

Figure 6.4.1 Layout Plan (Ampang Jajar Pilot Project)

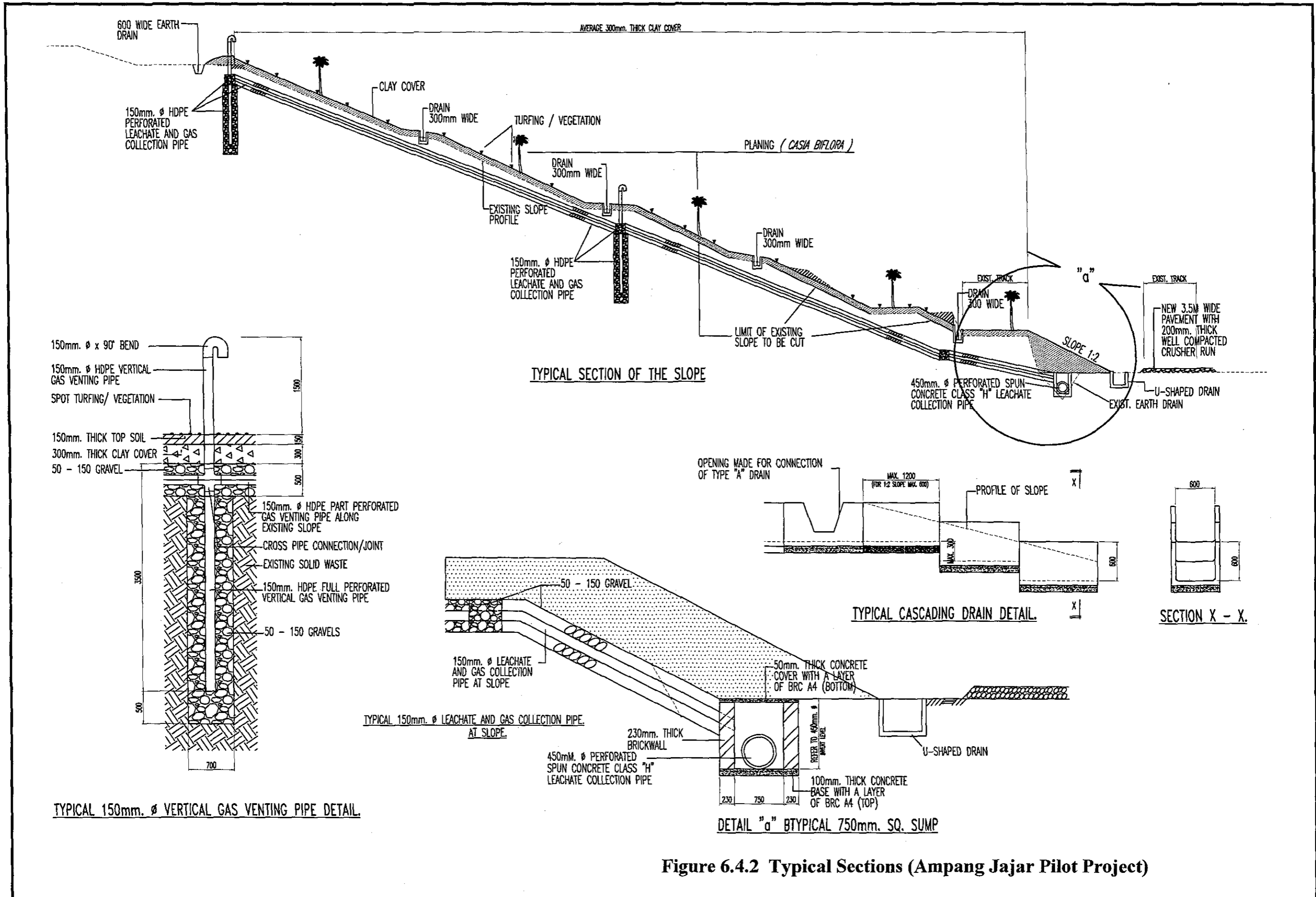
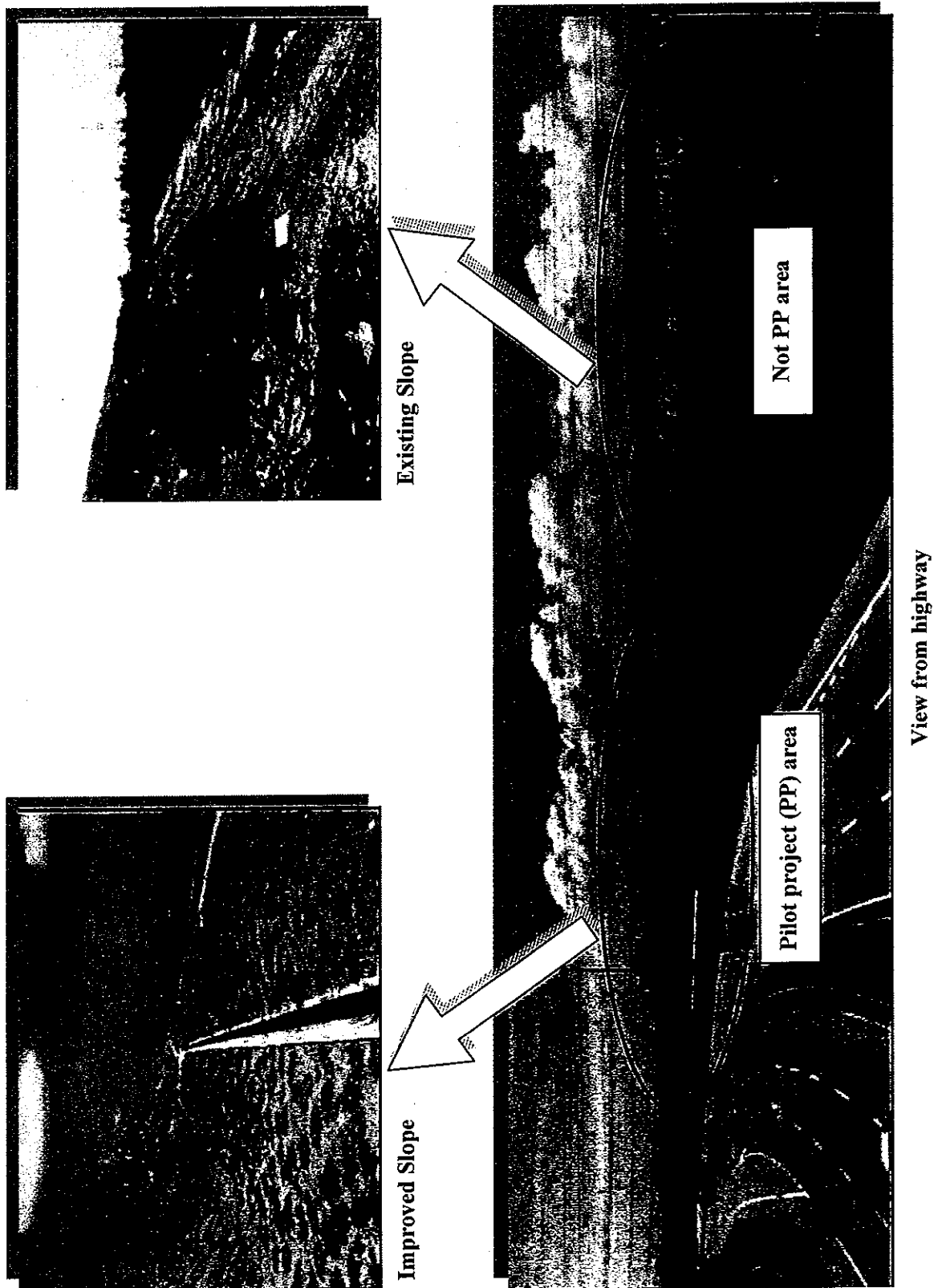


Figure 6.4.2 Typical Sections (Ampang Jajar Pilot Project)

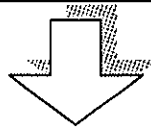
**Plate 6.4.1 Ampang Jaya Pilot Project 1**



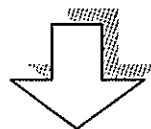
**Plate 6.4.2 Ampang Jajar Pilot Project 2**



**Before pilot project  
(PP)**



**During PP**



**After PP**  
(Improved slope,  
drainage, leachate  
collection (not  
visible) and  
access road)

### 6.4.3 Environmental Monitoring – Ampang Jajar PP

The following Table 6.4.3 summarizes the sampling quantity of monitoring.

**Table 6.4.3 Sample Number at Ampang Jajar Pilot Project Site**

| Sample type   | Ampang Jajar<br>(Number of locations) |
|---------------|---------------------------------------|
| Surface water | 2                                     |
| Leachate      | 2                                     |
| Groundwater   | 3                                     |
| Gas           | 2                                     |

For each location, samples will be taken four times; i.e. once before the pilot project improvement and three times after the project.

Evaluation of the monitoring result is summarised in Article 6.7.2.

## 6.5 PILOT PROJECT - PEKAN NENASI LANDFILL SITE (PAHANG)

### 6.5.1 Outline of the Site

#### (1) General

The Pekan Nenasi landfill site is situated on a wetland, south of Pekan Town and by the side of the East-Coast trunk road.

The landfill started operations in 1988 and was operated by Majlis Daerah Pekan. At present, the landfill is operated and managed by Alam Flora Sdn Bhd, under an interim concession agreement prior to the privatisation of the Solid Waste Management services. About 30 tonnes of waste per day is disposed at the site.

The site consists of two parts; i.e. the eastern front part nearest to the truck road and the western inner part, separated by the stream. The front part is about 2.8 ha and the back part is about 19 ha. Adjacent to the site is the 1.5 ha sewage sludge disposal site belonging to the sewerage services company, Indah Water Konsortium Sdn Bhd. Since April 2003, with the closure of the eastern front part, the waste is now being disposed at the new cells at the western back part.

In 2002, with the financial subsidy from MHLG, the Majlis Daerah Pekan with the assistance of Alam Flora Sdn Bhd carried out some upgrading work at the site to include the preparation of the western part, installation of the weighbridge, construction of the office building, and the vehicle maintenance workshop and yard. In 2003, further upgrading of the access road was carried out including the installation of the perimeter fence to prevent stray animals from entering the site. By the end of 2003, additional subsidy from MHLG provided for the installation of the leachate collection system in line with the JICA PP at the western part, on the second cell, and the provision of final cover for the eastern front part that was closed.

The brief description of the landfill operations and site characteristics are summarised in Table 6.5.1.

**Table 6.5.1 Pekan Nenasi Landfill Operations and Site Characteristics**

| Operational Characteristics  | Site Characteristics  |
|--|---|
| ⇒ Started operations in 1988   | ⇒ Located south of Pekan town, by the side of the east coast trunk road |
| ⇒ About 30 tonnes of waste are disposed at the landfill daily  | ⇒ Located on a wetland area   |
| ⇒ In 2002, upgrading work was carried out to provide the control building and workshop, weighbridge station and opening of the Phase I at the western part | ⇒ The site occupied an area of about 22ha                               |
| ⇒ The site expected to be used for a long period phased expansion  |   |

### 6.5.2 Pekan Nenasi Pilot Project Implementation

The Cell I of Phase I of the landfill site shall be upgraded to a semi-aerobic, Level 3, landfill site with leachate re-circulation system. As the surrounding bund has already been constructed, the rehabilitation works will include the construction of the leachate collection system, gas discharge pipes, leachate aeration pond and monitoring facilities.

Brief description and bill-of-quantities (BQ) of the Pilot Project is summarised in **Table 6.5.2**. **Figure 6.5.1** and **Figure 6.5.2** shows plan & design drawing of the pilot project and the photographic records of the progress of the work and the main facilities are shown in **Plate 6.5.1**.

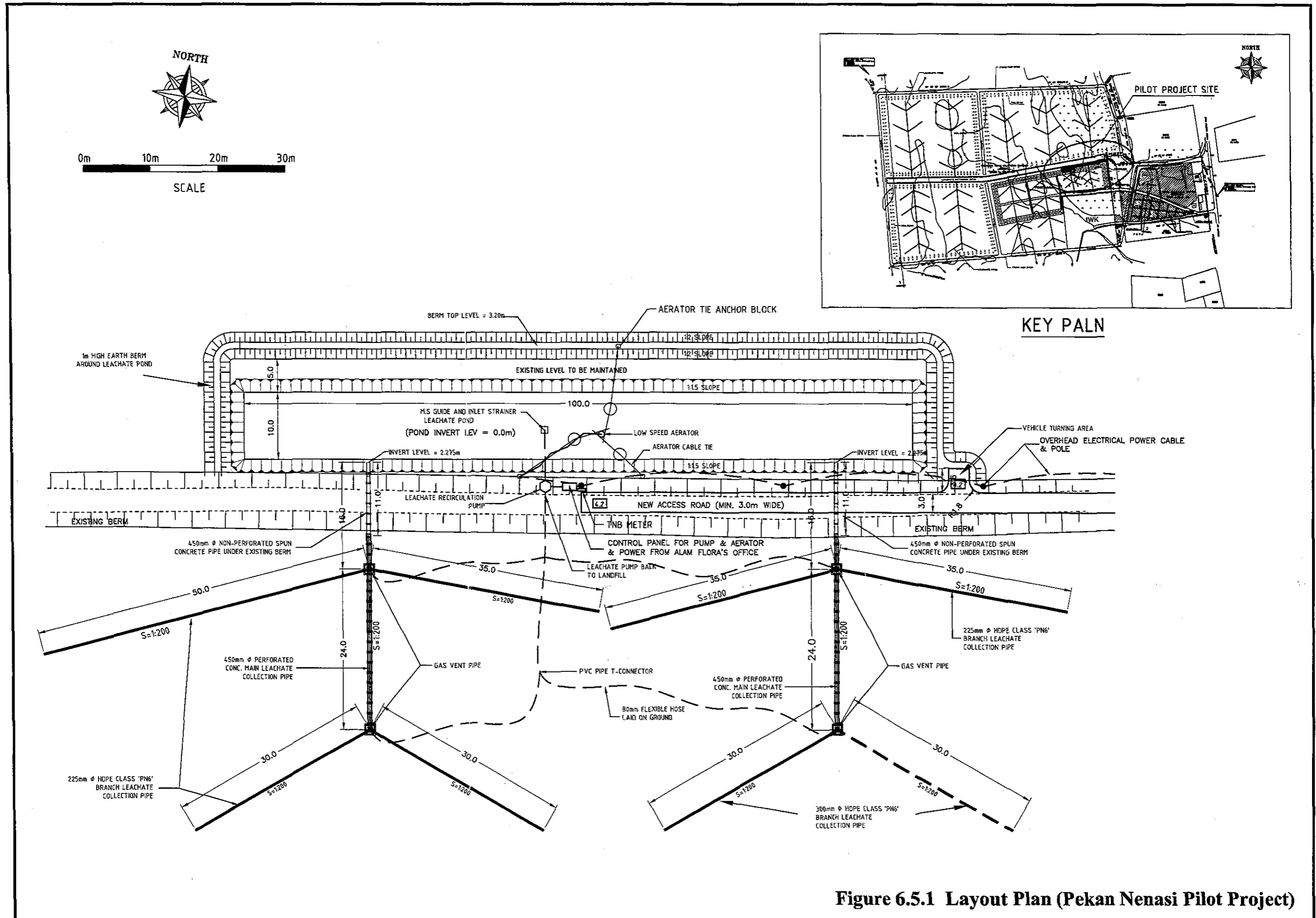
**Table 6.5.2 Pekan Nenasi PP Description**

| No. | Item/Description   | Quantity          |
|-----|--|-------------------|
| 1   | Leachate Collection System   |                   |
|     | Excavation of solid waste  | 500m <sup>3</sup> |
|     | Main leachate collection pipe (dia. = 450mm) installed in two lines<br><i>Non-perforated spun concrete pipe, Class H, of nominal diameter 450mm laid under the berm and road, with a length of 12m x 2 lines. Perforated spun concrete pipe, Class H of nominal diameter 450mm including placing of gravel around the pipe and preparation of pipe bed with crusher-run of 200mm, over wooden sleeper/wedge of length 30m x 2 lines.</i> | 84m               |
|     | Branch leachate collection pipe (dia. = 225mm) installed in 4 lines<br><i>Supply and install perforated spun concrete pipe of nominal diameter 225mm with minimum slope of 1:200 and total length of 290m. Pipes laid on compacted crusher run and surrounded by gravel.</i>   | 331m              |
| 2   | Gas venting system   |                   |
|     | Vertical gas venting pipe<br><i>Supply and install 4 gas collection pipes, uPVC class D, diameter 160mm with a height of 2.5m. Installation at square pits of brick walls of outer dimensions of 1.65 x 1.65m and clear height of 0.9m. These pits also serve intersection points between the main and branch pipes.</i>   | 4 units           |

|   |   |                     |
|---|---|---------------------|
| 3 | <b>Leachate pond</b>  |                     |
|   | <p><b>Excavation for leachate pond</b><br/><i>Leachate pond dimensions are 100m length x 10m bottom width x 2m depth and the pond is excavated at the location of the present pond so only part of the required excavation volume of 2,600m<sup>3</sup> is required.</i></p>  | 1,400m <sup>3</sup> |
|   | <p><b>Earth berm along the leachate pond (h = 1.0m, L = 145m)</b><br/><i>Supply impermeable clayey soil to form 1m high berm from the existing ground level, with slope of 1:2 and 1m width at the top. Top level of the berm is 3.20m from the ground level.</i></p>   | 145m                |
|   | <p><b>Access road embankment (t = 200mm) between dike and leachate pond</b><br/><i>Levelling, subgrade and fill the soil material with average thickness of 200mm crusher run. Access road constructed on existing berm with a minimum width of 3m.</i></p>   | 2,250m <sup>2</sup> |
|   | <p><b>Crusher-run pavement for access road</b><br/><i>Supply, level and compact the crusher run with a thickness of 300mm.</i></p>  | 180m <sup>3</sup>   |
|   | <p><b>Aerator (7.5 kw)</b><br/><i>Supply and installation of low speed surface aerator, vertically mounted geared motor, with electrical accessories and wiring of 300m extensions. Aerator installed at approximately centre point of the pond length.</i></p>   | 1 set               |
|   | <p><b>Re-circulation pump (5 kw)</b><br/><i>Supply and installation of suction pump with discharge outlet of diameter 80mm including all accessories and wiring of 300m extensions. Pump is installed near the access road between the waste disposal operations area and the pond. Rubber hoses are connected from the pump to 4 sprinklers installed at the top of each gas vent.</i></p> | 1 set               |







