

# **Public Perception and Acceptance of the Sustainable Urban Drainage System (SUDS) in Housing Schemes in Malaysia**

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## *Abstract*

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A study conducted by The Department of Environment Malaysia shows that there is an increase in numbers of polluted rivers. One problem is said to be due to indiscriminate dumping of wastes into the rivers. This phenomenon adversely affects the drainage capacities of rivers which then leads to more frequent occurrences of floods as well as an increase in the intensity of the floods. The issues are critical since 97% of the total water use originates from rivers.

In Malaysia, 40-60% of water use comes from the domestic domain. Domestic wastewater gives an impact on the quality of water. Public involvement is very important in order to control the current water situation as public contributions to water issues are very significant. In daily activities, the public pollutes the drainage runoff unconsciously. Increasing urban population causes a massive impact on human activities, especially in a developing country like Malaysia. In Malaysia, urbanization has a lot of advantages for the economic sector. Therefore, development needs to be carried out in order to provide a range of facilities for the population.

On the other hand, living in comfortable and convenient spaces has persuaded many people to renovate their houses. This then results in an increase in the number of impervious areas because housing developers only have to comply with providing 10% of open space. Developers usually choose to maximise the built-up areas to take full advantage of land use and this situation has resulted in an increase in surface run-off. This is in fact a major cause of flash floods.

Natural filtration devices have been incorporated in Sustainable Urban Drainage System (SUDS) as a means of imitating natural hydrological processes. They are found to be more effective compared to the conventional drainage system, and delay filtration and run-off of surface water. SUDS not only improve the technical approaches of a drainage system, but also assists in 'Best Management Practices' (BMPs). This includes management and maintenance together with better daily water usage. However, to assist the success of SUDS, public participation should be encouraged. The wider public and all stakeholders should have a better understanding of SUDS in order to allow them to get a clearer idea of their potential role. Improvement in the education system, frequent updates on information and training for maintenance workers are some of the actions that might influence the implementation of SUDS in Malaysia.



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***Abbreviation***

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ANZECC	Australia And New Zealand Environment And Conservation Council
ARI	Average Recurrence Interval
BEP	Best Environment Practices
BET	Best Available Technique
BMPs	Best Management Practices
CAP	Consumer Association of Penang
CIRIA	Construction Industry Research And Information Association
DID	Department Of Irrigation And Drainage
DOE	Department Of Environment
ECOPOND	Ecological Pond
GPT	Gross Pollutant Trap
IEA	Institute Of Engineers Australia
IWRM	Integrated Water Resources Management
JB	Johor Bahru
LCC	Life Cycle Cost Analysis
MNS	Malaysian Nature Society
MP	Malaysia Plan
MPJBT	Majlis Perbandaran Johor Bahru Tengah (Central Johor Bahru Municipal Council)
MSC	Multimedia Super Corridor
MSMA	Manual Saliran Mesra Alam (Sustainable Urban Drainage Manual)
NEP	National Economic Plan
NGO	Non-Governmental Organisation
OGGT	Oil, Grease and Grit Traps
PBA	Perbadanan Bekalan Air Pulau Pinang (Penang Water Company)
PWD	Public Work Department
REDAC	River Engineering And Drainage Research Centre
RIVERS' 04	1 <sup>st</sup> International Conference On Managing Rivers In The 21 <sup>st</sup> Century
SAJ	Syarikat Air Johor (Johor Water Company)
SMART	Stormwater Management And Road Tunnel Project
SUDS	Sustainable Urban Drainage System
UDDS	Urban Drainage Design Standard And Procedures For Peninsular Malaysia
USM	University Science Malaysia
WC	Water Closet



# Chapter 1

## *Background and Framework*

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### 1.0 Introduction

Although 75% of the Earth is covered by water (Fisher, 2004), only 3% of it fresh water and is suitable for living things (i.e. animals and human). In nature, water goes through several processes before it evaporates into the air (refer to Figure 1.0) in processes known as 'hydrological cycles'. However, pollution has been a major issue with regards to fresh water systems. From 'Water: No longer taken for granted':

*"As population continually modify the environment to suit their needs and desires, the natural processes, including the hydrologic cycle, are significantly disrupted..."*

(Fisher, 2004; 7)

There are two factors that have changed the basic quality and natural distribution of water; pollution and human intervention (Fisher, 2004). In order to make more improvement, the Sustainable Urban Drainage System (SUDS) has been chosen as a method for widespread implementation. The 'Manual Saliran Mesra Alam' (MSMA) is the first manual with sustainable drainage approaches and was launched in January 2001. This manual replaced the old hydrological manual which has been used for twenty-five years. The approached emphasise in this manual are based on sustainable development concept.

