-29	2
30-39	17
40-49	21
50-59	16
60-69	9
70-	4
Total	70

Regarding the source of water supply, all the respondents living in MPP used well water, while all the respondents in Kandal Province used river. 13 respondents answered that their farmlands were located very near to the planned disposal site.

### (2) Along the National Rout 303 and the lower basin of the Prek Thnot river

Village chiefs from the following villages attended the public hearing. The total number was 3 and all of them were the targets of the interview survey.

Village	Commune/Khum	Province	Position	Count
Ta Ley	Dang Kor	MPP	Village chief	1
Khvar	Dang Kor	MPP	Village chief	1
Preaek Roteang	Preaek Kampis	Kandal Province	Village chief	1

### (3) NGOs

The following two NGOs replied to the questionnaire by mail.

Organization
Center for Development (CFD)
Pour Sourier d'Enfant (PSE)

#### f.4.2. Knowledge about the development plan before the second public hearing

A little more than 20% of the respondents attended the first public hearing.

Table 15-83: Did you attend the 1<sup>st</sup> public hearing?

	1km from the planned disposal site				Along R303/ river	NGO
	Local Officials	Leader	Ordinal	Sub-total		
attended	5	1	7	13	2	1
not attended	4	11	42	57	1	1
Total	9	12	49	70	3	2

The majority of the respondents had already known something about the development plan before the second public hearing.

Table 15-84: Did you know the development plan before the hearing?

	1km from the planned disposal site				Along R303/ river	NGO
	Local Officials	Leader	Ordinal	Sub-total		
Yes	9	7	42	58	2	1
No	0	5	7	12	1	1

Among the respondents who had already known the development plan before the second

public hearing, 47 (more than 60%) replied that they were concerned about the development plan. Offensive odor was selected as the most serious concern, followed by water contamination.

#### f.4.3. Background of the development plan

Many of the participants of the first public hearing could not understand well who were responsible for the development plan and the operation of the new disposal site. In addition, MPP and PPWM emphasized the support of JICA, rather than their own efforts, to win the support of local residents. As a result, a lot of participants overestimated the role of JICA.

Reflecting on the result of the first public hearing, the team tried to make clear the roles and responsibilities of the main stakeholders as much as possible at the second public hearing. In particular, the JICA Study Team team encouraged MPP to show its responsibility clearly at its presentation. However, more than half of the respondents thought that JICA was responsible for the development plan. Few respondents of local residents recognized PPWM as an operator, the quality of whose operation would be a decisive factor in preventing environmental problems. It is likely that these kinds of misunderstandings considerably affected their conclusion whether to accept the development plan or not.

Table 15-85: Did you understand who's responsible for the development plan?

	1km from the planned disposal site				Along R303/ river	NGO
	Local Officials	Leader	Ordinal	Sub-total		
Yes	8	9	29	46	3	2
No	1	3	20	24	0	0
Total	9	12	49	70	3	2

Table 15-86: (to those who answered YES) Who is it?

(Let the interviewees to answer freely)

	1km from the planned disposal site				Along R303/river	NGO
	Local Officials	Leader	Ordinal	Sub-total		
JICA	7	6	24	37	3	
Local Authority	1		1	2		
MPP		1	2	3		2
PPWM		2	2	4		
Total	8	9	29	46	3	2

Table 15-87: Did you understand who is responsible for the operation of a new disposal site?

	1km from the planned disposal site				Along R303/river	NGO
	Local Officials	Leader	Ordinal	Sub-total		
Yes	4	6	23	33	2	2
No	5	6	24	35	1	
No reply			2	2		
Total	9	12	49	70	3	2

Table 15-88: (to those who answered YES) Who is it?

(Let the interviewees to answer freely)

	1km from the planned disposal site				Along R303/river	NGO
	Local Officials	Leader	Ordinal	Sub-total		
JICA		4	9	13	1	
Local Authority			1	1		
MPP	3	2	11	16	1	
PPWM	1		2	3		2
Total	4	6	23	33	2	2

Table 15-89: Did you understand why a new disposal site is necessary?

	1km from the planned disposal site				Along R303/river	NGO
	Official	Leader	Ordinal	Sub-total		
No, not at all		2	4	6		
No, not understand well	1	1	5	7	1	
Yes, a little	3	4	20	27	1	
Yes, understand well	5	5	20	30	1	2
Total	9	12	49	70	3	2

Table 15-90: Did you agree with the explanation?

	1km from the planned disposal site				Along R303/river	NGO
	Official	Leader	Ordinal	Sub-total		
I agree	8	11	45	64	3	2
to some extent	1	1	4	6		
do not agree	9					

Table 15-91: Did you understand why Dang Kor was selected as a site of the new disposal site?

	1km from the planned disposal site				Along R303/river	NGO
	Official	Leader	Ordinal	Sub-total		
No, not at all	1		5	6		1
No, not understand well	1	2	11	14		
Yes, a little	3	2	15	20	2	
Yes, understand well	4	8	18	30	1	1
Total	9	12	49	70	3	2

Table 15-92: Did you agree with the explanation?

	1km from the planned disposal site				Along R303/river	NGO
	Official	Leader	Ordinal	Sub-total		
I agree	7	10	29	46	3	1
I agree to some extent			4	4		
I do not agree						

#### f.4.4. Possible problems and their countermeasures

At the presentation of the EIA survey result and the explanation of the new disposal site, the details of possible problems and their countermeasures were explained. In order to evaluate how much meeting participants understood the explanation, the interviewees were asked to mention any problems they were concern about. Most of the respondents replied that they understood the possible problems, but among them 22 respondents did not mention any problems specifically. The concern that more than half of the respondents cited was only offensive odor.

Regarding the countermeasures, many respondents somehow understood water pollution control measures. This is probably because the presenter introduced the waste treatment systems in more detail than other measures.

Table 15-93: Did you understand the explanation about possible problems?

	1km from the planned disposal site				Along R303/river	NGO
	Official	Leader	Ordinal	Sub-total		
No, not at all			2	2		
No, not understand well			1	1		
Yes, a little	2	6	25	33	2	
Yes, understand well	7	6	21	34	1	2
Total	9	12	49	70	3	2

Table 15-94: (to those who answered YES) What kinds of problems are you concerned?  
Please tell us all you are concerned (multiple answer)

(Let the interviewees to answer freely)

Concern	5 villages	Village chief	NGO
offensive odor	45		2
fire and air pollution	11		1
breeding of vermin	18		2
water contamination	24		2
traffic congestion	7		2
dust from vehicles	2		
future of waste pickers			1
others			
public health	1		
dispute with landowner	1		
noise			1

Base: 67 (within 1km) , 3 (Village Chief) , 2 (NGO)

Table 15-95: Did you understand counter measures to prevent environment problems?

	1km from the planned disposal site				Along R303/river	NGO
	Official	Leader	Ordinal	Sub-total		
No, not at all			3	3		
No, not understand well		1	5	6	1	
Yes, a little	3	5	25	33	1	
Yes, understand well	6	6	15	27	1	2
Total	9	12	49	70	3	2

Table 15-96: Number of respondents who answered properly to the question “What kinds of countermeasures were proposed to deal with the following problems?”

(Let the interviewees to answer freely)

	5 villages	Village chief	NGO
Water pollution: introduction of waste water treatment facilities	42	2	2
Offensive odor: soil covering	16		2
Breeding of vermin: soil covering	1		2
Scattering of waste and dust: improvement of road and collection vehicles and so on	14		2

### Opinions on the development plan

To the question regarding the opinion about the development plan in general, all the respondents agree with the plan without condition or on a condition. Considering the fact that more than half the respondents thought that JICA is a responsible for the development plan and few recognized that PPWM is in charge of the operation of the new disposal site, it can be said that a careful attention is needed to evaluate this result.

Almost all the respondents that accepted the development plan on a condition cited “Necessary Countermeasures are taken to prevent environment problems” as the condition to accept the development plan, as shown in Table 15-98. In addition, some people called a special attention, requiring that all the measures that were proposed at the hearing would be certainly taken, as shown in Table 15-102. Therefore, it is important for MPP to show clearly that both the construction work and the operation of the disposal site will be implemented according to the plan. In particular, to control the daily operation is a decisive factor in preventing environment degradation.

One of effective ways to control the construction work and daily operation is monitoring by a group including local residents. A participatory monitoring system from the early stage of

planning could play an important role to win the trust of local residents and to reach a consensus with them. The result of the interview survey shows that many of the respondents were interested in a participatory monitoring system. It is important to establish a reliable monitoring system, while securing the budget.

On the other hand, since MPP will not allow waste pickers to pick up waste at the new disposal site, NGOs expressed their concern about the future of waste pickers who are now working at the SMCDS. According to the result of the interview survey, which was conducted with waste pickers at the first phase of the JICA study, more than half of the respondents wanted to start a new job, rather than moving to the new disposal site. It is very important for MPP to examine possible measures to support existing waste pickers to prepare new jobs from now. It is necessary for MPP to cooperate with NGOs that are supporting waste pickers.

Table 15-97: In general, do you agree with the development plan?

	1km from the planned disposal site				Along R303/river	NGO
	Official	Leader	Ordinal	Sub-total		
accept without conditions	5	10	31	46	3	
accept on a condition	4	2	18	24		2
not accept the plan						
I do not know						
Total	9	12	49	70	3	2

Table 15-98: (to those who accepted on a condition) What conditions do you set to accept the development plan? Please select all you agree with.

Conditions	(multi answer)		
	5 villages	village chief	NGO
Necessary Countermeasures are taken to prevent environment problems	24		1
When MPP buys land, enough compensation is provided for land owner	2		1
All the information on the plan is open to public	2		2
MPP provides special programs to promote local economy	7		2
The government tightens the regulation and control of disposal site	5		1
The regular monitoring is conducted to control the disposal site operation	6		1
Others	2		
to conduct medical check for local people once or twice a year			
to build all the necessary facilities before the operation starts			

Table 15-99: How do you think about a monitoring plan proposed at the hearing?

	1km from the planned disposal site				Along R303/river	NGO
	Official	Leader	Ordinal	Sub-total		
I cannot trust the monitoring system	1		1	2		
I did not understand the monitoring plan well		2	1	3		
I do not know if it is effective		2		2		
I do not remember it			1	1		
I do not think it works well			4	4	1	
I think it is a good system	8	8	42	58	2	2
Total	9	12	49	70	3	2

Table 15-100: (to those who said that it is a good system) What kinds of monitoring items do you think important? Please select all you agree with.

(multi answer)

	5 Villages	Village chiefs	NGO
Air quality	37	2	2
Fire	5	2	1
Soil covering	9	1	2
Traffic situation	22	1	
Water quality	55	3	2
Others (waste pickers)			1

Base: 58 (the 5 villages) , 2 (Village chiefs) , 2 (NGO)

Table 15-101: Are you willing to participate in a monitoring committee?

	1km from the planned disposal site				Along R303/river	NGO
	Official	Leader	Ordinal	Sub-total		
No, I do not want		1	5	6		
Yes, but a little bit	1		7	8		
Yes, I am willing to	8	11	37	56	3	2
Total	9	12	49	70	3	2

Table 15-102: If you have questions or comments, please tell us.

(1) respondents who live within a radius of 1 km from the planned disposal site

Please make sure that the new disposal site is constructed according to the plan that were explained at the hearing and starts the operation after all the necessary facilities are constructed	18
I want the road improved or constructed	12
I hope that the new disposal site provides job opportunities	8
I want MPP to take care of people's health (asking for water supply, health center and a regular medical check)	5

(2) village officials along R303 or Prek Thnot river

hope that the new disposal site provide job opportunities for local people	1
asking for water supply	1
make sure that the new disposal site is constructed according to the plan in order to prevent environment problems	1

(3) NGO

Since the new disposal site does not allow waste pickers to work inside the disposal site, they will lose their job. How do you solve this problem?	1
---	---

## f.5 Conclusion

More than half of the respondents replied that they understood well why Dang Kor was selected as the new disposal site and all of them agreed with the development plan either without condition or on a condition. However, judging from the result of free-answered questions, it seems that the level of understanding is not high. In particular, most respondent did not understand correctly who was responsible for either the development plan or the operation of the new disposal site. It is necessary for MPP and PPWM to take every opportunity to open information to local residents and to make them understand the development plan further.

The result of the interview survey revealed that many of the respondents are interested in a monitoring system. It is important to establish a reliable monitoring system to make a real consensus with local residents.

## **15.8 Environmental Management Plan**

### **15.8.1 Environmental Impact Mitigation Measures**

#### **a. Socio – cultural Characteristics**

##### **a.1 Economic activities**

###### **a.1.1. Required consideration**

###### **Alternative jobs for landowners**

Alternative jobs for landowners of the site should be proposed from the project owner. This request was also pointed out by local people at the 1<sup>st</sup> public hearing. Therefore, countermeasures were planned.

###### **Alternative jobs for waste pickers**

Based on the social environment survey to waste pickers, more than 90% of them do not continue waste picking work at the Dong Kor disposal site if they have other job opportunities. Therefore, alternative jobs should be created for the waste pickers.

#### **a.2 Countermeasures**

##### **a.2.1. Alternative jobs for landowners**

The project owner of the proposed disposal site shall give priority to the landowners when hiring staff. For example, the composting plant, one of facilities at the disposal site, will need many workers. The project owner, MPP, shall provide the landowners a chance for employment in order to compensate for their loss in agricultural income. New employment, landfill workers and composting workers in DKDS, would be 37 persons in total. The landowners who will loss in agricultural income would be 36 persons. Therefore, this issue will be covered.

##### **a.2.2. Alternative jobs for waste pickers**

In accordance with the M/P, PPWM organizes the waste pickers by the disposal site closure in 2007 and makes them work following a rule. Furthermore, PPWM encourages waste pickers to become primary or secondary waste collectors. It is possible for PPWM to employ some waste pickers as workers for primary collection and the recycling centers, but the number of jobs is limited.

500-700 waste pickers in SMCDS will lose their job. On the other hand, PPWM can create new job, waste collectors and sweepers, only 177 persons in 2015.

Considering the number of waste pickers who depend on the SMCDS to make a living, this is not just a waste management issue but a social issue that MPP should consider comprehensively. It is important for MPP to examine possible measures to support waste pickers in cooperation with all the government organizations, NGOs and international organizations concerned.



**b. Traffic and public facilities**

**b.1 Required consideration**

Improvement of the road surface quality by paving.

**b.2 Countermeasures**

Based on the waste collection and transportation system in the M/P, the collection vehicles will make a total of 322 trips per day in 2007. So the number of trips made by collection vehicles is not so large. However, the current road conditions are bad because it is not unpaved. The collection vehicles have to stop in front of every hole on the road as the vehicles would have to avoid or go through them slowly. This slowdown makes traffic jam and acceleration from low gear makes big noise and much exhaust gas. Unpaved road itself also is generating dust.

Following environmental items would be seriously affected.

- -Noise
- -Traffic jams
- -Air pollution

As for countermeasures, the most effective countermeasure is pavement on the road. By doing this, the collection vehicles can run smoothly.

The ADB will implement the “Mekong Tourism Development Project”. In this project, national road 303 will be paved in order to create better access from the center of Phnom Penh to the Killing Field Memorial. The section of the road from there to the entrance of the proposed disposal site is also to be paved in the Project. Therefore, traffic jams will be negligible.

**c. Cultural Property**

**c.1 Required consideration**

Consideration of visitors to the Killing Fields Memorial.

**c.2 Countermeasures**

A buffer zone will be installed around the disposal site to conceal the facilities to protect the view.

Moreover, in order to maintain the scenic landscape, the height of the landfill is to be 11m. Soil will be excavated to a depth of about 9m in order to secure a volume of landfill instead (the height of the landfill is 20m in total ).

**d. Public health**

**d.1 Required consideration**

- Prevention of the growth in population of vectors and vermin which have a negative impact on the study area.
- Treatment of the leachate from the disposal site.
- Prevention of landfill fires
- Monitoring
- Prevention of littering along the road

## d.2 Countermeasures

### d.2.1. Cover soil

The main source of vectors and vermin is the eggs of flies which have been deposited in the wastes before they arrive at the site. Most of these are buried deep in the wastes and succumb to the temperature increase. Near surface, however, the rise in temperature is not so high and the eggs hatch into larvae. Therefore, daily soil covering work will be carried out at the disposal site, which will minimise the growth in the population of vectors and vermin.

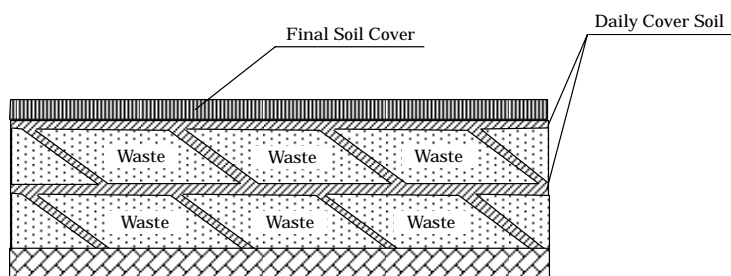
Landfill fire can arise from various causes, a cigarette thrown down by a worker, the sun's rays through a fragment of glass on the surface. Landfill fires will also be controlled by cover soil. Therefore, there will be very few opportunities for landfill fires.

The thickness of each layer is as follows:

- daily or weekly cover: 15 cm
- final cover: 50 cm (depending on the ultimate use)

Accordingly, the ratio of cover soil to the disposal volume of waste will be 10 %, excluding the final cover.

Soil for coverage was planned to be obtained from within the disposal site as the area is large enough.



It is useful to have a supply of water on the site to quench land fire. The water tank truck for dust could serve a double purpose.

### d.2.2. Leachate treatment facilities

All the leachate from the disposal site is to be treated on site year-round and will not be discharged outside the site. Therefore, leachate will not affect public health.

The leachate treatment process will vary in the wet and dry seasons as described below. The systems are comprised of the same facilities although referred to by different names.

Dry season : When the leachate quantity is small, it is to be treated with subsurface flow wetland ponds and evaporation ponds. Any overflow of treated leachate is to be returned to the regulation pond by recirculation pump.

Wet season : If the quantity of leachate exceeds the capacity of the wetland ponds, the wetland ponds and evaporation ponds are to be used as reservoir ponds. In case the leachate exceeds the expected amount, an emergency line is to be constructed to return excess leachate to the landfill site via the overflow pit.

The flow sheet of the leachate treatment facilities is shown in the following diagram.

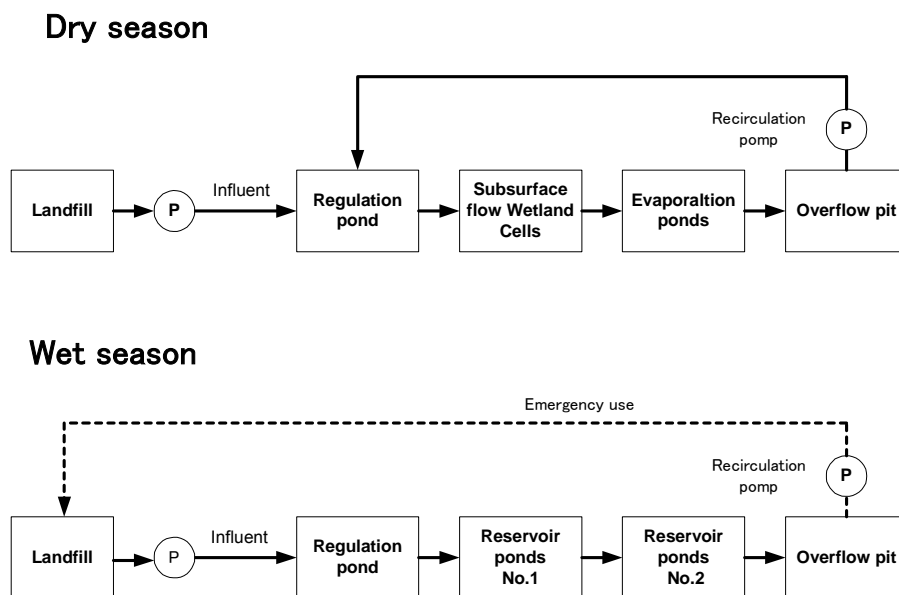


Figure 15-72: Flow sheet of Leachate Treatment Facilities

### d.2.3. Monitoring after the termination of operation

Leachate and landfill gas shall be monitored regularly after the site is closed to protect the health of people who may gather at the site after it is converted to a recreational facility. The details of the monitoring program are mentioned in the section, “Description of the Project”.

As for the infiltration to groundwater, the geological survey on the soil in the disposal site area revealed that the permeability of the natural soil is low. Therefore, it can be said that the existing ground can be used as a natural liner to control leakage.

### d.2.4. Prevention of littering along the road 303

In order to prevent the waste collection vehicles of littering along the national road 303, which is access road from center of Phnom Penh to the disposal site, enclosed waste collection vehicles shall be used. In case open top trucks, cloth tarps shall be used to cover them.

## e. Air pollution

### e.1 Required consideration

- Prevention of dust generation from the construction activities
- Consideration for landfill gas in the operational stage
- Prevention of landfill fires
- Prevention of dust generation from the collection vehicles
- Consideration for landfill gas in the operational stage

### e.2 Countermeasures

#### e.2.1. Dust from construction vehicles

During the dry season, regular watering shall be done to minimise dust generation.

#### e.2.2. Landfill gas in operational stage

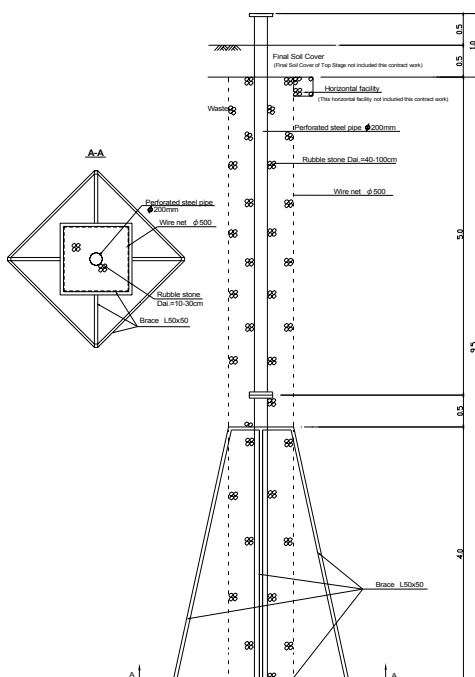
Gas removal facilities shall be installed for ventilation of landfill gas as follows:

### Vertical Gas Removal

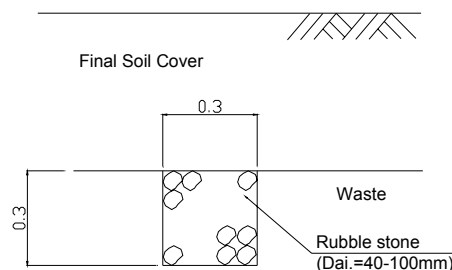
Before landfilling the waste, 5 meters of the vertical gas removal system will be constructed and extended as the waste is filled. After landfilling is complete, the vertical gas removal pipe will extend above ground to exhaust the gas. The structure is shown below.

### Horizontal Gas Removal

Before landfilling the waste, a horizontal gas removal system will be constructed. The structure is shown below.



Vertical Gas Removal



Horizontal Gas Removal

The details of the facilities are shown in the section, "Description of the Project".

#### e.2.3. Landfill fire

Soil cover shall be applied daily. This practice will help to minimise the possibility of any spontaneous fires breaking out, which can produce large quantities of smoke and environmentally harmful gases. Moreover, if a fire does break out, it shall be extinguished immediately with water.

#### e.2.4. Dust from collection vehicles

National road 303 is to be improved with ADB funding by 2007 by paving it up to the entrance of the Killing Fields Memorial. The section from there to the entrance of the proposed disposal site shall be improved in the Dang Kor Disposal Site Development Project. Therefore, dust from collection vehicles is not expected and the impact on air pollution will be negligible.

#### e.2.5. Landfill gas in closure stage

Landfill gas shall be monitored regularly after the site is closed to mitigate air pollution in the study area. The details of the monitoring program are mentioned in the section, "Description of the Project".

**f. Water quality**

**f.1 Required consideration**

- Treatment of leachate from the landfill site in the operational stage
- Treatment of leachate from the compost plant
- Treatment of wastewater from the maintenance workshop
- Treatment of leachate from the landfill site in the closure stage

**f.2 Countermeasures**

**Leachate from the landfill site in the operational stage and from the compost plant**

All the leachate from the landfill site and compost plant is to be treated on site year-round and will not be discharged outside the site. Therefore, leachate will not affect the river water. The leachate treatment process will vary in the wet and dry seasons as described below. The systems are comprised of the same facilities although referred to by different names.

Dry season : When the leachate quantity is small, it is to be treated with subsurface flow wetland ponds and evaporation ponds. Any overflow of treated leachate is to be returned to the regulation pond by recirculation pump.

Wet season : If the quantity of leachate exceeds the capacity of the wetland ponds, the wetland ponds and evaporation ponds are to be used as reservoir ponds. In case the leachate exceeds the expected amount, an emergency line is to be constructed to return excess leachate to the landfill site via the overflow pit.

As for the infiltration into groundwater, the geological survey on the soil for the disposal site area revealed that the permeability of the natural soil is low. Therefore, it can be said that the existing ground can be used as a natural liner to control leakage.

**Wastewater from the maintenance workshop**

The wastewater from the maintenance workshop is to be treated. As the wastewater contains oils such as grease or lubricant oil, an oil trap shall be installed in the drain to recover the oil content.

**Leachate from the landfill site in the closure stage**

The leachate treatment facilities shall continue to be used after closure of the disposal site although the production rate of leachate will diminish with time.

Moreover, leachate shall be monitored regularly after closure to protect the water quality of public water areas. The details of the monitoring program are mentioned in the section, "Description of the Project".

**g. Hydrological situation**

**g.1 Required consideration**

- Treatment of leachate from the landfill site in the operational stage
- Treatment of leachate from the compost plant
- Treatment of wastewater from the maintenance workshop
- Treatment of leachate from the landfill site in the closure stage  
(Same as "water quality")

**g.2 Countermeasures**

- Leachate from the landfill site in the operational stage and from the compost plant

- Wastewater from the maintenance workshop
- Leachate from the landfill site at the closure stage  
(Same as “water quality”)

**h. Soil contamination**

**h.1 Required consideration**

-Prevention of contamination from infectious and hazardous waste.

**h.2 Countermeasures**

In order to prevent soil contamination, Dang Kor disposal site shall be designed to receive only MSW and general waste from medical institutions and factories.

**i. Noise**

**i.1 Required consideration**

- Noise from waste collectional vehicles.

**i.2 Countermeasures**

**Road improvement**

National road 303 is to be improved with ADB funding by 2007 by paving it up to the entrance of the Killing Fields Memorial. Then section from there to the entrance of the proposed disposal site is also to be improved in the Dang Kor Disposal Site Development Project. Therefore, traffic jams are not expected and the impact on noise will be negligible.

**Disturbance control during construction**

Basically in case of DKDS construction, no significant noise is expected. However disturbance from noise should be kept as much as possible at low levels during construction phase. Noise emission from construction equipment and power generators should be controlled by silencers. Engines and mufflers of haulers and other vehicles of Project should be properly maintained to avoid excessive noise emissions. Speeds should be reduced to minimize noise emissions by vehicles.

**Manner of driving for collection vehicles**

Generally, noise generated from vehicles is affected by the manner of driving. Therefore, all the drivers of collection vehicles shall undergo training to improve their manner of driving.