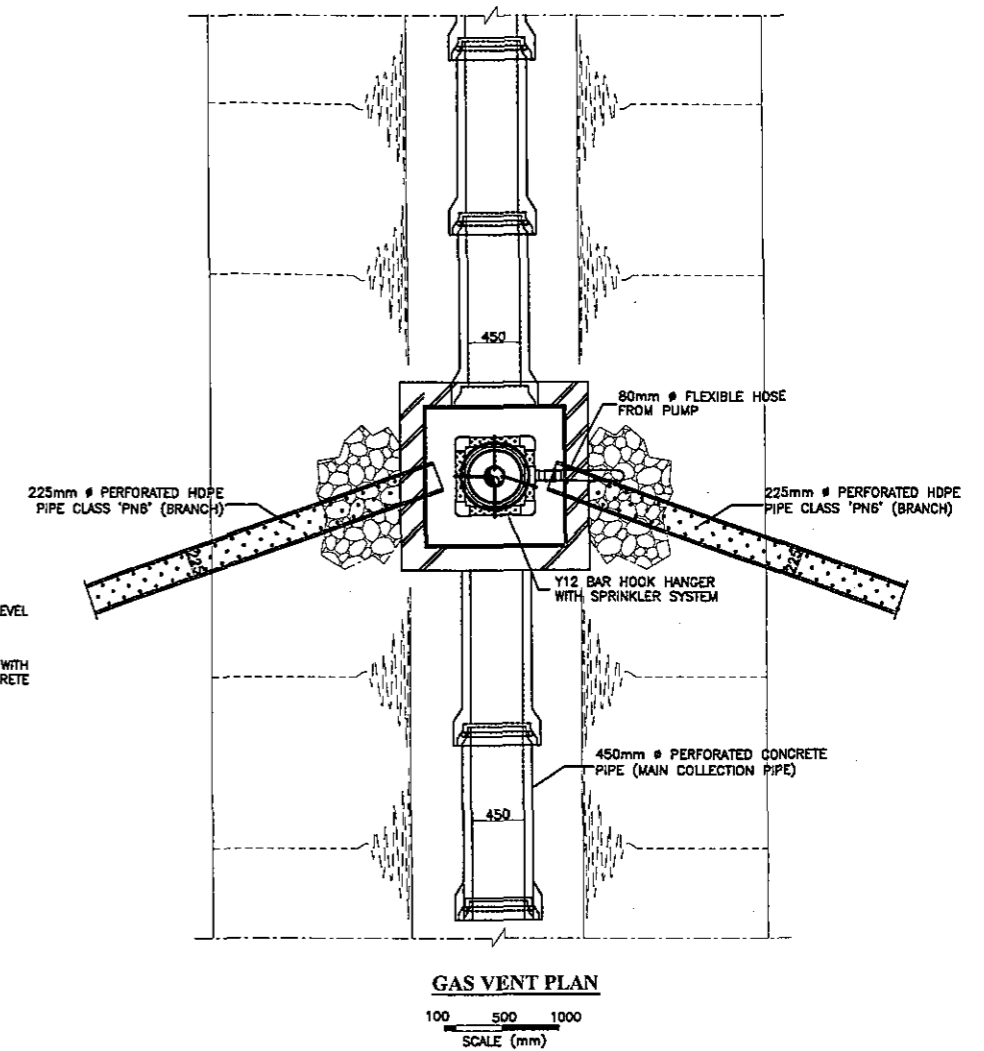
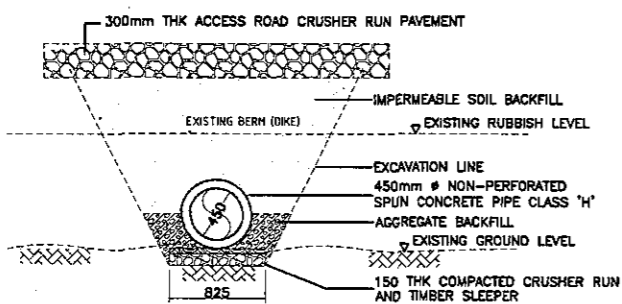
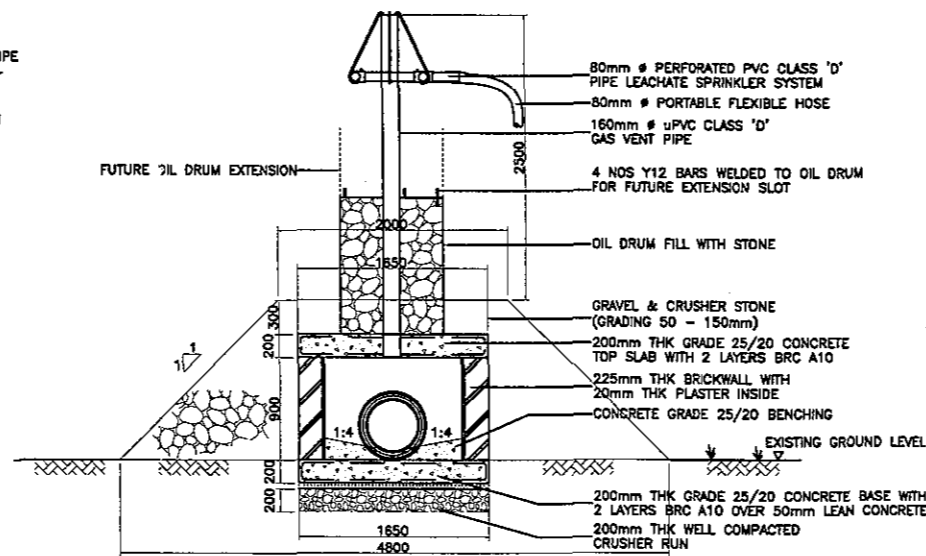
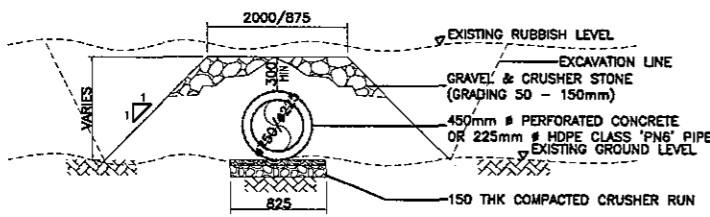
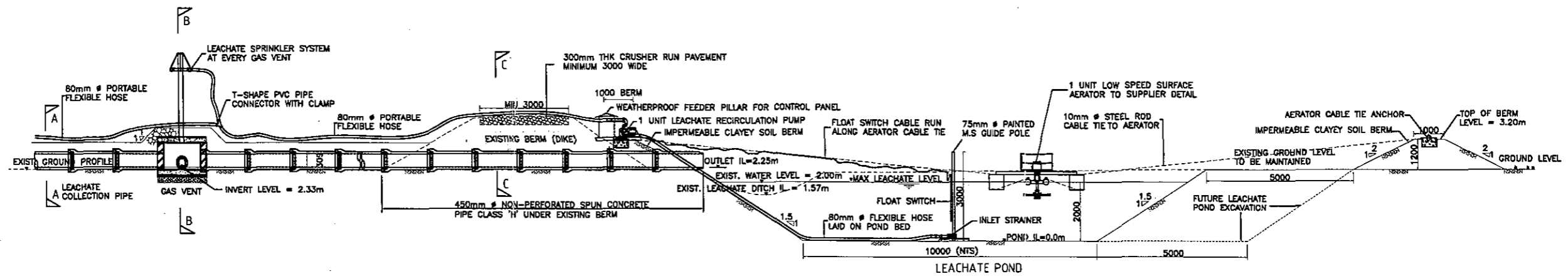
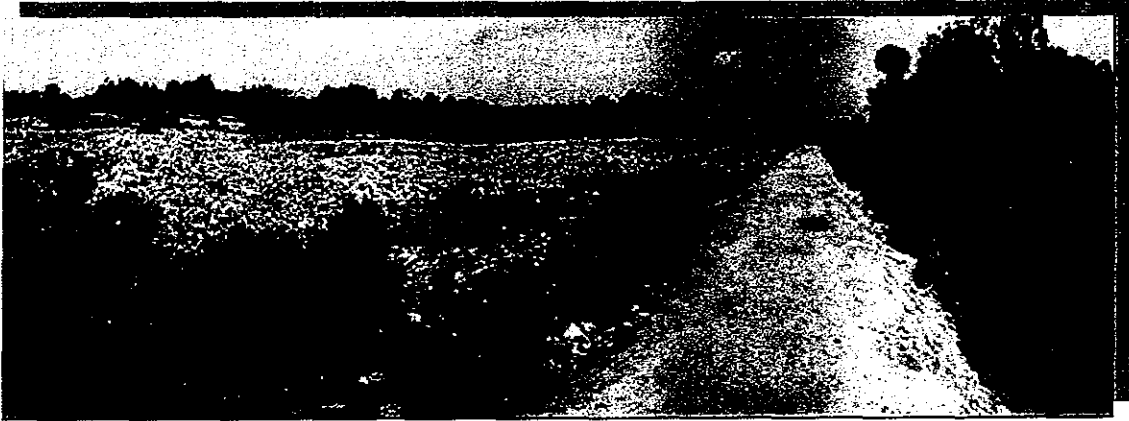


Figure 6.5.2 Typical Sections (Pekan Nenasi Pilot Project)

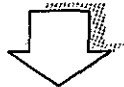
**Plate 6.5.1 Pekan Nenasi Pilot Project**



**Before pilot project (PP)**



**During PP**



**After PP**

(Installation of leachate pipe & gas vent)

### **6.5.3 Environmental Monitoring – Pekan Nenasi PP**

The following **Table 6.5.3** summarizes the sampling quantity of monitoring.

**Table 6.5.3 Sample Number at Pekan Nenasi Pilot Project Site**

| Sample type   | Pekan Nenasi<br>(Number of locations) |
|---------------|---------------------------------------|
| Surface water | 2                                     |
| Leachate      | 1                                     |
| Groundwater   | 3                                     |
| Gas           | 2                                     |

For each location, samples will be taken four times; i.e. once before the pilot project improvement and three times after the project.

Evaluation of the monitoring result is summarised in Article 6.7.2.

## **6.6 PILOT PROJECT - AMPANG JAYA CLOSED LANDFILL SITE (SELANGOR)**

### **6.6.1 Outline of the Site**

The Ampang Jaya landfill site, at Hulu Langat, was in operations from 1992 to 1998. The site was operated by MP Ampang Jaya and on closure, the land, together with the site, was reverted to the control of MP Kajang.

The site is located at about 3 km east of Ampang Jaya, on a hilly area near the basin of the Langat River. The Hulu Langat water intake point is located about 8 km down stream of the site.

About 400 tonnes/day of waste was disposed at the site (about 1 million tonnes in total). The waste was dumped from the top of the hill and filled at the western slope, eastern slope and at the bottom of western valley. In 1998, western slope became unstable and collapsed and the accident resulted in the death of 2 landfill workers and subsequently, the site was urgently closed.

During the operations of the site, some improvement works were carried out to reform the slopes, provide soil coverings, installation of gas ventilation pipes, and the installation of a leachate treatment plant and leachate pond. For access purposes, a temporary access road was constructed. However, due to the premature closure of the site, the leachate treatment plant was not completed and the entire site has been abandoned.

During the preliminary site visit survey in mid 2003, it was observed that the slopes have been covered with grass and shrubs, and leachate was observed flowing from the slopes and flowing into the nearby stream. The covering soil and surface water drainage were not sufficient. The site is now being used as an orchard at the top of hill and at part of the bottom valley.

The landfill gas contains about 22 % of methane and hydrogen sulphide (H<sub>2</sub>S), observed at the gas discharge pipe installed at the hilltop. The stream at the eastern side

of the hill seemed clean but contains about 40 ppm of nitrate compound (T-N). In the valley, leachate is leaking continuously. The main outflow is a wetland located at the centre of the valley. The amount of leachate flow is estimated to be about 100m<sup>3</sup>/day.

Since the site was abandoned after the landslide, the slopes remained in precarious state and posed a dangerous risk. The temporary access road and certain low lying areas have been badly eroded due to insufficient surface water drainage and the lack of maintenance.

The brief description of the closed landfill operations and site characteristics are summarised in **Table 6.6.1**.

**Table 6.6.1 Ampang Jaya Closed Landfill Operations and Site Characteristics**

| Operational Characteristics   | Location Characteristics   |
|---|--|
| ⇒ Started operations in 1992 and closed in 1998 after an accident at the site   | ⇒ Located east of MP Ampang Jaya on a hilly area in the basin of Sungai Langat   |
| ⇒ About 400 tonnes/day of waste was disposed at the landfill (about 1.0 million tons in total)                                    | ⇒ The Hulu Langat water intake point is located about 8km downstream of the site |
| ⇒ Waste was by dumped into the valley from the top and filled the western and eastern slopes and the bottom of the western valley |  |

### 6.6.2 Ampang Jaya Pilot Project Implementation

Since the site has been closed and abandoned, it must be closed properly. The safe closure plan included the installation of a proper surface drainage system, leachate collection systems and gas ventilations systems in order to close this site properly and keep the slope safe, stop erosion and avoid water contamination.

Brief description and bill-of-quantities (BQ) of the Pilot Project is summarised in **Table 6.6.2**. **Figure 6.6.1** and **Figure 6.6.2** shows plan & design drawing of the pilot project and the photographic records of the progress of the work and the main facilities are shown in **Plate 6.6.1**.

**Table 6.6.2 Ampang Jaya PP Bill of Quantities**

| No. | Item/Description   | Quantity            |
|-----|--|---------------------|
| 1   | Access way through the site<br>Improvement of existing access road which extends to the valley bed, descending from an elevation of 187.980 at the site entrance (Station 1) to an elevation of 105.800 at the pipe culvert crossing. Road section to be improved extends to a length of 1,032m. |                     |
|     | Excavation and fill work<br><i>Cut and fill works to form subgrade.</i>  | 4,500m <sup>3</sup> |
|     | Access way construction (w = 7.0m)<br><i>Level the subgrade.</i>   | 7,350m <sup>2</sup> |
|     | Crusher-run pavement (t = 200mm)<br><i>Supply, level and compact crusher run of thickness 200mm.</i>   | 3,675m <sup>2</sup> |
|     | Surface storm water plastered drains (width 450 to 600mm) at the higher road elevation section<br><i>Install plaster drain along the inner access road edge to a length of approximately 400m.</i>   | 400m                |

|   |  |                     |
|---|--|---------------------|
|   | Surface storm water drainage (w = 600 to 900mm) installed at the lower road section as it descends into the valley<br><i>Supply and install precast RC drains off size 600 x 600mm and 900 x 900mm to a length of about 500m along the inner edge of the access road.</i>  | 500m                |
|   | Pipe culvert at crossings (dia. = 1m)<br><i>Supply and installation of concrete pipe culvert of diameter 1.05m, spun pipe, Class H below the road to channel the water in the existing earth drain below the road.</i>   | 45m                 |
| 2 | Leachate collection<br>Main leachate collection pipes (dia. = 450mm)<br><i>Supply and install perforated spun concrete pipe, Class H, of nominal diameter 450mm, including placing of gravel around the pipe, with partial excavation and preparation of pipe bed with crusher run of 200mm and over wooden sleeper/wedge with a length of about 130m. RC pipe is installed in 5 sections with inclinations of 1:26, 1:13, 1:8 and 1:4 in ascending order. Elevations are RL 110 at the swamp and increasing to RL 125 at the foot of the waste slope.</i> | 126m                |
| 3 | Gas venting system and branch leachate pipes<br>Vertical gas venting pipe (dia. = 150mm)<br><i>Supply and install vertical gas ventilation perforated pipe, HDPE, of diameter 150mm and heights of approximately 1.5m. Pipes are installed at four locations at the upper portions of the pipe at the pits where pipe inclination changes.</i>   | 4 units             |
|   | Horizontal leachate and gas venting pipe (dia. = 100mm)<br><i>Supply and install horizontal gas ventilation perforated HDPE pipe, of diameter 100mm, in trenches of size 500m x 350m, surrounded by gravel of size 25mm. Pipes installed in pairs at 7 points of intersection with the main leachate pipe and at varying lengths, with the total length of 500m. The ends of the pipes bend to the vertical position to serve as gas vents as well.</i>  | 500m                |
| 4 | Surrounding wetland areas<br>Site clearing<br><i>Clearing the site, trees and shrubs in order to implement the construction of the storm water drainage and leachate retention pond.</i>   | 6,000m <sup>3</sup> |
|   | Storm water drainage (w = 600)<br><i>Supply and install RC pre-cast drains of 600 x 600mm surrounding the swamp (pond) and channelled to the earth drain in order to limit divert rain water from the pond.</i>  | 300m                |
|   | Excavation of wetland area<br><i>Deepening the swamp area to receive the collected leachate for retention before discharge into the water channel.</i>   | 1,500m <sup>3</sup> |
| 5 | Storm water drainage in the downstream area<br>Storm water drainage (w = 1,000 mm)<br><i>Supply and install three RC pipes under the access road to channel storm water from the storm water drainage system and leachate from the retention pond to the earth drain.</i>  | 200m                |