In supporting better water quality, the Malaysian Government included in the fourth of the five key thrusts, which is 'improving the standard and sustainability of the quality of life in its 9<sup>th</sup> Malaysian Plan (9MP) (Government Document- Malaysian 9<sup>th</sup> Development Plan 2006-2010, (2006), The Star, (1<sup>st</sup> April 2006)). This is an attempt to promote a sustainable development approach in Malaysia. Based on the World Sustainable Development Performance Index (9MP, 2006), Malaysia is in the 38<sup>th</sup> place out of 146 countries in the world and is in the 2<sup>nd</sup> place in Asia in their efforts to implement sustainable development. In supporting sustainable development, the Malaysia government have adopted legislation and guidelines in order to protect the environment especially those related to the marine and riverine ecological community (Basiron, 2004). The legislation and guidelines can be divided into four categories:

1. International laws and treaty
2. National policies and acts of parliament
3. State enactments
4. Local by-laws

Further explanation on government action in supporting sustainability and protecting the qualities of water can be found in Chapter 3.

The estimated amount of wastewater from urban activities which flows into the water bodies worldwide annually is 450km<sup>3</sup> and 600km<sup>3</sup> of water is needed to dilute it before it can be used again (Haughton and Hunter, 1994). It has been projected that the world population by year 2025 will be 10 billion, and an estimated 4.5 billion people in developing countries will be living in urban areas (Hough, 1995). An article in The Star (2006) stated that, by 2010, the population in Malaysia will reach 28.96 million with 63.8% living in urban areas (Table 1.0.1).

Public involvement is very important to control the current water situation as public contributions to the water issues are very significant (Apostolaki et al., 2001). In daily activities, the public pollute drainage runoff without being aware of it. The increase in urban population will have a massive impact on human activities, especially in a developing country like Malaysia. In Malaysia, urbanization has a lot of advantages for the economic sector. Therefore, development needs to be carried out in order to provide supporting facilities for the population. Discussion on related issues are elaborated in the section on the 'Definition of Keywords and Concepts' (refer to section 1.01)



					Average annual growth rate (%)	
	2005	%	2010	%	8MP	9MP
<b>Total population</b>	26.75		28.96		2.6	1.6
Citizens	24.36	100.0	26.79	100.00	2.0	1.9
Bumiputera	16.06	65.9	17.95	67.0	2.3	2.2
Chinese	6.15	25.3	6.52	24.3	1.3	1.2
India	1.83	7.5	1.97	7.4	1.6	1.4
Others	0.32	1.3	0.35	1.3	2.6	2.2
Non-citizens	2.39		2.17		11.0	-1.8
<b>Age structure</b>						
0-14	8.72	32.6	9.18	31.7	1.7	1.0
15-64	16.88	63.1	18.42	63.6	3.0	1.8
65 and above	1.15	4.3	1.36	4.7	4.3	3.4
<b>Dependency ratio (%)</b>	58.5		57.2	-	-	-
<b>Median age (years)</b>	23.3		24.2	-	-	-
<b>Total fertility rates</b>	2.76		2.48	-	-	-
Bumiputera	3.18		2.80			
Chinese	2.19		2.04			
Indian	2.34		2.15			
<b>Urban (%)</b>	63.0		63.8	-	-	-
<b>Rural (%)</b>	37.0		36.2	-	-	-

Table 1.0.1: Population size and age-structure 2001-2010 (million persons) (Source: Department of Statistics and Economic Planning Unit (2006))

### 1.0.1 Definition of Keywords and Concepts

These definitions are included in this study in order to offer better understanding of some of the keywords used in the following chapters. An explanation of concepts may offer further understandings of some of the theories that lay behind the keywords.

#### 1.0.1.1 Water Pollution

In general, water can be classified into categories such as drinking water, wastewater, coastal water and others. These categories can be related to stages within the hydrological cycle (Figure 1.0). Pollution can be understood as an unacceptable level of alteration of water quality relative to natural conditions within these different categories.