**j. Offensive odor**

**j.1 Required consideration**

- Offensive odor from the landfill site
- Offensive odor from the compost plant

**j.2 Countermeasures**

**Offensive odor from the landfill site**

In order to reduce the offensive odor from the landfill site, soil cover shall be done daily.

**Offensive odor from the compost plant**

In order to reduce the offensive odor from compost plant, the aerobic bio-decomposition method for composting shall be adopted. Moreover, composting works shall be done indoors.

**k. Fauna and flora**

**k.1 Required consideration**

- Leachate and landfill gas at the closure stage

**k.2 Countermeasures**

**Monitoring after the closure of the disposal site**

Leachate and landfill gas shall be monitored regularly after the disposal site is closed to protect the natural environment. The details of the monitoring program are mentioned in the section, "Description of the Project".

**l. Landscape**

**l.1 Required consideration**

- Harmonization of the disposal site and the surrounding landscape

**l.2 Countermeasures**

**Buffer zone**

A buffer zone shall be installed around the disposal site to conceal the facilities and maintain the view of the surrounding area.

**Height of the landfill**

In order to maintain the scenic landscape, the height of the landfill shall be 11 m. Therefore, the impact will be limited.

## **15.8.2 Institutional Strengthening and Training**

Enhancing the capability of each organization, PPWM (an operator of the disposal site), DPWT (a supervisor) and MOE/DOE (in charge of pollution control) is a key element to achieve the main goal of the development plan: to dispose of the growing amount of waste while minimizing environmental impact. In this section, the approach of strengthening institutional capacity and training staff is summarized.

**a. Organizations responsible for SWM**

M/P clarifies the organization responsible for SWM of MPP as follows.

- MPP/Cabinet formulates a comprehensive SWM policy and enforces it.
- DPWT supervises the construction of the disposal site and waste collection service to be carried out by PPWM.
- DOE monitors and controls SWM operated by PPWM and takes charge of public education.
- PPWM operates and maintains the SWM under their jurisdiction.
- MPP/Cabinet constitutes the coordination committee consisting of the above four agencies to coordinate each function and manages smoothly through a regular meeting.

**a.1 Construction of the new disposal site**

The construction of the Dang Kor disposal site will be supervised by DPWT according to the above clarification. Although DPWT has a lot of experience of the construction supervision but the construction of the disposal site applying international standards is the first in

Cambodia. However, DPWT should supervise a construction works of the disposal site with receive an international consultant which has suitable experience in this field.

### a.2 Landfill operation

PPWM takes charge of the landfill operation. PPWM has only 4 staffs for the landfill operation as of 2003, however, the M/P proposes to establish an organization for the disposal site management as shown in the below chart and table.

MPP has given a priority to this project and would strengthen PPWM's capability for landfill operation by employing the suitable staffs according to the proposed schedule by the middle of 2006.

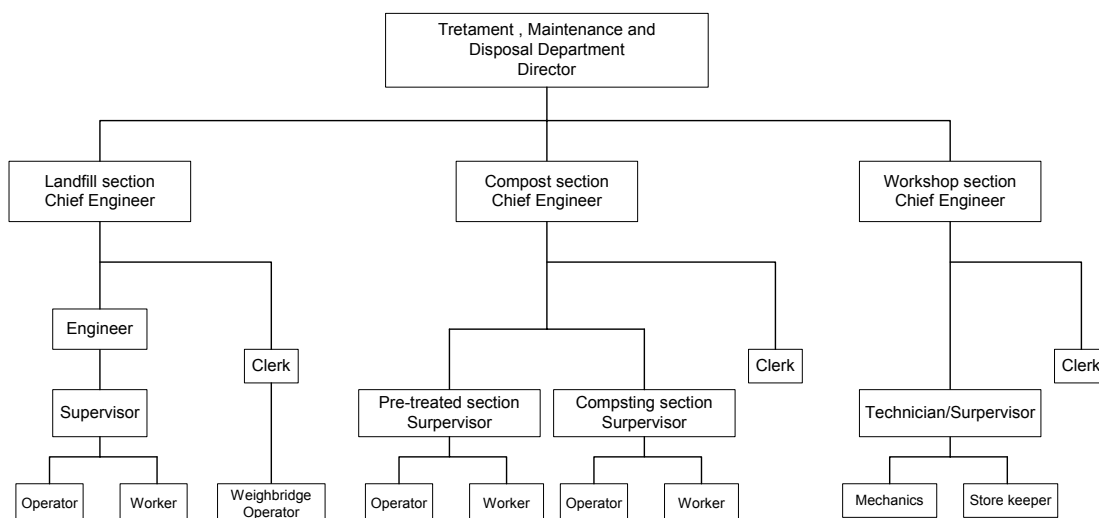


Figure 15-73: Organization Chart of Treatment, Maintenance and Disposal Site

Table 15-103: Staff Schedule

Section	At present	2007	2012	2015
<b>Landfill Operation</b>				
1. Section Chief	1	1	1	1
2. Engineer	-	1	1	1
3. Clerk	-	2	2	2
4. Truck scale operator	2	3	3	3
5. Supervisor	-	4	4	4
6. Operator	-	22	25	29
7. Worker	1	12	12	12
total	4	45	48	52
<b>Compost Plant</b>				
1. Section Chief		1	1	1
2. Clerk		1	1	1
3. Supervisor		2	2	2
4. Operator		2	2	2
5. Worker		25	25	25
Total		31	31	31
<b>Maintenance Workshop</b>				
1. Section Chief		1	1	1
2. Chief mechanic		1	1	1
3. Mechanician		13	16	19
4. Clerk		4	4	4
Total		19	22	25



### a.3 Monitoring and control

DOE is in charge of the monitoring and control of landfill operation to be carried out by PPWM. DOE will organize a monitoring committee to accomplish their duty mentioned in the next section.

### b. Training

Through the pilot project for improvement of SMC disposal site being carried out as a part of “The Study on SWM in the Municipality of Phnom Penh in the Kingdom of Cambodia” being conducted by JICA, PPWM’s capacity building was conducted for the planning, operation and management of a final disposal system, as shown in the table below.

Table 15-104: Training Items in the PP for Improvement of SMC Disposal Site

Category	Item	Description
Planning	Formulation of an improvement plan	<ul style="list-style-type: none"> <li>• Training in planning methodology was given through weekly meetings.</li> </ul>
	Preparations for implementation of the improvement plan	<ul style="list-style-type: none"> <li>• Negotiations were conducted to secure land for expansion of the disposal site.</li> <li>• Construction work was supervised.</li> <li>• WP registration system was introduced.</li> </ul>
Operation	Formulation of an operational plan	<ul style="list-style-type: none"> <li>• Training in planning methodology was given through weekly meetings.</li> </ul>
	Implementation of the operational plan	<ul style="list-style-type: none"> <li>• A Daily Landfill Operation Plan was prepared.</li> <li>• Instructions were given to collection vehicle drivers, heavy equipment operators and WP regarding the working face, and enforced.</li> </ul>
Management	Control of waste brought to the site	<ul style="list-style-type: none"> <li>• The incoming vehicles and waste were checked and controlled.</li> <li>• Incoming vehicles were weighed by weighbridge and the data was compiled.</li> <li>• On-site roads were maintained.</li> </ul>
	Operational control	<ul style="list-style-type: none"> <li>• Operation and maintenance of the working face.</li> </ul>

MPP and JICA will continue this pilot project to train the member of PPWM for proper management of the disposal site. In addition to this, Japanese Government decided to implement the technical cooperation project for strengthening of SWM for the municipality of Phnom Penh in Japanese fiscal year 2004.

Therefore, the PPWM’s capability for disposal site management will be strengthened by the commencement of the operation of Dang Kor disposal site.

## 15.8.3 Monitoring

### a. Monitoring Plan

Even if the plan, design and construction of the proposed landfill will be completed as a sanitary landfill, without proper operation it may have serious adverse impacts on the surrounding environment. The monitoring of landfill operation is the key to securing environmentally sound landfill operation.

Therefore, during the construction, operation and closure stage, regular monitoring is to be conducted on the items shown in the table below. The monitoring locations are shown in the following figure.

As for interval of the monitoring, internal monitoring by DOE shall be done in every month, monitoring by the monitoring committee shall be carried out twice a year.

Table 15-105: Monitoring plan of the Dang Kor Disposal Site

Items	Facility and equipment	Measuring Items	Stage		
			construction	Operation	Closure
Underground Water	Monitoring well	Electric conductivity, Cl <sup>-</sup> , pH		√	√
Surface Water	Water sampling	Electric conductivity, Cl <sup>-</sup> , pH		√	√
Landfill gas	Gas removal pipe	CH <sub>4</sub> , CO <sub>2</sub> , H <sub>2</sub> O, Temperature		√	√
Noise	Noise level meter	Odor, Noise	√	√	
Settlement	Settlement board	Settlement level		√	√
Landfill fire	Personal check,	Landfill fire		√	√
Offensive odor	Personal check,	Offensive odor		√	√

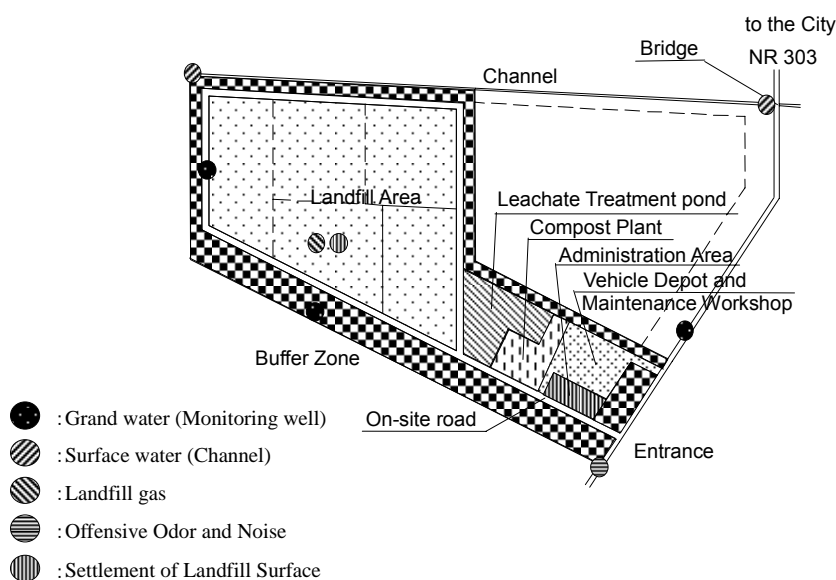


Figure 15-74: Location of Monitoring Points

**b. Monitoring committee**

In order to strengthen a monitoring system, a monitoring committee for the Project is proposed. The monitoring committee will have the following function.

- The committee members shall join in the monitoring and observe the environmental condition of the site and its surroundings.
- If the operation is suspected of having an effect on environmental conditions, the committee members shall be able to request a survey for it and be able to join on-site inspection.
- In order to proper operation of the disposal site, the committee and PPWM shall hold discussions whenever necessary.

The committee may include:

- MPP
- MoE

- DoE
- NGOs
- Representatives from local authorities and residents

## **15.9 Conclusion**

Based on the result of careful examination on the project, the environmental resources, the environmental impact analysis, the results of public participation, the environmental mitigation measures, analysis of alternatives, the environmental management plan and the institutional capacity, it is expected that the negative impact of this development project on the environment can be controlled to be negligible. Breakdown of conclusion for each aspect are following.

### **15.9.1 Project**

The Project is for the development of a new disposal site in Phnom Penh and the project owner is MPP. The Project is essential for proper SWM in Phnom Penh and to continue to provide SWM services to the citizens as the existing disposal site, SMCDS, will be closed by the end of 2007. The implementation of the project will provide public benefit to Phnom Penh citizens and contribute to SWM and environmental conservation in Phnom Penh.

The Project covers all stages of development, i.e. the construction stage, operational stage and closure stage, with environmental consideration. The site location, size, and disposal methods were also determined giving adequate consideration to the environment. The environmental management plan is also well considered. Not only countermeasures, the setting up of the monitoring committee for the Project and training for staff are also planned.

### **15.9.2 EIA Procedure**

The Project is subject to an EIA in accordance with the Sub-decree on Environmental Impact Assessment Process in Cambodia. As required in this Sub-decree, first an IEE was conducted and submitted to MOE.

The EIA of the Project was carried out based on the result of the IEE, which covered the environmental items that had been authorized by MOE on July 16<sup>th</sup> 2003.

### **15.9.3 Public participation**

In this EIA, public participation such as public hearing, public information are seriously concerned.

As for public participation, two public hearings were held, before and after the EIA survey, to develop consensus-building with the stakeholders. Their comments and questions were reflected in the project plan.

As for making the information available to the public, all the development plans and contents of the public hearings including the questions and answers were presented on a web site.

#### 15.9.4 Capacity of the project owners

The owner of the project is MPP. PPWM and DOE under MPP are responsible for operation and for control and monitoring of the Project respectively. As the C/P in the Study on Solid Waste Management in the Municipality of Phnom Penh implemented by JICA, the staffs of PPWM and MOE are undergoing training to enhance their skills through the pilot project for the improvement of SMCDS.

#### 15.9.5 Items that require special consideration

As a result, the impact of the Project on the surrounding environment is expected to be negligible, or diminished through mitigation measures and other projects that are expected to be implemented. However, special consideration will be needed for the following items.

##### a. Proper implementation

Even if the plan, design and construction of the proposed landfill will be completed as a sanitary landfill, the monitoring of the operation landfill and closure is the key to securing environmentally sound landfill operation. Therefore, during the construction, operation and closure stage, regular monitoring is essential. Following table shows the environmental items to be seriously considered as for proper implementation.

Parameter	Adverse impact
Water quality	The disposal site will generate leachate, and if it discharge the river or canal or infiltrate to the groundwater, they will be contaminated. Leachate will continue to be generated after the termination of operation. Although generation rate is diminish with time
Offensive odors	Organic waste of which disposed of at the site will generate offensive odor. The compost plant in the site also will generate offensive odor.
Landfill fire	Landfill fire will occur and harmful smoke will be generated at the landfill site.

In order to establish a monitoring system, a monitoring committee for the Project is proposed. The committee members shall join in the monitoring and observe the environmental condition of the site and its surroundings.

The committee may include:

- MPP
- MoE
- DoE
- NGOs
- Representatives from local authorities and residents

As for interval of the monitoring, internal monitoring by PPWM shall be done in every month, monitoring by the monitoring committee shall be carried out twice a year.

##### b. Road improvement

Based on the waste collection and transportation system in the M/P, the collection vehicles will make a total of 322 trips per day in 2007. So the number of trips made by collection vehicles is not so large. However, the current road conditions are bad because it is not unpaved. The collection vehicles have to stop in front of every hole on the road as the vehicles would have to avoid or go through them slowly. This slowdown makes traffic jam and acceleration from low gear makes big noise and much exhaust gas. Unpaved road itself also is generating dust.

Following environmental items would be seriously affected.

- -Noise
- -Traffic jams
- -Air pollution

As for countermeasures, the most effective countermeasure is pavement on the road. By doing this, the collection vehicles can run smoothly.

The ADB will implement the “Mekong Tourism Development Project”. In this project, national road 303 will be paved in order to create better access from the center of Phnom Penh to the Killing Field Memorial. The section of the road from there to the entrance of the proposed disposal site is also to be paved in the Project. Therefore, noise, traffic jams and air pollution will be negligible.

### **c. Alternative jobs**

When the existing disposal site, SMCDS, is closed at the end of 2006, 500 - 700 waste pickers who are picking valuables there will lose their job. As well as SMCDS, the land owners of this area will lose agricultural income as the proposed disposal site is mainly rice fields and will be bought by the project owner. Therefore, alternative jobs for them are considered.

As for waste pickers in SMCDS, PPWM will support them by providing job opportunity for waste collector. In accordance with the M/P, PPWM organizes the waste pickers by the disposal site closure in 2007 and makes them work following a rule. Furthermore, PPWM encourages waste pickers to become primary or secondary waste collectors. It is possible for PPWM to employ some waste pickers as workers for primary collection and the recycling centers, but the number of jobs is limited. 500-700 waste pickers in SMCDS will lose their job. On the other hand, PPWM can create new job, waste collectors and sweepers, only 254 persons in 2007. Considering the number of waste pickers who depend on the SMCDS to make a living, this is not just a waste management issue but a social issue that MPP should consider comprehensively. It is important for MPP to examine possible measures to support waste pickers in cooperation with all the government organizations, NGOs and international organizations concerned.

As for the landowners of the Dang Kor disposal site area, PPWM will support them by providing job opportunity for workers in Dang Kor disposal site. The project owner of the proposed disposal site shall give priority to the landowners when hiring staff. For example, the composting plant, one of facilities at the disposal site, will need many workers. The project owner, MPP, shall provide the landowners a chance for employment in order to compensate for their loss in agricultural income. New employment, landfill workers and composting workers in DKDS, would be 37 persons in total. The landowners who will loss in agricultural income would be 36 persons. Therefore, this issue will be covered.

These alternative jobs are a very important issue for social consideration. These are proper countermeasures for social consideration and in order to maintain a trusting relationship with NGOs and local residents. Considering the number of waste pickers who depend on the SMCDS to make a living, this is not just a waste management issue but a social issue that the MPP should consider comprehensively. The MPP has to take possible countermeasures in cooperation with related government organizations, NGOs and donor countries.

# Annex 16

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*Environment Impact Assessment  
(an addition)*

## Annex 16 Environment Impact Assessment (an addition)

### Modification of Dang Kor Disposal Site Development Project and third Public Hearing

#### 16.1 Modification of the Plan

##### 16.1.1 Modification of the Plan due to the Change of the Site Boundary

Since the boundary of the proposed site changed as shown in the Figure below, the proposed development plan shall be modified in accordance with the change. There are many changes required in comparison with the plan proposed in the DF/R (1). The following aspects are the major modifications:

- Construction of an access road along the irrigation canal;
- Protection of the main canal and diversion of secondary canal;
- Layout plan of the facilities
- Increase of the construction cost

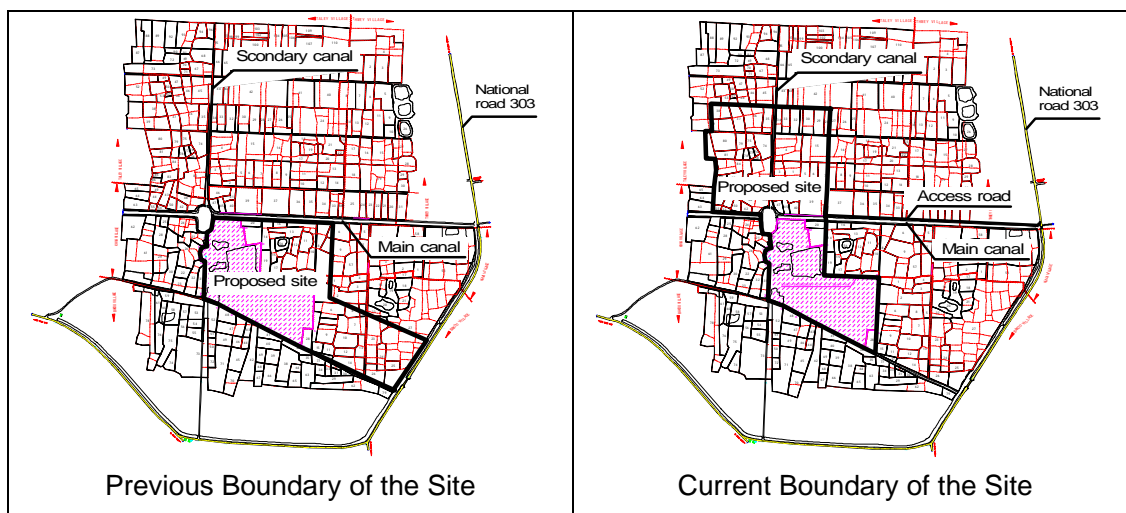


Figure 16-1: Change of the Boundary of the Site

#### a. Construction of an Access Road

As clearly understood by the Figure above, the previous boundary did not need an access road because it faces to the National Road 303. The current boundary, however, need an access road from the National Road 303 as shown in the Figure above. Since the bank of the main canal is the property of the MPP, the Team proposes to construct a 800 meters long access road along the main canal.

In this regard the Team had a meeting with the relevant authorities and people on June 29, 2004. The meeting concluded that the access road shall be constructed along the northern bank of the main canal as shown in the Figure below.

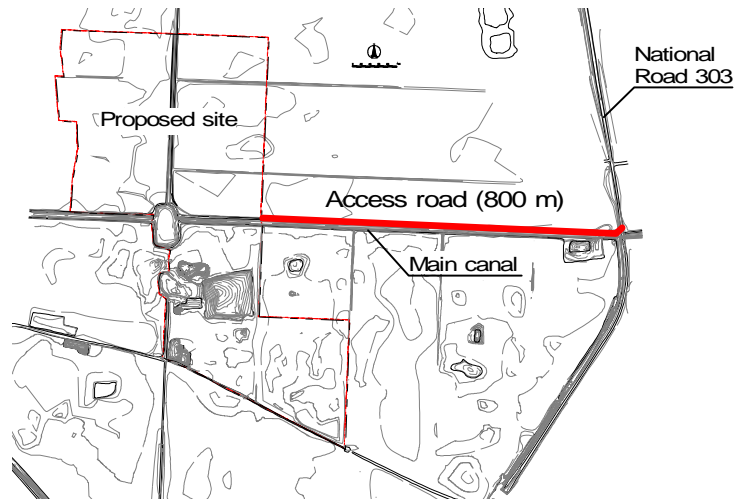


Figure 16-2: Proposed Plan of an Access Road

**b. Protection of Main Canal and Diversion of Secondary Canal**

As shown in the Figure 16-1, the main and secondary canals pass through the center of the new site. It is, therefore, necessary to protect the main canal from contamination by the operation of the disposal site and divert the secondary canal to maintain the water delivery function of it.

In order to discuss with this matter the Team had a meeting with the relevant authorities and people on June 29, 2004. The meeting concluded as follows:

- The main canal along the proposed site shall have the concrete-block liner to prevent the canal from erosion and infiltration of leachate. The buffer zone with trees and fence shall be constructed both sides of the canal as shown the Figure below in order to prevent the canal from waste scattering.
- The secondary canal, which passes from south to north, will be diverted along the eastern edge of the proposed site. The size of the canal to be diverted shall not be smaller than the present one.

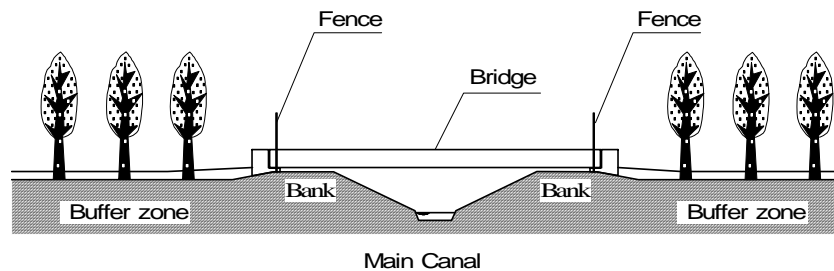


Figure 16-3: Cross-section Plan of the Main Canal along the Disposal Site



Main canal



Secondary canal



## 16.2 Layout Plan

Although the secondary canal will be diverted to the eastern edge of the new site, the proposed site is divided into two areas, the Northern site and Southern site, by the main canal, which passes from west to east. Taking these conditions into consideration, the Team proposed a layout plan of the facilities as shown in the Figure below. As shown in the Figure, each site will have the following facilities:

### Northern site:

Landfill area B, administration area, vehicle depot, maintenance workshop, etc.

### Southern site:

Landfill area A, leachate treatment facility, composting plant, etc.

The conceptual design of the site is presented in the following table.

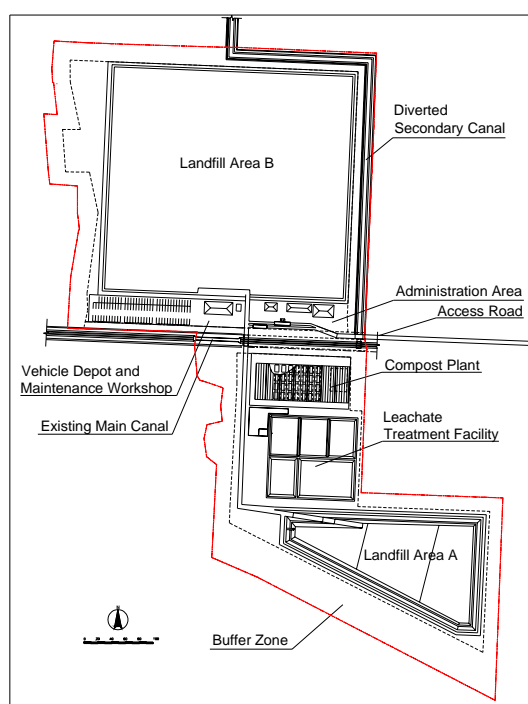


Figure 16-4: Layout Plan of the Facilities

Table 16-1: Design Concept of the Dang Kor Disposal Site (Phase 1)

Item		unit	Qty
Total area of disposal site		ha	approx.31.4
<b>Administration area</b>			
Area		ha	approx. 0.5
PPWM head office		no.	1
Weighbridge house		no.	1
Security and safety facility	Gate	no.	1
	Fence (Fixed type)	L.S.	1
<b>Landfill and leachate treatment facilities</b>			
Area		ha	approx. 17.0
Extent Capacity		m <sup>3</sup>	2,270,000
Life span		years	6
Level	Level of Landfill bottom from top of enclosing bank	m	-10
	Level of Landfill top from top of enclosing bank	m	+10
	Top of the enclosing bank	m (Altitude)	10.2

Sanitary waste disposal facility	Main access road (asphalt paved)	L.S.	1
	Main On-site road (gravel)	L.S.	1
	Secondary On-site road (gravel)	L.S.	1
	Fence (Movable type)	L.S.	1
Leachate collection facility -Perforated reinforced concrete pipe with rubble stone -Bottom layer as natural liner instead of artificial liner		L.S.	1
Leachate treatment facility -Wetland ponds + evaporation ponds (dry season) -Reservoir ponds + Recirculation facilities (wet season)		L.S.	1
Rain water drainage	U-shape concrete drain along the waste filling slope	L.S.	1
	Earth drain along the road	L.S.	1
Gas ventilation facility –Perforated steel pipe with rubble stone		L.S.	1
Monitoring well		L.S.	1
Buffer zone (Green belt etc.)		L.S.	1
<b>Compost facility</b>			
Area		ha	approx.1.1
Capacity		ton/day	20
Type		-	Windrow
<b>Vehicle Depot and Maintenance Workshop</b>			
Area		ha	approx. 1.1

L.S.: Lump Sum

#### a. Increase of the Construction Cost

Although the Team could not complete the revision of cost estimation for the new development plan of Dang Kor disposal site due to the delay of site boundary establishment, the development cost shall increase the following reasons:

1. Construction of the 800 meters long access road from the National Road 303
2. Protection of the main canal and diversion of the secondary canal
3. Separation of the site by main canal (Bridge with aqueduct for leachate connecting the two sites, on-site road, etc.)

#### b. Layout Plan of each Facilities

##### b.1 Administration section

The administration section is to be designed in the Dang Kor Disposal Site. The area is approximately 0.5 hectares.