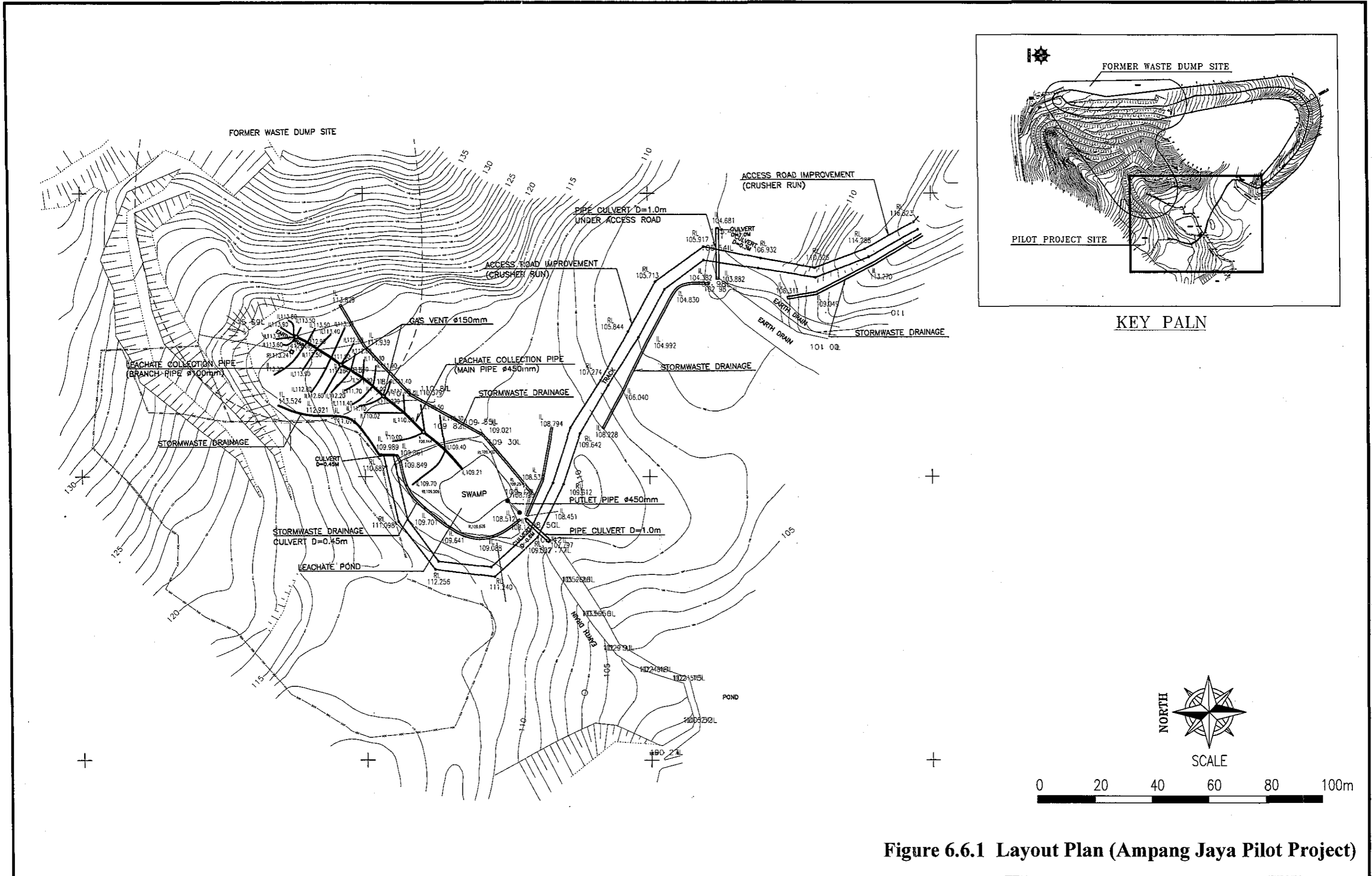
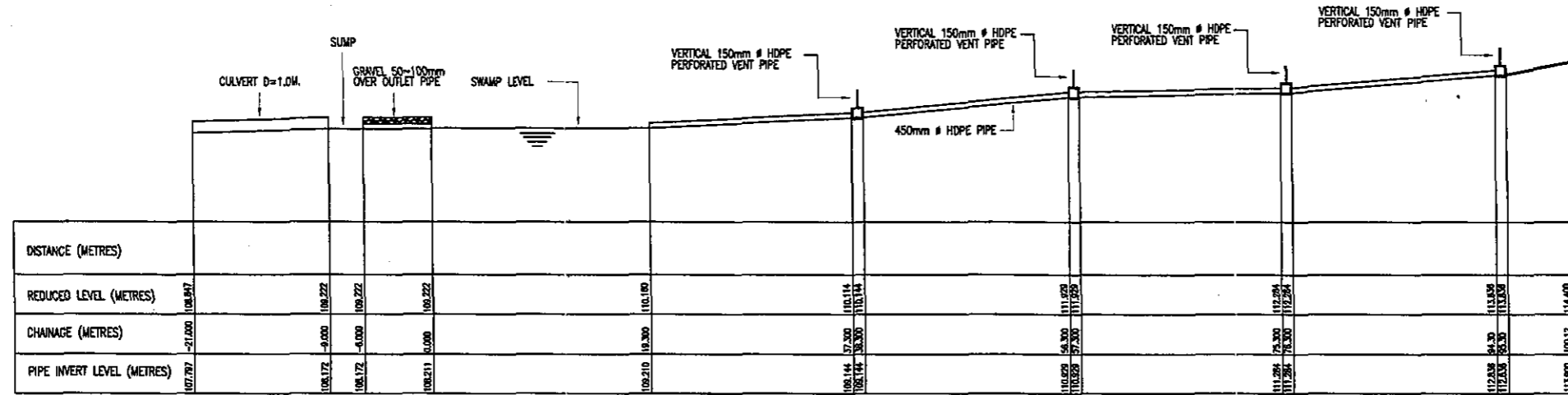
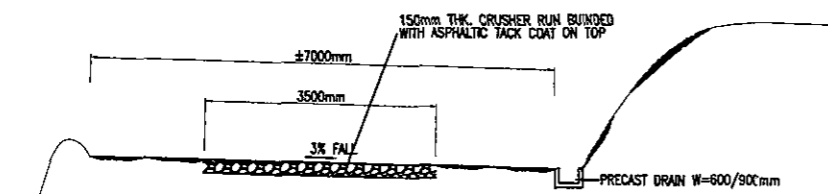


Figure 6.6.1 Layout Plan (Ampang Jaya Pilot Project)



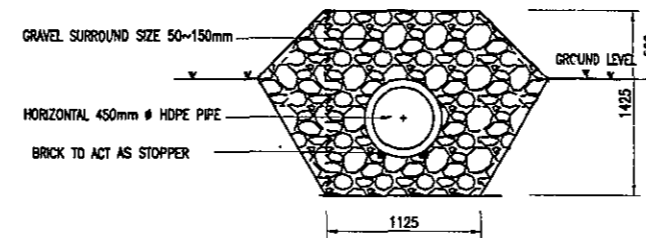
**LONGITUDINAL SECTION OF 450mm Ø LEACHATE PIPE**

SCALE VERTICAL 1 : 1000, HORIZONTAL 1 : 1000



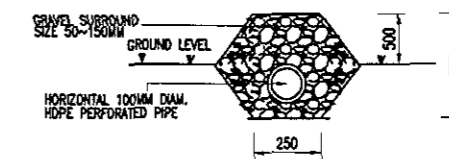
**TYPICAL SECTION OF ROAD WITH U-SHAPED PRECAST DRAIN**

NOT TO SCALE



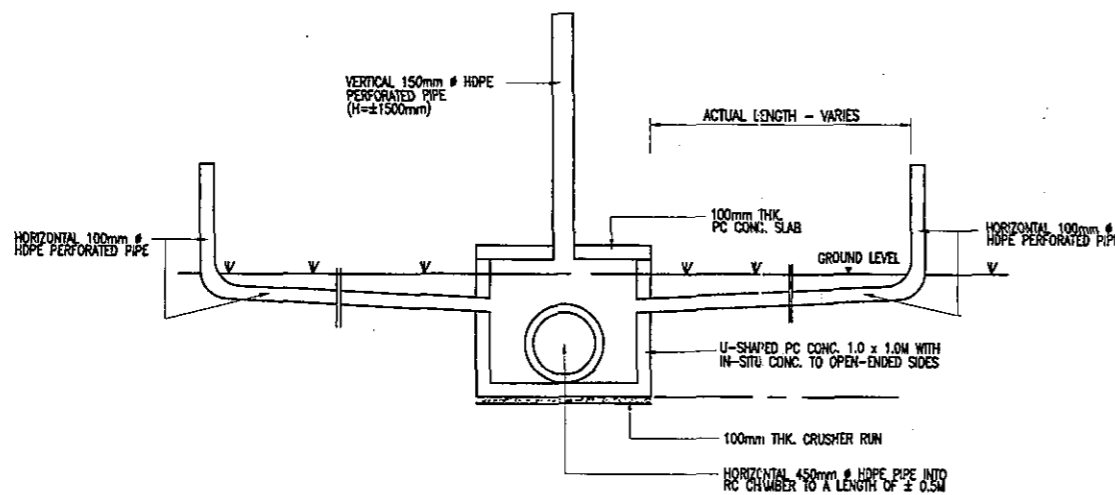
**TYPICAL SECTION OF GRAVEL SURROUND FOR 450mm Ø LEACHATE PIPE**

NOT TO SCALE



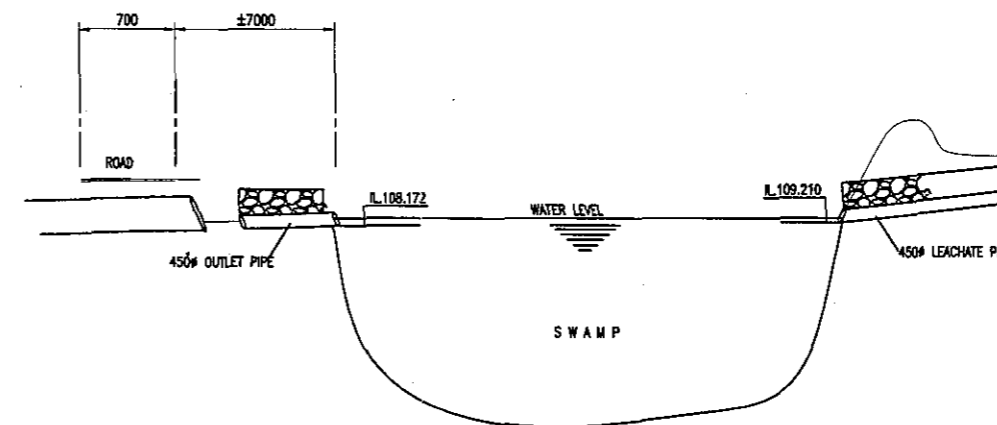
**TYPICAL SECTION OF GRAVEL SURROUND FOR 100mm Ø LEACHATE PIPE**

NOT TO SCALE



**TYPICAL SECTION AT JUNCTION OF HORIZONTAL AND VERTICAL LEACHATE/GAS PIPES**

NOT TO SCALE



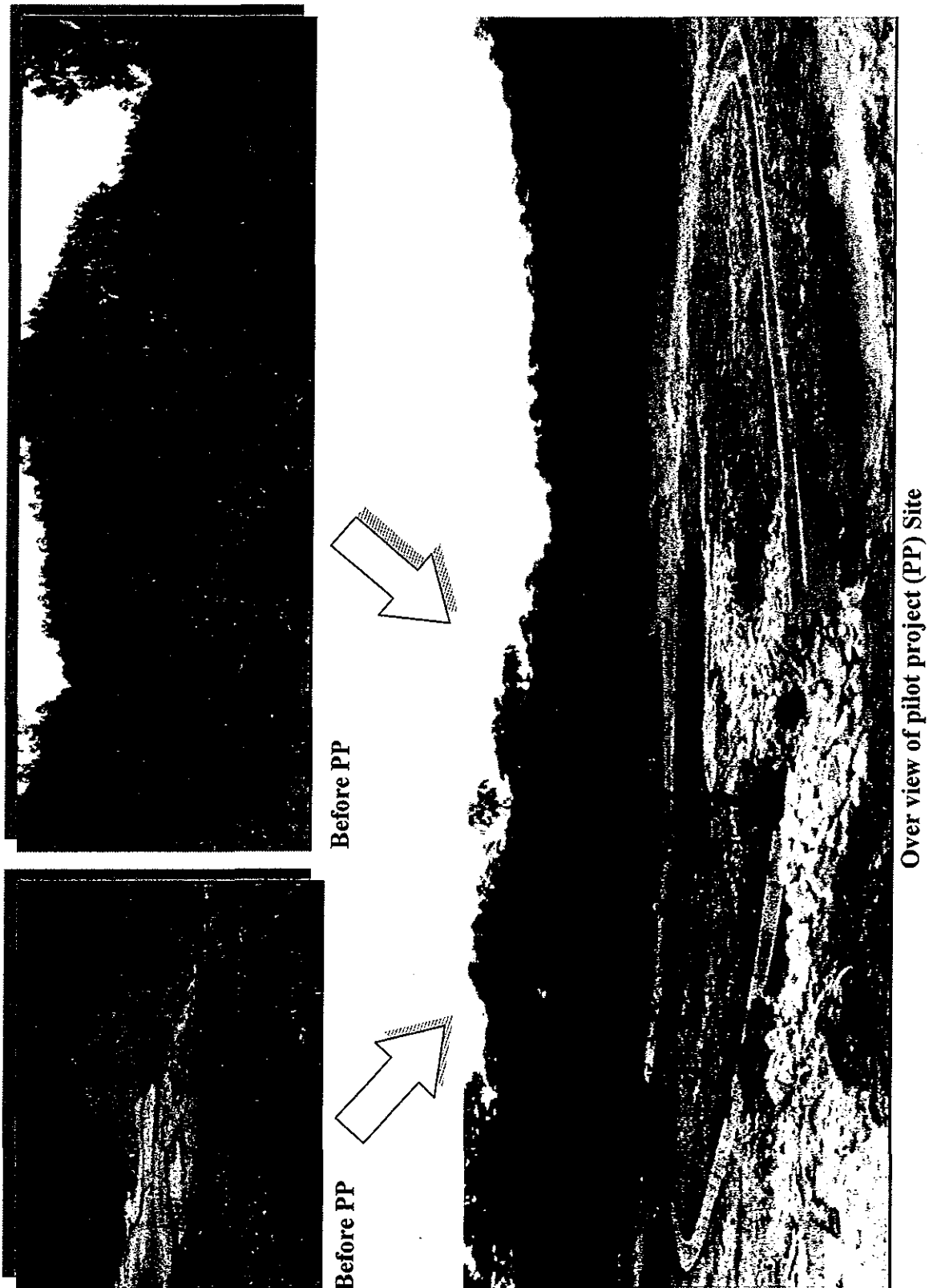
**CROSS SECTION AT SWAMP AREA**

NOT TO SCALE

Figure 6.6.2 Typical Sections (Ampang Jaya Pilot Project)



Plate 6.6.1 Ampang Jaya Pilot Project



### 6.6.3 Environmental Monitoring – Ampang Jaya PP

The following Table 6.6.3 summarizes the sampling quantity of monitoring.

**Table 6.6.3 Sample Number at Ampang Jaya Pilot Project Site**

| Sample type   | Ampang jaya<br>(Number of locations) |
|---------------|--------------------------------------|
| Surface water | 2                                    |
| Leachate      | 2                                    |
| Groundwater   | 2                                    |
| Gas           | 2                                    |

For each location, samples will be taken four times; i.e. once before the pilot project improvement and three times after the project.

Evaluation of the monitoring result is summarised in Article 6.7.2.

## 6.7 PILOT PROJECT EVALUATION

### 6.7.1 Technical Evaluation

#### (1) General

The Pilot Project sites were selected to reflect the 3 different types of site conditions, i.e.

- A landfill site operated under improved conditions and closed recently (Ampang Jajar)
- A site located in wetland area and currently still under operations (Pekan Nenasi), and
- A site closed for a number of years ago and which was poorly located and operated (Ampang Jaya).

The evaluation of the 3 Pilot Projects should take into consideration not only on the technical issues and outcome of the Pilot Project works but also on the performance of the stakeholders, local counterparts, consultants, and others. Such evaluation criteria includes the degree of technology transfer, confirmation of the technical capabilities of the Malaysian consultants and contractors, and enhancing the understanding of Local Authorities on safe closure.

The summary of the evaluation items is shown in Table 6.7.1.