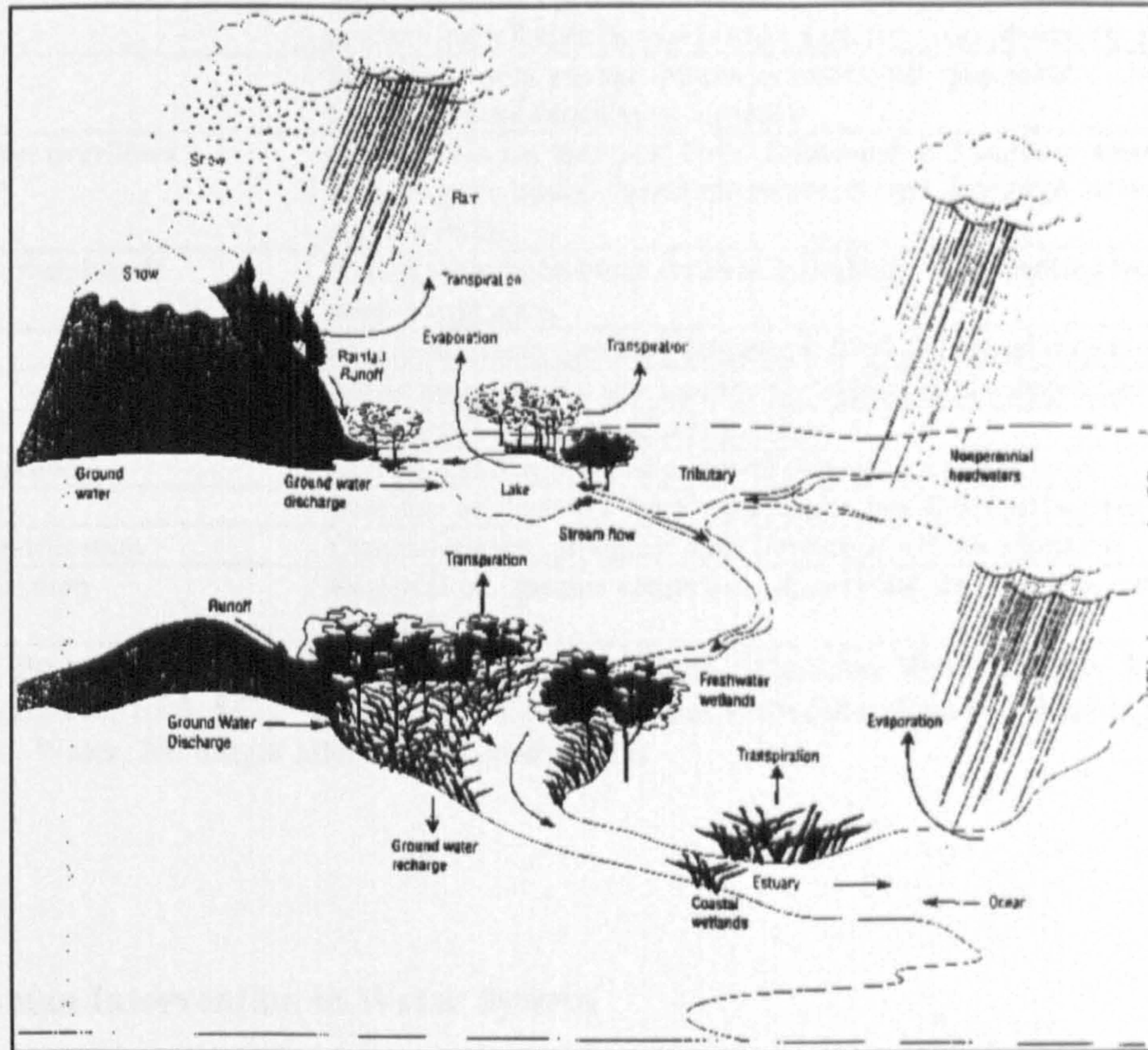


Figure 1.0.1: 'The Water Cycle' in National Water Quality Inventory: 1998 Report to Congress, EPA 841-F-00-006, US Environmental Protection Agency, Washington, DC, June 2000 (Source: Water: No longer taken for granted, 2003).

According to Fisher (2004) water pollution is caused by human introduction of materials or organisms into water bodies. Despite the longstanding belief that water has an inexhaustible capacity to process wastes, in fact it is extensively deteriorating due to technological impacts from many economic sectors (Table 1.0.2).