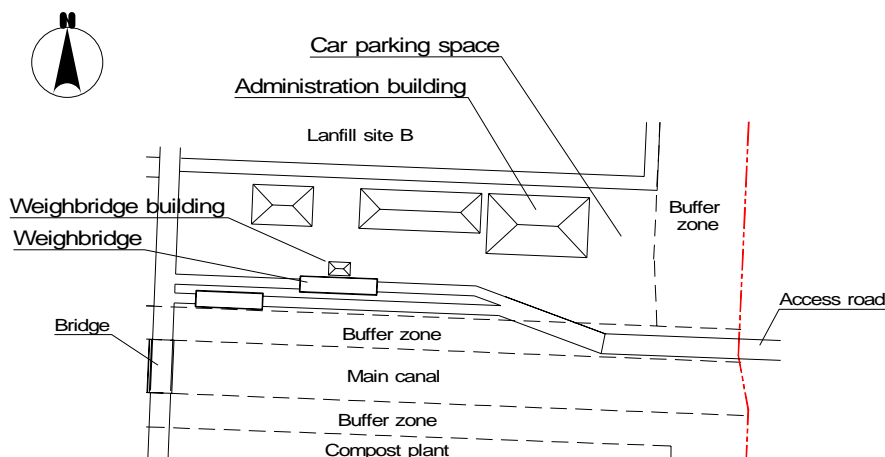


Figure 16-5: Layout of the Administration Section

### b.2 Disposal Sections

The disposal sections are located at the north side and the south side of the main canal respectively as shown in Figure 16-4. The capacity of landfill area A at the south side is 434,000m<sup>3</sup> while the landfill area B at north side is 1,836,000m<sup>3</sup>. The total capacity in the phase 1 is 2,270,000m<sup>3</sup>.

### b.3 Leachate Treatment Section

The leachate treatment facility is to be designed at Dang Kor Disposal Site. The area is approximately 1.1 hectares.

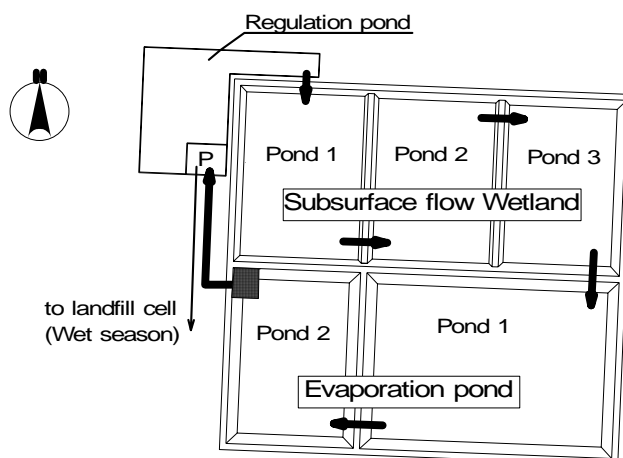


Figure 16-6: Layout of the Leachate Treatment Section

### b.4 Compost Section

The compost plant is to be designed in the Dang Kor Site. The area is approximately 1.1 hectares.

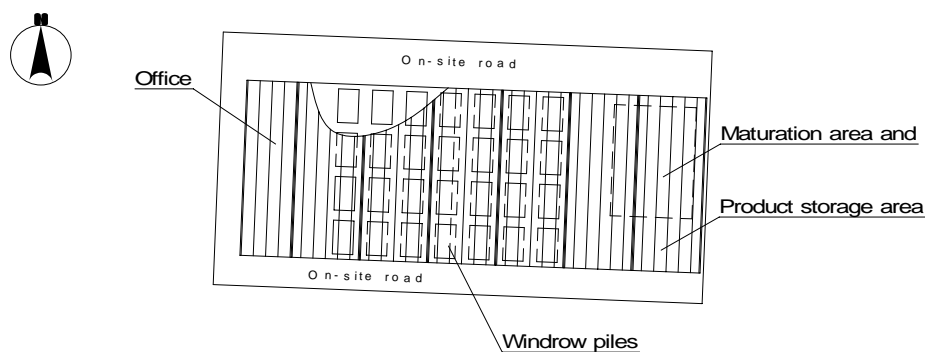


Figure 16-7: Layout of the Compost Section

### b.5 Vehicle Depot and Maintenance Workshop

The vehicle depot and maintenance workshop is designed in the Dang Kor Site. The area is approximately 1.1 hectares.

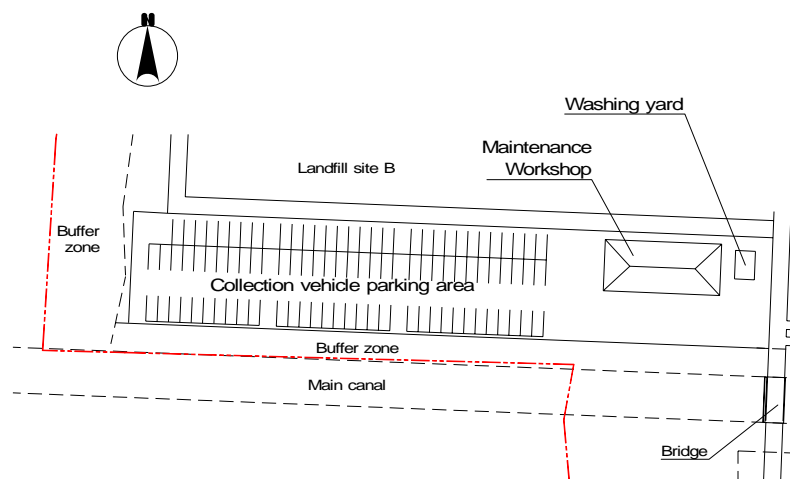


Figure 16-8: Layout of the Vehicle depot and Maintenance Workshop

### 16.2.1 Actions to be taken by MPP/PPWM

#### a. Further Land Acquisition for the Access Road

The construction of the access road from the National Road 303 is indispensable for the project implementation. As shown in the Figure 16-9, the right of way of the proposed road is beyond the land owned by the MPP. The MPP/PPWM, therefore, need to take prompt action to acquire the additional land (approximately 5,500 m<sup>2</sup>) along the main canal as indicated in the Figure 16-9.

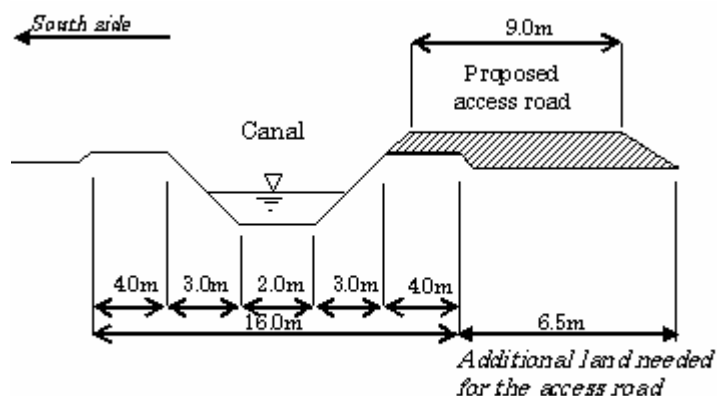


Figure 16-9: Plan of Access Road

#### b. Preparation for the Expansion of the Proposed Disposal Site

The Team calculated the durable period of the proposed landfill based on the acquired land area. Due to the separation of the site by the main canal, the durable period of the proposed landfill is only six years. The MPP/PPWM, therefore, need to prepare for the future expansion of the landfill. The Team recommends MPP/PPWM to understand the aspects described below and take necessary actions as follows:

- Direction of expansion shall be west and/or north
- Land to be acquired shall be connected to the current boundary in view of technical and economical advantages
- An ideal expansion plan is presented as shown in the Figure below
- Take necessary actions to acquire the land in the future expansion area

- Establish land use restriction of the surrounding area

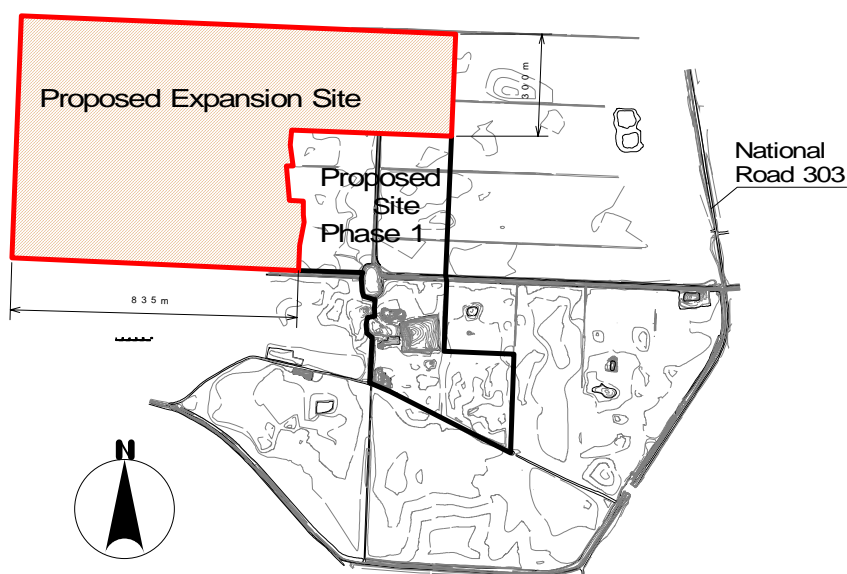


Figure 16-10: Proposed Future Expansion Plan

## 16.3 Disposal Plan

### 16.3.1 Target Operation Level of Land filling

- Target Level: Level 4
- Requirement of Level 4

The requirements for operation of a Level 4 landfill are as follows:

- to prevent infiltration of leachate;
- to cover waste with soil daily;
- to screen working areas from outsiders;
- to release gas promptly;
- to minimize the leachate quantity to be discharged outside;
- to have an adequate drainage system;
- to have a proper access road; and
- to have a leachate collection and evaporation system.

### 16.3.2 Commencement of Sanitary Landfill Operation

The operation of the new sanitary landfill is planned to commence at the beginning of 2007.

### 16.3.3 Estimated Amount of Waste Disposal in the Dang Kor Disposal Site

The proposed landfill in Dang Kor Disposal Site is designed to receive waste discharged from the following 7 Khans. The type of waste to be received will include MSW and general waste from medical institutions and factories.

Urban Area	Chamkar Mon
	Daun Penh
	Prampir Makara
	Toul Kork

Rural Area      Dang Kor  
Mean Chey  
Russei Keo

Table 16-2: Estimated Daily Amount of Waste Disposal in the Dang Kor Disposal site

Year	All Phnom Penh (Total) (ton/day)	Description			
		MSW		Medical Waste (general waste) (ton/day)	Industrial waste (general waste) (ton/day)
		Urban area (ton/day)	Rural area (ton/day)		
2007	923.7	548.8	325.1	12.3	37.5
2008	990.0	577.3	359.7	13.1	39.9
2009	1,064.7	606.6	401.6	13.9	42.6
2010	1,140.6	636.7	443.6	14.9	45.4
2011	1,205.0	659.7	481.8	15.7	47.8
2012	1,301.2	683.1	551.1	16.5	50.5
2013	1,367.0	705.9	590.6	17.4	53.1
2014	1,437.5	728.3	635.0	18.3	55.9
2015	1,539.7	751.4	710.0	19.3	59.0

## 16.4 Review of EIA Report

### 16.4.1 EIA comments of MOE and its approval

The EIA report on the Dang Kor Disposal Site Development Project was submitted to MOE through MPP on 26<sup>th</sup> May 2004. In order to assessment the environmental impacts mentioned in the report, MOE, DOE and JICA Study Team (the Team) visited the site of Dang Kor altogether on 17<sup>th</sup> June 2004.

Based on the EIA report and the field survey, MOE issued an approval letter to MPP for the EIA results on the Dang Kor Disposal Site Development Project on 15<sup>th</sup> July 2004. In this approval letter, the following comments of MOE were also mentioned.

- To keep the canals which are located in the disposal site in the same condition
- To confirm the height of enclosing bank for prevention of flood
- To take enough countermeasures to minimize the offensive odor in the operation period
- To conserve surface and ground water quality, and soil quality in and around the disposal site
- To conserve the natural habitat for birds or fish and so on.
- To take enough countermeasures for prevention of the generation of vermin.
- To take proper operation of waste collection vehicles in order to avoid littering the waste on the road unintentionally which may cause offensive odor.

### 16.4.2 Answers to the Comments of MOE on the EIA Report

Based on the comments of MOE on EIA report by the letter dated on 15<sup>th</sup> July 2004, JICA Study Team prepared the answers and submitted to MPP as follows.

#### a. Protection of Irrigation / Drainage Canals

##### a.1 Ownership

The owner of the canal passing the disposal site is the Department of Water Resources and Meteorology in MPP (DOWRM). DOWRM is responsible for planning, construction and maintenance of the canal.

## a.2 Future plan of the canal

There is a plan to rehabilitate the main canal, crossing the site from west to east, from 2004 to 2005 and to construct access road along the bank of the main canal from the national road 303. As for further future plan, it is not clear.

## a.3 Protection plan for the main canal

Protection plan for the main canal is following.

### Location

Taking into account drainage performance of the main canal, it will be kept at current location and no diversion will be done.

### Buffer zone and fence

Buffer zone and fence will be installed along the both sides of main canal in order to prevent the canal from scattering waste in the landfill (see Figure 16-11).

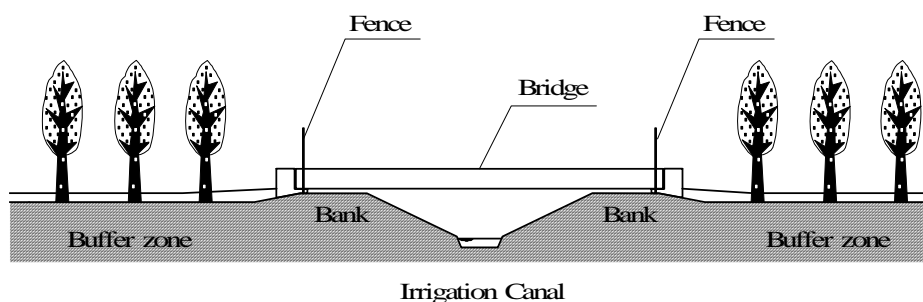


Figure 16-11: cross-section plan of the main canal

### Lining of the main canal

In order to prevent the main canal from erosion and infiltration of leachate, the surface of the main canal will be covered by concrete-block lining.

### Aqueduct

Leachate treatment pond will be located at the south side of the main canal. In order to send the leachate collected from north side of the main canal to south side, an aqueduct will be installed along the bridge over the main canal. As the leachate pipe will be installed in the aqueduct, there is no risk of leachate leakage to the main canal (see Figure 16-12).

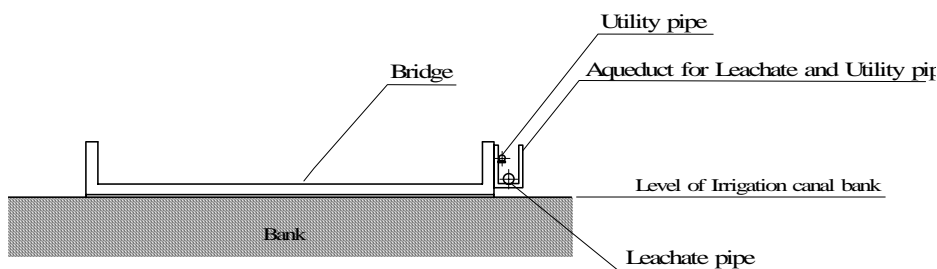


Figure 16-12: Bridge and Aqueduct over the main canal

## a.4 Protection plan for a secondary canal

Protection plan for the secondary canal, cutting across the site from south to north, is as follows:

### Location

The secondary canal will be diverted along the west or east edge of the site. It will be finalized on the meeting with related local authorities and landowners concerned with the diversion plan.

**b. Flood Control Measures**

**b.1 Field Survey on Past Flood Level**

Basically, the height of enclosing bank of waste disposal site must be decided by the past flood level, which quite varies with the river flood level.

However, as a result of a meeting with the Department of Water Resources and Meteorology of MPP, it can be said that there is no record of flood in the past around the site.

Therefore, a field survey was carried out to find a mark of past flood levels on 23<sup>rd</sup> June 2004.

**Site 1**

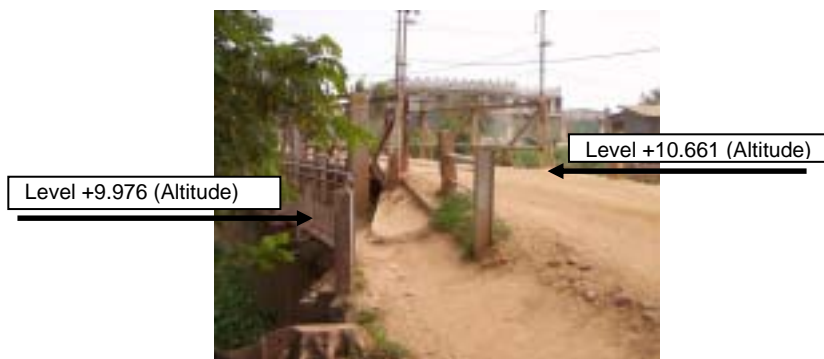
A mark of past flood level was found at a farmer's house along the national road 303, 1km north from the site (see the picture below). It occurred some time between 2000 and 2001 (the exact date could not be identified).



Flood level of Farmer's House

**Site 2**

According to DPWT, the sidewalk of Phum Mol bridge (sidewalk on the left side of the bridge in the picture below) located at the border between Sangkat Dang Kor and Mean Chey, 4km north of the site, was flooded. However, the driveway for bridge was not flooded. Therefore, it can be said that the past flood level was between the level of the sidewalk and the driveway of the bridge. It also occurred some time between 2000 and 2001. (the exact date could not be identified)



Flood Levels of Phum Mol Bridge



### **Flood level**

Based on these marks the past flood level above the sea level was calculated as follows.

The past flood level  $\div$  9.9m above the sea level

### **b.2 Conclusion**

Based on the results of the survey, the height of enclosing bank of Dang Kor disposal site was modified to 10.2m above the sea level.

### **c. Offensive Odor**

There are 2points to be considered.

#### **c.1 Landfill area**

##### **Adverse impact**

In the landfill area, organic waste will be decomposed and offensive odor will be produced.

##### **Countermeasures**

In order to reduce the offensive odor from the landfill area, soil covering will be done daily.

#### **c.2 Compost plant**

##### **Adverse impact**

The emission of Methane and Hydrosulfite from anaerobic bio-decomposition waste in composting process may produce offensive odor.

##### **Countermeasures**

In order to reduce the offensive odor from the compost plant, the aerobic bio-decomposition method will be adopted for composting.

### **d. Water Quality / Soil Quality**

#### **d.1 Surface water**

##### **Adverse impact**

##### **Landfill area**

Ggeneration of leachate from landfill may cause water contamination if it is discharged into the river or canal or infiltrated into the groundwater.

##### **Compost plant**

In the pre-treatment stage, raw materials for compost, market waste, will generate leachate.

##### **Maintenance workshop**

The maintenance workshop will use a large volume of water for washing vehicles. This wastewater contains oils such as grease or lubricant oil.

##### **Countermeasures**

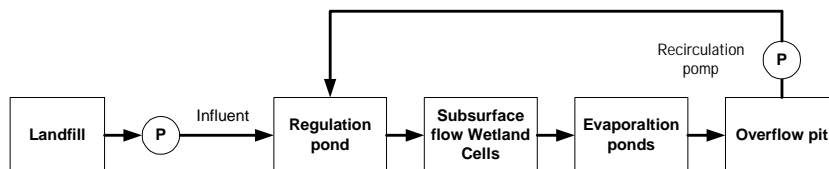
##### **Leachate from the landfill area and from the compost plat**

The leachate from the landfill area and the wastewater from the compost plant is to be treated on site and will not be discharged outside. Therefore, the leachate as well as the wastewater will not affect the river water and the canals. The leachate treatment process will be different between the wet and dry seasons as described below.

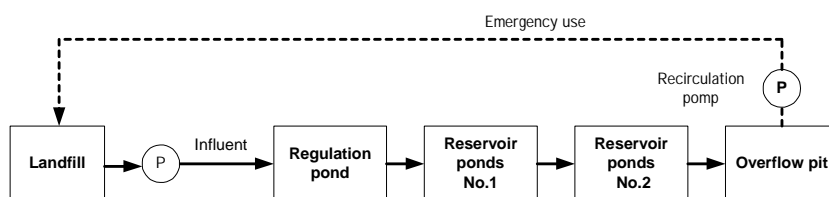
Dry season : When the leachate quantity is small, it is to be treated with subsurface flow wetland cells and evaporation ponds. Any overflow of treated leachate is to be returned to the regulation pond by recirculation pump.

Wet season : If the quantity of leachate exceeds the capacity of the wetland ponds, the wetland cells and evaporation ponds are to be used as reservoir ponds. If the leachate exceeds the expected amount, an emergency line is to be constructed to return excess leachate to the landfill site via the overflow pit.

### Dry season



### Wet season



### Wastewater from the maintenance workshop

The wastewater from the maintenance workshop is to be treated. As the wastewater contains oils such as grease or lubricant oil, an oil trap will be installed in the drain to recover the oil content. Then treated wastewater will be sent to the leachate treatment facility.

### Contamination of the canals

As the main and secondary canals run the disposal site area, countermeasures will be taken to protect their water quality from contamination of leachate and waste (See 1.1.3 and 1.1.4).

## d.2 Groundwater and soil quality

### Adverse impact

The leachate from landfill area and wastewater from compost plant and the maintenance workshop may contaminate groundwater through their infiltration.

### Countermeasures

As for the infiltration into groundwater, the geological survey on the soil for the disposal site area revealed that the permeability of the natural soil is low. Therefore, it can be said that the existing ground can be used as a natural liner to control leakage.

As for the upper sand layer, it needs to be covered with bottom clay soil of low permeability as shown in the diagram below.

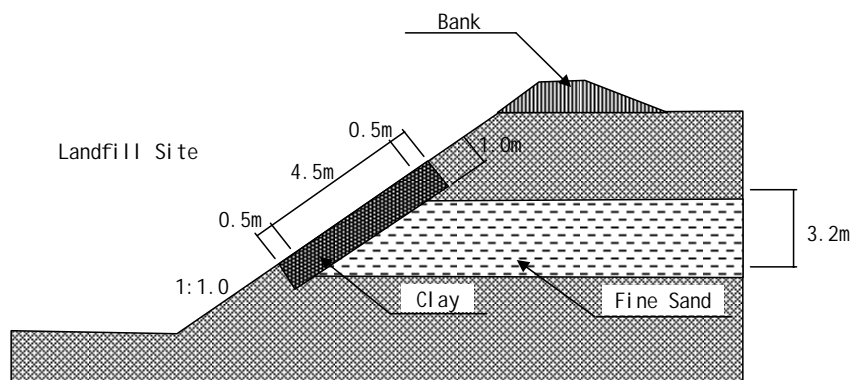


Figure 16-13: Structure of Soil condition

**e. Conservation of the Natural Habitats for Birds, Fishes, etc.**

**Adverse impact**

The majority of the site is used as agricultural land and canals also exist there. Although there are very few green trees in the proposed disposal site, and the natural environment of the site is not abundant in flora and fauna, if the disposal site is constructed, the land use of the proposed site is changed. Therefore, it may impact upon fauna and flora such as birds and fishes.

**Countermeasures**

As for birds, a lot of green trees are to be planted around the site as a buffer zone. The width of the zone is 20 m to 50 m. The site of the buffer zone may be changed into a new natural environment for birds in the future.

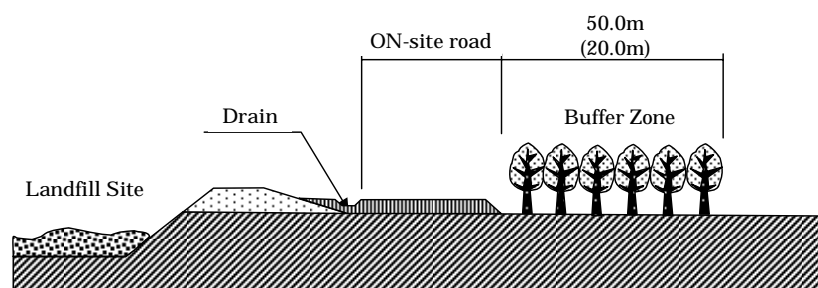


Figure 16-14: Buffer zone

As for fishes, water of the main and secondary canal will be protected from contamination by leachate and waste (See 1.1.3 and 1.1.4).

**f. Prevention of the Generation of Vermin**

**Adverse impact**

The waste in the disposal site is expected to promote growth in the population of vermin which will have a negative health and environmental impacts on the area and its surroundings. Therefore, the impact upon public health is considered.

**Countermeasures**

The main source of vermin is the eggs of flies which have been deposited in the wastes before they arrive at the site. Most of them will be buried deep in the wastes and succumb to the temperature increase. Near surface, however, the rise in temperature is not so high and the eggs hatches into larvae. Therefore, daily soil cover will be carried out at the disposal site, which will minimise the generation of the vermin.

Soil cover is shown in Figure 16-15 and the thickness of each layer is as follows:

- daily or weekly soil cover soil: 15 cm
- final soil cover: 50 cm (depending on the land use after its closure)

Accordingly, the ratio of cover soil to the disposal volume of waste will be 10 %, excluding final covering soil.

Soil for covering waste is planned to be obtained from the future landfill area in the DKDS.

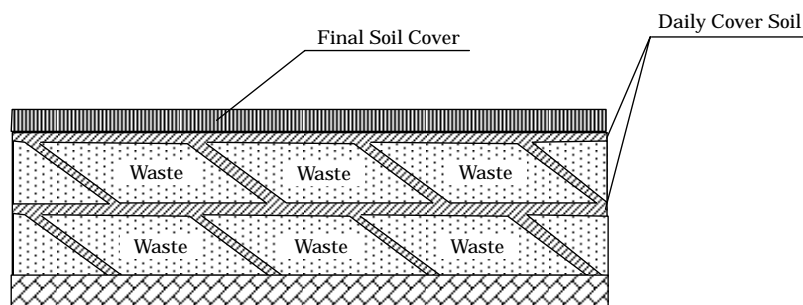


Figure 16-15: Structure of soil covering

#### g. Prevention of Littering Waste from Collection Vehicles

##### Adverse impact

The waste collection vehicles may litter waste on the national road 303, which is access road from the center of Phnom Penh to the disposal site.

##### Countermeasures

In order to prevent the collection vehicles from littering waste on the national road 303, enclosing collection vehicles will be used. In the case of using open top trucks, cloth tarps will be used to cover them.

## 16.5 3<sup>rd</sup> Public Hearing

### 16.5.1 Background

Based on the 1st and 2nd public hearing and EIA survey, the Dang Kor disposal site development plan was modified and EIA report was submitted to MOE. After the planning of the draft development project, MPP tried to secure the site area in accordance with the development plan. However MPP couldn't get a part of the site land as required due to a rise in the land price after the 1st and 2nd public hearing and follow up interview surveys to them. Therefore, the land which MPP could secure was changed and the Dang Kor disposal site development plan was also changed in accordance with the finally secured land even though the planning concept and contents of it was not changed. On the other hand, MOE gave MPP some comments on EIA report. In response to the comments from MOE, follow up field survey and modification of the development plan were carried out.