**Table 6.7.1 Evaluation of Pilot Projects**

| Item                              | A* | B* | C* | Comment  |
|-----------------------------------|----|----|----|--|
| 1. Malaysian technical capability |    |    |    |  |
| (1) Detailed design               | O  |    |    | Detailed design was prepared by Local consultants appropriately based on the instruction of the JICA Study Team. |
| (2) Construction                  | O  |    |    | Contractors implemented the construction   |

|   |   |   |   |   |
|---|---|---|---|---|
|   |   |   |   | woks well.  |
| <b>2. Construction Implementation</b>             |   |   |   |   |
| (1) Construction period                           | O | O |   | Ampang Jaya PP completed on time, but Ampang Jajar and Pekan Nenasi PP faced some delays due to rainy season.                                 |
| (2) Budget maintenance                            | O |   |   | All PPs completed within the budgets.   |
| (3) Equipment and materials                       |   | O |   | All the equipment and materials for the works procured in Malaysia.   |
| (4) Workmanship                                   |   | O |   | Contractors implemented the construction woks as it was designed.   |
| <b>3. Applicability of Guidelines</b>             |   |   |   |   |
| (1) Ampang Jajar PP                               | O |   |   | Re-formation of slope and application of C3 level (leachate collection, drainage system, gas vents, etc).                                     |
| (2) Pekan Nenasi PP                               | O |   |   | Application of C3 level (semi-aerobic landfill system including leachate re-circulation system).  |
| (3) Ampang Jaya PP                                |   | O |   | Installation of leachate collection and drainage system.  |
| <b>4. Deepening understanding of safe closure</b> |   |   |   |   |
| (1) MHLG  |   | O |   | Arrangement of C/P personnel for each pilot site for supervise works.<br>Implementation of training workshops.                                |
| (2) Local Authorities                             | O |   | O | Active participation of Las in Ampang Jajar and Pekan Nenasi PP.<br>Inadequate participation in the case of Ampang Jaya PP.                   |
| (3) Site operators                                | O |   |   | Understanding and Cooperation of landfill operators during implementation.<br>Adjacent cell was developed by LA's initiative in Pekan Nenasi. |
| (4) Public  | O |   |   | Based on the public hearing to Ampang Jajar residents (about 200 attendees), PP was totally accepted by the public.                           |
| (5) 1 <sup>st</sup> Training Workshop             | O |   |   | Topic: Evaluation of landfill sites and planning of pilot projects.<br>Attendees: federal/state government and local authorities.             |
| (6) 2 <sup>nd</sup> Training Workshop             | O |   |   | Topic: Detail design, construction work and monitoring of PP.<br>Attendees: Federal/state government, LAs, and concessionaires.               |
| <b>5. Environmental improvement</b>               |   |   |   |   |
| (1) Ampang Jajar                                  | O |   |   | Surface water & Leachate improved.<br>Landscaping improved.   |
| (2) Pekan Nenasi                                  |   | O |   | Leachete improved.<br>Continuous monitoring is required.  |
| (3) Ampang Jaya                                   |   | O | O | Leachate can be controlled.<br>Leachate treatment is urgently required.   |

Note: \* Key: A = Excellent, B = Satisfactory, C = Inadequate

## (2) Achievement of Safe Closure Requirements – Pilot Projects

The PP Plans for the 3 PPs were set up in order to determine the suitability and sustainability of implementing safe closure for the landfill sites in Malaysia. The results of the PPs, the achievements and experiences gained will be used to establish and review the Guideline for Safe Closure in Malaysia.

As with all projects, the actual implementation of the PPs will differ slightly from the original concept designs due to changes necessary to accommodate the variations at the site and also due to circumstances that were faced with during the construction period.

However, in all cases, the initial objectives of the PP should be preserved. The achievements and the degree of satisfaction have been identified and evaluated, and the shortcomings and remarks are as follows:

**1) Suitability of the Guideline on landfills under different conditions**

From the results and experiences gained from the PPs, it was concluded that the guidelines presented in the Draft Guideline were generally sufficient and were adopted satisfactory for the 3 PPs. However, there are certain areas that may require on-site considerations, i.e. the technical details on local materials selection, local compaction methods and testing could be addressed.

**2) Construction methods and materials**

The local construction methods employed in the PPs were general satisfactory and were in accordance with normal practices. The selection of local construction material were also satisfactory and all the required materials were available locally and readily available.

**3) Constructions costs**

The estimates for the construction cost were initially prepared by the Study Team and subsequently tenders were called for the actual works. The actual PP implementation cost was within the estimated budget.

**4) Construction period**

The actual construction period differed for the 3 PPs, nevertheless all construction works were completed within the 3 months period, i.e. from September to December 2003. The Ampang Jajar PP and the Pekan Nenasi PP were slightly delayed due to the rainy season.

**5) Local technical capabilities in design, construction and maintenance**

For the PP, only the conceptual designs and specifications were prepared by the Study Team. The detailed designs and the works were prepared and provided by the local consultants and contractors. Based on the outcome of the detailed design work and overall construction performance, the capabilities of the local consultants and contractors were considered good and satisfactory.

The topographical surveys and soil investigations were all completed without major difficulties. The construction works were also completed satisfactorily without major technical difficulties except for the rain falls that delayed the progress of the works.

**6) The effect of safe closure and rehabilitation of landfills**

All the 3 PPs have contributed to the improvement of the sites based on both the environmental standpoints and also the aesthetic viewpoints.

For Ampang Jajar, the PP works have improved the eastern slopes and put in leachate collection facilities. The aesthetics also improved tremendously and are now more acceptable by the public, both at the park side and view from the highway. The vegetation growth at the site should be monitored regularly and looked after. All dead patches of grass should be replaced and all over grown areas should be cut and maintained.

For Pekan Nenasi, this site is still in operations and hence the PP effect may not be as obvious in a short period of PP. Nevertheless, with the installation of the leachate collection system, this will improve conditions of the site and will accelerate the decomposition process. All these will reduce the negative environmental effects during the life span of the site and will more the task of safe closure must easier in the future. However, proper operations and maintenance of the facilities are required. The aerator and recirculation pump must be operated continuously thorough the life span of the site.

For Ampang Jaya, this site has been abandoned but nevertheless the improvement works will ensure that the leachate are now being collected in the pond and retained before discharge to the stream. It is strongly urged that MHLG or the Local Authority should implement additional improvement works by installing better mechanical treatment systems such as aerators and recirculation pumps. This will improve the quality of the leachate further. It must be reiterated that the Hulu Langat water intake point is situated downstream of the site and thus is it essential that the untreated leachate from this site should not contaminate the river source.

### **(3) Proposal for Continuous Operation and Maintenance**

The sustainability and continuous improvement of the PP sites can only be achieved with proper care in the operations and maintenance of the installed facilities. As such the following have been proposed.

#### **1) Ampang Jajar Pilot Project**

The Local Authority will have to arrange for the necessary the manpower and budget to operate and maintain the Pilot Project area, and to continue with the improvements to the remaining area in order to implement safe closure for the entire site. The following activities have been proposed:

1. To carry out monthly inspections and maintenance of the open drains, and manholes
2. To carry out monthly inspections and maintenance of the gas vents
3. To carry out monthly inspections and maintenance of the main leachate pipe outlets
4. To carry out monthly inspections of the leachate pond, the aerators, and the re-circulation system
5. To carry out inspections on the plants and turfing growth, and to replace any damaged plants.

6. To carry out monthly inspections of the slopes and to look out for areas with soil erosions or failures
7. To prepare the budget for the design and construction of the remaining sections to continue with the safe closure works.

## **2) Pekan Nenasi Pilot Project**

The Pekan Nenasi landfill site is still an operating site and the operator, Alam Flora Sdn Bhd, has already taken steps to introduce similar improvement scheme to the adjacent cell. The following activities have been proposed for the operator to implement.

1. To carry out regular monitoring of the leachate level in the leachate pond to ensure that the level should be below the leachate collection pipe discharge outlet.
2. To carry out monthly inspections and maintenance of the gas vents
3. To ensure the aerator is operated daily for around 5 to 8 hours
4. To operate the leachate re-circulation system continuously
5. For the adjacent cell already being developed by Alam Flora Sdn Bhd, it is necessary to construct the new leachate pond and install an aerator and re-circulation system.

## **3) Ampang Jaya Pilot Project**

The Ampang Jaya Landfill was initially operated by the Ampang Jaya Municipal Council (MPAJ) and was subsequently transferred to the Kajang Municipal Council (MPKj) after its abrupt closure. MPKj has expressed their reluctance to undertake or be involved in the safe closure works for the site. The Study Team propose that MHLG should take responsibility for the site and be involved in the PP activities, including the long term post closure management activities.

1. To carry out monthly inspections and maintenance of the gas vents
2. To carry out monthly inspections of the leachate pond and the leachate drainage pipe
3. To carry out monthly inspections of the leachate collection pipes
4. To carry out monthly inspections of the stormwater drains
5. To develop a plan to provide and install an aerator in the leachate pond and introduction of re-circulation system for treatment of the leachate prior to discharging into the stream.

## **(4) Degree of Satisfaction of the Local Authorities where PP are located**

The 3 Pilot Projects sites are under the management and stewardship of the Seberang Perai Municipal Council (MPSP), the Pekan District Council (MDP) and the Kajang

Municipal Council (MPKj). As explained earlier, the MPKj did not participate in the Pilot Project, nevertheless, all the 3 Local Authorities were regularly informed of the status of the PP.

Information of the works were disseminated through presentations at the technical working group levels, reports submitted by the team, meetings with the respective design consultants and contractors and videos showing the phases of implementation.

i. **Majlis Perbandaran Seberang Perai (MPSP) – Ampang Jajar PP**

MPSP showed great enthusiasm for the Pilot Project and is now preparing their own development plan for the remaining area not covered under the PP. One concern raised by MPSP was the delay in handing over and the lack of clarity of responsibility for maintenance of the already damaged works.

ii. **Majlis Daerah Pekan (MDP) – Pekan Nenas PP**

MDP are satisfied with the Pilot Project and have carried out with their site operator, Alam Flora Sdn Bhd, the development of the adjacent cell on the same principle as the pilot project. However they have requested more explanation by the Study Team on the operation system of the pilot project (aerator and re-circulation system operation).

iii. **Majlis Perbandaran Kajang (MPKj) – Ampang Jaya PP**

Since MPKj did not participate in the PP works, the overall supervisory management of the works were handled by the Counterpart members of MHLG. The Counterpart members expressed their satisfaction with the PP works and the site has since been used as the “exhibition” site for others to visit and to appreciate the PP works.

## **6.7.2 Environmental Evaluation**

### **(1) Evaluation of Ampang Jajar Pilot Project**

#### **1) Leachate and surface water**

The results of the monitoring for BOD<sub>5</sub>, COD, total-nitrogen (T-N) and electric conductivity for the leachate sample indicated an increased in concentration during the February, 2004 monitoring, i.e. just after the PP works. These could be due to the effects of improved rainwater drainage system provided by the PP works. Since lesser surface water got into the waste layers, the leachate concentration temporally increased. However, the COD, total-nitrogen (T-N) decreased for both the subsequent May and July, 2004 monitoring. These may indicate the long-term effects of the PP works. The segregation of the rainwater could have increased and promoted the organic degradation inside the landfill layers. Continuous monitoring of these parameters is necessary in order to reach the conclusions the assumption. The BOD<sub>5</sub> results did not show such clear trends of improvement. This may be due to the fact that this section of the landfill site is already quite old and the biodegradable organic are already in low concentration range. The electric conductivity showed consistent improvements.

The results of the monitoring for the surface water taken downstream of the site were more or less similar to those of the leachate, but at the lower (diluted) concentration range. The COD, total-nitrogen (T-N) and electric conductivity value started to decrease from the baseline values immediately after the PP works. This was considered reasonable as lesser surface water seeping into the landfill layers caused the initial increase in the concentration of the leachate, and also resulted in fewer overflow of the leachate into the surface water system. The COD value initially exceeded the Effluent Standard B limits during the baseline survey in August 2003. However, after the PP works, the COD results has been constantly lower than the Effluent Standard B

The Boron and Iron values for the leachate and surface water exceeded the Effluent Standard B limits during the baseline survey in August 2003. After the PP works, the results for the Boron and Iron tended to decrease and at the recent monitoring in July, 2004, their values were all below the Standard B limits.

These are considered as positive effects of the PP improvement works.

## **2) Groundwater**

The results of the monitoring for the groundwater, taken from the sampling well downstream direction of groundwater flow, remained roughly unchanged from before the PP and after. This is due to the fact that the groundwater flow is very slow and any changes in the water quality at the landfill area will take years before it reaches and affects the water quality at the well.

## **3) Landfill gas**

The results for the gas monitoring showed fluctuated data for all the major parameters such as CH<sub>4</sub>, CO<sub>2</sub>, O<sub>2</sub> and N<sub>2</sub>. It seemed that the landfill gas generated by the organic decay, namely CH<sub>4</sub> and CO<sub>2</sub> tend to decrease after the PP works. However, it is premature at this early stage to conclude about the long-term effects of the PP improvement from the limited current data.

## **(2) Evaluation of Pekan Nenas Pilot Project**

### **1) Leachate and surface water**

The results of the monitoring for COD, total-nitrogen (T-N) and electric conductivity of the leachate showed decreasing tendency after the PP works. However, the results for BOD<sub>5</sub> seemed they were not changed by the PP works.

As for the results of the surface water, the concentrations of the key parameters were all at very low levels and it seemed that the surface water was not heavily contaminated by the leachate from the site, eventhough the surface water around the site was stagnated.

### **2) Groundwater**

The results of the monitoring for the groundwater, taken from the well at the middle of the site and just southeast of the PP improved area, indicated there was no clear tendency of change in the water quality parameters. This was considered reasonable considering the slow groundwater flow and the presence of the sewage sludge disposal area adjacent to the site



### **(3) Evaluation of Ampang Jaya Pilot Project**

#### **1) Leachate and surface water**

The PP works at the site included the leachate collection system but without the leachate circulation or leachate treatment. Therefore, the leachate quality was not expected to improve much. The results for the leachate sampling shows almost constant leachate quality taken at the discharge of the leachate pond. The samples taken a little further from pond indicated improving quality for the COD, T-N and electric conductivity after February, 2004. The PP works resulted in the leachate being collected and thus minimise the penetration of the leachate into the ground and discharge to the waterways downstream. The leachate is now discharged straight to the surface water drains from the pond.

The results of the surface water showed increased tendency for the major parameters after the PP works. This was considered reasonable as more leachate were collected by collection system and directly discharged to the waterway. It was noted that the COD values exceeded the Effluent Standard A limits.

It was observed during the baseline survey that concentrations of Boron, Iron and Manganese were high in the leachate. The Boron in well below the Effluent Standard A, but Iron and Manganese have exceeded the limits. They also exhibited the tendency to increase upwards.

It is strongly recommended that the leachate treatment system should be provided, as there is a water intake point downstream of the site.

#### **2) Groundwater**

The results of the groundwater taken from the well downstream of the site indicated not much change. Since the PP works provided the better leachate collection system to reduce the ground penetration, the groundwater quality should improve in the long-term. However within the present monitoring period of the pilot project, the changes cannot be observed easily.

#### **3) Landfill gas**

The monitoring results of the landfill gas taken at the gas well located at the top of the landfill showed slight decrease in CH<sub>4</sub> and CO<sub>2</sub> and increase in N<sub>2</sub>. This may indicate better air circulation into the waste layers. On the other hand, the results from the well at the bottom of the valley showed the opposite tendency with slight increase in CH<sub>4</sub> and CO<sub>2</sub> and decrease in N<sub>2</sub>. In both points, the changes were not so significant and cannot be related definitely to the PP improvement works.

#### **(4) Summary and conclusions**

The PP works have provided positive effects in certain points whilst the other points did not show any changes or negative effects. The evaluation of the PP improvement from the environmental points of view are summarised in **Table 6.7.2**.

**Table 6.7.2 Summary of Environmental Evaluation**

|               | Ampang Jajar PP  | Pekan Nenasi PP  | Ampang Jaya PP   |
|---------------|--|--|--|
| Leachate      | <b>Positive effect.</b><br>Quality deteriorated after PP due to lesser dilution, but started to improve later. | <b>Positive effect.</b><br>Quality generally improved. | No change in quality but now in better controlled with leachate collection system. |
| Surface water | <b>Positive effect</b><br>Quality very well improved.  | No change.<br>No significant influence of leachate.    | Negative effect.<br>As leachate is directly discharge.                             |
| Groundwater   | No change<br>Flow is slow.   | No change.<br>Flow is slow.                            | No change.<br>Flow in slow.  |
| Landfill gas  | Fluctuating data.<br>Require continuous monitoring.  | No change.<br>No landfill gas.                         | Slight change.<br>Require continuous monitoring.                                   |
| Note          |  |  | Urgently requires leachate treatment system.                                       |

In order to continue the post closure management of PP sites, in line with the Safe Closure Guideline, the following monitoring programme has been recommended, as shown in **Table 6.7.3**.

**Table 6.7.3 Monitoring Programme**

| Monitoring media/parameters | Item and parameters  | Frequency        | Location                   |
|-----------------------------|--|------------------|----------------------------|
| Leachate                    | <ul style="list-style-type: none"> <li>• pH</li> <li>• BOD</li> <li>• COD</li> <li>• Nitrogen (Ammonia, Nitrate, Nitrite)</li> <li>• ORP</li> <li>• EC</li> <li>• TOC</li> </ul>   | 4 times per year | 1 point per leachate pond  |
| Landfill gas                | <ul style="list-style-type: none"> <li>• Oxygen (O<sub>2</sub>)</li> <li>• Nitrogen (N<sub>2</sub>)</li> <li>• Methane (CH<sub>4</sub>)</li> <li>• Carbon dioxide (CO<sub>2</sub>)</li> <li>• Hydrogen sulphide (H<sub>2</sub>S)</li> <li>• Temperature</li> </ul> | 2 times per year | 2 points per site          |
| Soil subsidence             | Topographic level at the top of the landfill   | Once a year      | 1 point per landfill block |
| Groundwater                 | Groundwater benchmark parameters   | Once a year      | 3 points per site          |
| Surface water               | Effluent standard parameters   | Once a year      | 2 points per stream        |

### **6.7.3 The Evaluation of the Improvement of Ampang Jajar Landfill Site**

#### **(1) Background**

The evaluation of the Ampang Jajar PP was done through the monitoring programme. However, the evaluation on the comprehensive effects and the feasibility of improvement is difficult at this time since post monitoring of the improvement is carried out in a very short period of time. Due to the constraint, the Study Team decided to implement the survey on public opinion for the improvement in line with a contingent valuation method (CVM), in which widely used to estimate economic values for all kinds of environmental services, in order to take into account aspect of the willingness to pay for the project. With the cooperation from MPSP, the survey was carried out on August 14, 2004 during the “Health Awareness Campaign” workshop, which was organised by MPSP with cooperation of the local community association.