<b>Category</b>	<b>Examples</b>
Industrial	Pulp and paper mills, chemical manufacturers, steel plants, metal process and product manufacturers, textile manufactures, food processing plant
Municipal	Publicly owned sewage treatment plants that may receive indirect discharges from industrial facilities or business
Combined sewer overflows	Single facilities that treat both stormwater and sanitary sewage, which may become over loaded during storm events and discharge untreated wastes into surface water.
Storm sewer/ urban runoff	Runoff from impervious surfaces including streets, parking lots, buildings, and other paved areas
Agricultural	Crop production, pastures, rangeland, feedlots, animal operations
Silvicultural	Forest management, tree harvesting, logging road construction
Construction	Land development, road construction
Resource extraction	Mining, petroleum drilling, runoff from mines tailing sites
Land disposal	Leachate or discharge from septic tanks, landfills, and hazardous waste sites
Hydrologic modification	Channelization,, dredging, dam construction, flow regulation
Habitat modification	Removal of riparian vegetation, streambank modification, drainage/filling of wetlands

Table 1.0.2: Pollution source categories used in this report, "National Water Quality Inventory: 1998 Report to Congress, EPA 841-F-00-006, US Environmental Protection Agency, Washington, DC, June 2000 (Source: Water: No longer taken for granted, 2003).

### **1.0.1.2 Human Intervention in Water System**

Urbanization provides people with many facilities and infrastructure without realizing that they have intervened in the natural processes in the environmental system, especially the hydrological cycle. An alteration of any phase of hydrological cycle, such as dams, irrigation, drainage and hydroelectric plants, are considered as human intervention (Fisher, 2004). In this study, the focus is on drainage systems. Basically, drainage is used in agriculture and also as a method to drain surface water into the nearest water bodies.

As discussed earlier (refer to section 1.1), Malaysia has also faced many problems related to water pollution issues (refer to Chapter 3, section 3.1.2). However, the Malaysian government has made an effort to introduce MSMA as one of the solutions for stormwater management. The introduction of the SMART Tunnel (refer to Chapter 8) is also the latest method for stormwater management. It has been functioning since 2007.



### 1.0.1.3 Awareness and Perception

Humans are believed to dominate the processes involved in environmental changes (Bell, et al., 2001; and Bonnes and Secchiaroli, 1995). These processes occur both in intentional and unintentional ways. The action taken is then stimulated based on experiences. Psychologists have suggested that 'environmental stimulation' is influenced by two processes; awareness and perception. According to Goldstein (1999) cited in Bell, et al., 2001; 57:

*"Sensation (awareness) has been applied to the relatively straightforward activity of human sensory systems in reacting to simple stimuli such as an individual sound or a flash of light"*

Goldstein explains that the awareness and evaluation process are formed on the sensations created by an array of photons of light stimulating in one's eye receptor cells. Humans learn and experienced things based on what they see. It is a process that they go through in their daily life.

However, 'perception' has been defined as involving more complicated processes (Bell, et al., 2001; and Bonnes and Secchiaroli, 1995). Perception is a process of integration and interpretation of complex and important stimuli that human experience in their daily life. This perceptual process has been discussed in as early as the 19<sup>th</sup> century. Researchers have tried to understand how humans differ in sensing lights, colours and other phenomenon (Bell, et al., 2001). Researchers have realised that psychologists only managed to investigate only observable phenomena such as physical and behavioural elements. The later studies focused instead on biological events that lead to sensations. For example the function of ears and eyes are seen as a basis to the neurological sensations generated by light and sounds. Therefore, scientists have concluded that the part that humans perceive is based on the mechanical transmission of a sensory from one nervous system to another. Later, these processes will end at the back part of the brain cortex known as 'primary visual receiving area'. All the process capturing perceptual experience will lead towards meaningful individual perception of space. This meaningful perception of space can either be an encouraging or unconstructive experience. They then assist in the human process of feeling those memories influence their perceptions.