#### a. Objective

It was essential to explain the change of the development plan and the results of EIA review by MOE. Therefore, the 3<sup>rd</sup> public hearing was conducted with the following objectives:

- To explain the background of the 3<sup>rd</sup> public hearing
- To report the results of EIA review

- To respond to the comments from MOE for EIA report and from attendants of 1<sup>st</sup> and 2<sup>nd</sup> public hearing.
- To explain the change of the development plan and to explain the development plan.

**b. Contents of 3<sup>rd</sup> Public Hearing**

Date: 15<sup>th</sup> of July 2004  
 Time: 8:00 ~ 11:00 am  
 Venue: Thom Matray Pagoda, Prey Sor Sangkat (Same as previous)  
 Main attendants:  
 MOE Mr. Oung Vuthy Department of EIA  
 MPP Mr. Heng Vantha Deputy Chief of Cabinet  
 DOE Ms. Kuon Kinny Deputy Director  
 PPWM Mr. Sao Kuchhon Governor  
 Mr. Leng Simen Deputy Governor  
 Khan Dang Kor Mr. Krouch Phan Governor  
 JICA Study Team Mr. Susumu Shimura, Ms. Keiko Kani, Mr. Takeshi Higo  
 JICA Mr. Hiroto Mitsugi, Mr. Tomohiro Ono,  
 Ms. Mitsue Tamagake (as observers)

**The people and parties concerned (Local officers, residents, NGOs, etc.)**

Affected area	People and parties to be invited (person)
An area within 1km radius from the center of proposed disposal site	Representative of all household ( approx. 350, the household list will be prepared )
Along the national road 303rd which connects the center of Phnom Penh and the proposed disposal site (from the proposed disposal site until the bridge which is located at the north edge of Dang Kor Sangkat)	all village chiefs and vice village chiefs of the 9 villages in the area (18, see Annex)
Along the downstream of Prek Thnot river which is located in the south of the proposed disposal site (from the south of proposed disposal site until the bridge of National road 2nd)	all village chiefs and vice village chiefs of the 14 villages in the area (28, see Annex)
Others	NGOs Approx. 5 group (5)
Press	Approx. 30
Total	Approximately 400 people

**Program:**

	Title	Presentators	Time
1	Registration		7:30-8:00
2	Opening remark	Mr. Heng Vantha , Deputy Chief of Cabinet, MPP	8:00-8:15
3	Presentation		
3-1	Background of the 3rd public hearing and answers to the comments of attendants at 1st and 2nd public hearing	Mr. Sao Kuchhon, Governor, PPWM	8:15-8:45
3-2	The results of EIA review	Mr. Oung Vuthy, Department of EIA, MOE	8:45-9:15
3-3	The Dang Kor development site development plan and its modification	Nr. Takeshi Higo, JICA Study Team	9:15-9:45
3-4	Evaluation of the modified development plan	Ms. Kuon Kinny, Deputy Director, DOE	9:45-10:15
4	Q&A		10:15-10:45
5	Closing remarks	Mr. Krouch Phan, Governor, Dang Kor Khan	10:45-11:00
6	Press tour		11:30-12:30

**c. Attendant**

The attendant of the 3<sup>rd</sup> public hearing was following (excluding the presentators).

Category of attendant	Number
Local residents (An area within 1km radius from the center of proposed disposal site)	303 household
Local authorities (Along the national road 303rd and along the downstream of Prek Thnot river)	21 persons
Staff of the Department of Environment (MPP and Kandal Province)	5 persons
NGOs	9 persons
JICA (as observers)	3 persons
Press	11 persons
Total	352 persons

As shown in the above, the 3<sup>rd</sup> public hearing had many attendants. Especially the attendants from local residents, who are living in an area within 1km radius from the center of proposed disposal site, reached 303 households. It is calculated that 83.7% of the total number of targeted households have been attended on the 3<sup>rd</sup> public hearing in comparison to the 51.3% of it on the 2<sup>nd</sup> public hearing.

**d. Questions & Answers**

**d.1 Question (by Mr. Lim Kol, from Phum Spean Thmor, Srok Kandal Stung, Khet Kandal)**

“My village is 300 meters away (Notes by JICA ST: actual distance is approximately 500m) from the proposed Dang Kor Disposal Site(DKDS). My villagers use Stung Preak Thnot water for living. I am worried that waste will be discharged to Stung Preak Thnot. I also requested the MPP/PPWM to complete all construction work before starting disposal of the waste at the proposed dump site. Lastly when the construction will start and end? I strongly support to this project and thank for JICA that assists in this development project.”

**Answer (by Governor of PPWM and added by JICA ST)**

“As mentioned in the presentation by JICA ST and DOE, the bottom of the landfill about two meters in depth is clay. And the sand layer will be secured by impermeable clay layer. So, it is able to conserve the ground water quality. For the countermeasure against the flood, the enclosing bank will be installed higher than the flood level. Flood will not flow to the landfill so waste water generated in the landfill could not spread out to the outside area also. In addition, there are evaporation and treatment ponds at the landfill. Replying to the second question that worried about operation of the landfill before its constructions are not completed, PPWM is responsible for DKDS and PPWM respects to the technical instructions of JICA ST, monitoring from DOE and MOE as well as the observation from the local people. It means that this project is under the responsibility of all concerned agencies. Local people and authority will make objections against this operation if it makes any fault”.

JICA ST added to the answer of PPWM’s governor, “Why leachate treatment will not discharge outside the landfill? Leachate generated by the waste dumped at the landfill will be pumped up to the treatment ponds for leachate treatment. After treated, it will be discharged to the evaporation pond. In case of heavy rain, it will be pumped up to the landfill. The leachate treatment system consists of regulation pond, treatment pond and evaporation pond. Regarding the construction period, its earliest case, it will start in January, 2006 and will finish in December, 2006.

**d.2 Question (by PSE's representative)**

"I have two questions for MPP and JICA ST. First question is regarding the shift of disposal site from SMCDS to the DKDS, does MPP have any solutions or measures for the waste pickers who work at SMCDS? I had asked many waste-picker families about this and they replied that they did not know anything about the closure of SMCDS. Second question: For the DKDS, are waste pickers allowed to enter the landfill or not? If allowed, how many persons of waste pickers will be allowed to enter to the DKDS?"

**Answered (by Governor of PPWM)**

"Social issues were also considered by JICA ST. Regarding DKDS, it differs from SMCDS that waste will be separated immediately and will be used for composting at the composting plant in DKDS after collection vehicles arrive (Notes by JICA ST: Only market waste will be sent to the compost plant. However other wastes will be immediately covered by soil at the landfill area). It means that waste pickers will lose their job. How will they do for living? PPWM is planning to employ some waste pickers who work at the SMCDS as workers for primary waste collection or as workers for composting plant. If they do not want to work as mentioned above, they can change their job.

**d.3 Question added (PSE's representative)**

"How much is the waste pickers will be chosen to work for composting plant at the DKDS? Because there are a lot of waste-picker families working at SMCDS."

**Answered (by Governor of PPWM)**

"As being planned, we will not be able to employ all waste pickers to work for the DKDS. Now, MPP and other NGOs have been discussing how to help them. I notice that JFPR which works closely with poor people is considering on this."

**d.4 Question (by representative of Cooperation Committee for Cambodia)**

There are 3 questions:

- How many total area of the DKDS? How many years can we dispose of the waste at the DKDS?
- What type of wastes can be disposed of? Can industrial, hospital and hazardous waste be disposed of at this landfill?
- For daily soil covering, how can you secure it?"

**Answered (by DOE)**

- The total area of DKDS is 30 ha.
- This landfill receives only municipal solid waste, not industrial, hospital and hazardous waste because we have had a place where industrial and hazardous waste can be discharged in Kandal province.
- The soil for soil covering will be taken from the DKDS.

**Added answer (by JICA ST)**

"The life span of DKDS is six years. This is the image of the landfill operation in Thailand. Daily soil covered on the waste is taken from the reservation area of the landfill. When we start operation, we have to consider the future operation of the landfill. For Dang Kor dumpsite, first we will operate landfill area A, therefore, the soil covered the waste will be taken from landfill area B. Then, the hole generated by soil excavation, will be filled by the waste."

#### **d.5 Question (by representative of World Vision of Cambodia)**

There are two questions:

- As PPWM mentioned before, PPWM is planning to employ waste pickers to work as primary waste collectors and composting plant workers. How many workers will be required for Dang Kor dumpsite?
- How many waste pickers (percentage) who work at SMCDS are ensured to be chosen by PPWM to work for new disposal site?"

#### **Answered (by JICA ST)**

"As PPWM mentioned, waste pickers will not allow to pick up the waste at the DKDS. PPWM is planning to employ waste pickers who work at SMCDS to work as primary collection workers. PPWM will also expand collection service to the un-serviced areas so that PPWM will employ waste pickers who can work with PPWM."

#### **e. Evaluation**

PPWM, the executing agency of the operation of the Dang Kor disposal site, and the concerning party, MOE and DOE, have been accomplished their accountability in the 3<sup>rd</sup> public hearing to the participant through their presentation and the answers to the questions from participants as the owner and control agencies of the project. Especially the presentation of PPWM was made by the governor and he answered to the questions from attendants by himself..

## **16.6 Follow-up Survey of 3<sup>rd</sup> Public Hearing**

At the third public hearings, several participants asked questions and there were vigorous discussions on the environmental and socio-economic impacts of the disposal site. However, most of questions were asked by participants from NGOs. As same in the two previous public hearings, a follow-up survey was conducted after the third public hearing in order to grasp how much local authorities and residents understood the content of presentations and how they reviewed the proposed development plan.

### **16.6.1 Survey methods**

The follow-up survey was conducted in the following method.

#### **a. Survey Methods**

Team assistants visited houses of selected participants and made an interview with them based on the questionnaire.

#### **b. Targets of survey**

The targets of the follow-up survey were local authorities and residents that attended the third public hearing. Regarding the local authorities, all the participants, in total 30, were selected as interviewees, while samples of ordinary people were selected randomly from participants.





**c. Sampling method**

All the participants of ordinary people were divided by housing group they belong to. The number of samples allocated to housing groups was decided according to the number of participants, and samples are randomly selected from each housing group. The numbers of participants of the third public hearing and samples of the follow-up survey by Sangkat are shown below.

Table 16-3: Number of participants by Sangkat

Sangkat	Sangkat Chief	Phum chief	Local Residents
Cheung Ek		7	113
Dangkor	1	7	165
Prey Sor		2	0
Spen Thmomey	2	1	25
Prek Hou	2		0
total	5	17	303

Table 16-4: Samples for interview survey by Sangkat

Sangkat	Sangkat Chief	Phum chief	Local Residents		total
			Housing Group Leader	Ordinary people	
Cheung Ek		7		22	29
Dangkor	1	7	1	33	42
Prey Sor		2			2
Spen Thmomey	2	1		8	11
Prek Hou	2				2
total	5	17	1	63	86

**d. Survey Period**

The interview survey was conducted from August 12 to August 14, 2004.

**e. Contents of Questions**

The questions were divided into 4 categories shown as follows.

- 1) First and second public hearing
- 2) Outline of the third public hearing
- 3) Level of understanding about the development plan
- 4) Comments and opinions about the development plan

The result of the follow-up surveys after the first and second public hearing reveals that it is very difficult to evaluate the level of understanding of local people about the development plan by questions with 3-4 choices. Therefore, in this survey, free-answer questions were used as much as possible

**16.6.2 Result of the survey**

The result of the follow-up survey is summarized below.

**a. About first and second public hearing**

All the interviewees were asked if they participated in the first and second public hearing. The result is shown in Table 16-5.

Table 16-5: Participation in the first and second public hearing

	Sangkat Chief	Phum chief	Leader	Ordinary
First PH* only		17.6%		1.6%
Second PH only	40.0%	23.5%		38.1%
Both 1st and 2nd PHs	0.0%	23.5%	100.0%	7.9%
not attend previous PHs	60.0%	35.3%		52.4%
total	100%	100%	100%	100%

Base: 5 (Sangkat chief), 17 (Phum chief), 1 (leader of housing group) and 83 (ordinary people)  
PH\*: Public Hearing

Since local authorities of Sangkats which were located along the Prek Thnot river in Kandal province were invited to the public hearing for the first time, about half of the respondents of local authorities did not participate in the first nor second public hearing. As for the ordinary people, about half of the participants were also first timers, even though all the households located within a radius of 1 km from the planned site were invite to the second public hearing. Therefore, it is necessary to check if there are any more households from which no family member has participated in public hearing yet.

At the third public hearing, the main topic was the modification of the plan, and the details of the development plan were not explained, because all the participants were supposed to participate in the previous hearings. There is a possibility that some participants had difficulty to understand the presentations well due to their limited knowledge.

Those who attended the first and second public hearing were asked to tell the topics of these public hearings in open question format. Most of them remembered only in fragments.

#### b. About third public hearing

Around 90% of respondents answered that they remembered the third public hearing well or a little bit. The result of free answer question to those who remembered the third public hearing about the theme of each presentation was shown below. There was little difference in the level of understanding about presentations except the modification of the plan between first-time participants and the rest. The presentation which more than 50% of them answered its theme correctly was only "Result of EIA Review". This might result from their serious concerns about risks caused by the new disposal site.

Table 16-6: Topics of presentations of the 3<sup>rd</sup> public hearing

	1st only	2nd only	both	neither	total
Background of the 3rd PH	25%	13%	20%	12%	15%
Summmary of the 1st and 2nd PH	0%	7%	10%	2%	5%
Result of EIA review	50%	60%	70%	67%	68%
Modification of the development plan	25%	43%	40%	33%	40%
Evaluation of the modified plan	0%	40%	50%	26%	35%
Others	25%	23%	20%	31%	28%

Base: 4 (1<sup>st</sup> only), 30 (2<sup>nd</sup> only), 10 (both), and 42 (neither)

To the questions about the content of each presentation, about 30% of respondents replied that they did not remember. Those who replied that they remembered were asked to tell the content of each presentation and to evaluate each presentation in terms of the easiness to understand and the way of presentation. The result reveals that their understandings are generally fragmented. Even though more than half of the respondents replied that each

presentation was relatively easy to understand, it could be said that it was difficult for them to continue to listen to presentations for 2-3 hours.

**c. Level of understanding about the development plan**

So far three public hearings were organized. The follow-up survey tried to grasp how much participants deepen their knowledge through three public hearings.

In order to grasp how much respondents understand what kind of place disposal sites are, the question about operations at disposal site were asked. Almost all of the respondents replied that they knew what kinds of place disposal sites are. To them open answer question about operations conducted at the disposal sites were asked. The result is shown in Table 16-7. The operation the largest number of respondents mentioned was compost production.

Table 16-7: What kinds of operations are conducted at disposal sites?

	Sangkat Chief	Phum chief	Leader	Ordinary	total
Unloading waste (collection vehicle)	80%	41%	0%	41%	43%
Landfill operation	60%	29%	0%	14%	20%
Compost production	80%	82%	100%	76%	78%
Leachage treatment	40%	53%	100%	56%	55%
Construction of the next landfill area	20%	35%	100%	38%	37%
Others		12%		6%	7%

Base: 5 (Sangkat chief), 17 (Phum Chief), 1 (housing group leader), and 61 (ordinary people)

The results of questions about the planned starting year of the operation, the operation period of time, and the expected number of collection vehicles which come in and out of the new disposal site everyday.

Table 16-8: When the new disposal site start its operation?

	Sangkat Chief	Phum chief	Leader	Ordinary	total
2004	0%	6%	0%	0%	1%
2005	0%	0%	0%	3%	2%
2006	20%	6%	0%	5%	6%
2007	40%	29%	0%	10%	15%
2008	20%	41%	0%	52%	48%
2009	0%	0%	0%	2%	1%
I do not know	20%	18%	100%	29%	27%

Base: all

Table 16-9: How long the new disposal site will be operated?

	Sangkat Chief	Phum chief	Leader	Ordinary	total
5 years	0%	0%	0%	2%	1%
10 yrsrs	0%	0%	0%	2%	1%
15years	0%	6%	0%	2%	2%
20 years	0%	6%	0%	0%	1%
25 years	20%	0%	0%	0%	1%
100 years	0%	6%	0%	0%	1%
I do not know	80%	82%	100%	95%	92%

Base: all

Table 16-10: How many collection vehicles are expected to pass the road everyday?

	Sangkat Chief	Phum chief	Leader	Ordinary	total
I do not know	80%	71%	100%	86%	83%
5 cars	0%	0%	0%	2%	1%
10 cars	0%	0%	0%	3%	2%
15 cars	0%	0%	0%	2%	1%
30 cars	0%	6%	0%	0%	1%
50 cars	0%	0%	0%	2%	1%
100 cars	20%	18%	0%	0%	5%
150 cars	0%	0%	0%	2%	1%
180 cars	0%	0%	0%	2%	1%
200 cars	0%	6%	0%	0%	1%
blank		0%	0%	3%	2%

Base all

The result of free-answer questions about possible risks caused by disposal sites and concerns respondents had are shown below.

Table 16-11: Concerned environment and social risks

	Sangkat Chief	Phum chief	Leader	Ordinary	total
underground water contamination	80%	65%	100%	49%	54.7%
offensive odor	100%	76%	100%	95%	91.9%
fire and air pollution	0%	12%	0%	5%	5.8%
breeding of vermin	0%	29%	100%	43%	38.4%
water contamination	80%	41%	100%	35%	31.4%
traffic congestion					
dust from vehicles					
others	20%	6%			
scattered waste along the street					

Base: all

Table 16-12: Most serious concern

	Sangkat Chief	Phum chief	Leader	Ordinary
underground water contamination		11.8%		12.7%
offensive odor		47.1%	100.0%	69.8%
breeding of vermin		5.9%		0.0%
water contamination		17.6%		3.2%
water contamination	80.0%	11.8%		14.3%
others	20.0%	5.9%		0.0%

What respondents concerned most was offensive odor, while only 5.8% of respondents mentioned fire and air pollution, which causes a serious environmental problem at SMCDS.

Almost half of the respondents understand the outline of countermeasures.

The result of questions about the responsible organizations of planning and operation of the new disposal site is shown below. Unlike in the previous follow up surveys, the questions were asked in the open answer format (multiple answers).

Table 16-13: Responsible organization for the development plan

(multiple answer)	Sangkat Chief	Phum chief	Leader	Ordinary
MPP	80%	76%	100%	35%
Local aithorities	20%	35%		6%
PPWM	40%			6%
JICA	20%	65%	100%	32%
MOE	20%	24%		8%
I do not know		12%		44%

Base: all

Table 16-14: Responsible organization for operation

(multiple answer)	Sangkat Chief	Phum chief	Leader	Ordinary
MPP	20%	59%	100%	35%
Local aithorities		24%		8%
PPWM	60%	24%	100%	17%
JICA		6%		14%
MOE	20%	12%		5%
I do not know	40%	18%		43%

Base: all

More than 30% of the respondents did not know the responsible organizations. Through the two previous public hearing, MPP increased in its presence and showed its responsibility, while PPWM still had a low profile in ordinary people. It seems that the roles and responsibilities of MPP and JICA were still unclear for most of local residents.

### 16.6.3 Comments and Opinions about the development plan

All but one somehow agreed with the reasons why the new disposal site was needed and the site in Dang Kor was selected as a project site. Regarding to the development plan, all but one agreed with it with or without conditions.

Table 16-15: Pros and cons about the development plan

	Sangkat Chief	Phum chief	Leader	Ordinary
I accept the plan without conditions	20.0%	17.6%		34.9%
I accept the plan with conditions	80.0%	82.4%	100.0%	63.5%
I do not accept the plan				1.6%

Base: all

Table 16-16: Conditions to accept the plan

	Sangkat Chief	Phum chief	Leader	Ordinary
Necessary countermeasure are taken	100.0%	100.0%	100.0%	97.5%
Enough compensation is provided for land owners	0.0%	0.0%		7.5%
All the information is open to public	50.0%	7.1%		2.5%
MPP promote local economy	0.0%	21.4%		5.0%
The government tightens regulation and control	50.0%	21.4%	100.0%	30.0%
The regular monitoring is conducted	75.0%	64.3%	100.0%	55.0%
Others	25.0%	21.4%		5.0%
Regular health check				
to take a measure to prevent waste scattering				

Base: 4 (Sangkat chief), 14 (Phum chief), 1 (housing group leader), and 40 (ordinary people)

Comments to the development plan were summarized below. Respondents mainly required that necessary measures are surely taken and the improvement of the roads should be completed before the start of operation. According to the interviewers, many of respondents expected increased job opportunities provided by the new disposal site during the chatting

after the interview. It seems that local authorities and residents expected economic benefit from the new disposal site to some extent.

#### **16.6.4 Findings**

Even though this public hearing was third one, it could be said that local authorities and residents understood the development roughly but their knowledge was still fragmented. Since their knowledge on waste management so limited, it is necessary for MPP and PPWM to take further measures to make them understand the development plan, possible risks and countermeasures well.

The development of visualized educational materials about waste management for beginners is one of possible measures. (A sample of educational material to explain what kind of place final disposal sites are was already developed.) The presentation methods and styles should be also improved. One of possible ideas is that PPWM and MPP staff visits each village and organize a small meeting to provide necessary information with developed educational materials before the development plan is finalized. It is very important for MPP and PPWM to take a continuous effort to keep in touch with local authorities and residents and to make them understand the development plan well.

At this time, those who was against the development plan appeared for the first time. It is likely that as more people deepen the knowledge on waste management issues, more people would be against the plan. It is necessary for MPP and PPWM to promote dialogue with local authorities and residents and to establish the relationship of mutual trust.

# Annex 17

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*C/P Training in Laos (Vientiane)*

## Annex 17 C/P Training in Laos (Vientiane)

### 17.1 Objective

The objective of the training is to facilitate the C/P (DPWT/PPWM of MPP) to understand and obtain sufficient knowledge to implement the SWM master plan (M/P) to be proposed by the Team.

Specifically, the training program provided the following opportunities:

- Vientiane differs from Phnom Penh in natural, social and economic situation. The C/P members was able to inspect similar SWM systems of some important system components to be recommended in the M/P, such as the communal container collection system, the waste collection fee and costumer management system, the operation and incoming waste control system of the final disposal site, etc. Some of the systems are planned to be implemented as pilot project components.
- The C/P received some lectures on how the improvement plan proposed by the JICA SWM Study was implemented by responsible persons in Vientiane Municipality (VM) and how to overcome the several issues and problems encountered in the implementation stage.
- The C/P inquired several issues and problems in SWM and exchange opinions on it with relevant personnel in Vientiane Municipality.

### 17.2 Outline of Draft Training Program

#### 17.2.1 Training Period

Training in Cambodia :	September 29
Training in Laos :	September 30 to October 3 (4days)
Total :	5 days

#### 17.2.2 Place

(Cambodia)

- Holliday Villa Hotel in Phnom Penh

(Laos)

- City of Vientiane for inspection of collection and cleansing works
- KM-18 final disposal site for inspection of operation and incoming waste control system of the final disposal site
- KM-7 Head office and workshop of Urban Cleansing Service Division (UCSD) of VM for the lecture of waste collection fee and costumer management system and inspection of vehicle maintenance



### 17.2.3 Participants

There were nine participants in total, eight from MPP (Municipality of Phnom Penh) and one from MOE (Ministry of Environment).

Of the above, two were from DPWT (Department of Public Works and Transport) and three from PPWM (Phnom Penh Waste Management Authority), the executing organizations of MPP (five in total). The names and positions of the participants are as shown in the tables below.

<b>MPP</b>	
Ms. Mom Sandap	Director of Planning Department
Ms. Khuon Kimny	Director of Department of Environment
Mr. Ean Narin	Deputy Director of Department of Public Works and Transport
Mr. Moeung Sophan	Chief of Public Works Office of Department of Public Works and Transport
Mr. Ouch Vannt	Vice Governor of Phnom Penh Waste Management Authority
Mr. Leng Simen:	Vice Governor of Phnom Penh Waste Management Authority
Mr. Sam Piseth·	Assistant to the Governor of MPP
Mr. Tep Sambath	Staff of Phnom Penh Waste Management Authority
<b>MOE</b>	
Mr. Heng Nareth	Director of Department of Pollution Control
<b>Study Team</b>	
Mr. Shimura	Planner of training program, lecturer, and training facilitator
Mr. Takahashi	Responsible for coordination/logistical support (i.e. arrangement of rooms)

### 17.2.4 Contents of Training

The training was planned and implemented as described below.

Table 17-1: Contents of Training

<b>Draft Subject</b>	<b>Subject</b>	<b>Person in charge</b>
<b>Training in Cambodia</b>	<b>Training in Cambodia on September 29 (Mon)</b>	
Outline of SWM improvement plan in Vientiane	Outline of SWM Master Plan and history of establishment of SWM in Vientiane	Mr. Shimura
History of establishment of the SWM in Vientiane	Issues and problems encountered in the implementation of SWM M/P and measures for overcoming them	Mr. Shimura
Questions and answers	Questions and answers	Mr. Shimura
Training in Laos	Training in Laos	
<b>1st day</b>	<b>1st day: September 30 (Tue)</b>	
Move (Phnom Penh to Vientiane)	Leave Phnom Penh by VN 840 (VN840 : (Phnom Penh < 15:25 > ~ Vientiane < 16:55 >)	Mr. Shimura, Mr. Takahashi
Inspection of the cleansing activities in Vientiane	Inspection of the City of Vientiane	Mr. Shimura, Mr. Takahashi
<b>2nd day</b>	<b>2nd day: October 1 (Wed)</b>	
(morning) Issues and problems encountered in the implementation of the SWM M/P and measures for overcoming them	<ul style="list-style-type: none"> <li>· Courtesy visit to Vice-Mayor of Vientiane Municipality</li> <li>· Overview of SWM in Vientiane</li> </ul>	Managing Director of Urban Cleansing Service Division (UCSD) of Dept. Communication, Transport and Construction : Mr. Oudone
Waste fee collection and customer management system	<ul style="list-style-type: none"> <li>· Explanation of waste fee collection and customer management system</li> <li>· Explanation of waste collection and waste disposal data management system</li> </ul>	Deputy Director of UCSD of Dept. of Communication, Transport and Construction : Dr. Sayamang JICA Senior Volunteer: Mr. Nara
(afternoon) Site inspection where the container collection system is being operated in the city of Vientiane	<ul style="list-style-type: none"> <li>· Site inspections of waste collection condition in Vientiane</li> <li>· Site inspections of public container collection by a skip-loader</li> <li>· Site inspections of waste fee collection condition and questions and answers</li> </ul>	Mr. Oudone Mr. Sayamang JICA Senior Volunteer: Mr. Sezutsu Mr. Shimura, Mr. Takahashi
<b>3rd day</b>	<b>3rd day: October 2 (Thu)</b>	
(morning) Site inspection of the operation and incoming waste control system of the KM-18 final disposal site improved under Japanese grant aid	Inspection of operation conditions at KM 18 disposal site <ul style="list-style-type: none"> <li>· Measurement of incoming waste by weighbridge, washing of waste collection vehicles, operation of the final disposal site, separate disposal of medical wastes</li> </ul>	Mr. Oudone Mr. Sezutsu, Mr. Shimura, Mr. Takahashi
Inspection of the maintenance system of the equipment	<ul style="list-style-type: none"> <li>· Inspection of the vehicle maintenance workshop and its management system</li> <li>· Inspection of the customer management system (beneficiaries of the waste collection service)</li> </ul>	Mr. Oudone, Mr. Sezutsu, Mr. Shimura, Mr. Takahashi
(afternoon) Exchange of opinions with relevant personnel in Vientiane	<ul style="list-style-type: none"> <li>· Introduction of cleansing activities in Vientiane by video</li> <li>· Exchange of opinions with relevant personnel in Vientiane</li> </ul>	Mr. Oudone, Dr. Sayamang, Mr. Sezutsu, Mr. Shimura, Mr. Takahashi
Closing speech	Closing speech	Mr. Shimura
<b>4th day</b>	<b>4th day: October 3 (Fri)</b>	
Move (Vientiane to Phnom Penh)	Leave Vientiane by VN 841 (VN841 ; Vientiane < 10:00 > ~ Phnom Penh < 11:40 >)	Mr. Shimura, Mr. Takahashi

## 17.3 Results of Training

### 17.3.1 Collection and Street Cleaning System

#### a. Items pointed out to the C/P (MPP/PPWM)

In general, Vientiane Municipality has adopted a collection and street cleaning system based on the M/P formulated in the JICA development study.