#### **(2) Methodology**

Two types of questionnaires were prepared by the Study Team and forwarded to MPSP in July, 2004. The actual procedures of the survey at the workshop are as follows.

- (i) The questionnaires were given to every participant during the registration.
- (ii) A local Study Team member made a presentation the overview of the project
- (iii) The presenter later explained every questions and how to answer them.
- (iv) The questionnaires were collected by the staff of MPSP after the presentation
- (v) The completed questionnaires were handed to the Study Team
- (vi) The delivered questionnaires were analysed by the Study Team

The questionnaires were designed to gather the public opinion on the pilot project, especially the cost sharing aspect for the improvement of landfill site. The period for post-closure management (PCM) for the Ampang Jajar landfill site may need a period of at least 10 years. In the questionnaire, the question on the willingness to pay for the project was asked. If the public are willing to pay, then he or she was asked to write down the annual amount they are willing to pay for a period of 10 years.

For those that we not willing to pay, they were requested to state the reason for their decision on why they are not willing to pay on the questionnaire.

#### **(3) Result of the survey**

##### **1) The attendees and the number of completed questionnaires**

A total of 216 members of the public attended the survey session and 79 attendees returned their completed questionnaires, which only account for 37% of the total attendees. It is noted that about 1/3 of the attendees were junior and/or senior high school students, and questionnaire was not delivered to them.

##### **2) Analysis of the questionnaires**

###### **a. Willingness to pay**

From the analysis of the collected questionnaires, 49 attendees expressed their willingness to pay, 21 expressed not willing to pay and 9 attendees showed “no-idea”

The analysis showed that 70% of the attendees that completed their questionnaire expressed their willing to pay for the project.

Those that expressed their reluctance to pay cited the reasons that MPSP should finance the project since MPSP have been collecting taxes from them. However, those attendees that were reluctant to pay did expressed their support for the project, Hence, in essence a total of 58 attendees that completed their questionnaires did express their support for the project. This accounted for about 73% of the total attendees that completed their questionnaires.

**b. The amount that is willing to pay**

From the evaluation of the replies of the questionnaires, it indicated that for those attendees that expressed their willingness to pay for the project, have also indicated that they were willing to pay up to about RM6.30/household/year for the next 10 years, in order to support the project financially.

However, from the analysis of the “multiple choice” selections for the preferred amount to pay, the amount that the public are willing to finance the cost of the project was estimated at RM11.00/household/year.

From the analysis of the 2 sets of questionnaires, it was concluded that base on the response of the attendees, it was more likely that the lower amount of RM6.30/household/year is preferred.

**(4) Evaluation of project cost**

In order to estimate the value for the improvement of the Ampang Jajar landfill site as one of pilot projects, the Study Team applies the figures from the survey and calculates the value of willingness to pay. The summary of the results is as follows:

- (i) 70% of households are in favour of the project and are willing to pay.
- (ii) The amount they are willing to pay for the project is estimated to be RM6.30/household/year for the next 10 years.

The general conditions for the project in Ampang Jajar landfill site are as follows:

- (a) The number of the households in MPSP is about 166,266 in the year of 2003.
- (b) In the workshop, it is explained that the project covered 20% of whole area of the site. Therefore, the attendees at the workshop recognised the scale of the project and evaluate the cost based on this scale.
- (c) In the workshop and questionnaires, it is explained that period of 10 years is required to finance the project.

Based on above conditions, value of willingness to pay for the project implementation can be estimated as follows:

$$70\% \times 166,266 \text{ households} \times \text{RM}6.30/\text{household}/\text{year} \times 100/20 \times 10 \text{ years} = \text{RM}36,662,000$$

Meanwhile, in accordance with the pilot project cost and O/M cost estimation by the JICA study, project cost can be estimated as follows:

$$\text{RM}669,805 \times 100/20 + \text{RM}241,699 \times 10 \text{ years} = \text{RM}5,766,000$$

Compare with above two values, it can be assumed that the project cost can be covered by the value of willingness to pay.



## **CHAPTER 7 FORMULATION OF LANDFILL DATABASE**

### **7.1 LANDFILL INVENTORY IN MALAYSIA**

#### **7.1.1 Outline of the Survey**

##### **(1) Objectives**

The “Landfill Inventory in Malaysia” was prepared for the purpose of using the data as references for future development and management of the landfill sites. The objectives of the landfill site surveys were as follows:

- To gather information, collate and prepare the Landfill Inventory.
- To arrange and prioritise the landfill sites for safe closure and rehabilitation.
- To formulate landfill database

##### **(2) Landfill sites to be covered in the survey**

The landfill site survey has been carried out for landfill s located in he Peninsular Malaysia, and the types of landfill sites covered in the survey were as follows:

- Landfill sites that receive municipal solid waste.
- Landfills that are still in operations or have been closed.

##### **(3) Survey Procedure**

Based on recommendations and assistance from MHLG, the JICA Study Team visited a total of 34 Local Authorities within Peninsular Malaysia. A total of 64 landfill sites were visited and the field surveys carried out (i.e. 38 sites still in operations and 26 closed sites).

As per the official lists of landfills provided by MHLG, the total number of officially registered landfill sites for the whole for Malaysia is 267 (i.e. 168 sites still in operations and 99 closed sites). Due to time constraints, the JICA Study Team field survey exercise only managed to cover approximately 24% of the 267 landfill sites in all over Malaysia. However, it was noted that some of the closed sites visited were not listed in the official MHLG landfill site lists, and thus it is strongly recommended that MHLG should continue the work and complete the inventory of all the remaining sites, and to identify any existing sites that were not included in the list.

On the other hand, questionnaires on landfill sites inventory have been sent to all local authorities in Peninsular Malaysia. And questionnaire answers for other 83 landfill sites were submitted by the LAs. Therefore, landfill database has been formulated for total of 147 landfill sites; i.e. operating 92 sites and closed 55 sites.

**Table 7.1.1** shows the outline of 147 landfill sites covered by the landfill inventory survey of the JICA.

**Table 7.1.1 List of Landfill Sites Covered by the JICA Study**

| ID | State      | No.   | Name of LA       | Name of Site       | Landfill Level | Category  | Year Start | Year End | Area (ha) | Environmental Risk | Value of Land Utilization | The necessity of the safe closure |      |      |      | Group | Closure Level |
|----|------------|-------|------------------|--------------------|----------------|-----------|------------|----------|-----------|--------------------|---------------------------|-----------------------------------|------|------|------|-------|---------------|
|    |            |       |                  |                    |                |           |            |          |           |                    |                           | C1                                | C2   | C3   | C4   |       |               |
| 1  | Selangor   | SL-01 | MP Petaling Jaya | Kelana Jaya        | Level 1        | Closed    | 1990       | 1996     | 8.1       | 0.28               | 0.80                      | 0.46                              |      |      |      | CL-C  | C2            |
| 2  | Selangor   | SL-02 | MP Klang         | Telok Kapas        | Level 1        | Operation | 2000       | 2003     | 32.4      | 0.40               | 0.28                      | 0.44                              | 0.55 | 0.43 |      | OP-D  | C2            |
| 3  | Selangor   | SL-03 | MP Kajang        | Sungai Kenbong     | Open Dump      | Operation | 1996       | 2008     | 16.2      | 0.64               | 0.29                      | 0.76                              | 0.63 | 1.00 |      | OP-B  | C3            |
| 4  | Selangor   | SL-04 | MP Selayang      | Kundang            | Level 1        | Operation | 1996       | 2005     | 32.4      | 0.34               | 0.00                      | 0.44                              | 0.48 | 0.43 |      | OP-D  | C2            |
| 5  | DBKL       | DB-01 | DB Kuala Lumpur  | Taman Beringin     | Level 2        | Operation | 1996       | 2004     | 12.0      | 0.43               | 0.52                      | 0.54                              | 0.63 | 0.47 |      | OP-A  | C3            |
| 6  | N.Sembilan | NS-01 | MP Nilai         | Pajam              | Level 1        | Operation | 1996       | 2018     | 27.9      | 0.23               | 0.28                      | 0.42                              |      |      |      | OP-D  | C1            |
| 7  | N.Sembilan | NS-02 | MP Nilai         | Kuala Sawah        | Level 1        | Closed    | 1998       | 2003     | 10.1      | 0.53               | 0.11                      | 0.58                              | 0.63 | 1.00 |      | CL-B  | C3            |
| 8  | N.Sembilan | NS-03 | MP Seremban      | Sikamat            | Level 1        | Operation | 1986       | 2003     | 5.3       | 0.39               | 0.58                      | 0.68                              | 0.45 | 0.25 |      | OP-C  | C3            |
| 9  | N.Sembilan | NS-04 | MP Port Dickson  | Quarters MPPD      | Open Dump      | Closed    | 1950       | 1960     | 0.4       | 0.24               | 0.23                      | 0.22                              |      |      |      | CL-D  | C1            |
| 10 | N.Sembilan | NS-05 | MP Port Dickson  | Bukit Palung       | Open Dump      | Operation | 1975       | 2013     | 25.0      | 0.41               | 0.22                      | 0.78                              | 0.33 | 0.25 |      | OP-B  | C3            |
| 11 | N.Sembilan | NS-06 | MP Port Dickson  | Pengkalan Kempas   | Open Dump      | Closed    | 1990       | 2002     | 1.2       | 0.28               | 0.33                      | 0.25                              |      | 0.21 |      | CL-D  | C2            |
| 12 | N.Sembilan | NS-07 | MP Port Dickson  | Sua Belong         | Open Dump      | Operation | 1998       | 2008     | 3.2       | 0.47               | 0.06                      | 0.78                              | 0.52 | 0.47 |      | OP-B  | C3            |
| 13 | Melaka     | ML-01 | MD Alor Gajah    | Air Molek          | Open Dump      | Operation | 1970       | 2013     | 2.4       | 0.35               | 0.19                      | 0.78                              |      |      |      | OP-D  | C1            |
| 14 | Melaka     | ML-02 | MD Alor Gajah    | Pulaiu Sebang      | Open Dump      | Closed    | 1960       | 2002     | 0.8       | 0.45               | 0.13                      | 0.69                              | 0.63 |      |      | CL-B  | C2            |
| 15 | Melaka     | ML-03 | MB Melaka        | Krubong            | Level 2        | Operation | 1994       | 2005     | 27.7      | 0.45               | 0.28                      | 0.78                              | 0.52 | 0.47 |      | OP-B  | C3            |
| 16 | Melaka     | ML-04 | MB Melaka        | Krubong A          | Open Dump      | Closed    | 1974       | 1994     |           | 0.32               | 0.72                      | 0.34                              |      |      |      | CL-C  | C2            |
| 17 | Melaka     | ML-05 | MB Melaka        | Kota Laksamana     | Open Dump      | Closed    | 1950       | 1973     |           | 0.30               | 0.71                      | 0.35                              |      |      |      | CL-C  | C2            |
| 18 | Melaka     | ML-06 | MD Jasin         | Lipat Kajang       | Level 1        | Closed    | 1967       | 2000     | 3.2       | 0.43               | 0.42                      | 0.31                              |      | 0.57 |      | CL-B  | C3            |
| 19 | Melaka     | ML-07 | MD Jasin         | Batang Melaka      | Open Dump      | Closed    | 1970       | 2001     | 1.5       | 0.28               | 0.42                      | 0.39                              |      |      |      | CL-D  | C1            |
| 20 | Melaka     | ML-08 | MD Jasin         | Kesang Pajak       | Open Dump      | Closed    | 2001       | 2002     | 9.2       | 0.59               | 0.52                      | 0.40                              | 0.26 | 0.70 | 0.43 | CL-A  | C4            |
| 21 | Johor      | JH-01 | MD Tangkak       | ChoHong            | Open Dump      | Closed    | 1970       | 2000     | 1.0       | 0.58               | 0.38                      | 0.34                              | 0.29 | 0.57 | 0.43 | CL-B  | C4            |
| 22 | Johor      | JH-02 | MP Muar          | Bakri              | Level 1        | Operation | 1993       | 2005     | 14.6      | 0.32               | 0.46                      | 0.31                              | 0.37 | 0.21 |      | OP-C  | C3            |
| 23 | Johor      | JH-03 | MP JB Tengah     | Ulu Tiram          | Level 2        | Operation | 1997       | 2003     | 17.4      | 0.46               | 0.18                      | 0.95                              | 0.75 | 0.47 |      | OP-B  | C3            |
| 24 | Johor      | JH-04 | MP JB Tengah     | Lima Kedai         | Open Dump      | Closed    | 1992       | 1997     | 2.5       | 0.22               | 0.14                      | 0.27                              |      |      |      | CL-D  | C1            |
| 25 | Johor      | JH-05 | MP JB Tengah     | Kempas             | Open Dump      | Closed    | 1988       | 1997     | 0.9       | 0.27               | 0.42                      | 0.34                              |      |      |      | CL-D  | C1            |
| 26 | Johor      | JH-06 | MP JB Tengah     | Taman Mega Ria     | Open Dump      | Closed    | 1988       | 1997     | 6.5       | 0.37               | 0.45                      | 0.27                              | 0.40 | 0.47 |      | CL-D  | C2            |
| 27 | Johor      | JH-07 | MD Kota Tinggi   | Batu Empat         | Open Dump      | Operation | 1988       | 2004     | 6.0       | 0.69               | 0.09                      | 1.00                              | 0.63 | 1.00 |      | OP-B  | C3            |
| 28 | Johor      | JH-08 | MD Kota Tinggi   | Sungai Rengit      | Open Dump      | Operation | 1998       | 2008     |           | 0.36               | 0.10                      | 0.95                              | 0.23 |      |      | OP-D  | C2            |
| 29 | Johor      | JH-09 | MD Kota Tinggi   | Bandar Kota Tinggi | Open Dump      | Closed    |            | 1988     | 1.6       | 0.44               | 0.68                      | 0.34                              |      | 0.53 |      | CL-A  | C3            |
| 30 | Johor      | JH-10 | MD Mersing       | Jemaluang          | Open Dump      | Operation | 1993       | 2013     | 4.0       | 0.27               | 0.07                      | 0.47                              |      |      |      | OP-D  | C1            |
| 31 | Johor      | JH-11 | MD Mersing       | Endau              | Open Dump      | Operation | 1993       | 2013     | 4.9       | 0.27               | 0.20                      | 0.47                              |      |      |      | OP-D  | C1            |
| 32 | Johor      | JH-12 | MD Mersing       | Sri Pantai         | Open Dump      | Operation | 1993       | 2013     | 4.0       | 0.38               | 0.36                      | 0.86                              | 0.26 |      |      | OP-D  | C2            |
| 33 | Pahang     | PH-01 | MD Rompin        | Kampong Feri       | Level 1        | Operation | 1983       | 2020     | 5.0       | 0.26               | 0.50                      | 0.59                              |      |      |      | OP-C  | C2            |