In this study discussions are more focused on an ecological perception of the environment, called 'functionalism'. Functionalism allows humans to compare the present sensation with one that they have experienced earlier (Kaplan and Kaplan, 1982; and Ulrich, 1993). This will help them to stimulate signals in identifying positive or negative impacts. J. J. Gibson's ecological theory, emphasizes the processing of individual cues in visual images (Bell, et al., 2001). Gibson's, (Bell, et al., 2001; 65) states:



*“...rather than perceiving individual features or cues that we organize into recognizable patterns, we respond to meaning that already exists in an ecologically structured environment. We may overlook some of this embedded meaning, but it is readily available to an appropriately attuned organism mobile enough to experience it...”*

Gibson believes that perceptions towards environment are occur in a more direct manner. The properties of environments should not be perceived as distinct points but as meaningful entities. Describing Gibson's approach based on 'Perception of Affordances', it is established that we receive lots of information directly through our perception of the environment. These processes of exploring environment allow humans to experience objects in many ways from different perspectives. This is known as 'invariant functional properties'. Through the process of perception of affordances, one can identify the 'ecological niche'. This ecological niche is a set of affordances that are utilized by human natural instinct. For example, one can afford to change the environment based on his comfort levels, such as having an expensive accommodation with beautiful scenery. Humans learn from their experiences (Appleton, 1997; and Bonnes and Secchiaroli, 1995); therefore, the process of awareness and perception help them to understand more of the threats that are faced by their surrounding environment. These will lead to an acceptance of changes or adaptation (Bell, et al., 2001; and Bonnes and Secchiaroli, 1995).

## **1.1 Public Perception of SUDS**

Kaplan (1989) refers to water as a very important element in landscape. However, how does the public perceive their landscape nowadays, and how does water play its role in the current environment? As a developing country, Malaysia faces a major water pollution problem. According to the Department of Drainage (DID), there is an increasing number of rivers that are polluted each year (Abdullah and Mohamed, 1998). Therefore, DID launched a 'Love Our Rivers' campaign in 1993. However, in 1999, the campaign committee reported that the campaign did not fulfil the main objectives due to a lack of awareness and education (DID 'Love Our Rivers Campaign' webpage, 1999; further discussion refer to Chapter 3). The community's participation and professional involvement are needed to support sustainable drainage implementation. Although the public and professionals in the construction industries might have a different understanding or opinion of sustainable drainage, these discrepancies should be solved to provide the benefit of good quality living environment to everyone (further discussion in Chapter 6 and Chapter 7).



Baker and Boonchote (1998), found that, due to different perceptions and understandings in identifying the awareness between a technical expert and the public about industrial hazards, there is a difficulty in analysing the risks. In conclusion, they did mention that there was a need for proper education and training for experts to devise a rationale on how to tackle the public (Baker and Boonchote, 1998). It is clearly shown that to get SUDS recognized by the public and professionals in the construction related industry, a proper outline of environmental education, especially relating to water issues, is needed.

## 1.2 Research Context

The percentage of urban population has increased over the past ten years in Malaysia as shown in Table 1.2.1. In 1998, a National Water Resources Study was held to assess and update water resources availability in Peninsular Malaysia and also to formulate a Master Plan for Water Resources Management and Development in order to forecast water demand for all users until the year 2050.

	Peninsula Malaysia	Sabah	Sarawak	Malaysia
Urban	86 (37)	33 (21)	37 (18)	51 (34)
Rural	14 (53)	67 (79)	63 (82)	49 (66)

Table 1.2.1: Distribution between urban and rural areas 1991 (percentage). A comparison between Census data 1991 and 1980 (figures in the brackets). (Source: Population and Housing Census Malaysia 1991).

Rapid developments have taken place in many parts of the country in order to fulfil demand, especially in urban areas such as Kuala Lumpur, Georgetown and Johor Bahru. However, uncontrolled development activities in watersheds and along river corridors have increased the severity of floods. It has been estimated that 29 000 km<sup>2</sup> or 9% of total land area in the country is prone to flood affecting approximately 2.7 million people (Abdullah and Mohamed, 1998). The rapid developments with total impervious areas are very high since housing developers only have to comply with providing 10% of open space. Normally, the developers will maximise built-up areas to take full advantage of land use and this situation has resulted in an increase in surface run-off. At present, this has been recognised as a major cause of flash floods in urban areas. Urbanization has increased the amount of impervious ground. This eventually increases the fraction of rainfall which then turns to runoff. Usually, rainwater gets intercepted by vegetation; infiltrates into the ground, and takes times to travel to the river. However, in this case, it is collected from the roofs and other paved grounds and canalised efficiently to public drains which, in turn, rapidly carry it to the nearest river.