##### a.1 Collection system

- For small quantity generators such as general households, etc.:

Waste is disposed of in bamboo baskets and collected by compactor skip loader truck or dump truck with canopy. The collection frequency and quantity is generally one basket per household per week, or determined by customer request.

- For large quantity generators such as markets, etc.:

Five m<sup>3</sup> containers are collected by skip loader truck. The collection frequency and quantity (no. of containers) is determined by customer request.

##### a.2 Street cleaning system

Street cleaning is done manually using cheap labor.

#### b. The situation in Vientiane and the C/P's response

##### b.1 Collection system

- In contrast to Phnom Penh, scattered waste is rarely seen in Vientiane. The C/P understood that this was basically due to the discharge and collection system mentioned above and public cooperation.
- The C/P also found the collection service to be very efficient compared to Phnom Penh (In bamboo basket collection, only a small amount of time was required for loading and hardly any time for container collection).



Waste discharged in bamboo baskets



Waste collection by skip loader truck

##### b.2 Street cleaning system

- Street cleaning work is generally done manually. A few years ago a street cleaning vehicle was provided through grant aid. However, after being in operation for one year, the part shown below wore out and the vehicle could no

longer be used. The problem is that the part costs 3,500 dollars and is difficult to purchase. Moreover, with that money it is possible to hire 120 street cleaners for a month.

- The C/P, Phnom Penh, understood the importance of continuing to carry out street cleaning manually as proposed by the Study Team in the M/P.



Broken part costing 3,500US\$



Street cleaning vehicle

### 17.3.2 Fee Collection System

#### a. Items pointed out to the C/P (MPP/PPWM)

##### a.1 Waste collection fee

The collection service in Vientiane Municipality (VM) is covered by the fee collected from residents and businesses, the beneficiaries of the service. An agreement is made with the customer before the collection service is provided. As inflation is severe, the contract is for a period of three months. In general, the collection service fee is established based on the proposal in the JICA development study from 12 years ago.

- Small quantity generators are generally charged 8,000 kips/month (1US\$ = 10,800 kips) for the collection of one bamboo basket per week. (At the time of the JICA study it was 500 kips/month (1US\$ = 730 kips).).
- There are three methods for collecting fees: 1) direct collection by VM staff, 2) indirect collection by Bans (the smallest unit of government), and 3) the lending out of collection vehicles to CBOs (Community Based Organizations) or CBEs (Community Based Enterprises) in Bans (In this case, vehicles are lent out at a price). Of these methods, 1) was proposed in the JICA study but 2) is the most common at present. It includes fee collection plus supervision/monitoring (hearing of complaints, prosecuting of violators, and management of sanitary conditions in the districts) and 10% of the amount collected is paid to the Bans.
- VM currently has 20 staff members responsible for fee collection but they are mostly done engaging on collection contracts.
- For large quantity generators, an agreement is made to lease containers and the fee varies depending on the collection frequency. The container fee is currently the most important source of revenue for the Cleansing Department of Vientiane. Therefore, the department manufactures the containers by itself.

**a.2 Disposal fee**

- At present, 10 kips/kg (10,000 kips/ton, about 1US\$/ton) is charged for waste disposed of at the disposal site other than from VM collection vehicles.

**a.3 Others**

As for other sources of revenue, the biggest is the budget paid out by VM for the public area cleansing service and beautification of the city. There is also revenue, although small, from a fee charged for the collection and disposal of sludge from septic tanks.

**b. The situation in Vientiane and the C/P's response**

**b.1 Waste collection fee**

- The collection fee for small quantity generators is based on the number of bamboo baskets. The C/P found this to be a rational system as the fee is determined by the generation amount.
- Of the fee collection methods, the C/P was very interested in Method 2, where the fee is indirectly collected by Bans (the smallest unit of government). This was because the fee collection includes supervision/monitoring work, such as the hearing of complaints, prosecuting of violators, and the management of sanitary conditions of districts, which are troublesome tasks that should be carried out by the Cleansing Department.
- In the training, the C/P visited the Nasai Ban office and obtained information on the situation from the Ban Chief and Ban fee collectors. They found that of the 334 households in the Ban, there is a collection agreement with 229 households and a total of 3,290,000 kips/month is collected. Regarding those who do not have an agreement or cannot afford to pay the fee, they are cooperating by placing their waste in bamboo baskets at collection sites in front of their homes. The revenue collected by the Ban office from issuing marriage licenses, etc. is small. Of the 329,000 kips collected per month, only 50,000 kips is paid to the Ban office and the remainder of that goes to the fee collectors.
- The collection fee for large quantity generators is based on a container leasing agreement, and varies depending on the collection frequency, etc. The C/P found this to be a rational system as the fee is generally determined by the generation amount.

**b.2 Disposal fee**

- As the disposal fee is charged based on the measurement data at the disposal site, the C/P recognized the importance of operating the truck scale installed in the Study.
- The C/P thought a fee of 1US\$/ton was quite sufficient. The study team, therefore, explained how this was not adequate to cover the operation of a sanitary landfill, which requires 5US\$/ton. However, as raising the fee leads to illegal dumping, the C/P realized the importance of subsidizing the cost to some degree from the city budget in order to set a fair fee.

### b.3 Other

- The C/P understood the importance of the VM's covering the cost of the public area cleansing service and providing a budget for activities to beautify the city. With waste collection, there is a direct benefit and as the waste generator (beneficiary) can be identified, it is possible to charge a fee (share the burden). However, with public services such as the cleaning of public areas and beautification of the city, the beneficiary cannot be identified so it should be shouldered by the city. The C/P recognized that the situation in Phnom Penh, where this burden is left to CINTRI with hardly any assistance from the city, is an issue that needs to be addressed.



Interview with Ban staff on the waste collection fee system



Management of measurement data at the final disposal site

### 17.3.3 O&M of Equipment and Vehicles

#### a. Items pointed out to the C/P (MPP/PPWM)

- The methods for daily inspection, O&M of spare parts and vehicles, etc. of the maintenance shop constructed through grant aid were explained, and the actual management situation was inspected.
- At the final disposal site, the C/P happened to observe the driver of the skip loader truck rinsing the containers using the pump from the road sprinkler.
- It was explained that in order to reduce the amount spent on purchasing containers, the containers were manufactured at the maintenance shop.

#### b. The situation in Vientiane and the C/P's response

- The waste collection dump trucks used in the 1991 JICA study were still in operation, which made the C/P understand the importance of daily inspections.
- In the Study, the construction of maintenance shops is targeted for the F/S. The C/P fully understands the importance of this.



Washing of container at disposal site



Construction of container at maintenance shop

### 17.3.4 Final Disposal System

#### a. Items pointed out to the C/P (MPP/PPWM)

According to the M/P established in the JICA study, the sanitary landfill constructed by grant aid was a Level 2 (sanitary landfill where leachate is not treated but daily soil covering is carried out), and was to be upgraded to a Level 3 (leachate is treated by recirculation system) in the year 2000.

However, the landfill has been downgraded to a Level 1, where soil covering is only carried out occasionally (controlled tipping). This is due to the fact that there is a shortage in fuel required for the daily operation of heavy equipment.

#### b. The situation in Vientiane and the C/P's response

- In general, the operation of heavy equipment (typically a bulldozer) at a sanitary landfill for eight hours a day requires 200 liters of fuel. At the disposal site in Vientiane, although the three heavy equipments and two dump trucks provided through grant aid are still in operation, it would require 800 liters of fuel a day to operate five of them for a full eight hours, which would cost 240/day or 7,200 dollars/month. With that money it is possible to hire 240 laborers for one month.
- It became clear that one of the main reasons for the shortage of fuel is because the city does not allocate an adequate budget. As mentioned above, it is difficult to raise the disposal fee as it will lead to illegal dumping. Furthermore, even if the sanitary conditions of the dumpsite worsen, the number of residents affected by it is small. As a result, the politicians who allocate the budget do not consider it a high priority.
- As a result of the visit by the personnel from Phnom Penh, a budget was quickly allocated for improvement of the disposal site. Compared to the time of Mr. Shimura's visit on September 17, the conditions had clearly improved. Both VM and MPP personnel recognize that making politicians understand that continuing sanitary landfill operation at the disposal site will cost money and that there is a need for improvement are major issues.





Disposal site prior to training (Sep. 17)



Disposal site during training (October 2)

## 17.4 Evaluation of the Training

### a. Promotion of working level exchange between MPP and VM

MPP and VM have very similar socio-economic conditions. From this standpoint, they face many common problems with waste management. This training allowed working level officials from MPP and VM to exchange views on these common problems, and they recognized this to be a good opportunity for them to work hard together to improve their respective waste disposal services in the future.

### b. Impact on VM

As mentioned above, the reason why UCSD/VM is not able to maintain the KM-18 disposal site as a sanitary landfill (Level 2) is largely due to the reduced budget from the city. Despite the fact that the Mayor and Vice Mayor, the head of the municipal government in charge of policy making, have a great interest in making the city beautiful and eliminating garbage from the city, they have a very low interest in the disposal site. This had led to the reduction in budget allocated from the city.

The C/P's visit to Vientiane to study the waste management conditions there is thought to have had a great impact on the heads of the municipal government. As a result, the budget was quickly allocated for the improvement of the disposal site. This shows that this training has not only had a favorable impact on MPP/PPWM but also on the solid waste management service of UCSD/VM.

### c. Overall Evaluation

Nine C/P personnel participated in this third country training (in Laos), which cost approximately 250,000 yen.

Moreover, it appears that to keep administrative heads interested in disposal sites and to keep key personnel motivated, there is a need to create this kind of opportunity for exchange on a regular basis.

## 17.5 Conclusion

Nine C/P personnel participated in this third country training (in Laos), which cost approximately 250,000 yen.

Moreover, it appears that to keep administrative heads interested in disposal sites and to keep key personnel motivated, there is a need to create this kind of opportunity for exchange on a regular basis.



# Annex 18

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*Report of  
Group Training Workshop  
in Phnom Penh*

## Annex 18 Report of Group Training Workshop in Phnom Penh

In the process of the study, the Team held group training workshops in Phnom Penh two times in order to disseminate the results of the study to main local governments in Cambodia.

### 18.1 First Group Training Workshop in Phnom Penh

The first group training workshop in Phnom Penh was held from December 29, 2003 to January 2.

#### 18.1.1 Objectives

The Sub-decree on Solid Waste Management (the Sub-decree on SWM) stipulates Municipal SWM (MSWM: Non-Hazardous Waste Management or Household Waste Management) is the responsibility of local governments. The Sub-decree also stipulates that each local government should promptly formulate a short, medium and long-term plan on MSWM for the proper management of its waste. Although Phnom Penh, the capital city, is formulating the MSWM Master Plan (M/P) by this study, none of the local governments in Cambodia have formulated a MSWM plan.

Taking the above-mentioned situation into consideration, the group training in Phnom Penh was conducted with the following objectives:

- To support main local governments (Main local governments mean here 4 municipalities and 20 provincial towns) to facilitate formulation of their MSWM M/Ps;
- To provide necessary information and knowledge to key personnel of main local governments for the formulation of their MSWM M/Ps by themselves; and
- To guide main local governments to prepare action plans (A/Ps) for their MSWM, which identify what they have to do for the formulation of M/P.

In order to achieve the above objectives, the group training will invite key personnel of main local governments to Phnom Penh and provide them necessary information and knowledge, which are obtained through the conduct of the Study on SWM in the MPP; i.e. the field surveys, the process of the formulation of M/P, the contents of Feasibility Study, pilot projects.

#### 18.1.2 Outline of Workshop

##### a. Training Period

The first group training workshop in Phnom Penh was conducted 5 days from December 29, 2003 to January 2, 2004. The number of participants including lecturers was 55 in total.

##### b. Place

- Lecture and group workshop : Phnom Penh Hotel
- Inspection : Pilot project sites conducted by JICA Study Team

##### c. Participants

Administratively, Cambodia is divided into 20 provinces and four municipalities (refer to Figure 18-1). In the training, there were 51 participants in total from 19 of the provinces,

excluding Stueng Traeng, and the four municipalities. The breakdown of the participants is as follows: 29 persons from provincial towns and municipalities, 16 from MPP (Municipality of Phnom Penh), and six from central government agencies such as MOE (Ministry of Environment). Of the 16 participants from MPP, three were from DPWT (Department of Public Works and Transport) and five from PPWM (Phnom Penh Waste Management Authority), which are directly concerned with the project (eight in total). The names and positions of the participants are as shown in the tables below.

Table 18-1: Participants from Municipalities other than MPP and Provincial Towns

No	Province Name	Name	Position
1	Banteay Mean Chey	Puth Chuop	Provincial Director of Environment
2	Bat Dambang	Ouk Vong	Provincial Chief Cabinet
3	"	Choup Sarun	Provincial Department of Environment
4	Kampong Cham	Ban Buntheoun	Provincial Director of Department of Environment
5	"	Thoeunsrey Neang	Provincial Department of Environment staff
6	Kampong Chhnang	Ouk Sophat	Provincial Department of Environment, Chief of pollution Control
7	"	Ouk Dim	Provincial Secretary General
8	Kampong Spueu	Khleang Thuch	Vice Chief of Financial Department
9	Kampong Thum	Mam Rithy	Provincial Director of Department of Environment
10	Kampot	Long Sreng	Deputy Director of Department of Environment
11	Kandal	Long Yan	Deputy Director Department of Environment
12	"	Nou Nim	Secretary General
13	Kaoh kong	Sao Sinthuon	Director of Department of Environment
14	Kracheh	Yin Khim	Deputy Provincial Cabinet
15	Mondol Kiri	Em Chhoeurn	Director of Department of Environment
16	Preah Vihear	Song Bun Leang	Provincial Chief Cabinet
17	Prey Veang	Khim Yaun	Provincial Secretary Administration General Officer
18	Pousat	Vong Samol	Provincial Chief of Cabinet
19	Rotanak Kiri	Khen Phosy	Deputy Provincial Cabinet
20	Siem Reab	Phourng Lina	Provincial Department of Environment
21	"	Chan Sara	Deputy Chief Cabinet
22	Krong Preah Sihanouk	Chhay Sokunda	Deputy Secretary General
23	"	Hem Saroeun	Director of Department of Environment
24	Svay Rieng	Chann Savann	Vice Secretary General
25	Takaev	Yos Nasy	Chief of Cabinet
26	Otdar Mean Chey	Thach tharath	Chief of Staff Department
27	Krong Kaeb	Ken Satha	Municipality of Chief of Cabinet of KEP
28	"	Chourb Kao	Director of Department of Environment
29	Krong Pailin	Ly Sun Eang	Provincial Director of Department of Environment

Table 18-2: Participants from MPP

No	Name	Position
1	Moeung Sophan	DPWT, Chief Office
2	Kong Saravath Chan	DPWT, Public Office
3	Chim Chea	DPWT, Public Office
4	Moeng Chantha	DPWT, Public Office
5	Mao Kolmardi	DPWT,
6	Leng Simen	PPWM, Vice Governor
7	Heng Sambath	PPWM, Staff
8	Youn Davy	PPWM, Staff

No	Name	Position
9	Tiv Kim Piseth	MPP, Deputy Chief Cabinet
10	Dor Samphors	MPP
11	Kang Bunna	MPP
12	Mok Vibol	MPP
13	Neth Monyponnaka	DIME, Staff
14	Sok Sokun	DOH
15	Uong Bunal	DOE, Deputy Director of Department of pollution control and education
16	Tes Norearith	DOE, Planning EIA Staff

Table 18-3: Participants from Central Government

No	Ministry	Name	Position
1	Ministry of Environment (MOE)	Chin Sothun	Department of Pollution Control Vice Office of Solid Waste Management
2	"	Ou Vitou	Department of Pollution Control Technical office of Solid Waste Management
3	"	Saran Sambo	Department of Pollution Control Vice chief office of Solid Waste Management
4	Ministry of Health (MOH)	Som Seiharath	Coordinator of Medical Waste Management
5	Ministry of Industry and mines Energy (MIME)	Hout Rithy	Deputy Chief office
6	Ministry of Public Works and Transport (MPWT)	Kong Sophal	Chief Office

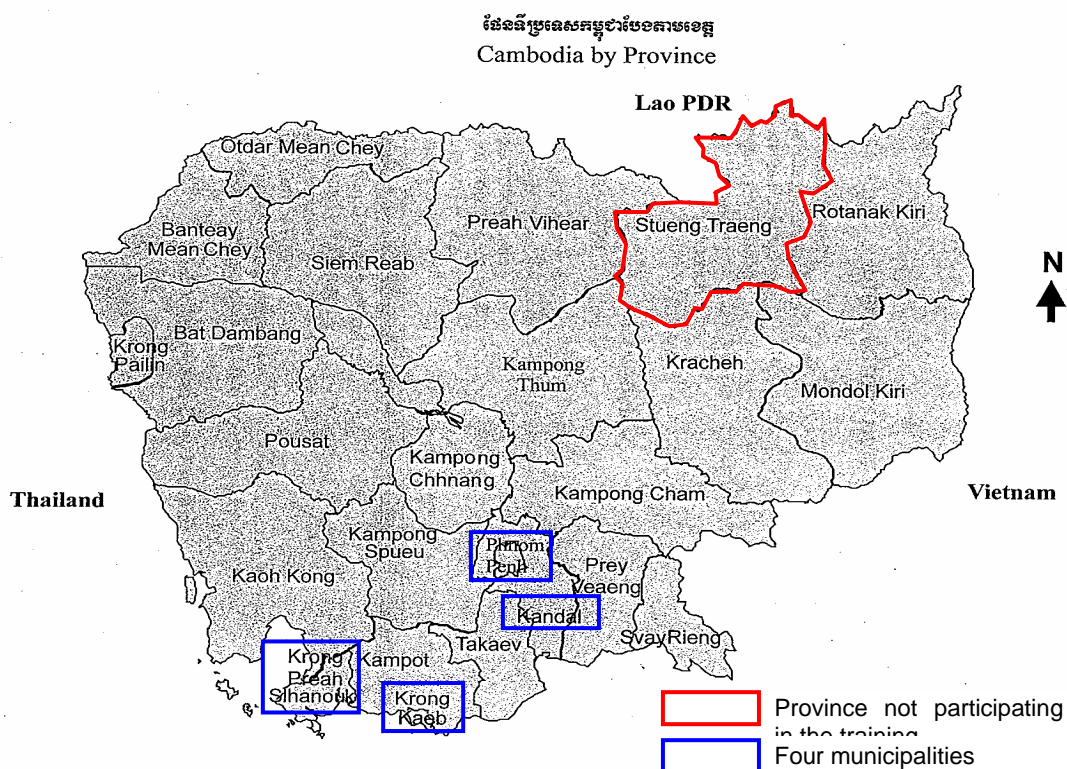


Figure 18-1: Administrative Divisions of Cambodia

#### d. Preparation and Implementation of Training

The persons in charge of preparing and implementing the training program were as follows:

- Prof. Dr. Kitawaki : Lecturer and training facilitator
- Mr. Fujikawa : Lecturer and training facilitator
- Mr. Shimura : Planner of training program, lecturer and training facilitator
- Mr. Takahashi : Responsible for coordination/logistical support (i.e. arrangement of lecture rooms, etc.)

#### e. Training Program

The training program was planned and implemented as shown in the table below.

Table 18-4: Contents of Training

Draft subject	Subject	Responsible Personnel
<b>Day 1 (December 29)</b>	<b>Day 1 (December 29)</b>	
(morning)	(morning) Opening speech	Mr.Chikaraishi, Resident Representative JICA Cambodia Office Mr. Chhan Saphan Secretary of State, Ministry of Environment
Issues and problems on SWM in the developing countries and its improvement methods	Issues and problems on SWM in the developing countries and its improvement methods	Dr. Kitawaki
Administrative issues and problems on SWM and its improvement methods	Administrative issues and problems on SWM and its improvement methods	Mr. Fujikawa
(afternoon) Formulation of the draft M/P of SWM in the municipality of Phnom Penh and outline of the proposed technical system	(afternoon) Explanation of Joint PRAKAS on Municipal Solid Waste Management	Mr. Chea Sina, MOE
Institutional system proposed in the M/P of SWM in the municipality of Phnom Penh	·Field surveys such as WACS, POS, T&M survey, etc. · Waste amount and composition survey ·Time and motion survey ·Water quality survey	·Mr. Shimura ·Mr. Chhim Khindarath ·Mr. Tep Sambath ·Ms. Hem Visal
<b>Day 2 (December 30)</b>	<b>Day 2 (December 30)</b>	
(morning) Basic surveys for the M/P (WACS, T&M, POS, etc.)	(morning) Waste flow and its preparation	Mr. Shimura
Draft MPP SWM M/P and Pilot Projects	Waste collection system plan	Mr. Anai
(afternoon) Improvement measures of landfills in developing countries	(afternoon) Intermediate treatment system plan and final disposal system plan	Mr. Shimura
	Pilot projects for collection & promotion of composting	Mr. Anai
Issues/problems encountered and overcoming measures applied for the implementation of the SWM M/P in Vientiane	Pilot projects for Steng Mean Chey Disposal Site (SMCDS) & database management	Mr. Shimura
<b>Day 3 (December 31)</b>	<b>Day 3 (December 31)</b>	
(morning) · Site inspection of the pilot project for improvement of the SMC disposal site and incoming waste control system · Site inspection of the pilot project for collection improvement	(morning) · Site inspections of pilot projects for collection service expansion & separate collection · Site inspections of pilot projects for SMCDS & database management	Mr. Anai, Mr. Shimura

Draft subject	Subject	Responsible Personnel
(afternoon) Action plan to formulate the SWM Master Plan	(afternoon) Preparation of A/P for formulation of M/P	Dr. Kitawaki
Procedure to formulate an Action Plan (A/P)	Procedure of the preparation of A/P	Mr. Shimura
Guidance to formulate the A/P	Guidance of the preparation of A/P	Dr. Kitawaki, Mr. Fujikawa, Mr. Shimura
-----	<b>Day 4 (January 1)</b>	
-----	Guidance of the preparation of A/P	Mr. Shimura
<b>Day 4 (January 2)</b>	<b>Day 5 (January 2)</b>	
(afternoon) · Guidance to formulate the A/P · Presentation of the A/Ps prepared by the participants	(morning) Presentation of A/Ps prepared by the participants	Dr. Kitawaki, Mr. Fujikawa, Mr. Shimura
(afternoon) · Evaluation of the A/P presented and overall evaluation of the C/P training	(afternoon) Evaluation of A/Ps and the training	Dr. Kitawaki
Handing out of certification and closing speech	Closing speech	HE. Kep Chuk Tema, Governor, MPP
	Handing out of certifications	Mr. Chikaraishi, Resident Representative JICA Cambodia Office HE. Kep Chuk Tema, Governor, MPP Dr. Kitawaki, Mr. Fujikawa, Mr. Anai

### 18.1.3 Execution of Workshop

#### a. Execution of Workshop

The training programs of the workshop were executed as shown in the photos below.



Scene from lectures



Inspection of pilot project (1) (separation collection and CSARO recycling center)



Inspection of pilot project ( 2 ) (expanding of collection service in uncollected area)



Inspection of pilot project ( 3 ) (SMCDS improvement)



Group workshop



Presentation of A/P by participants and handing out certifications



## b. Results of Training

### b.1 Master Plan (M/P) and Action Plan (A/P)

Of the nine M/Ps and A/Ps prepared and presented by the participants in the training, the presentation on Battambang is shown below.