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| ID | State      | No.   | Name of LA         | Name of Site                  | Landfill Level | Category  | Year Start | Year End | Area (ha) | Environmental Risk | Value of Land Utilization | The necessity of the safe closure |      |      |      | Group | Closure Level |
|----|------------|-------|--------------------|-------------------------------|----------------|-----------|------------|----------|-----------|--------------------|---------------------------|-----------------------------------|------|------|------|-------|---------------|
|    |            |       |                    |                               |                |           |            |          |           |                    |                           | C1                                | C2   | C3   | C4   |       |               |
| 34 | Pahang     | PH-02 | MD Pekan           | Pekan Nenasi                  | Level 2        | Operation | 1988       | 2023     | 22.7      | 0.26               | 0.22                      | 0.49                              | 0.30 | 0.21 |      | OP-D  | C2            |
| 35 | Pahang     | PH-03 | MP Kuantan         | Taman Bandar                  | Open Dump      | Closed    | 1983       | 1986     | 2.0       | 0.24               | 0.58                      | 0.20                              |      |      |      | CL-C  | C2            |
| 36 | Pahang     | PH-04 | MP Kuantan         | Gambang                       | Open Dump      | Closed    | 1965       | 2001     | 2.0       | 0.28               | 0.18                      | 0.53                              |      |      |      | CL-D  | C1            |
| 37 | Pahang     | PH-05 | MP Kuantan         | Indera Mahkota                | Level 1        | Closed    | 1985       | 1993     | 50.0      | 0.26               | 0.55                      |                                   |      |      |      | CL-C  | -             |
| 38 | Pahang     | PH-06 | MP Kuantan         | Jabor Jerangau                | Level 2        | Operation | 1993       | 2018     | 55.0      | 0.30               | 0.18                      | 0.36                              | 0.55 | 0.43 |      | OP-D  | C2            |
| 39 | Terengganu | TR-01 | MP Kemaman         | Fikri                         | Open Dump      | Closed    | 1976       | 1985     | 2.0       | 0.26               | 1.00                      | 0.22                              |      |      |      | CL-C  | C2            |
| 40 | Terengganu | TR-02 | MP Kemaman         | Gelugor                       | Open Dump      | Closed    | 1981       | 1992     | 1.2       | 0.22               | 0.40                      | 0.22                              |      |      |      | CL-D  | C1            |
| 41 | Terengganu | TR-03 | MP Kemaman         | Gelugor                       | Open Dump      | Operation | 1993       | 2006     | 10.0      | 0.32               | 0.50                      | 0.59                              |      |      |      | OP-C  | C2            |
| 42 | Terengganu | TR-04 | MP Kemaman         | Mak Cii Paya                  | Open Dump      | Operation | 1985       | 2006     | 5.0       | 0.28               | 0.46                      | 0.54                              |      |      |      | OP-C  | C2            |
| 43 | Terengganu | TR-05 | MP K. Terengganu   | Tok Jembal                    | Open Dump      | Closed    | 1985       | 1994     | 8.1       | 0.28               | 0.55                      | 0.22                              |      |      |      | CL-C  | C2            |
| 44 | Terengganu | TR-06 | MP K. Terengganu   | Wakaf Tok Keh                 | Open Dump      | Closed    | 1975       | 1985     | 4.0       | 0.29               | 0.68                      | 0.29                              |      |      |      | CL-C  | C2            |
| 45 | Terengganu | TR-07 | MP K. Terengganu   | Kubang Ikan                   | Open Dump      | Operation | 1998       | 2004     | 13.3      | 0.53               | 0.49                      | 1.00                              | 0.63 | 0.47 |      | OP-A  | C3            |
| 46 | Kelantan   | KL-01 | MP Kota Baru       | Panji                         | Open Dump      | Closed    | 1961       | 1987     | 4.0       | 0.26               | 0.80                      | 0.22                              |      |      |      | CL-C  | C2            |
| 47 | Kelantan   | KL-02 | MP Kota Baru       | Tebing Tinggi                 | Open Dump      | Operation | 1987       | 2003     | 19.0      | 0.55               | 0.20                      | 0.81                              | 0.70 | 0.47 |      | OP-B  | C3            |
| 48 | Kelantan   | KL-03 | MD K. Krai Selatan | Sungai Sam                    | Open Dump      | Closed    | 1984       | 2000     | 0.3       | 0.32               | 0.00                      | 0.46                              | 0.29 |      |      | CL-D  | C2            |
| 49 | Kelantan   | KL-04 | MD K. Krai Selatan | Bukit Tembeling               | Open Dump      | Operation | 2000       | 2013     | 4.0       | 0.39               | 0.00                      | 0.90                              | 0.34 |      |      | OP-D  | C2            |
| 50 | Perak      | PR-01 | MD Kinta Selatan   | Sg. Siput Selatan             | Level 2        | Operation | 1990       | 2028     | 26.7      | 0.20               | 0.46                      | 0.41                              |      |      |      | OP-C  | C2            |
| 51 | Perak      | PR-02 | MD Kinta Selatan   | Kg. Batu Putih (Kg. Tersusun) | Open Dump      | Closed    | 1980       |          | 2.0       | 0.26               | 1.00                      | 0.22                              |      |      |      | CL-C  | C2            |
| 52 | Perak      | PR-03 | MD Kinta Selatan   | Taman Sri Kampar              | Open Dump      | Closed    | 1960       | 1970     | 4.0       | 0.49               | 0.40                      | 0.44                              | 0.40 | 0.30 | 0.30 | CL-B  | C4            |
| 53 | Perak      | PR-04 | MB Ipoh            | Bercham                       | Level 1        | Operation | 1986       | 2007     | 50.0      | 0.49               | 0.57                      | 0.80                              | 0.63 | 0.47 |      | OP-A  | C3            |
| 54 | Perak      | PR-05 | MB Ipoh            | Buntong                       | Open Dump      | Closed    | 1970       | 1986     | 20.0      | 0.28               | 0.96                      | 0.22                              |      |      |      | CL-C  | C2            |
| 55 | Perak      | PR-06 | MB Taiping         | Jebong                        | Open Dump      | Operation | 2000       | 2008     | 20.0      | 0.70               | 0.48                      | 0.85                              | 0.75 | 0.47 | 0.81 | OP-A  | C4            |
| 56 | Perak      | PR-07 | MB Taiping         | Tekkah Jaya                   | Open Dump      | Closed    | 1980       | 1999     | 40.0      | 0.39               | 0.67                      | 0.59                              |      |      | 0.37 | CL-C  | C3            |
| 57 | Perak      | PR-08 | MD Tapah           | Pekan Getah                   | Level 1        | Operation | 1985       | 2004     | 21.5      | 0.52               | 0.62                      | 0.95                              | 0.63 | 0.47 |      | OP-A  | C3            |
| 58 | Perak      | PR-09 | MD Tapah           | Bidor                         | Level 1        | Operation | 1980       | 2013     | 2.1       | 0.60               | 0.38                      | 0.95                              | 0.86 | 0.47 |      | OP-B  | C3            |
| 59 | Penang     | PP-01 | MP Pulau Pinang    | Jeti Jelutong                 | Level 1        | Operation | 1980       | 2001     | 20.0      | 0.53               | 0.62                      | 0.73                              | 0.82 | 0.47 |      | OP-A  | C3            |
| 60 | Penang     | PP-02 | MP Seberang Perai  | Ampang Jajar                  | Level 3        | Operation | 1980       | 2003     | 17.0      | 0.32               | 0.50                      | 0.68                              | 0.60 | 0.43 |      | OP-C  | C3            |
| 61 | Penang     | PP-03 | MP Seberang Perai  | Pulau Burong                  | Level 3        | Operation | 1980       | 2009     | 64.0      | 0.28               | 0.09                      | 0.44                              | 0.48 | 0.43 |      | OP-D  | C2            |
| 62 | Kedah      | KD-01 | MP Kulim Kedah     | Padang Cina                   | Open Dump      | Operation | 1996       | 2023     | 56.0      | 0.57               | 0.05                      | 0.88                              | 0.82 | 0.47 |      | OP-B  | C3            |
| 63 | Kedah      | KD-02 | MD Baling          | Pulai                         | Level 3        | Operation | 2001       | 2018     | 6.8       | 0.65               | 0.09                      | 0.44                              | 0.59 | 1.00 | 0.81 | OP-B  | C4            |
| 64 | Kedah      | KD-03 | MD Baling          | Kuala Pegang                  | Open Dump      | Closed    | 1989       | 2002     | 11.0      | 0.35               | 0.12                      | 0.63                              |      |      |      | CL-D  | C1            |
| 65 | Kedah      | KD-04 | MP Sungai Petani   | Semeling                      | Level 1        | Operation | 1989       | 2013     | 51.0      | 0.45               | 0.23                      | 0.80                              | 0.63 | 0.47 |      | OP-B  | C3            |
| 66 | Kedah      | KD-05 | MP Sungai Petani   | Jeniang                       | Open Dump      | Closed    | 1985       | 2001     | 1.5       | 0.23               | 0.12                      | 0.22                              |      |      |      | CL-D  | C1            |
| 67 | Kedah      | KD-06 | MP Kota Setar      | Bukit Tok Bertandok           | Level 2        | Operation | 1983       | 2009     | 9.7       | 0.61               | 0.35                      | 0.58                              | 0.78 | 0.96 |      | OP-B  | C3            |
| 68 | Kedah      | KD-07 | MD Kubang Pasu     | Paya Kemunting                | Level 2        | Operation | 1974       | 2005     | 5.0       | 0.41               | 0.23                      | 0.90                              | 0.60 | 0.43 |      | OP-B  | C3            |
| 69 | Perlis     | PL-01 | MP Kangar          | Kuala Perlis                  | Open Dump      | Operation | 1983       | 2003     | 8.0       | 0.52               | 0.70                      | 0.95                              | 0.52 | 0.25 |      | OP-A  | C3            |

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|-----|------------|-------|----------------------|---|----------------|-----------|------------|----------|-----------|--------------------|---------------------------|-----------------------------------|------|------|------|-------|---------------|----|
|     |            |       |                      |   |                |           |            |          |           |                    |                           | C1                                | C2   | C3   | C4   |       |               |    |
| 70  | Kelantan   | KL-05 | MD K.Krai Selatan    | Dabong  | Open Dump      | Operation | 1996       | 2006     | 0.2       | 0.34               | 0.24                      | 0.49                              |      |      |      |       | OP-D          | C1 |
| 71  | Pahang     | PH-07 | MP Kuantan           | Atabara   | Open Dump      | Closed    | 1984       | 1985     | 20.0      | 0.26               | 0.46                      |                                   |      |      |      |       | CL-D          | -  |
| 72  | Pahang     | PH-08 | MD Bentong           | Sungai Sematut  | Level 1        | Closed    |            |          | 2.0       | 0.41               | 0.30                      | 0.45                              | 0.23 | 0.36 | 0.36 |       | CL-B          | C4 |
| 73  | Pahang     | PH-09 | MD Bentong           | Chamang   | Open Dump      | Operation | 1995       | 2006     | 3.0       | 0.46               | 0.30                      | 0.43                              | 0.23 | 0.36 | 0.36 |       | OP-B          | C4 |
| 74  | Pahang     | PH-10 | MP Temerloh          | Ulu Tualang   | Level 3        | Operation | 1998       | 2006     | 7.3       | 0.20               | 0.54                      | 0.26                              |      |      |      |       | OP-C          | C2 |
| 75  | Pahang     | PH-11 | MD Cameron Highlands | Tapak Pelupusan Sisa Pepejal MDCH (Simpang Pulau)     | Open Dump      | Operation | 2001       | 2008     | 0.4       | 0.40               | 0.30                      | 0.24                              | 0.26 | 0.30 | 0.21 |       | OP-B          | C4 |
| 76  | Pahang     | PH-12 | MD Cameron Highlands | Tapak Pelupusan Sisa Pepejal MDCH (Cameron Highlands) | Open Dump      | Closed    | 1990       | 2001     | 0.4       | 0.34               | 0.62                      | 0.51                              |      |      |      |       | CL-C          | C2 |
| 77  | Selangor   | SL-05 | MD Kuala Langat      | Tapak Pelupusan Sampah                                | Open Dump      | Operation |            | 2007     | 6.1       | 0.47               | 0.35                      | 0.53                              |      | 0.64 |      |       | OP-B          | C3 |
| 78  | Selangor   | SL-06 | MD Kuala Langat      | Tapak Pelupusan Tanjung Sepat                         | Open Dump      | Closed    | 1985       | 1995     | 1.0       | 0.23               | 0.41                      |                                   |      |      |      |       | CL-D          | -  |
| 79  | Selangor   | SL-07 | MD Kuala Langat      | Tapak Pelupusan Banting                               | Open Dump      | Closed    | 1985       | 1998     | 3.0       | 0.48               | 0.76                      | 0.47                              | 0.36 | 0.36 | 0.32 |       | CL-A          | C4 |
| 80  | Pahang     | PH-13 | MD Jerantut          | Kg.Mat Lilau  | Level 2        | Operation | 1997       | 2005     | 4.4       | 0.68               | 0.18                      | 0.65                              | 0.94 | 1.00 |      |       | OP-B          | C3 |
| 81  | Pahang     | PH-14 | MD Jerantut          | Batu 57   | Open Dump      | Closed    | 1984       | 1996     | 2.0       | 0.32               | 0.76                      | 0.33                              |      |      |      |       | CL-C          | C2 |
| 82  | Pahang     | PH-15 | MD Maran             | Tapak Sampah Maran                                    | Level 2        | Operation | 1988       | 2013     | 4.0       | 0.30               | 0.24                      | 0.47                              | 0.36 | 0.26 |      |       | OP-D          | C2 |
| 83  | Pahang     | PH-16 | MD Maran             | Tapak Sampah Jengka 10                                | Level 1        | Operation | 1997       | 2030     | 8.0       | 0.42               | 0.24                      |                                   | 0.22 | 0.90 |      |       | OP-B          | C3 |
| 84  | Pahang     | PH-17 | MD Raub              | Sg.Ruan   | Level 3        | Operation | 1997       |          | 3.4       | 0.22               | 0.40                      | 0.43                              |      |      | 0.21 |       | OP-D          | C2 |
| 85  | Pahang     | PH-18 | MD Raub              | Cheroh  | Level 3        | Operation | 1991       | 2008     | 4.9       | 0.30               | 0.54                      | 0.43                              | 0.31 | 0.30 | 0.21 |       | OP-C          | C3 |
| 86  | Perak      | PR-10 | MD Hilir Perak       | MDHP (Teluk Intan)                                    | Open Dump      | Operation | 1993       | 2008     | 20.3      | 0.35               | 0.35                      | 0.55                              |      |      |      |       | OP-D          | C1 |
| 87  | Perak      | PR-11 | MD Hilir Perak       | Tapak Sampah MDHP (Kaw. Pekan Jenderata)              | Open Dump      | Operation | 1979       | 2006     | 0.4       | 0.35               | 0.22                      | 0.55                              |      |      |      |       | OP-D          | C1 |
| 88  | Perak      | PR-12 | MD Hilir Perak       | Tapak Sampah MDHP (Kaw. Bagan Datoh)                  | Open Dump      | Operation | 1979       | 2006     | 1.2       | 0.39               | 0.32                      | 0.51                              |      |      |      |       | OP-D          | C1 |
| 89  | Perak      | PR-13 | MD Kuala Kangsar     | MDKK  | Open Dump      | Operation | 1986       | 2006     | 13.4      | 0.48               | 0.30                      | 0.57                              | 0.23 | 0.36 | 0.36 |       | OP-B          | C4 |
| 90  | Perak      | PR-14 | MD Lenggong          | Air Kala  | Open Dump      | Operation | 1989       | 2008     | 1.5       | 0.34               | 0.30                      | 0.53                              |      |      |      |       | OP-D          | C1 |
| 91  | Perak      | PR-15 | MD Lenggong          | Kuak  | Open Dump      | Closed    | 1979       | 1999     | 1.2       | 0.31               | 0.29                      | 0.33                              |      |      |      |       | CL-D          | C1 |
| 92  | Kelantan   | KL-06 | MD Jeli              | MD Jeli (Bato 'O')                                    | Open Dump      | Closed    | 1990       | 2000     | 0.4       | 0.36               | 0.33                      | 0.57                              |      |      |      |       | CL-D          | C1 |
| 93  | Kelantan   | KL-07 | MD Jeli              | MD Jeli (Kg.Sg.Mengkong)                              | Open Dump      | Operation | 2000       | 2015     | 2.4       | 0.42               | 0.05                      | 0.61                              | 0.36 | 0.26 |      |       | OP-B          | C3 |
| 94  | Perak      | PR-16 | MD Pengkalan Hulu    | Tapak Pelupusan Sisa Pepejal                          | Open Dump      | Operation | 1993       | 2009     | 8.4       | 0.52               | 0.30                      | 0.45                              | 0.44 | 0.26 | 0.61 |       | OP-B          | C4 |
| 95  | Perak      | PR-17 | MD Selama            | Tapak Pelupusan MDS                                   | Open Dump      | Operation | 1991       | 2008     | 4.0       | 0.44               | 0.58                      | 0.65                              | 0.22 |      |      |       | OP-A          | C3 |
| 96  | Perak      | PR-18 | MD Tanjung Malim     | Panderas  | Open Dump      | Operation | 1980       | 2010     | 2.5       | 0.73               | 0.60                      | 0.87                              | 0.54 | 0.69 |      |       | OP-A          | C3 |
| 97  | Selangor   | SL-08 | MB Shah Alam         | MPSA  | Open Dump      | Closed    |            | 1996     | 12.0      | 0.26               | 0.12                      |                                   |      |      |      |       | CL-D          | -  |
| 98  | Selangor   | SL-09 | MP Subang Jaya       | Worldwide Landfills Sdn Bhd                           | Level 4        | Operation | 1995       | 2015     | 43.0      | 0.35               | 0.63                      | 0.22                              | 0.48 | 0.56 | 0.21 |       | OP-C          | C3 |
| 99  | Selangor   | SL-10 | MD Kuala Selangor    | Kubang Badak B.Berjantai                              |                | Operation | 1984       |          | 20.0      | 0.38               | 0.31                      | 0.65                              | 0.39 | 0.39 |      |       | OP-D          | C2 |
| 100 | Selangor   | SL-11 | MD Sabak Bernam      | Jalan Panchang Bedena                                 | Level 3        | Operation | 1984       | 2006     | 4.0       | 0.18               | 0.30                      |                                   | 0.22 | 0.26 |      |       | OP-D          | C2 |
| 101 | Perak      | PR-19 | MD Kerian            | Jalan Dnnistown Parit Buntar                          | Open Dump      | Operation | 1979       | 2003     | 0.8       | 0.64               | 0.60                      | 0.69                              | 0.79 | 0.56 | 0.21 |       | OP-A          | C4 |
| 102 | Perak      | PR-20 | MD Kerian            | Pematang Pasir Alor Pongsu (Beriah) Bagan Serai.      | Open Dump      | Operation | 1983       | 2005     | 2.4       | 0.64               | 0.60                      | 0.69                              | 0.79 | 0.56 | 0.21 |       | OP-A          | C4 |
| 103 | Terengganu | TR-08 | MD Besut             | Landfield (Sistem Tambus)                             | Open Dump      | Operation | 1993       | 2010     | 4.6       | 0.32               | 0.20                      | 0.45                              |      |      |      |       | OP-D          | C1 |
| 104 | Terengganu | TR-09 | MD Hulu Terengganu   | Tapak Pelupusan MDHT                                  | Open Dump      | Operation | 1982       | 2013     | 9.5       | 0.30               | 0.52                      |                                   |      |      | 0.30 |       | OP-C          | C3 |
| 105 | Terengganu | TR-10 | MD Marang            | MDM   | Open Dump      | Operation | 1986       | 2004     | 2.5       | 0.29               | 0.04                      | 0.39                              |      |      |      |       | OP-D          | C1 |