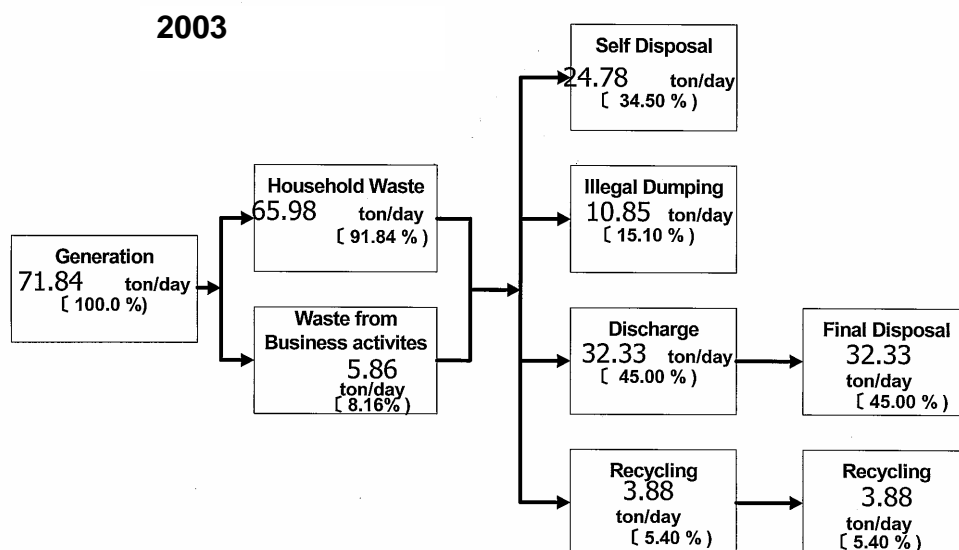
#### Master Plan

Table 0-1: The SWM Master Plan for Battambang

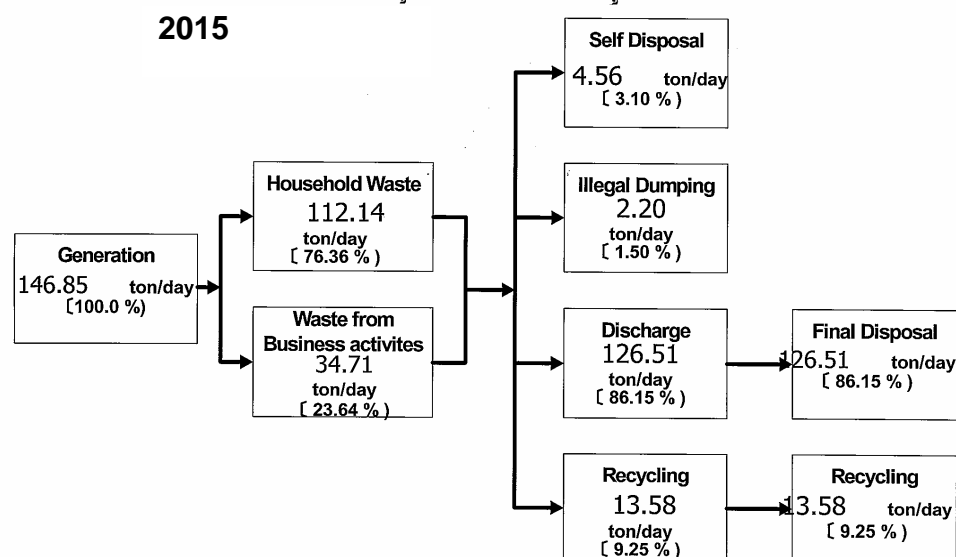
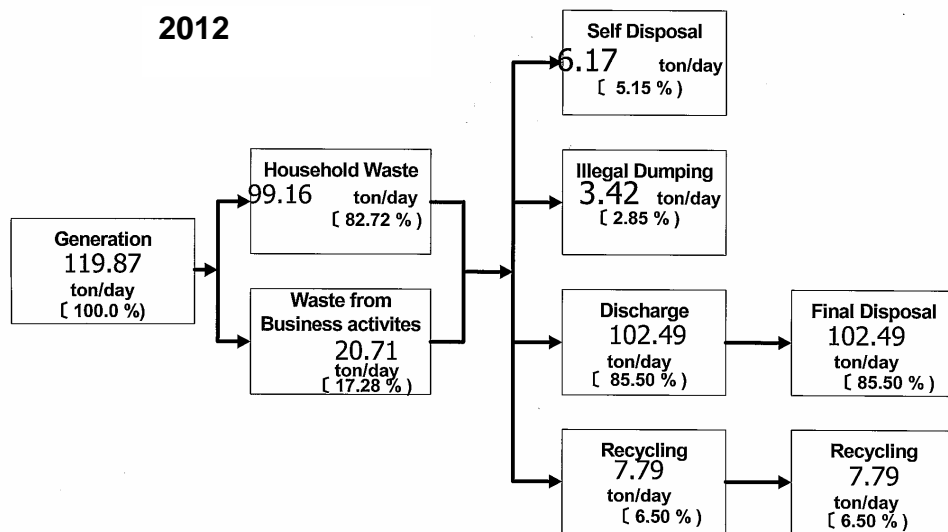
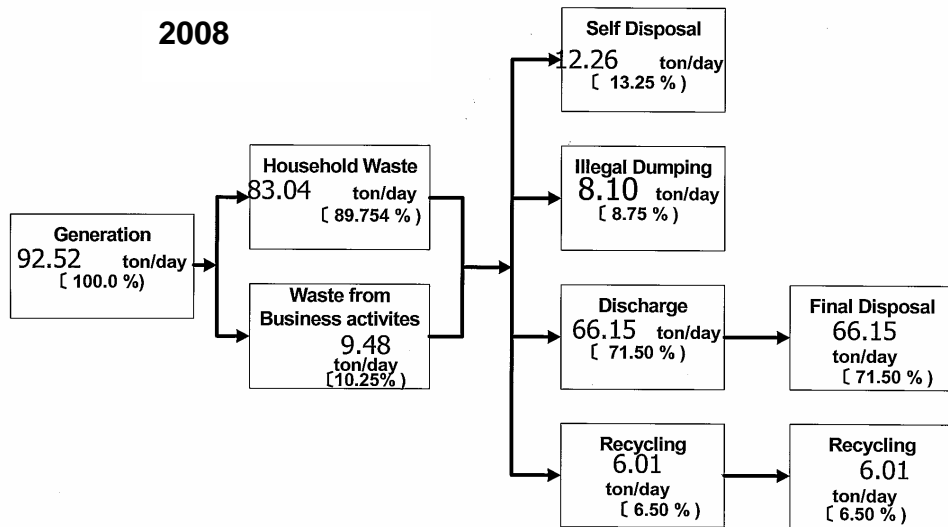
Components	Phase Present (2003)	Phase 1 (2008)	Phase 2 (2012)	Phase 3 (2015)
<b>1. MSW Generation</b>				
Population in 777	185,478	183,606	168,650	180,282
MSW Amount (ton/day)				
Generation	71.84	62.52	119.87	146.85
Discharge	32.33	68.15	102.49	126.51
Collection	32.33	68.15	102.49	126.51
MSW Composition (%)				
Non-compostable	100	40.50	39.85	37.50
Compostable	-	59.50	60.15	62.50
<b>2. Refuse Collection &amp; Transportation</b>				
Collection rate	45.00	71.50	85.50	86.15
Ratio of improper disposal to generation	15.10	8.75	2.85	1.5
Separate collection rate to refuse collection	-	1.1	1.3	1.4
Collection system	In front household	In front household		
Major type of vehicles (unit)	4	5	7	7
Transportation system	Push cart, Tractor	Tractor, Container, Compactor	Tractor, Container, Compactor	Bulldozer, Compactor
Executing organisation	Everyday	Everyday	Everyday	Everyday
Unit cost (US\$/ton)	-	4.25	7.20	9.50
<b>3. Public Area Cleansing</b>				
Method of sweeping	Manual	Manual	Manual	Manual
Length of served road (km)	5	8	12	15
Operation by	Private company	Private company	Private and Gov't	Private and Gov't
Unit cost (US\$/ton)	10	125	17.75	20.25
<b>4. Recycling Intermediate Treatment</b>				
Compost plant Site	0	0	Chrey Kaong 200	Chrey Kaong 500
Treated amount (ton/year)				
Unit cost (US\$/ton)	No	No	No	No
Recycling at generation	Market waste	Market waste	Market waste	Market waste
Overall recycling rate	No	No	0.8	1.3
Recycling system	Dig a hole	Dig a hole	Dig a hole	Dig a hole
<b>5. Final Disposal</b>				
Method of operation	Open dumpsite	Landfill No.4	Landfill No.4	Landfill No.4
Final disposal site	Andaung Chagn	Andaung Chagn	Chrey Kaong	Chrey Kaong
Distance from city (km)	4	4	10	10
Operation by	Private company	Private company	Private and Gov't	Private and Gov't
Nos. of workers	20	20	24	30
Tipping fee (US\$/ton)	0.75	1.20	3.45	3.45
Unit cost (US\$/ton)	0.43	3.66	2.78	2.78
Main equipment	Push cart, Tractor	Tractor, Container, Compactor	Tractor, Container, Compactor	Bulldozer, Compactor
<b>6. Maintenance &amp; Repair</b>				
Preventive Maintenance	Private company	Private company	Private and Gov't	Private and Gov't
Major repair	Private company	Private company	Private and Gov't	Private and Gov't

Components	Phase Present (2003)	Phase 1 (2008)	Phase 2 (2012)	Phase 3 (2015)
<b>7. Public Organisations Responsible on SWM</b>				
Operation by	Private company	Private company	Private and Gov't	Private and Gov't
Responsible on SWM	Battambang District Hall			
<b>8. Financial Matters</b>				
Unit SWM Cost (US\$/ton)	-	7.15	10.27	8.45
Revenue Source		570	726	815
Collection rate of waste collection fee (%)	-	80.00	85.00	90.00
Coverage rate of waste collection fee to SWM	-	25	35	40
Total revenue (US\$ 1,000)	-	570	726	815
Budget allocation from general finance (%)	-	1.00	1.20	1.50
Sale of recyclables and compost (%)	-	-	0	70
Tipping fee (%)	-	-	-	-
Total revenue per capita (US\$)	-	-	3.18	3.62
Municipal Budget (thousand US\$)	-	10	15	22
Share of SWM budget	-	0.8	0.7	0.8
<b>9. Public and Private Partnership</b>				
Operation by	Private company	Private company	Private and Gov't	Private and Gov't
<b>10. Public Co-operation</b>				
Local authorities at province, district, commune, and DoE will conduct educational outreach to publics as well as to local communities so they can get involve with the us, especially from NGOs.				
<b>11. Medical SWM</b>				
Generation (ton/day)	0.1	0.2	0.35	0.5
Treatment at generation	Discharge, burn	Discharge	Discharge, burn	Discharge, burn
Final disposal	Open	Only after treatment	Only after treatment	Only after treatment
<b>12. Industrial SWM</b>				
Generation of HW (ton/day)	1.5	1.74	2.01	2.35
HW treatment	None	FDS	FDS	FDS
Final disposal	Open	Monitoring and controlling	Monitoring and controlling	Monitoring and controlling

#### Waste Flow







**ផែនការសកម្មភាពសំរាប់បង្កើតផែនការមេ (១)**

វាយមូលធនសកម្មភាព	កាលបរិច្ឆេទធ្វើ	អ្នកទទួលខុសត្រូវធ្វើ	តំណកំសំគាល់
១. ប្រជុំផ្សព្វផ្សាយការងាររបៀបចំផែនការមេ	សប្តាហ៍ទី ១ ខែ មករា ២០០៤	លោក អ៊ុក វិង្ស	
២. ចុះស្រង់ទិន្នន័យសំនល់តាមផ្ទះ	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក សេង ហួរ	
៣. ស្រង់ទិន្នន័យតាមភោជនីយដ្ឋាន	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក អ៊ុន ក្រាជូ	
៤. ស្រង់ស្ថិតិហាងម៉ឺនញូ	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក ត្រី ព្រី វិណ្ណា	
៥. ស្រង់ទិន្នន័យតូបលក់ដូរតាមផ្សារ	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក វង់ កាអុន	
៦. ស្រង់ទិន្នន័យលិខិតស្នាក់នៅ	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក កឹម ផុន	
៧. ស្រង់ស្ថិតិសំនល់តាមដងផ្លូវ	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក ម៉ុក សារិវណ្ណា	
៨. ស្រង់ស្ថិតិបន្ទប់តាមផ្ទះសំណាក់ និងសណ្ឋាគារ	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក អ៊ុន ក្រាជូ	

**ផែនការសកម្មភាពសំរាប់បង្កើតផែនការមេ (២)**

វាយមូលធនសកម្មភាព	កាលបរិច្ឆេទធ្វើ	អ្នកទទួលខុសត្រូវធ្វើ	តំណកំសំគាល់
៩. ស្រង់ស្ថិតិការងារលើកិច្ចសន្យា - ក្រុមហ៊ុនបេតុង	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក សួន សារុន	
១០. ស្រង់ទិន្នន័យសំនល់ចាក់ ដោយខ្លួនឯង	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក សេង ហួរ លោក ម៉ុក សារិវណ្ណា	
១១. ស្រង់ទិន្នន័យសំនល់ចាក់ ដោយខ្លួនគ្នា	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក សេង ហួរ	
១២. ស្រង់ទិន្នន័យសំនល់ចាក់សេវា ឌីកាធាក	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក ម៉ុក សារិវណ្ណា លោក សេង ហួរ លោក ម៉ុក សារិវណ្ណា	
១៣. ស្រង់ទិន្នន័យសំនល់កែច្នៃ	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក សេង ហួរ	
១៤. ត្រួតពិនិត្យសំនល់ចាក់ចោល ចុងក្រោយ	សប្តាហ៍ទី ២ ខែ មករា ២០០៤	លោក ម៉ុក សារិវណ្ណា លោក សេង ហួរ	
១៥. ប្រជុំប្រភពព័ត៌មានស្រុកស្រាវជ្រាវ	លើសខែ កុម្ភៈ ឆ្នាំ ២០០៤	លោក ម៉ុក វិង្ស	

**b.2 Feedback from the Participants**

**b.2.1. Feedback on Each Day's Lecture**

Each day after the lectures, the participants were asked to complete a questionnaire. The questions and responses were as follows:

(December 29)

Total number of respondents: 37

“Did you understand all parts of today’s program?” : < Y : 19, N : 18 >

“Please describe the parts that you did not understand below.”

- Formulation of M/P for SWM : 8
- Water quality parameters, i.e. PCB : 2
- Other : 8

(December 30)

Total number of respondents: 32

“Did you understand all parts of today’s program?” : < Y : 15, N : 17 >

“Please describe the parts that you did not understand below.”

- Leachate treatment : 3
- Management of final disposal site : 5
- Other : 9

(December 31)

Total number of respondents: 38

“Did you understand all parts of today’s program?” : < Y : 14, N : 24 >

“Please describe the parts that you did not understand below.”

- Acquisitions of data, i.e. waste generation amount : 5
- Formulation of M/P for SWM : 5
- Other : 14

### **b.2.2. Feedback on the Training**

On the final day of training, the participants were asked to complete a questionnaire concerning the overall training program. The questions and responses were as follows:

(January 2)

Total number of respondents: 47

Q1 “Your organization’s department”

**Response:** Central Government : 3, MPP : 14, Local Government : 27

Q2 “Do you think the group training workshop in Phnom Penh is useful for your job?”

**Response:** Y : 47, N : 0

Q3 “Did you know about joint PRAKAS on Municipal Solid Waste Management before the group training?”

**Response:** Y : 36, N : 11

Q5-1 “What did you want to learn through the group training workshop?”

**Response:**

- About formulating A/Ps and M/Ps: 19
- About final disposal sites: 8
- About SWM in communities: 7

Q5-2 “Were you able to obtain such knowledge through the group training workshop?”

**Response:** Y : 23, Partly : 24, N : 0

Q6 “Do you have some ideas to improve this group training workshop in Phnom Penh? What did you want to see and know more about?”

**Response:**

- The training period was too short. It should be longer: 17
- Group discussions: 7

The training should include lectures on hazardous and medical wastes: 2

Q7 “What is the most important issue on solid waste management in your cities?”

**Response:**

Waste collection and disposal:	18
Management of final disposal site:	15
Resident participation:	12

Q8 “What kind of support do you need to improve solid waste management in your cities?”

Response

Technical support and financial support (JICA, Government of Japan):	21: 42
Support for final disposal sites:	8

### **b.2.3. General assessment of questionnaire results and attitude of participants**

The training covered topics and issues that the participants were interested in learning about and they seemed to have understood most of them. However, due to the limited time, they were not able to understand all the topics and issues. It was surprising to find that although the participants were key personnel responsible for SWM in Cambodia, close to one fourth of them were not familiar with the PRAKAS on Municipal Solid Waste Management.

Regarding administrative support to local governments, many of the participants were expecting to make improvements through assistance from JICA.

According to the initial training schedule, January 1 was to be a day off. However, due to the strong request by the participants, the study team used that day to give guidance on the preparation of A/P.

As shown above, the participants were very serious about the training. The personnel responsible for SWM from local governments showed they were enthusiastic and earnest about improving solid waste administration.

## **18.1.4 Evaluation of the Workshop**

### **a. Acquisition of required knowledge/information for the formulation of M/P**

The relevant personnel from local governments (LGS) that participated in the training obtained the basic knowledge and information required for the formulation of a MSWM M/P, which was the primary objective of the training. In order to determine the degree of understanding, the participating LGs were asked to prepare waste flows of their respective cities. In regard to this, the LGs had to have an understanding of what the Phnom Penh M/P was, and use it as an example to prepare the waste flow of their cities by themselves. At the end of the training, the waste flows of nine cities were presented, which confirms their understanding. Although the preparation of M/Ps on their own is unlikely, several of the participants from LGs would be able to formulate an outline of an M/P (formulation of an equipment and facility plan in accordance with the generation amount, discharge amount, collection amount, and final disposal amount) provided they had a certain amount of expert support.

**b. Building of a network among persons relevant to SWM**

All the local governments (LGs) that participated in the training, including MPP, are faced with many problems concerning SWM. In this training, key personnel confronting these problems were able to consult with each other and exchange views on how to cope with such problems. Moreover, MOE played an active role in preparing for the training program by contacting the relevant personnel from local towns and municipalities by letter and by phone to invite them to attend. In the training, there was interaction between personnel from the central government and SWM personnel from local towns and municipalities; that is, the training was used as an opportunity to lay the groundwork for a network to facilitate information exchange on SWM between local governments and between the central and local governments. This will enable LGs to work hard together to improve their respective waste disposal services in the future. This network is also expected to be very effective in filtering in the central government's policies on SWM to the local towns and municipalities.

**c. Impact on the central government**

The participants from the central government, including the MOE, frequently receive support from abroad, and have obtained the latest knowledge and information on SWM in advanced nations through seminars, workshops, and overseas training. There is a great disparity between this latest knowledge and information and the existing MSWM situation of local governments (LGs) responsible for such work. In this group training, the participants from the central government became well aware of this disparity through the work done jointly with LA personnel, such as the formulation of A/Ps. As a result, it is expected that the central government will set forth more realistic policies in the actual improvement of SWM.

**d. Leadership of MPP/DPWT/PPWM**

Until now, DPWT/PPWM of MPP, the counterparts (C/P) in this study, have been passively learning about the formulation of M/P from the study team. In the training, however, DPWT/MPP played an active role in conveying the information and knowledge they acquired to other local towns and municipalities.

From this standpoint, in this training DPWT/PPWM made a positive effort to fulfill their roles as leaders of the other local authorities in Cambodia. Not only the C/P, DPWT/PPWM, but also a number of personnel from the Mayor's Office including the Mayor, participated in the training. They actively carried out work such as computer operation, etc. for the participants from other LGs in the lectures and group works they were in charge of, and supported the overall work.

**e. Overall Evaluation**

This group training included 51 participants from Cambodia and cost about 3.6 million yen in total. (Travel and lecture room expenses accounted for 1.2 million yen and personnel and accommodation expenses of consultants 2.4 million yen.) The cost per C/P was 70,000 yen, which is much cheaper than past C/P training in Japan.

Even so, as mentioned above, the training was effective and the LGs were able to obtain the basic knowledge and information required for the formulation of their respective MSWM M/Ps in the future. The training also had considerable secondary effects, such as the fact that many people were able to gain an understanding of this JICA study, interaction at the working level, etc.

The C/P training conducted in JICA studies in the past targeted the C/P personnel. As a result, it did not provide adequate opportunity to convey the study results to key personnel from other relevant organizations. This training was very significant in that it provided not only MPP personnel who are carrying out SWM improvement with assistance from Japan, but also many SWM personnel from other LGs throughout Cambodia with the chance to learn measures for improving SWM and acquire other relevant knowledge and information using the results of the Study. The study team sincerely hopes that this kind of opportunity can be created through JICA studies in the future.

## **18.2 Second Group Training Workshop in Phnom Penh**

### **18.2.1 Objectives**

The first group training workshop in Phnom Penh was conducted to raise planning capabilities of main local governments in Cambodia. However, the operational knowledge of proper SWM was not provided in the first workshop. The second group training workshop in Phnom Penh, therefore, was conducted with the following objectives:

- To disseminate the results of the Study to main local governments, stressing on the pilot projects of the Study, especially the expansion of waste collection services and the operation of improved landfill in order to raise operational capabilities of SWM of them;
- To provide necessary information and knowledge to key personnel of main local governments for the proper operation of SWM services;
- To guide main local governments to improve their SWM referring the experiences of the Study in MPP as a model of the improvement; and
- To prepare action plans (A/Ps) for the improvement of SWM in three local governments (Krong Preah Sihanouk, Kampong Cham and Siem Reab) as models of A/Ps.

In order to achieve the above objectives, the second group training workshop will invite key personnel of main local governments to Phnom Penh and provide them necessary information and knowledge, which are obtained through the conduct of the Study on SWM in the MPP.

### **18.2.2 Outline of Workshop**

#### **a. Training Period**

The second group training workshop in Phnom Penh was conducted 5 days from September 13, 2004 to September 17, 2004.

#### **b. Place**

- Lecture and group workshop : Phnom Penh Hotel
- Inspection : Pilot project sites conducted by JICA Study Team and C/P (DPWT, PPWM, DOE)
  - 1) Expansion of collection service:  
Konkea Pos communities, Sangkat Toul Sankae, Sangkat Phnom Penh Thmey, Sangkat Chroy Changwer and Sangkat Cha Ampov
  - 2) Public education campaign:  
Sangkat Monorom and Sangkat Boeung Trabek

3) Improvement of landfill operation:

Stung Mean Chey disposal site

**c. Participants**

In the second training, there were 55 participants in total from the twenty provinces and the four municipalities (refer to Figure 18-2). The breakdown of the participants is as follows: 31 persons from 20 provincial towns and 3 municipalities other than MPP, 14 from MPP (Municipality of Phnom Penh), and four from central government agencies such as MOE (Ministry of Environment). Of the 14 participants from MPP, one was from DPWT (Department of Public Works and Transport) and three from PPWM (Phnom Penh Waste Management), which are directly concerned with the project (four in total). 6 persons came from universities and others.

The names and positions of the participants are as shown in the tables below.

Table 18-5: Participants from Municipalities other than MPP and Provincial Towns

No	Province Name	Name	Position
1	Banteay Mean Chey	Duong Sophannareth	Deputy Chief of Cabinet
2	Bat Dambang	Mok Sarivanna	Official of the provincial office
3	"	Choup Sarun	Provincial Department of Environment
4	Kampong Cham	Ban Bunthoeun	Provincial Director of Department of Environment
5	"	Thoeunsrey Neang	Provincial Department of Environment staff
6	"	Duch Sophan	Representative Waste Transport Community
7	Kampong Chhnang	Dork Sothea	Provincial Director of Department of Environment
8	"	Ouk Sophat	Provincial Department of Environment, Chief of Pollution control
9	Kampong Spueu	Khlkeang Thuch	Deputy director of Provincial Finance office
10	"	Koy Sonin	Deputy Director of Department of Environment
11	Kampong Thum	Roath Sieng Hay	Chief office of Department of Environment
12	Kampot	Khem Bun Heng	Director of Department of Environment
13	Kandal	Long Yan	Deputy Director Department of Environment
14	"	Nou Nim	Secretary General
15	Koh kong	Sao Sin Thuon	Director of Department of Environment
16	Kracheh	Khath Sovann	Deputy Director of Department of Environment
17	Mondol Kiri	Im Chhoeurn	Director of Department of Environment
18	Preah Vihear	Song Bun Leang	Provincial Chief Cabinet
19	Prey Veang	Ouk Sophal	Deputy Chief of Provincial Inspection
20	Pousat	Vong Sam Ol	Provincial Chief of Cabinet
21	Rotanak Kiri	Kham Soulot	Provincial chief of pollution office
22	Siem Reab	Phourng Lina	Provincial Department of Environment
23	"	An Vannak	Deputy Chief of Cabinet
24	Krong Preah Sihanouk	Sun Sokhan	Secretary General
25	"	Hem Saroeun	Director of Department of Environment
26	Stueng Traeng	Suy Bunto	Official of Department of Environment
27	Svay Rieng	Chann Savann	Vice Secretary General
28	Takaev	Chan Chan	Vice Secretary General
29	Otdar Mean Chey	Thach Tharath	Chief of Staff Department
30	Krong Kaeb	Chan Tha	Vice Chief of Cabinet
31	Krong Pailin	Ly Sun Eang	Provincial Director of Department of Environment

Table 18-6 : Participants from MPP

No	Name	Position
32	Mann Chheoun	Chief of Cabinet
33	Nuon Someth	Deputy chief of Cabinet
34	Tiv Kim Piseth	Deputy chief of Cabinet
35	Keo Samal	Protocol Officer
36	Chheang Tola	International Relation Office
37	Chhim Thony	Chief of Protocol
38	Sao Kun Chhon	Governor of Phnom Penh Waste Management (PPWM)
39	Leng Simen	Vice Governor of Phnom Penh Waste Management (PPWM)
40	Ouch Vann	Vice Governor of Phnom Penh Waste Management (PPWM)
41	Meng Phoumarith	Department of Public Work and Transport (DPWT)
42	Neth Mony Ponnaka	Department of Mines and Industry Energy (DMIE)
43	Sok Sokun	Department of Health (DOH)
44	Khuon Kimny	Deputy director of Department of Environment
45	Khim Nora	Department of Environment Staff

Table 18-7 : Participants from Central Government

No	Ministry	Name	Position
46	Ministry of Environment (MOE)	Tuy Men Song	Department of Pollution Control Officer
47	"	Ou Manira	Department of Pollution Control Vice Chief office
48	"	Sarun Sambo	Department of Pollution Control Chief office of Solid Waste Management
49	Ministry of Industry and mines Energy(MIME)	Huot Ritthy	Technical Department Deputy Chief office

Table 18-8 : Participants from others

No	Name	Position
50	Natsuki Murata	JOCV (Department of Environment in Siem Reab)
51	Som Sankhar	S.O.M (Local Contractor)
52	Satoshi Fukuki	Student: Tokyo University of Science
53	Keitaro Aoyagi	Student: Tokyo University
54	Sin Sochiet	Student: Tokyo University of Science
55	Chie Aisaka	Student: Tokyo University of Science



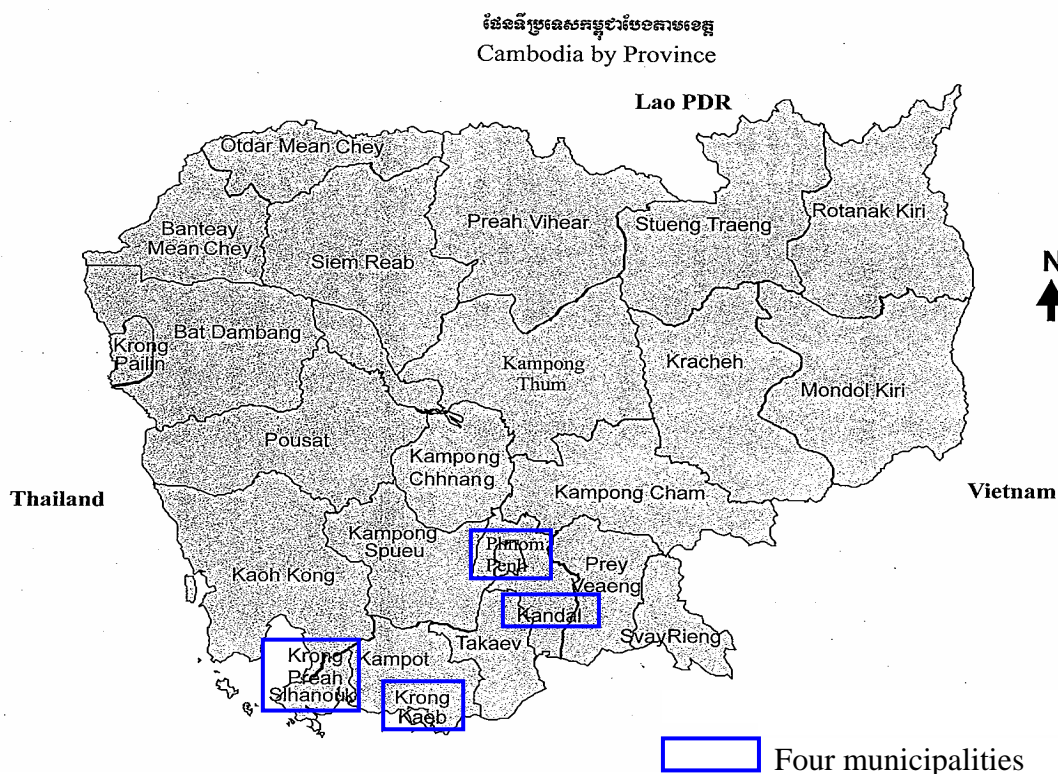


Figure 18-2: Administrative Divisions of Cambodia

**d. Preparation and Implementation of Training**

The persons in charge of preparing and implementing the training program were as follows:

- Prof. Dr. Kitawaki : Lecturer and training facilitator
- Mr. Shimura : Planner of training program, lecturer and training facilitator
- Mr. Takahashi : Responsible for coordination/logistical support (i.e. arrangement of lecture rooms, etc.)

**e. Training Program**

The training program was planned and implemented as shown in the table below.