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|-----|------------|-------|--------------------|--|----------------|-----------|------------|----------|-----------|--------------------|---------------------------|-----------------------------------|------|------|------|-------|---------------|
|     |            |       |                    |  |                |           |            |          |           |                    |                           | C1                                | C2   | C3   | C4   |       |               |
| 106 | Johor      | JH-13 | MD Labis           | Pusat Membuang Sampah Jalan Temayar      | Open Dump      | Operation |            | 2005     |           | 0.40               | 0.35                      | 0.67                              | 0.30 | 0.26 |      | OP-D  | C2            |
| 107 | Johor      | JH-14 | MD Labis           | Pusat Membuang Sampah Jalan Maskil       | Open Dump      | Operation | 2003       | 2013     |           | 0.40               | 0.35                      | 0.67                              | 0.30 | 0.26 |      | OP-D  | C2            |
| 108 | Johor      | JH-15 | MD Pontian         | Tapak Pelupusan Jalan Sawah, Pekan Nenas | Open Dump      | Operation | 1998       | 2008     | 12.0      | 0.40               | 0.13                      | 0.41                              | 0.30 | 0.26 |      | OP-D  | C2            |
| 109 | Johor      | JH-16 | MD Pontian         | Tapak Pelupusan Rimba Terjun, Pontian    | Open Dump      | Operation | 1980       | 2003     | 12.0      | 0.45               | 0.38                      | 0.31                              | 0.65 | 0.56 |      | OP-B  | C3            |
| 110 | Johor      | JH-17 | MD Pontian         | Tapak Pelupusan Sangiang, Ayer Baloi     | Open Dump      | Operation | 1986       | 2006     | 1.2       | 0.55               | 0.14                      | 0.55                              | 0.21 | 0.24 | 0.51 | OP-B  | C4            |
| 111 | Johor      | JH-18 | MD Segamat         | Segamat Baru                             |                | Closed    |            | 2003     | 3.3       | 0.40               | 0.33                      | 0.35                              | 0.57 | 0.56 | 0.21 | CL-D  | C2            |
| 112 | Johor      | JH-19 | MD Segamat         | Jementah                                 |                | Operation | 1970       | 2023     | 10.0      | 0.27               | 0.20                      | 0.41                              | 0.30 | 0.26 |      | OP-D  | C2            |
| 113 | Johor      | JH-20 | MD Segamat         | Lebuh Raya Segamat / Kuantan             |                | Operation | 2003       |          | 90.0      | 0.36               | 0.29                      | 0.39                              | 0.57 | 0.56 | 0.21 | OP-D  | C2            |
| 114 | Johor      | JH-21 | MD Tangkak         | Simpang Bekoh                            | Open Dump      | Operation | 2000       | 2023     | 3.0       | 0.46               | 0.10                      | 0.20                              | 0.22 | 0.79 |      | OP-B  | C3            |
| 115 | Johor      | JH-22 | MD Tangkak         | Batu 16 Sengkang, Bukit Gambir           | Open Dump      | Operation | 1970       | 2004     | 7.0       | 0.43               | 0.52                      | 0.53                              | 0.26 | 0.20 |      | OP-A  | C3            |
| 116 | Johor      | JH-23 | MD Simpang Renggam | Simpang Renggam (Ladang Cep 1)           | Open Dump      | Operation | 1996       | 2012     | 6.0       | 0.39               | 0.30                      | 0.92                              | 0.28 |      |      | OP-D  | C2            |
| 117 | Johor      | JH-24 | MD Simpang Renggam | Machap                                   | Open Dump      | Closed    | 1986       | 1996     | 3.0       | 0.47               | 0.18                      | 0.53                              | 0.62 | 0.56 |      | CL-B  | C3            |
| 118 | Johor      | JH-25 | MD Simpang Renggam | Renggam                                  | Open Dump      | Closed    | 1980       | 1984     | 2.0       | 0.34               | 0.22                      | 0.33                              | 0.22 | 0.26 |      | CL-D  | C2            |
| 119 | Johor      | JH-26 | MD Simpang Renggam | Simpang Renggam (Jln Kulai Cina)         | Open Dump      | Closed    | 1990       | 1995     | 0.5       | 0.46               | 0.60                      | 0.55                              | 0.26 | 0.30 |      | CL-A  | C3            |
| 120 | Johor      | JH-27 | MD Yong Peng       | MDYP                                     |                | Operation | 1990       |          | 0.4       | 0.49               | 0.24                      | 0.71                              | 0.65 | 0.56 | 0.21 | OP-B  | C4            |
| 121 | Kedah      | KD-08 | MP Langkawi        | Tapak Pelupusan Sisa-Sisa Pepejal Majlis | Level 1        | Operation | 1988       | 2013     | 30.0      | 0.49               | 0.00                      | 0.44                              | 0.36 | 0.90 |      | OP-B  | C3            |
| 122 | Kedah      | KD-09 | MD Padang Terap    | MDPT                                     | Open Dump      | Operation | 1988       |          | 2.0       | 0.53               | 0.42                      | 0.83                              | 0.57 | 0.56 |      | OP-A  | C3            |
| 123 | Kelantan   | KL-08 | MD Bachok          | Kg. Sungai Gali, Telong                  | Open Dump      | Operation | 1995       | 2009     | 10.0      | 0.40               | 0.30                      | 0.65                              | 0.27 |      |      | OP-D  | C2            |
| 124 | Kelantan   | KL-09 | MD Bachok          | Kg. Hujung Repek, Repek                  | Open Dump      | Closed    | 1985       | 1995     | 2.5       | 0.49               | 0.52                      | 0.51                              |      |      | 0.59 | CL-A  | C4            |
| 125 | Perak      | PR-21 | MD Gerik           | MD Gerik (1)                             | Open Dump      | Closed    | 1976       | 1997     | 1.8       | 0.28               | 0.10                      | 0.24                              |      |      |      | CL-D  | C1            |
| 126 | Perak      | PR-22 | MD Gerik           | MD Gerik (2)                             | Open Dump      | Operation | 1997       | 2032     | 2.0       | 0.49               | 0.18                      | 0.47                              | 0.48 | 0.56 |      | OP-B  | C3            |
| 127 | Kelantan   | KL-10 | MD Machang         | Air Berlega                              | Open Dump      | Operation | 2002       | 2010     | 4.0       | 0.40               | 0.30                      | 0.53                              | 0.36 | 0.26 |      | OP-B  | C3            |
| 128 | Kelantan   | KL-11 | MD Pasir Puteh     | Tapak Pelupusan Bukit Gedombak           | Open Dump      | Operation | 1982       | 2020     | 2.0       | 0.38               | 0.22                      | 0.45                              | 0.22 |      |      | OP-D  | C2            |
| 129 | Kelantan   | KL-12 | MD Tumpat          | Kok Bedollah                             | Level 1        | Operation | 1988       |          | 20.0      | 0.35               | 0.15                      | 0.44                              | 0.36 | 0.26 |      | OP-D  | C2            |
| 130 | N.Sembilan | NS-08 | MP Port Dickson    | Bt.2, Jln Seremban                       |                | Closed    |            | 1972     | 2.0       | 0.22               | 0.27                      | 0.37                              |      |      |      | CL-D  | C1            |
| 131 | N.Sembilan | NS-09 | MD Jelebu          | Pertang                                  | Open Dump      | Closed    | 1997       | 2002     | 2.4       | 0.33               | 0.17                      | 0.41                              |      |      |      | CL-D  | C1            |
| 132 | N.Sembilan | NS-10 | MD Jelebu          | Sg. Muntuh                               | Open Dump      | Operation | 2002       | 2032     | 6.1       | 0.33               | 0.17                      | 0.41                              |      |      |      | OP-D  | C1            |
| 133 | N.Sembilan | NS-11 | MD Jempol          | MD Jempol (Rompin)                       | Open Dump      | Operation | 1993       |          | 5.0       | 0.39               | 0.05                      | 0.59                              |      |      |      | OP-D  | C1            |
| 134 | N.Sembilan | NS-12 | MD Jempol          | MD Jempol (Bahau)                        | Open Dump      | Closed    | 1981       | 1993     | 1.2       | 0.26               | 0.38                      | 0.28                              |      |      |      | CL-D  | C1            |
| 135 | N.Sembilan | NS-13 | MD Rembau          | Chembong                                 | Open Dump      | Operation | 1982       | 2010     | 4.0       | 0.43               | 0.41                      | 0.51                              | 0.35 | 0.26 |      | OP-A  | C3            |
| 136 | Kelantan   | KL-13 | MD Tanah Merah     | KG. Cat Rimau                            | Open Dump      | Closed    | 1981       | 1999     |           | 0.60               | 0.32                      | 0.94                              | 0.54 | 0.30 | 0.44 | CL-B  | C4            |
| 137 | Perak      | PR-23 | MP Manjung         | Sungai Wangi                             | Level 1        | Operation | 1980       | 2003     | 10.1      | 0.42               | 0.09                      | 0.67                              | 0.40 | 0.30 | 0.21 | OP-B  | C4            |
| 138 | Perak      | PR-24 | MP Manjung         | Tapak Pelupusan Teluk Cempedak           | Level 1        | Operation | 1990       | 2005     | 2.0       | 0.34               | 0.44                      | 0.47                              |      |      | 0.21 | OP-C  | C3            |
| 139 | Perak      | PR-25 | MP Manjung         | Pantai Remis                             | Open Dump      | Operation | 1970       |          | 1.2       | 0.38               | 0.12                      | 0.31                              | 0.26 | 0.30 | 0.21 | OP-D  | C2            |
| 140 | Perak      | PR-26 | MP Manjung         | Beruas                                   | Open Dump      | Operation | 1970       |          | 0.8       | 0.37               | 0.09                      | 0.45                              | 0.36 | 0.26 |      | OP-D  | C2            |
| 141 | Selangor   | SL-12 |                    | Ampang Jaya                              | Level 1        | Closed    | 1980       | 1997     | 10.0      | 0.67               | 0.33                      | 0.47                              | 0.86 | 1.00 |      | CL-B  | C3            |

| ID  | State | No.   | Name of LA      | Name of Site                 | Landfill Level | Category  | Year Start | Year End | Area (ha) | Environmental Risk | Value of Land Utilization | The necessity of the safe closure |      |      |    | Group | Closure Level |
|-----|-------|-------|-----------------|------------------------------|----------------|-----------|------------|----------|-----------|--------------------|---------------------------|-----------------------------------|------|------|----|-------|---------------|
|     |       |       |                 |                              |                |           |            |          |           |                    |                           | C1                                | C2   | C3   | C4 |       |               |
| 142 | DBKL  | DB-02 | DB Kuala Lumpur | Jinjang Utara                | Level 2        | Operation | 1979       |          | 10.0      | 0.52               | 0.59                      | 0.69                              | 0.76 | 0.30 |    | OP-A  | C3            |
| 143 | DBKL  | DB-03 | DB Kuala Lumpur | Sri Petaling                 | Level 1        | Closed    | 1979       | 1991     | 21.0      | 0.35               | 0.59                      | 0.26                              | 0.30 | 0.26 |    | CL-C  | C3            |
| 144 | DBKL  | DB-04 | DB Kuala Lumpur | Sungai Bersi                 | Level 2        | Closed    | 1989       | 1995     | 14.0      | 0.36               | 0.59                      | 0.26                              | 0.44 | 0.26 |    | CL-C  | C3            |
| 145 | DBKL  | DB-05 | DB Kuala Lumpur | Paka 2                       | Level 2        | Closed    | 1989       | 1994     | 6.5       | 0.37               | 0.59                      | 0.63                              | 0.36 | 0.26 |    | CL-C  | C3            |
| 146 | DBKL  | DB-06 | DB Kuala Lumpur | Paka 1                       | Level 1        | Closed    | 1989       | 1994     | 6.5       | 0.40               | 0.75                      | 0.63                              | 0.36 | 0.26 |    | CL-A  | C3            |
| 147 | DBKL  | DB-07 | DB Kuala Lumpur | Kampung Semarak (Brickfield) | Open Dump      | Closed    |            |          |           | 0.44               | 0.63                      | 0.63                              | 0.36 | 0.26 |    | CL-A  | C3            |

## 7.1.2 Results of the Survey

### (1) Basic information of the landfill site visited

The number and the status of landfill sites that were visited (64 landfills) are represented in the chart as shown in Figure 7.1.1.

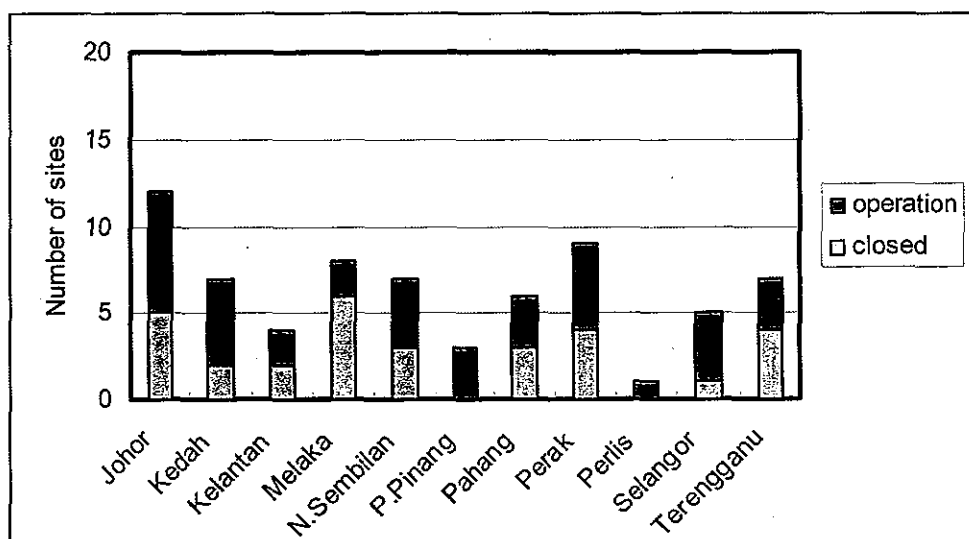


Figure 7.1.1 Number and Status of Landfill Sites in Peninsular Malaysia

The management and land ownership structure of the landfill sites covered by the landfill inventory survey (147 sites) are shown in Table 7.1.2.

**Table 7.1.2 Management and Land Ownership of the Landfill Sites**

| Item           |                   | Status of landfill sites |             | Total      |
|----------------|-------------------|--------------------------|-------------|------------|
|                |                   | Closed                   | Operational |            |
| Managed by     | Local Authority   | 48                       | 65          | 113 (77%)  |
|                | Others (Private)  | 5                        | 26          | 31 (21%)   |
|                | Unknown           | 2                        | 1           | 3 (2%)     |
| Land ownership | Government*       | 40                       | 83          | 123 (84%)  |
|                | Private (Private) | 9                        | 7           | 16 (11%)   |
|                | Unknown           | 6                        | 2           | 8 (5%)     |
| Total          |                   | 55                       | 92          | 147 (100%) |

Source: JICA Study Team and MHLG, 2003

Note: "Government" includes State and Local Authority.

## (2) Environmental impact conditions

The general classification of landfill sites is tabulated in **Table 7.1.3**, ranging from Level 0, for open dumping grounds to the more sophisticated sanitary landfill Level 4.

**Table 7.1.3 Classification of Landfill Sites**

| State      | Unknown   | Level 0     | Level 1     | Level 2    | Level 3   | Level 4   | Total         |
|------------|-----------|-------------|-------------|------------|-----------|-----------|---------------|
| Johor      | 4         | 21          | 1           | 1          | -         | -         | 27            |
| Kedah      | -         | 4           | 2           | 2          | 1         | -         | 9             |
| Kelantan   | -         | 12          | 1           | -          | -         | -         | 13            |
| Melaka     | -         | 6           | 1           | 1          | -         | -         | 8             |
| N.Sembilan | 1         | 9           | 3           | -          | -         | -         | 13            |
| P.Pinang   | -         | -           | 1           | -          | 2         | -         | 4             |
| Pahang     | -         | 7           | 4           | 4          | 3         | -         | 18            |
| Perak      | -         | 20          | 5           | 1          | -         | -         | 26            |
| Perlis     | -         | 1           | -           | -          | -         | -         | 1             |
| Selangor   | 1         | 5           | 4           | -          | 1         | 1         | 12            |
| Terengganu | -         | 10          | -           | -          | -         | -         | 10            |
| DBKL       | -         | 1           | 2           | 4          | -         | -         | 7             |
| Total      | 6<br>(4%) | 96<br>(65%) | 24<br>(16%) | 13<br>(9%) | 7<br>(5%) | 1<br>(1%) | 147<br>(100%) |

Source: JICA Study Team & MHLG, 2003

Notes: Level 0: Open dumping Grounds

Level 1: Landfill with control tipping

Level 2: Landfill with a bund and daily cover soil

Level 3: Landfill with leachate recirculation system

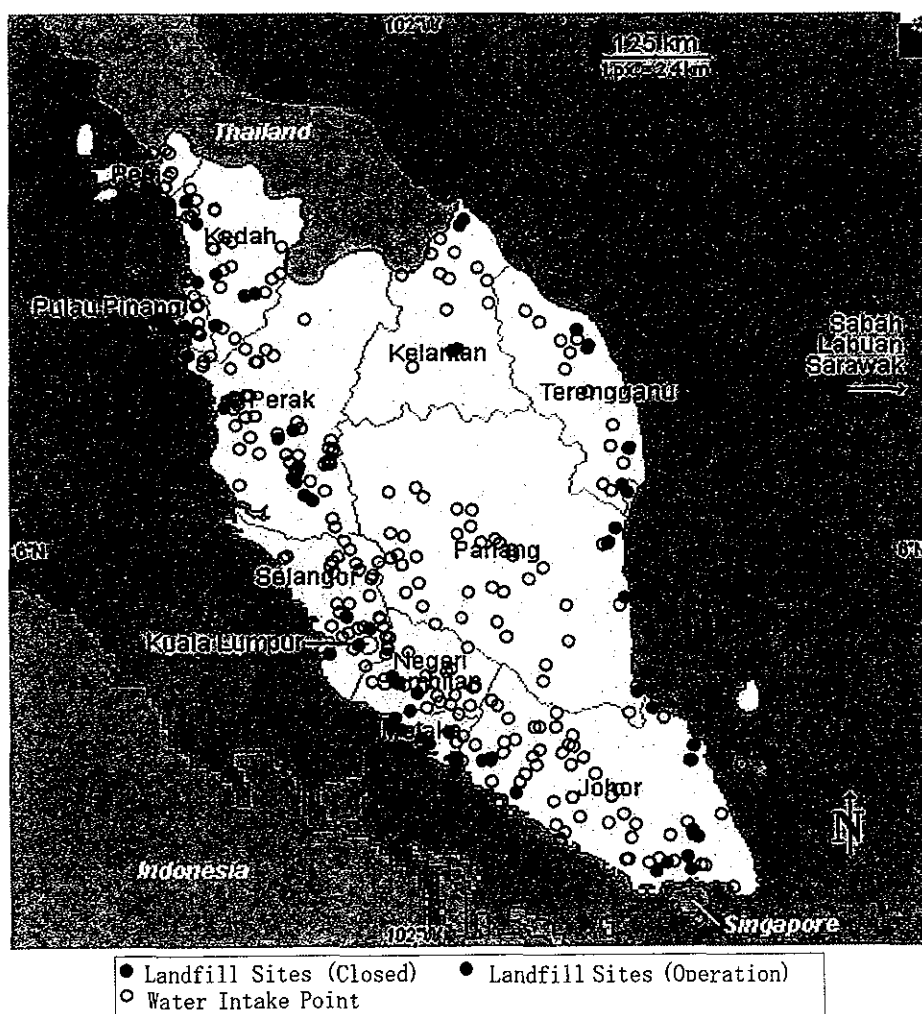
Level 4: Landfill with leachate treatment system

The general distribution of the landfill sites visited is shown in **Figure 7.1.2**, together with the locations of the water intake points as references. The number of landfill sites with water intake points downstream is tabulated in **Table 7.1.4**.

**Table 7.1.4 Location of Landfill Sites to Water Intake Points**

| State        | Number of sites upstream of intake points | Number of sites downstream of intake points | No intake points nearby | Unknown          | Total of landfill sites |
|--------------|---|---|-------------------------|------------------|-------------------------|
| Johor        | 4   | 3   | 19                      | 1                | 27                      |
| Kedah        | 3   | 1   | 5                       | -                | 9                       |
| Kelantan     | -   | 1   | 12                      | -                | 13                      |
| Melaka       | 2   | 1   | 5                       | -                | 8                       |
| N.Sembilan   | 1   | 1   | 11                      | -                | 13                      |
| P.Pinang     | -   | -   | 3                       | 1                | 4                       |
| Pahang       | 2   | 2   | 12                      | 2                | 18                      |
| Perak        | 1   | 5   | 18                      | 2                | 26                      |
| Perlis       | -   | 1   | -                       | -                | 1                       |
| Selangor     | 3   | 2   | 4                       | 3                | 12                      |
| Terengganu   | -   | 3   | 7                       | -                | 10                      |
| DBKL         | -   | -   | 7                       | -                | 7                       |
| <b>Total</b> | <b>16</b><br>(11%)                        | <b>20</b><br>(14%)                          | <b>103</b><br>(70%)     | <b>8</b><br>(5%) | <b>147</b><br>(100%)    |

Source: JICA Study Team & MHLG, 2003



**Figure 7.1.2 Distribution of Landfill Sites in Malaysia**

### (3) Post-closure land utilisation

From the survey of the closed sites, the various post-closure land utilisation are summarised in **Table 7.1.5**.

**Table 7.1.5 Land Use of Closed Landfill Sites**

| Land Use          | Number    |                |
|-------------------|-----------|----------------|
| Vacant            | 25        | (45%)          |
| Housing           | 5         | (9%)           |
| Industry/commerce | 9*(4+1)   | (16%)*         |
| Recreation        | 7*(4)     | (13%)*         |
| Agriculture       | 8*(1)     | (15%)*         |
| Others            | 3         | (5%)           |
| Unknown           | 3         | (5%)           |
| <b>Total</b>      | <b>55</b> | <b>(100%)*</b> |

Source: JICA Study Team & MHLG, 2003 \*Due to multiple answer

The level and potential for post-closure land use of the landfill sites are summarised **Table 7.1.6**.

**Table 7.1.6 Level and Potential for Post-closure Land Use of the Landfill Sites**

| Level of Land Use | Closed sites | Operation sites | Total      |               |
|-------------------|--------------|-----------------|------------|---------------|
| High              | 12           | 10              | 22         | (15%)         |
| Medium            | 10           | 5               | 15         | (10%)         |
| Low               | 16           | 16              | 32         | (22%)         |
| Unknown           | 17           | 61              | 78         | (53%)         |
| <b>Total</b>      | <b>55</b>    | <b>92</b>       | <b>147</b> | <b>(100%)</b> |

Source: JICA Study Team & MHLG, 2003

#### 7.1.3 Formulation of the Landfill Database

The data collated from the landfill inventory survey have been formulated into the database format called "Landfill Closure Management Information System (LACMIS)".

The LACMIS database is based upon the Geographical Information System (GIS) that comprises of a series of spatial data and non-spatial attribute data. The Spatial Data include geographical information on the Administration boundaries, the landfill site location, the location of water intake points, hydrological map and the transportation network. The non-spatial attribute data include information on the administrative database, the environmental database, the land utilisation database and the rating database.

**Figure 7.1.3** shows the example page of the LACMIS visual display with the map of the Peninsular Malaysia, indicating the locations of the major cities/town, roads, rivers, and the locations of the landfill sites.

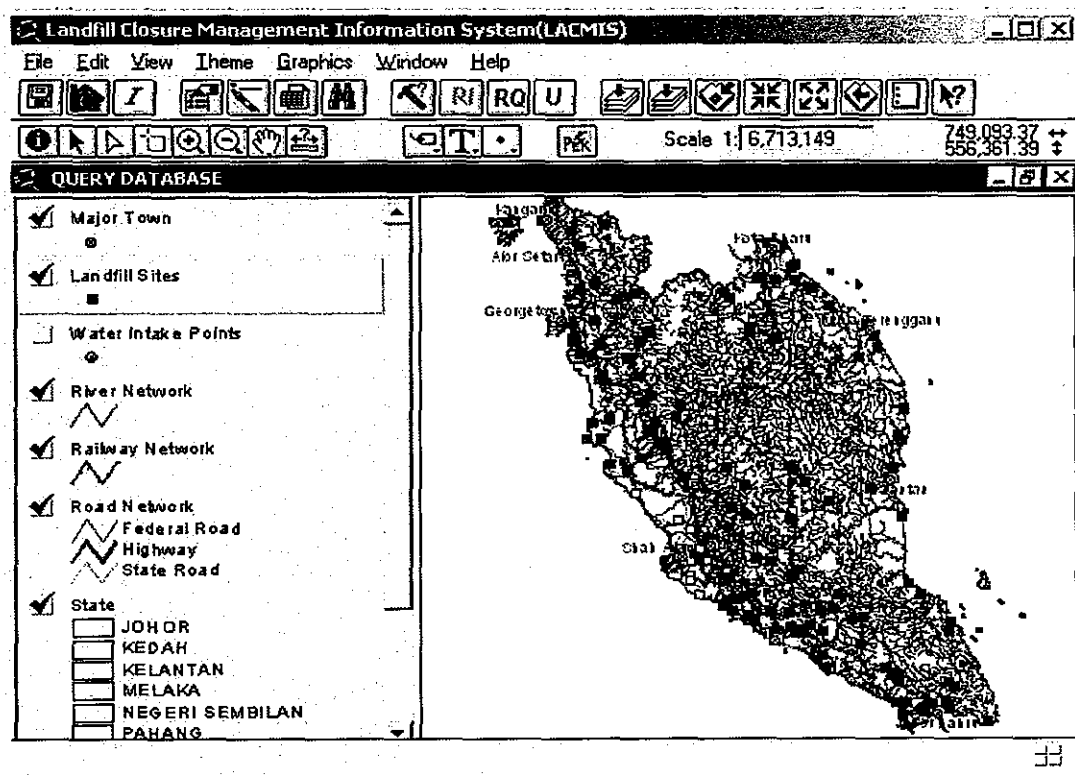


Figure 7.1.3 Example of LACMIS Visual Display

#### 7.1.4 Management of the Landfill Database

Handling procedure of landfill database “Landfill Closure Management Information System (LACMIS)” is shown in Figure 7.1.4. Landfill database shall be opened especially to developers who are going to develop the closed landfill site for other purposes. Responsible authorities of State government (LSMC) take on this role.



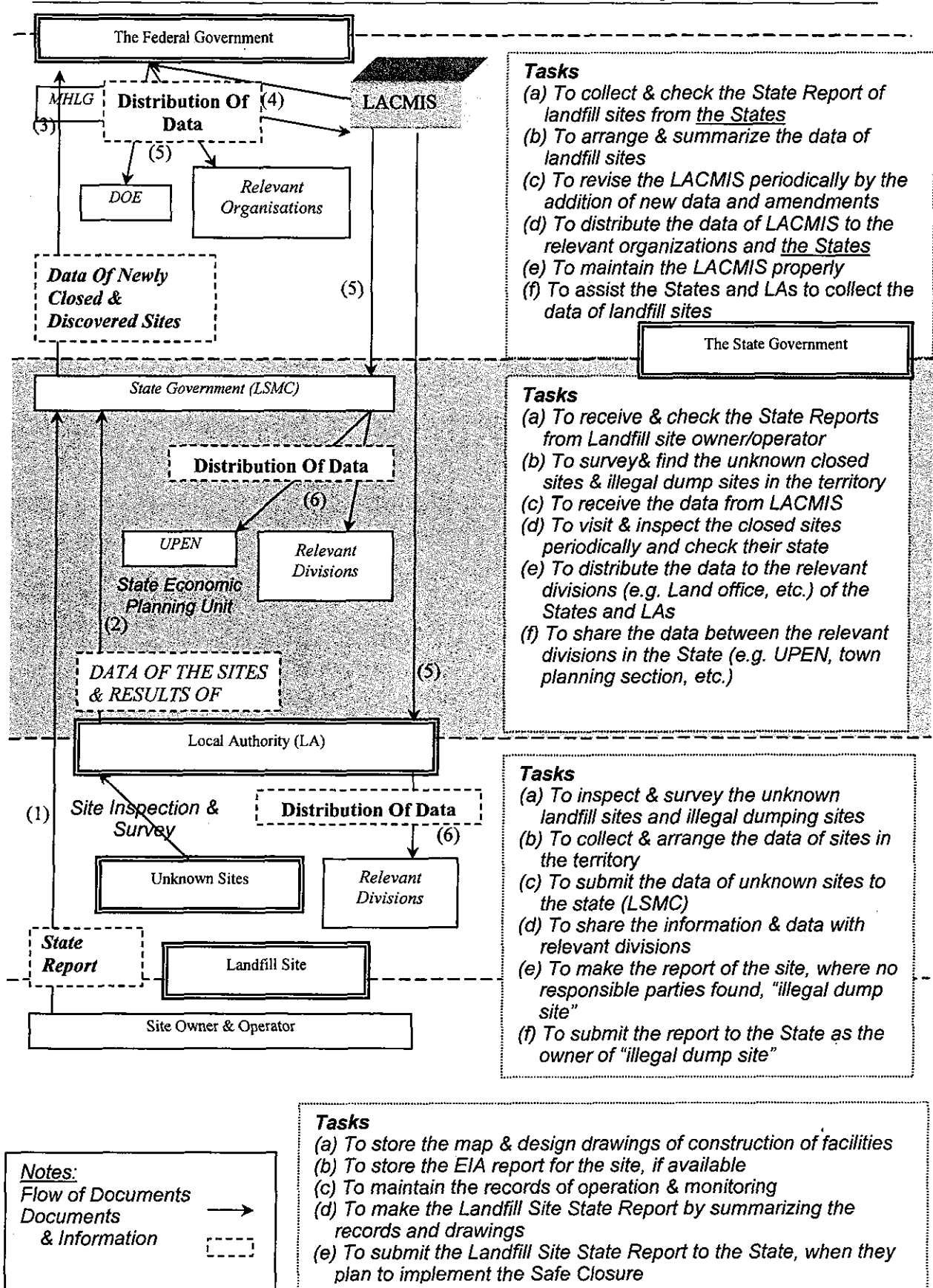


Figure 7.1.4 Roles of the Stakeholders for Management of the LACMIS



## CHAPTER 8 REVIEW OF TECHNICAL GUIDELINE ON SANITARY LANDFILL

### 8.1 BACKGROUND

#### 8.1.1 Technical Guideline on Sanitary Landfill (draft), 1990

In the late 1980's, in line with JICA's long-term corporation with the Government of Malaysia, JICA's SWM experts were dispatched to Malaysia on 3 occasions to advise on SWM in Malaysia. One of the results of the activities, The "Technical Guideline on Sanitary Landfill, Design and Operation (Draft)" was prepared by the JICA expert, Professor Dr. Matsufuji of the Fukuoka University, Japan in October 1990. The Technical Guideline (draft) was prepared and edited with reference to the "Guideline for Construction of Landfill Disposal Site (1989)" published by the Japan Waste Management Association, and also by taking into consideration of the existing conditions of the landfill sites and appropriate technology in Malaysia.

The Technical Guideline (draft) is still in the "draft" stage and is currently still under referred by the related authorities of the Government of Malaysia.

Recently in Malaysia, with the growing awareness and urgent need to introduce more advanced concepts in landfill design and operation, has prompted the review of the Technical Guideline on Sanitary Landfill (draft). As such, the previously existing Technical Guideline had to be reviewed and updated to reflect changes in current technology and the standard practices in Malaysia. The review process also looked into the development of the environmentally safe landfill site and the appropriate approach towards development of the concept plan, design and physical work, and the ultimate influence on the closure of the landfill site.

As a result of the review, "*Technical Guideline on Sanitary Landfill, Design and Operation (Revised draft, 2004)*" has been prepared.

#### 8.1.2 Items to be Reviewed

The items or section in the Technical Guideline that were reviewed were generally to reflect the changes in the present conditions of solid waste management activities in Malaysia, and with consideration and reference to the "Designing procedures and development planning of landfill sites(2001)" and "Guideline for Construction of Landfill Disposal Site (1989)" published by the Japan Waste Management Association. The key items for consideration were as follows

- a. Recommendation for Semi-aerobic Landfill System: In order to minimise the environmental impact caused by the existing landfill sites, the introduction of the semi-aerobic landfill system and the proper techniques of construction and operations of the landfills are necessary. The concept of semi-aerobic system, which has been adopted as the standard landfill system for Japan will be used as the basis for the review.
- b. Sanitary Landfill Levels: There is the need to develop and establish a standard description for the sanitary landfill levels that should be applied throughout

Malaysia. The review was based on the proposed concept of each of the 4 sanitary landfill levels; i.e. Level 1 (primitive level), Level 2 (minimum level), Level 3 (basic level) and Level 4 (advanced level).

- c. **Function of the Landfill:** The description and functions of the landfill were also reviewed in order to clearly define the main functions, i.e. the "storage and treatment function", "environmental protection function", and "land development function".
- d. **Necessity of the Cover Soil:** In order ensure that the proper landfill daily covering activities are realised, the relevant technical requirement and procedures were added to the Technical Guideline.
- e. **Environmental Monitoring:** The description and recommendations for the preparation of the monitoring programme was included.
- f. **Countermeasures for Heavy Rainfalls:** In Malaysia, there are heavy rainfalls throughout the year especially during the monsoon season and also experienced the short burst of heavy downpour, several countermeasures for heavy rainfall was added.
- g. **Sectional Land filling:** When dealing with relatively large landfill site, the land filling process should be carried out in cells or in sectional manner, encouraging better surface water drainage, reducing leachate and minimising the operation and maintenance cost.
- h. **Design Requirements for Leachate Control Systems:** The design requirements for the leachate control system have been included in the Technical Guideline. These included the recommendations on the calculations of leachate treatment facilities.
- i. **Treatment Method of Leachate:** The recommended techniques for leachate pre-treatment, leachate circulation, biological treatment, physical treatment and natural treatment have been addressed and included in the guideline.
- j. **Occupational Health and Safety:** The occupational health and safety directives are essential for all landfill operations and managements. The recommendations and precautionary items on the sanitary and working conditions have been addressed and included.
- k. **Landfill Operation and Maintenance Control:** In line with the SWM privatization, the Government will have the responsibility to monitor all the landfill operations and to check on the activities of the operators. Certain performance indicators have been considered and included such as the recording of the incoming waste, landfill activities, conditions of the facilities and equipment, the outcome of environmental protection and monitoring, and the social considerations. The newly developed "Part III Operation and Maintenance Control of Sanitary Landfill" has also been added.
- l. **Rehabilitation of Existing Landfill Site:** The necessity and recommendations for rehabilitation of the existing landfill sites were reviewed and addressed in the Guideline.

- m. **Cost for Landfill Construction and Operation:** The assumptions and cost estimations for landfill construction were addressed and included for references.
- n. **Explanation of Intermediate Treatment:** Introduction on the related intermediate treatment systems such as recycling, incineration system, were added.
- o. **Updating of Data:** The outdated information and data were reviewed and updated based on the new information attained from the Study.
- p. **Revision of the Contents:** The overall contents of the original Guideline (draft) have been reviewed and revised to reflect the necessary changes and updating works. The salient points of each chapter have been highlighted and presented for ease of reference.