Table 18-9: Contents of Training

Draft subject	Subject	Responsible Personnel
Day 1 (September 13) (morning) Opening Speech	Day 1 (September 13) (morning) Opening Speech	Mr.Chikaraishi, Resident Representative JICA Cambodia Office HE. Kep Chuk Tema, Governor, MPP
Objectives, schedule and procedure of the workshop	(Pro1)Objectives, schedule and procedure of the second group training workshop in Phnom Penh	Mr. Susumu Shimura
How to expand collection services to non-collection area: "Pilot project for	(Pro2)How to expand collection services to non-collection area:	Mr. Leng Simen, PPWM

Draft subject	Subject	Responsible Personnel
the expansion of collection services”	“Pilot project for the expansion of waste collection services”	Mr. Junji Anai
(afternoon) How to raise public awareness and cooperation on SWM: “Pilot project for public education campaign”	(afternoon) (Pro3)Pilot project of the increase in public awareness: “Introduction of waste discharge rules”	Mr. Svay Pros, DOE Ms. Keiko Kani
How to raise public awareness and cooperation on SWM: “What a city in Japan is doing for it?”	(Pro4)Promotion of public awareness on solid waste management by municipalities in Japan	Ms. Keiko Kani
Day 2 (September 14)	Day 2 (September 14)	
(morning) Visit of pilot project sites for the expansion of collection services and public education campaign	(morning) Site Visit (Pro5)Maps and information for site visit: - expansion of the waste collection services - public education campaign	Mr. Junji Anai, Ms. Keiko Kani
(afternoon) How to improve an open dump site and to conduct sanitary landfill operation “Pilot project for the improvement of SMCDS”	(afternoon) (Pro6)How to improve an open dump site and to conduct sanitary landfill operation “Pilot project for the improvement of SMCDS”	Mr. Ouch Vann, PPWM Mr. Susumu Shimura Mr. Tamotsu Suzuki
EIA and public hearing for Dang Kor Disposal Site Development Project	(Pro7)EIA and public hearing for Dang Kor disposal site development project	Mr. Sao Kun Chhoun, PPWM Ms. Kuon Kinny, DOE
Day 3 (September 15)	Day 3 (September 15)	
(morning) Environmental problems and solid waste management	(morning) (Pro8)Environmental problems and solid waste management	Dr. Kitawaki
Guidance for the preparation of A/P for urgent improvement of SWM in each local government (1) “Identification of problems on current SWM in the three local governments”	(Pro9)Guidance for the preparation of A/P for urgent improvement of SWM in each local government (1): “Identification of problems on current SWM in the three local governments”	Representatives from · Sihanoukville, · Kampon Cham · Siem Reab Mr. Susumu Shimura Mr. Tamotsu Suzuki
(afternoon) Site visit to pilot project site for the improvement of SMCDS	(afternoon) Site Visit (Pro10)Maps and information for site visit to pilot project site for the improvement of SMCDS	Mr. Susumu Shimura Mr. Tamotsu Suzuki
Day 4 (September 16)	Day 4 (September 16)	
(morning) Guidance for the preparation of A/P for urgent improvement of SWM in each local government (2) “Applicable SWM method and system for local governments in Cambodia”	(morning) (Pro11)Guidance for the preparation of A/P for urgent improvement of SWM in each local government (2): “Applicable SWM method and system for local governments in Cambodia”	Mr. Susumu Shimura Team Member
Guidance for the preparation of A/P for urgent improvement of SWM in each local government (3): “Presentation of proposed A/Ps for three local governments”	(Pro12)Guidance for the preparation of A/P for urgent improvement of SWM in each local government (3): “Presentation of proposed A/Ps for three local governments”	Representatives from · Sihanoukville, · Kampon Cham · Siem Reab Mr. Susumu Shimura Team Member
(afternoon) Preparation of A/P for urgent improvement of SWM in each local government (1)	(afternoon) (Pro13)Preparation of A/P for urgent improvement of SWM in each local government (1)	All trainees
Day 5 (September 17)	Day 5 (September 17)	
(morning) Preparation of A/Ps for urgent improvement of SWM in each local	(morning) (Pro14)Preparation of A/P for urgent improvement of SWM in each local	All trainees

Draft subject	Subject	Responsible Personnel
government (2)	government (2)	
Presentation of A/Ps	(Pro15)Presentation of A/Ps	Representatives of trainees
(afternoon) Evaluation of A/Ps and training	(afternoon) Evaluation of A/Ps and training	Dr. Kitawaki
Closing speech and handing out of certification	(Pro17)Hand out of training certification	HE. Dr. Mok Mareth Senior Minister and Minister, Ministry of Environment Dr. Kitawaki
	Closing speech	HE. Dr. Mok Mareth Senior Minister and Minister, Ministry of Environment

### 18.2.3 Execution of Workshop

#### a. Execution of Workshop

The training programs of the workshop were executed as shown in the photos below.



Scene from lectures



Inspection of expansion of collection services



Inspection of public education campaign



Inspection of improvement of landfill operation at SMCDS



Inspection of a new disposal site



Presentation of A/P by participants and handing out certifications



**b. Results of Training**

**b.1 Action Plan (A/P)**

Of the five A/Ps prepared and presented by the participants in the second workshop, the presentation of Banteay Meanchey is shown below.

**Step 4-1: A/P for Banteay Meanchey (1):  
Collection and Street Sweeping System (1)**

Items	in 2004	in 2007
1. Municipality or Province		
1.1 Area (km <sup>2</sup> )	6,679	6,679
1.2 Number of Khan or Srok	8	8
1.3 Number of Household	103,932	113,932
1.4 Population in 2003	644,948	744,948
1.5 Population Density (person/ha)	0.96	1
1.6 Waste Generation Rate (g/person/day)	500	550
1.7 Waste Generation Amount (ton/day)	322	410
2. Khan (Srok) with Collection Service	1 Srok	1 Srok
2.1 Area (km <sup>2</sup> )	56ha	56ha
2.2 Number of Household	13,904	18,955
2.3 Population in 2003	87,825	105,425
2.4 Population Density (person/ha)	1.5	2
2.5 Waste Generation Amount (ton/day)	44	58

**Step 4-2: A/P for Banteay Meanchey (2):  
Collection and Street Sweeping System (2)**

Items	in 2004	in 2007
3. Collection Service		
3.1 Collection Service Provider	Private	Provincial office
3.2 Number of Service Customers including business	869	2592
3.3 Collection Amount (ton/day)	7	21
3.4 Collection Service Cover Rate (%:3.3/1.7)	2%	5%
3.5 Collection Service Cover Rate (%:3.3/2.5)	15%	36%
3.6 Collection Vehicle (Unit)	5ton:2; 7ton:2	6
3.7 Number of Workers (person)	20	25
3.8 Number of Fee Collectors (person)	3	4
3.9 Maintenance and Vehicle Depot	1	1
4. Street Sweeping		
4.1 Service Provider	contractor	Provincial office
4.2 Collection and Transportation	Contractor	Provincial office
4.3 Length of Road with Service (km)	1	5
4.4 Method of Service	hand	hand
4.5 Number of Sweeper (person)	5	10

**Step 4-3  
A/P for Banteay Meanchey (3):  
Intermediate Treatment System in 2007**

Items	
Waste Treatment Facility	Incinerators at hospital
Reuse and Recycling	People and public sector are buying Et Chay
Reuse and Recycling Amount (ton/day)	2

**Step 4-4  
Current SWM of Banteay Meanchey (4):  
Final Disposal System in 2007**

Items	
Name and Location	Phnom Touk
Distance from City Center (km)	7km
Area of the Site (km <sup>2</sup> )	2ha
Owner of the Land	Provincial office
Construction of Site	contractor
Operation	contractor
Landfill Equipment	Tractor
Number of Workers (person)	4
Status of Operation and Cost (US\$)	1500
Environmental preservation measures	Buffer zone

**Step 4-5: A/P for Banteay Meanchey (5): Priority actions to be taken (1) – Expansion of collection services**

Organization	Actions to be taken
Municipality or Provincial Government	1. Study the need cooperating with Srok and Khum 2. Preparation for expansion project with contractor 3. Finding financial sources to support to activities 4. Control on resent fee collection system and modify if needed 5. Broadcasting on radio and TV for public awareness. 6. Create discharge rule
DOE	1. Help provincial office on the above said points especially in 1, 2 and 5 2. Draft discharge rule
Private Co. or Service Providers	1. Study on the extra need 2. Improvement works for landfill 3. Expand and enforce its collection service
Khan & Sangkat or Srok & Khum	1. Help provincial office as above

**Step 4-6: A/P for Banteay Meanchey (6): Priority actions to be taken (2) – Raise public cooperation**

Organization	Actions to be taken
DOE	1. Preparing discharge rule with cooperation from Srok and Khum 2. Draft discharge rule 3. Prepare and take action in 3R and public education cooperating with lower authorities.
Municipality or Provincial Government	1. Create discharge rule 2. Finding financial source for 3R and public education
Private Co. or Service Providers	1. cooperate with DOE for discharge rule 2. Share the discharge rule to people 3. Strict in collection schedule
Khan & Sangkat or Srok & Khum	1. Cooperate with DOE for discharge rule 2. Cooperate with DoE and service provider

**Step 4-7: A/P for Banteay Meanchey (7): Priority actions to be taken (3) – Improvement of final disposal site**

Organization	Actions to be taken
DOE	1. Monitoring and finding out the problems happening at landfill recently 2. Study and preparation improvement work plan (with technical support from MoE or JICA) 3. Request to contractor as well as provincial office to improve and monitor landfill.
Municipality or Provincial Government	1. Give possibility to DoE to study and prepare improvement work plan. 2. Responsible for improvement works especially access road 3. Find an appropriate location for new landfill construction
Private Co. or Landfill Operators	1. Help DoE in above works 2. Give a proper operation at landfill 3. well done task

## **b.2 Feedback from the Participants**

### **b.2.1. Feedback on Each Day's Lecture**

Each day after the lectures, the participants were asked to complete a questionnaire. The questions and responses were as follows:

(September 13)

Total number of respondents: 36

“What did you learn in today's program?”

- Public awareness and public education on discharge rules : 28
- Expansion of collection services : 26
- Others : 29

“Which part of today's presentation didn't you understand?”

- Procedure of public education and promotion of public awareness : 7
- Waste separation : 2
- Others : 17

(September 14)

Total number of respondents: 33

“What did you learn in today's program?”

- Improvement works at SMCDS : 22
- Public participation and public education : 21
- EIA and public hearing : 15
- Others : 30

“Which part of today's presentation didn't you understand?”

- Improvement works of landfill and financial supports : 6
- Public participations : 5
- Other : 4

(September 15)

Total number of respondents: 24

“What did you learn in today's program?”

- Bad SWM harms to public health : 20
- Improvement works at SMCDS : 14
- Others : 21

“Which part of today's presentation didn't you understand?”

- What is a problem of firing condition at SMCD : 2
- Request to have trainings for SWM : 2

- Other : 8

(September 16)

Total number of respondents: 38

“What did you learn in today’s program?”

- Action Plan for 3 cities : 7
- Guideline for preparation of A/P of SWM : 7
- Other : 8

“Which part of today’s presentation didn’t you understand?”

- Short time in A/P’s practice : 2
- Lack of computer skill : 5

### **b.2.2. Feedback on the Training**

On the final day of training, the participants were asked to complete a questionnaire concerning the overall training program. The questions and responses were as follows:

(September 17)

Total number of respondents: 34

Q1 “Your organization’s department”

**Response :** Central Government : 1, MPP : 5, Local Government : 28

Q2 “Do you think the second group training workshop in Phnom Penh is useful for your job?”

**Response:** Y : 34, N : 0

Q3 “Did you know applicable Solid Waste Management methods and systems before the second group training?”

**Response:** Y : 13, N : 21

Q5-1 “What did you want to learn through the second group training workshop?”

**Response:**

- About SWM : 11
- About final disposal sites : 11
- About SWM for M/Ps and A/Ps : 9

Q5-2 “Were you able to obtain such knowledge through the second group training workshop?”

**Response:** Y : 24, Partly : 10, N : 0

Q6 “Do you have some ideas to improve this second group training workshop in Phnom Penh? What did you want to see and know more about?”

**Response:**

Continue this training courses	: 13
Technical experiences on SWM	: 6
Leachate treatment and landfill management	: 4

Q7 “What is the most difficult issue on solid waste management in your cities?”

**Response:**

Lack of budget, equipment and human resources	: 19
Waste collection service system	: 18
Resident participation	: 9

Q8 “What kind of support do you need to improve solid waste management in your cities?”

**Response:**

Technical support and financial support (JICA, Government of Japan: 16):	30
Donation of equipment of waste collection and landfill operation :	10
Establishment of training courses on SWM:	4

**b.2.3. General assessment of questionnaire results and attitude of participants**

The training covered topics and issues that the participants were interested in learning about. Because 100% of respondents expressed the training was useful. However, due to the limited time, they were not able to understand all the topics and issues. Because about 29% of respondents expressed they obtained the knowledge needed.

Regarding administrative support to local governments, most of the participants (about 88%) were expecting to make improvements through the technical as well as financial assistance from JICA.

The participants were very serious about the training. The personnel responsible for SWM from local governments showed they were enthusiastic and earnest about improving solid waste administration. Compare to the first workshop, the participants asked much more questions to the lecturers. This is because the topics of the second workshop are focusing on the operational aspects which most of participants are interested in.

## 18.2.4 Evaluation of the Workshop

**a. Acquisition of required operational knowledge/information for the improvement of SWM**

The relevant personnel from local governments (LGs) that participated in the training obtained the basic knowledge and information required for the proper operation of SWM, which was the primary objective of the training. Especially the following results of the pilot projects in Phnom Penh are good examples for them:

- Expansion of collection service through the cooperation of Sangkats officers
- Public education campaign for establishing waste discharge rules



- Method of improving a open dump site

In order to determine the degree of understanding, the participating LGs were asked to prepare action plans (A/Ps) for the urgent improvement of current SWM in their respective cities. In regard to this, the LGs had to have an understanding of what the Phnom Penh M/P was, and use it as an example to prepare the A/Ps of their cities by themselves. At the end of the training, the A/Ps of five cities were presented, which confirms their understanding.

**b. Building of a network among persons relevant to SWM**

As described in the evaluation of the first group training workshop, the workshop contributed to establish a network among persons relevant to SWM. This will enable LGs to consult each other to improve their respective waste disposal services. This network is also very effective in filtering in the central government's policies on SWM to the local towns and municipalities.

**c. Leadership of MPP/DPWT/DOE/PPWM**

Compare with the first workshop, MPP/DPWT/DOE/PPWM played more active role in conveying the information and knowledge they acquired to other local towns and municipalities. Most of lectures were presented by the C/P personnel or participation of them.

From this standpoint, in this training MPP/DPWT/DOE/PPWM made a positive effort to fulfill their roles as leaders of the other local authorities in Cambodia. Not only the C/P, DPWT/PPWM, but also a number of personnel from the Mayor's Office including the Mayor, participated in the training. They actively carried out work such as computer operation, etc. for the participants from other LGs in the lectures and group works they were in charge of, and supported the overall work.

**d. Overall Evaluation**

The Team considers this workshop is successful and effective considering the following aspects:

- This group training included 55 participants from Cambodia and cost about 6.7 million yen in total. (Travel and lecture room expenses accounted for 1.8 million yen and personnel and accommodation expenses of consultants 4.9 million yen.) The cost per C/P was 122,000 yen, which is much cheaper than past C/P training in Japan.
- As described above, the participants from LGs were able to obtain the basic knowledge and information required for the proper operation of their SWM. The training also had considerable secondary effects, such as the fact that many people were able to gain an understanding of this JICA study, interaction at the working level, etc.
- This training was very significant in that it provided not only MPP personnel who are carrying out SWM improvement with assistance from Japan, but also many SWM personnel from other LGs throughout Cambodia with the chance to learn measures for improving SWM and acquire other relevant knowledge and information using the results of the Study.

# Annex 19

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*Measurement of  
Apparent Density*

## Annex 19 Measurement of Apparent Density

### 19.1 Background

The measurement of apparent density of solid waste was conducted to get basic data necessary to calculate accurately the capacity of a new disposal site. Three parts filled with waste of different age were selected for the test on the site and samples were collected from three depths, 0.5m(surface), 2.5m and 4m at deepest, since a machine was capable of excavating waste up to 5m deep. The apparent density of newly dumped waste was also measured to compare with the data.

### 19.2 Process of Measurement

#### 19.2.1 Location of sampling

The location of test sampling was decided among part of the disposal site whose age was approximately identified. Sampling point A is located at the end of the model block and on the part available as an on-site-road before the disposal site was improved. Sampling point B is located on the former secondary road in the southern part of the disposal site and beside the new leachate treatment pond. Point C is located in the expanded area and is approximately 7m high from the bottom.

Sampling point A : October 2003	(9 months after disposal)
Sampling point B : January 2004	(6 months after disposal)
Sampling point C : June 2004	(2 months after disposal)

The sampling points are as shown below.

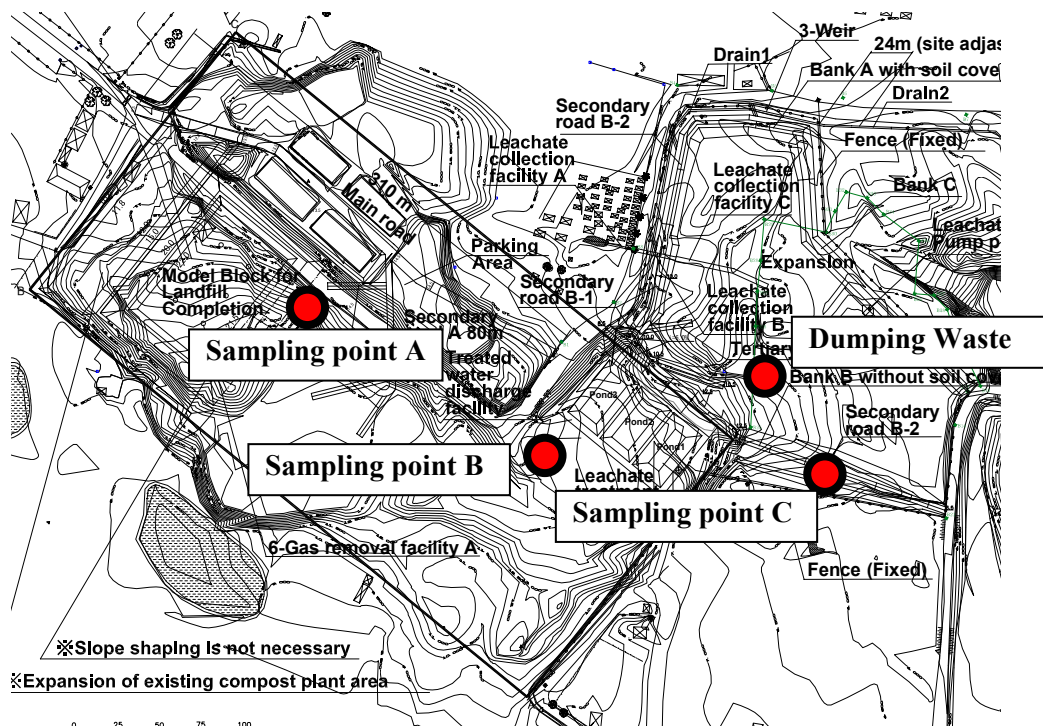


Figure 19-1: Location of sampling points

## 19.2.2 Time of Measurement

The time of measurement is as shown in the following table.

Table 19-1: Time of measurement

Location	Time	Remarks
Sampling point A	14 July 2004	Weather : fine Heavy rain on the previous day, 13 July
Sampling point B	15 July 2004	Weather : fine and cloudy The part 1m higher than the surrounding area was selected because the water level of leachate was high in the surrounding area.
Sampling point C	16 July 2004	Weather : cloudy The surface of waste was burning.
Dumping waste	15 July 2004	Weather : fine The waste was dumped the day before, on 14 July.

The situation of the sampling points is as shown below.



Sampling point A



Sampling point B



Sampling point C

## 19.2.3 Method of Measurement

### a. Measurement at Sampling Point

The waste was excavated by a backhoe at the sampling point and a sample was taken to measure the water content after apparent density was measured. The process of measurement was as follows.

- ① The surface at a sampling point was cleaned and a mark was put on the area to be excavated.
- ② The waste was excavated 50cm deep by manpower.
- ③ A section of waste 30cm wide, 30cm long and 30cm deep was taken and weighed. The accurate volume was confirmed by measuring the water volume which filled the plastic bag set up within the sampling pit. Some of the weighed waste was kept as a sample to measure water content. (Measurement of first layer)
- ④ The waste was excavated 2m deep by a backhoe and then by hand up to 2.5m deep.
- ⑤ A section of waste 30cm wide, 30cm long and 30cm deep was taken at the point of 2.5m deep and weighed in the same manner as the case of the first layer. The accurate volume was confirmed by measuring the water volume which filled the plastic bag set up within the sampling pit. Some of the weighed waste was kept as a sample to measure water content. (Measurement of second layer)
- ⑥ The waste was excavated 3.5m deep by a backhoe and then by hand up to 4 m deep, paying attention to the leachate from the bottom.
- ⑦ A section of waste 30cm wide, 30cm long and 30cm deep was taken at the point of 4 m deep and weighed in the same manner as the case of the first layer. The accurate volume

was confirmed by measuring the water volume which filled the plastic bag set up within the sampling pit. Some of the weighed waste was kept as a sample to measure water content. (Measurement of third layer)

- ⑧ The samples were kept in the drying area and their water content was measured after they were dry.

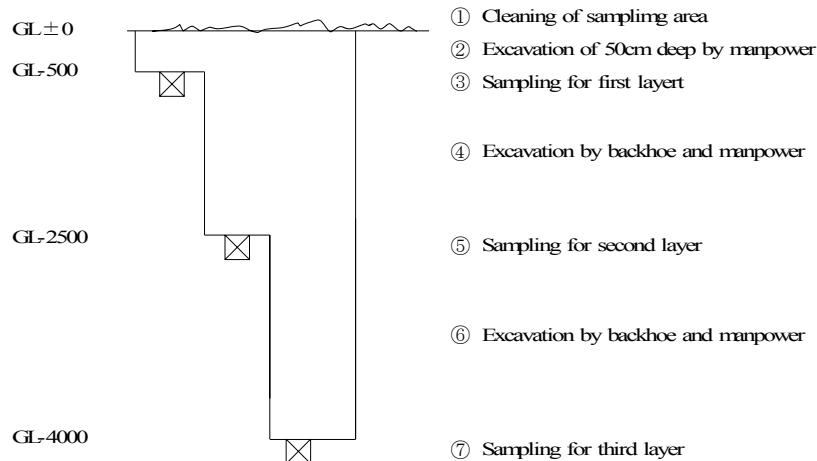


Figure 19-2: Concept of Sampling

#### b. Measurement of Newly Dumped Waste

The waste dumped on the previous day and compacted by a bulldozer at the disposal site was measured to get the data of newly dumped waste.

- The surface at the sampling point was cleaned and a mark was put on the area to be excavated.
- The waste was excavated 50cm deep by manpower. A section of waste 30cm wide, 30cm long and 30cm deep was taken and weighed. The accurate volume was confirmed by measuring the water volume which filled the plastic bag set up within the sampling pit. Some of the weighed waste was kept as a sample to measure water content.
- The weighed waste was kept as a sample to measure water content. (Measurement of newly dumped waste)

## 19.3 Results

### 19.3.1 Result of Measurement

The result of measurement is shown in the following table.

More than 1.7kg of the sampling waste was measured to determine its water content in order to reduce accidental errors after drying for 3 weeks to get the samples completely dry.

Table 19-2: Apparent Density and Water Content of Waste

Depth	Item	A	B	C	D
		After 9 weeks	After 6 weeks	After 2 weeks	The day before
0.5 m	Apparent Density (ton/m <sup>3</sup> )	1.20	0.67	1.35	0.56
	Water Content (%)	33.3	27.8	52.4	43.8
1.5 m	Apparent Density (ton/m <sup>3</sup> )	0.97	---	---	---
	Water Content (%)	35.9	---	---	---
2.5 m	Apparent Density (ton/m <sup>3</sup> )	1.00	0.81	1.03	---
	Water Content (%)	42.4	44.7	46.8	---
4.0 m	Apparent Density (ton/m <sup>3</sup> )	---	1.45	1.47	---
	Water Content (%)	---	49.2	47.1	---

The water content of landfill waste 0.5m deep under the surface was also measured. Three samples were taken from the waste dumped respectively on that day and the day before. The result is shown in the following table.

Table 19-3: Water content of waste under the surface

Sampling	Water Content(%)	Average(%)
Waste immediately after dumped from collection vehicles	60.5	59.4
	62.5	
	55.3	
Waste dumped on the previous day	53.1	48.5
	41.3	
	51.2	

### 19.3.2 Situation of Measurement

#### Sampling point A

- The study team demonstrated the method of measurement to assistants at sampling point A.



Photo: Demonstration of Method

- The waste consisted mainly of plastic, mixed with a big plastic sheet. The amount of bottles and cans in the waste seemed to be less than that in newly dumped waste and there were a few coconut shells here and there.
- No signs of fire could be confirmed in any layer of the landfill except the surface layer on the way of excavation. The same was true with other sampling points.

- The temperature was 40-50°C in the deeper landfill layer. The same was true with other sampling points.
- Water was gathered in the landfill 3m deep. However, it was deemed to be not leachate but rainwater which fell the day before because no water was found at the other sampling points though the depth of the landfill was the same.

#### **Sampling point B**

- Sampling point B is located 1m higher than the surrounding area. Leachate was gathered in the landfill 4.5m deep.
- The leachate was gathered while the second landfill layer was being excavated by a backhoe after completion of measurement for the first layer. The following picture shows the situation of leachate.



Photo: Gathering of leachate

- Signs of fire were found in the landfill waste to 20cm deep from the surface.
- The waste composition was almost the same as that of sampling point A and a lot of plastics were mixed.

#### **Sampling point C**

- Sampling point C is located near the present disposal area, adjacent to the steep slope of waste to the south and 7m high above the bottom. Leachate was gathered in the landfill layer 4.5m deep.
- Waste on the surface was burning smokily at sampling point C. The situation was as shown in the following photo. The depth of landfill burning was approximately 20 cm from the surface.



Photo: Burning at sampling point C

#### **Dumped waste**

- The waste dumped the day before was not burning because it might keep much water. However, the result of the water content test showed a low value of 43.8%.



The waste might be burning because a fire promotes drying of nearby wet waste and ignites it.

### Process of Measurement



Photo: Excavation (manpower)



Photo: Excavation (backhoe)



Photo: Measurement of test pit (Width)



Photo: Measurement of test pit (Depth)



Photo: Measurement of volume of test pit



Photo: Measurement of depth



Photo: Drying (Initial drying)



Photo: Drying (Secondary drying)



## **19.4 Findings**

1. Apparent density tends to increase in proportion to the depth of landfill. It is more than 1.4 tons/m<sup>3</sup> in the case of waste 4m deep. The following factors are presumed to reduce waste volume and affect apparent density; weighting by accumulation of waste, vertical and horizontal removal of water out of a landfill layer, decomposition of organic matter and burning of waste.
2. The apparent density of surface-waste is high at sampling point A. The reason seems to be that a bulldozer often passed on the waste during construction of the model block. In addition, the apparent density of deep-layer-waste is lower than that of surface-waste. This means that compaction by a bulldozer can affect surface-waste but not deep-layer-waste, and that it is very effective to compact the waste immediately after it is dumped.
3. The apparent density of surface-waste is high at sampling point C because waste, especially plastic waste, has burned and the waste volume has been reduced.
4. The water content of newly dumped waste is high and decreases quickly to 45-50% immediately after dumping. Leachate was found gathering in a relatively shallow landfill layer. This leachate may be rainwater which fell the day before. However, it is also supposed that leachate has actually been gathered within the waste because there is no facility for the collection and discharge of leachate and a test pit became a leachate pond after aged waste was taken away. Therefore, it is estimated that rainwater in consolidated waste moves downwards and horizontally extremely slowly without facilities for leachate collection and discharge.
5. It has been confirmed that in the disposal site where garbage is disposed directly like SMC, the apparent density rises high up to 1.4 ton/ m<sup>3</sup> due to the removal of water moving-out of waste downwards or horizontally, the compaction of waste, the decomposition of organic matter and the burning of waste. Therefore, those effects should be taken into consideration when the capacity of disposal site is designed.
6. As prohibition of waste picking and daily soil cover will prevent the waste from burning in the planned disposal site, the result of this measurement cannot be applied directly. With due regard to the safety rate, the apparent density of 0.8-1.0 tons/m<sup>3</sup> should be adopted.

# Annex 20

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*Measurement of Subsidence  
at the Model Block*

## Annex 20 Measurement of Subsidence at the Model Block

### 20.1 Outline

It is necessary for the team to determine the degree of settlement of waste at the disposal site, as it is required to calculate accurately the capacity of the new disposal site. In this pilot project the team set up settlement boards at the model block and measured their height above the sea level regularly to get the data on settlement.

Since settlement was also found during construction of the model block in Phase 2, the team took into consideration the data obtained during formation of the model block.

### 20.2 Method of Measurement

The settlement boards were set up at three points 21.75m above sea level in the model block and the depth of settlement was measured by regularly measuring the height of the boards. The boards were set up not on the surface of cover soil but on the surface of the waste itself to avoid the influence of cover material. The settlement data which had been measured using a post set up on the surface of the model block to control the height above sea level could be also utilized for analysis of settlement.

The settlement board and the method of installation are shown below.

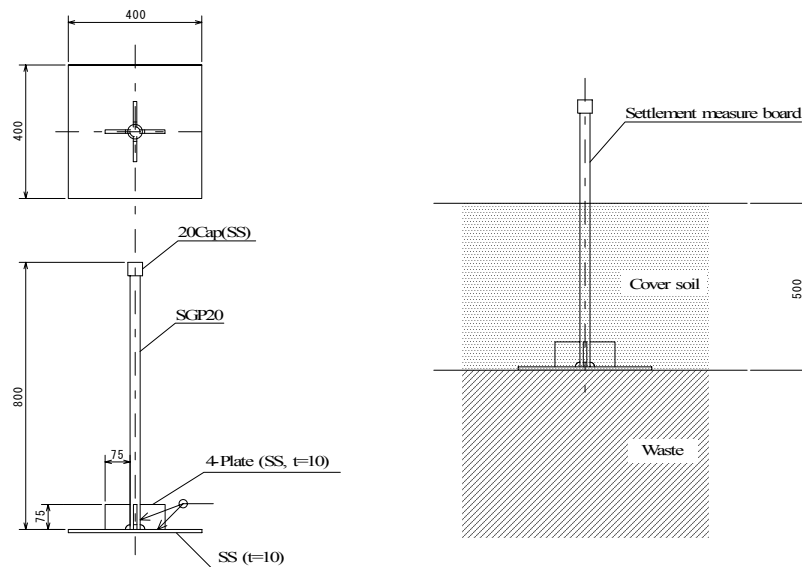


Figure 20-1: Settlement board and method of installation

### 20.3 Location of Settlement Boards

#### 20.3.1 Location of Settlement Boards

Settlement boards are set up between the gas removal pipes to minimize the influence of the pipes in the model block. The designed heights of the final soil-covered surface are 21.75m above the sea level at points of A and B, and 19.75m at point C. Therefore, the heights of the waste surface are to be 21.25m and 19.25m respectively after the cover thickness of 0.5m is

deducted, and the model block is to be 11.75m high because the ground level of the weighbridge and the main road is 10m high above sea level.

The location of the settlement boards is as shown in the figure below.

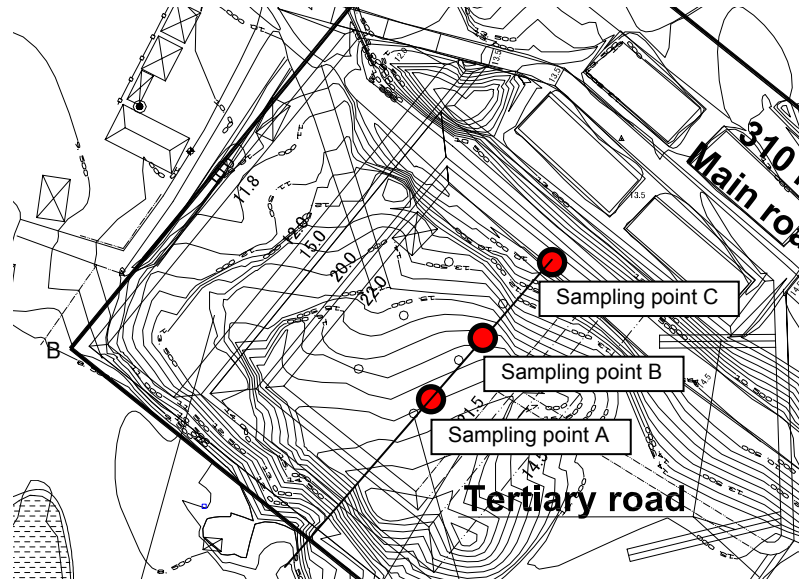


Figure 20-2: Location of settlement boards (Plan)

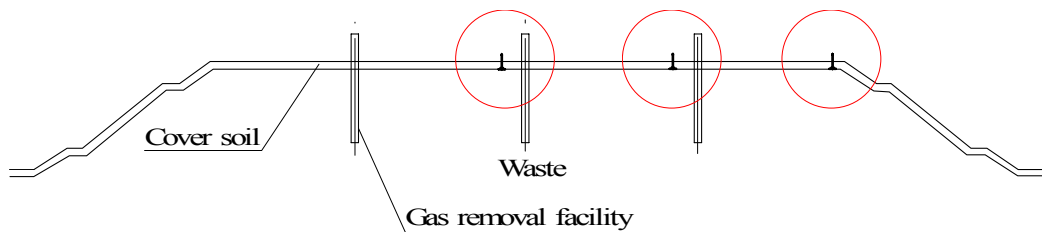


Figure 20-3: Location of settlement boards (Section)

The measuring points for the height above sea level are set up to control the height of the model block as shown in the figure.

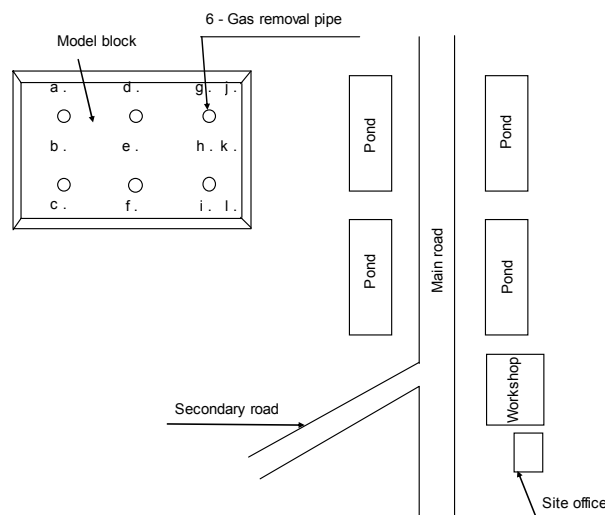


Figure 20-4: Location of above-sea-level control points of model block height

### 20.3.2 Situation of Waste at the Measuring Point

#### a. Waste before Formation of Model Block

The model block was formulated during the pilot project conducted in Phase 2. Before formation of the model block, waste disposal had been finished at the western part of the block and a small mountain of waste was formulated at the southern part of the block. The disposal area seemed to expand to the northern part of the block. The team tried to determine the history of waste disposal activities from PPWM staff but it was impossible to make it clear. Therefore, the team supposes that they disposed of the waste in the area where collection vehicles could easily access at the beginning and they have gradually formulated a small mountain of waste up to today. The highest part of the area was 22m above sea level before formation of the model block.

At the eastern part of the model block, a main road was located 10m above sea level and the main road was constructed with soil 2-3m thick. This proves that the area including the main road was a wetland lower than the surrounding area.

The result of the topographic survey conducted at the beginning of the study is as shown in the figure below.

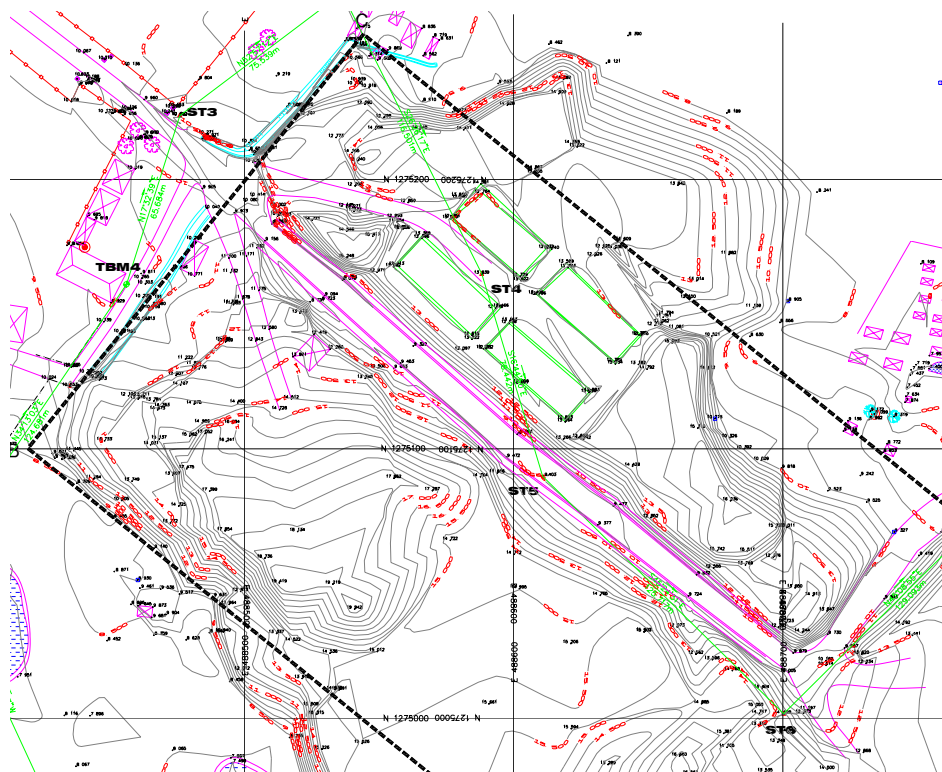


Figure 20-5: Topography of SMCDs at the beginning of the study

#### b. Waste for Model Block Formation

Aged waste and dumped waste were used to form the model block. The model block is divided into three sections as follows and shown in the figure below.

- Section 1 : The western part was filled with aged waste from the southwest area of the site after levelling of existing waste. The surface of the waste is 17m above sea and the accumulated waste is 4-5m deep.

- Section 2 : The central part was filled mainly with aged waste from the southwest area of the site and additionally with dumped waste, due to the limited time and shortage of aged waste.
- Section 3 : Almost all of the eastern part including the main road was filled with dumped waste and is 11-12m deep.

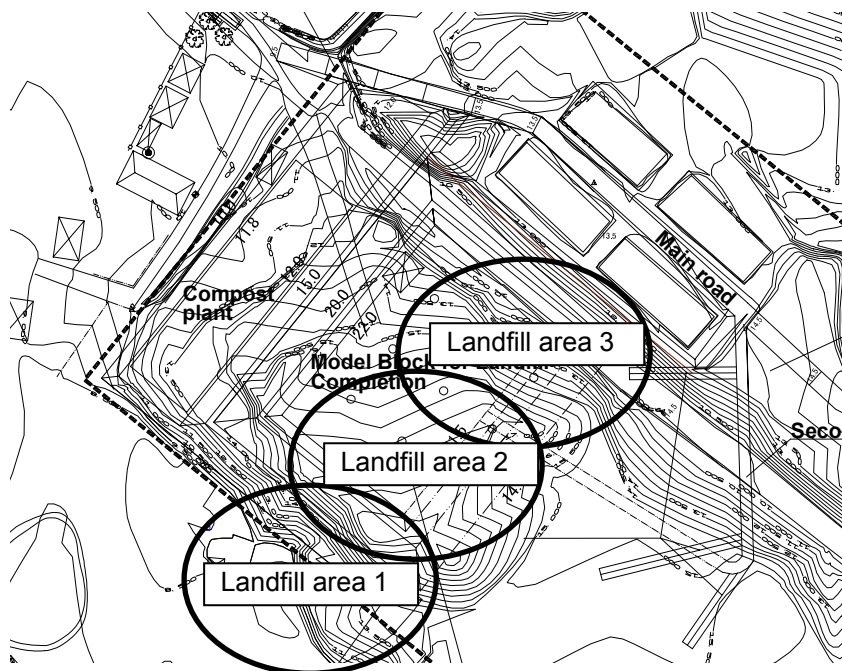


Figure 20-6: Landfill sections at the model block

## 20.4 Method of Measurement

The heights above sea level of the settlement boards were measured once a month, four times in total. It was measured by a transit utilizing a bench mark set up for a topographic survey.

## 20.5 The Result

### 20.5.1 Change of Sea Level Height

The result for each measuring point is shown in the table and figure below. The following trend is made clear regarding the degree of settlement.

Point A (1.6mm/day) < Point B (3.2mm/day) < Point C (4.5mm/day)

Table 20-1: Change of height above the sea level

Date	Days	Point A		Point B		Point C	
		Altitude (m)	Difference (m)	Altitude (m)	Difference (m)	Altitude (m)	Difference (m)
Basic Height (m)		21.25	---	21.25	---	19.25	---
05/07/04	1	20.250	0.000	19.303	0.000	17.021	0.000
05/08/04	32	20.183	-0.067	19.169	-0.134	16.833	-0.188
06/09/04	64	20.133	-0.117	19.074	-0.229	16.715	-0.306
25/09/04	83	20.120	-0.130	19.034	-0.269	16.651	-0.370
Settlement (mm/day)		---	1.6	---	3.2	---	4.5

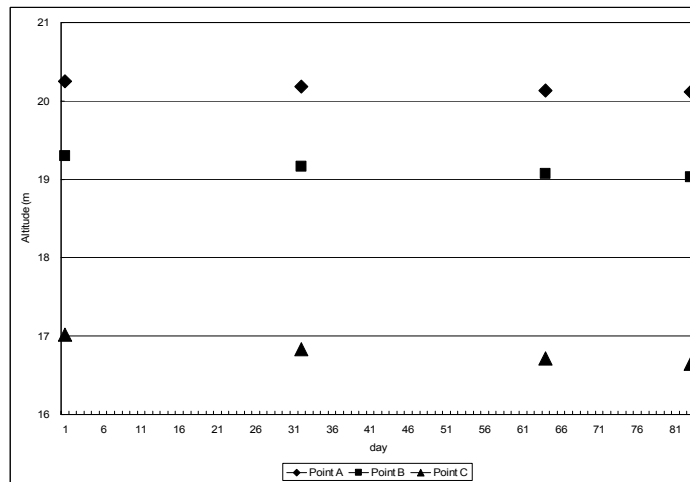
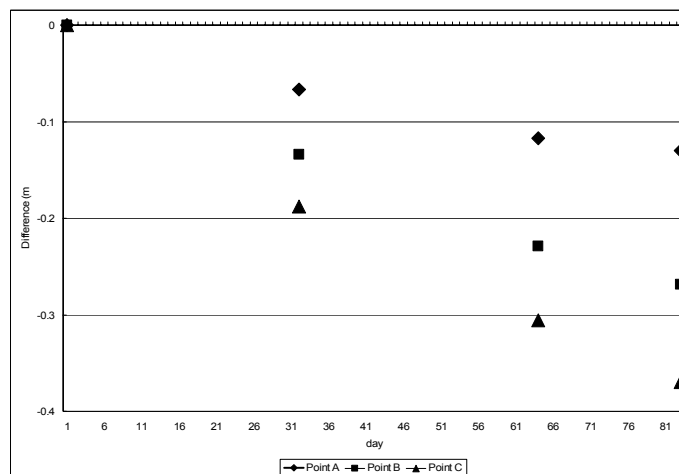


Figure 20-7: Measured height above sea level

### 20.5.2 Change of the Difference in Height

The change of the difference in height based on the height above sea level on the 5<sup>th</sup> of July is shown in the figure below.



### 20.5.3 Data immediately after Completion of the Model Block

The data measured immediately after completion of the model block is shown in the table below. Soil covering was carried out from point a in the direction of point l. It started in the middle of December and continued until 9 January 2004. Therefore, a period of 1 to 15 days had passed before measurement of the height above sea level began. The time past after completion of the model block had more of an influence on the data of point a – point c than that of point j – point l because the former was constructed earlier.

The settlement rate is 10.2-18.4mm/day for point a – point f and 59.8-77.2mm/day for point g – point l. The difference of these rates seems to be caused by both the varying length of time after covering with soil and the kind of waste utilized to make the model block. However, judging from the result, it is impossible to estimate how much they influenced the rates.

Table 20-2: Data immediately after completion of the model block

Sampling point	a	b	c	d	e	f	g	h	i	j	k	l	
Date of beginning	31/12/03						10/1/04						
Basic height	22.00m	21.75m	21.50m	22.00m	21.75m	21.50m	22.00m	21.75m	21.50m	22.00m	21.75m	21.50m	
Days	1	21.301	21.040	20.725	21.265	21.096	20.605	21.658	21.408	21.158	21.701	21.402	21.156
	3							21.126	20.868	20.676	21.129	20.824	20.661
	9	21.154	20.956	20.628	21.178	21.007	20.525						
	10							20.699	20.386	20.280	20.565	20.267	20.205
	13	20.942	20.835	20.492	21.056	20.879	20.427						
	17							20.443	20.301	19.931	20.183	19.938	19.762
	20	20.876	20.748	20.408	20.983	20.796	20.349						
	22							20.342	20.120	19.893	20.002	19.733	19.678
	27	20.791	20.702	20.383	20.920	20.737	20.284						
32	20.712	20.679	20.336	20.880	20.667	20.278							
Difference (m)	0.589	0.361	0.389	0.385	0.429	0.327	1.316	1.288	1.265	1.699	1.669	1.478	
Settlement (mm/day)	18.4	11.3	12.2	12.0	13.4	10.2	59.8	58.5	57.5	77.2	75.9	67.2	

#### 20.5.4 Prediction Formula based on the Data

Simple formulas (linear, exponential, logistic, power series) were formulated based on the data measured this time and immediately after completion of the model block. Multiple correlation coefficients in the event that the formulas are applied to the data of each measuring point are shown in Table 20-3.

Judging from the multiple correlation coefficients and their order, the following becomes clear.

- The order of multiple correlation coefficients based on the data obtained by the settlement boards is as follows:  
exponential > linear > logistic > power series
- The order of multiple correlation coefficients based on the data measured immediately after completion of the model block is as follows:  
point a – point f : exponential > linear > logistic > power series  
point g – point l : power series > exponential > linear > logistic

It was clarified that the degree of settlement had changed in accordance with a power series formula during the period immediately after dumping and in accordance with an exponential or linear formula after gradual stabilization of settlement.

Table 20-3: Multiple correlation coefficients and their order for each point

Measurement	point	Item	linear	Exponential	Logistic	Power series
By Settlement Board	point A	Multi. Correl.	0.9853	0.9855	0.9840	0.9604
		Order	2	1	3	4
	point B	Multi. Correl.	0.9907	0.9909	0.9884	0.9563
		Order	2	1	3	4
	point C	Multi. Correl.	0.9901	0.9905	0.9867	0.9590
		Order	2	1	3	4
Height at Control of Model Block	point a	Multi. Correl.	0.9708	0.9715	0.9654	0.9276
		Order	2	1	3	4
	point b	Multi. Correl.	0.9713	0.9717	0.9673	0.9191
		Order	2	1	3	4
	point c	Multi. Correl.	0.9640	0.9645	0.9593	0.9278
		Order	2	1	3	4
	point d	Multi. Correl.	0.9819	0.9822	0.9788	0.9164
		Order	2	1	3	4



point e	Mult. Correl.	0.9860	0.9863	0.9836	0.9072
	Order	2	1	3	4
point f	Multi. Correl.	0.9777	0.9781	0.9744	0.9174
	Order	2	1	3	4
point g	Multi. Correl	0.9346	0.9367	0.9206	0.9986
	Order	3	2	4	1
point h	Multi. Correl	0.9117	0.9139	0.8971	0.9944
	Order	3	2	4	1
point i	Multi. Correl	0.9445	0.9465	0.9308	0.9957
	Order	3	2	4	1
point j	Multi. Correl	0.9593	0.9615	0.9449	0.9967
	Order	3	2	4	1
point k	Multi. Correl	0.9556	0.9578	0.9412	0.9975
	Order	3	2	4	1
point l	Multi. Correl	0.9614	0.9634	0.9481	0.9925
	Order	3	2	4	1

### 20.5.5 Expansion of Prediction Formula

A direct combination of the data measured this time with the data obtained during control of the model block formation is not reliable because the methods are a little different. Therefore, the team treated the data consecutively, taking the restriction into consideration.

Combinations are as shown in the table below. The power series formula is adopted. The height above sea level at point **k** is revised.

Table 20-4: Combination for expansion of formula

	Data during Height Control	Data by Settlement Board
Combination 1	point e	point A
Combination 2	point h	point B
Combination 3	point k	point C

#### a. Combination 1

Real data and the calculated value are as shown in the figure below. The multiple correlation coefficient is 0.9574 and the power series formula is as follows:

$$Y \text{ (m)} = 21.32 \times X^{(-0.0097)}$$

Y: Projected landfill height above sea level, X: days after disposal

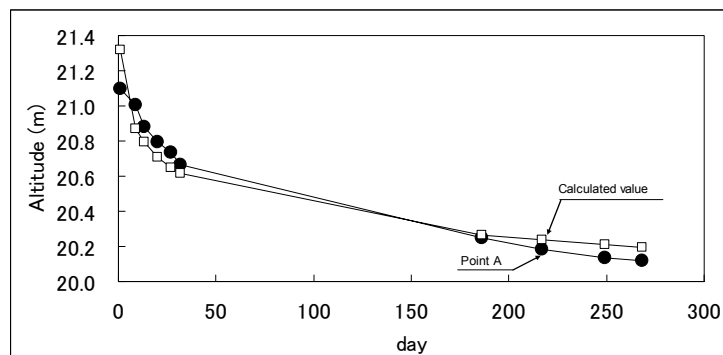


Figure 20-8: Projected settlement in case of Combination 1

**b. Combination 2**

Real data and the calculated value are as shown in the figure below. The multiple correlation coefficient is 0.9978 and the power series formula is as follows:

$$Y (m) = 21.41 \times X^{(-0.02067)}$$

Y: Projected landfill height above sea level, X: days after disposal

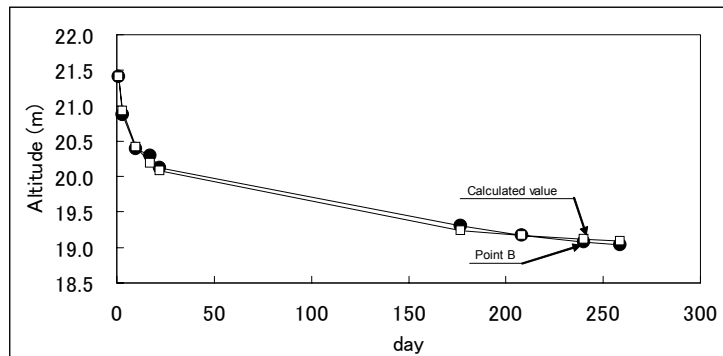


Figure 20-9: Projected settlement in case of Combination 2

**c. Combination 3**

Real data and the calculated value are as shown in the figure below. The multiple correlation coefficient is 0.9945 and the power series formula is as follows:

$$Y (m) = 19.16 \times X^{(-0.02476)}$$

Y: Projected landfill height above the sea level, X: days after disposal

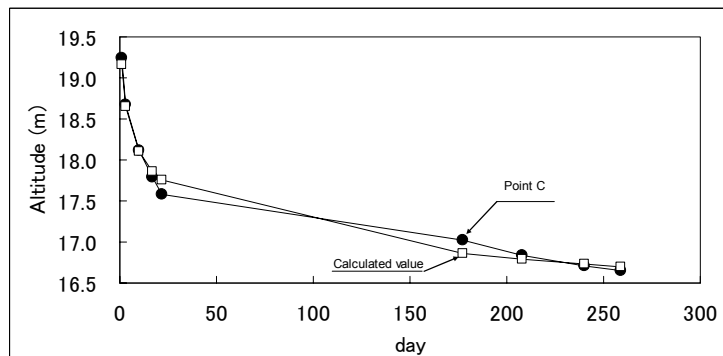


Figure 20-10: Projected settlement in case of Combination 3

**d. Evaluation of Expansion**

Every power series formula seems to show settlement alteration of the disposal site after covering with soil because it has a high multiple correlation coefficient.

## 20.6 Photographs



Photo : Model block (2004/03/06)



Photo : Model block (2004/10/08)



Photo : Settlement at model block (2004/09/12)



Photo: Settlement board



Photo: Measurement of settlement

## 20.7 Findings

The following was found through the settlement measurement at the model block:

1. Settlement of the disposal site depends on the kind of waste.

2. The site filled with aged waste settles less than the site filled with newly dumped waste.
3. The site filled with newly dumped waste settles a lot at initial stage and then the speed of settlement gradually decreases. The trend can be expressed by the power series formula.
4. The projected heights above sea level for each measuring point are as shown in Table 20-5.
5. . At point C, which is filled with newly dumped waste, the height above sea level will be 15.91m 5 years after termination of disposal. This means that 36% of the initial landfill thickness will settle.

Table 20-5: Projected height above the sea level

	Point A	Point B	Point C
	Projected Height(m)	Projected Height(m)	Projected Height(m)
Basic Height	21.25	21.25	19.25
After 1 year	20.13	18.95	16.55
After 2 years	20.00	18.68	16.27
After 3 years	19.92	18.53	16.11
After 4 years	19.87	18.42	16.00
After 5 years	19.82	18.33	15.91
Difference(m)	1.43	2.92	3.34
Depth of Waste (m)	11.25	11.25	9.25
Settlement(%)	12.7	26.0	36.1

6. The prediction formula obtained by inducing the result at point C is as follows:

$$Y (m) = H \times X^{(-0.02476)}$$

Y: Projected depth of landfill l(m)

H: Initial depth of landfill (m)

X: Days after termination of disposal

This formula can be applied to the projection of settlement for the disposal site dumped with new waste, after termination of operation, and continuous measurement of settlement at the model block and other places will make it more precise. Therefore, it is recommended that an organization should be set up for regular measurement of settlement in order to utilize a more accurate formula for the planning of DKDS.

# Annex 21

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*Minutes of Meeting*

# **Annex 21 Minutes of Meeting**