The Malaysian government has spent millions of Malaysian Ringgit (MYR) on DID projects and flood mitigation (Tables 1.2.2 and 1.2.3). The Malaysian Government spent MYR930 million from 1971 to 1995 on flood mitigation work; and under the 7<sup>th</sup> Malaysian Plan, the allocation for flood mitigation programmes was MYR900 million (Utusan Malaysia, 2000). This is seen as a big investment in order to improve environmental quality. The 9<sup>th</sup> Malaysian Plan allocated MYR1.13 billion to environmental protection (Table 1.2.4) of which MYR4 billion was earmarked for flood mitigation programmes.

Category	1 <sup>st</sup> MP (1966-70)	2 <sup>nd</sup> MP (1971-75)	3 <sup>rd</sup> MP (1976-80)	4 <sup>th</sup> MP (1981-85)	5 <sup>th</sup> MP (1986-90)	6 <sup>th</sup> MP (1991-95)	7 <sup>th</sup> MP (1996-00)
Irrigation	260	140	305	257.8	59.8	70.2	197.9
Agriculture drainage	25	40	155	129	79.3	110.9	131
River management	-	-	-	-	-	55.3	145.4
River (Flood mitigation)	7	14	56	163	203.4	377.7	873.1
Water resources (Hydrology)	-	-	-	4.3	2.0	11	20.9
Coastal protection	-	-	-	-	12.4	128.4	123.1
Other program	8	16	35	18.3	24.4	64.7	102.9
total	300	210	551	572.4	381.3		

Table 1.2.2: DID development expenditure in Malaysian Plan (MP) (unit: million MYR) (Source: Zainal Abidin MR., 2002)

Year	Budget (MYR)	Expenditure (MYR)
2001	365 990 000	339 656 194
2002	487 410 960	-
2003	300 700 000	-
2004	272 800 000	-
2005	122 927 040	-
Total	1 549 828 000	-

Table 1.2.3: Flood mitigation projects – 8<sup>th</sup> Malaysian Plan Budget (Source: Zainal Abidin MR., 2002)

Environmental protection strategy	Budget allocation for 9 <sup>th</sup> MP (MYR)
Cleaning, conserve and beautify rivers	510 million
Coastal management	350 million
Forest re-planting	200 million
Wildlife management	70 million
Flood mitigation programme	4 billion

Table 1.2.4: Allocation for environmental strategic plan in the 9<sup>th</sup> Malaysian Plan (Source: Berita Harian, 1<sup>st</sup> April 2006)

### **1.3 Background Research**

This study focuses on the current scenario of urban drainage system in residential areas in Malaysia. This includes the Malaysian domestic water usage and its contribution towards environmental issues; the action taken by the Malaysian government to encourage an environmental friendly drainage solution; and a few examples of the sustainable drainage systems in Malaysia. This study may lead to further ideas on how the public and professionals might play their role in supporting and improving the implementation of the Sustainable Urban Drainage System (SUDS). It also includes an introduction to the basic principles of the SUDS and how the component works to sustain our environment.

The research aims and research questions may give a clearer view of the scope and context of this study. This study also discusses the structure of the methodology that will be used to allow the researcher to explore the situation in order to obtain results for a better drainage system in housing areas in Malaysia.

### **1.4 Directly Relevant Research**

This study involves many facets of research areas which are of great relevance. 'Public perception and acceptance of the SUDS in housing schemes in Malaysia' needs a good understanding of issues related to various fields such as human perceptions on living environment, an understanding of cultural issues, public attitudes to SUDS, a technical understanding of SUDS as well research methodologies. All these issues need a good background understanding of environmental psychology.

#### **1.4.1 Human Perception and Acceptance of Living Environment**

As discussed in the introductory paragraph, human perception is mostly influenced by their experience. Experiences lead humans to stimulate perception. Perception then helps human to generate an acceptance of changes or adaptation.

Kaplan's works focuses more on human perception of environmental values. The experience of nature: A psychological perspective (1989) is a study of people and the way they appreciate nature. It is an interesting long-term research. The method which really contributes to this study



is mainly related with the use of images in assessing people's appreciation and awareness. People are seen as bonded with nature, whether direct or indirect, and to study people's perceptions is difficult as people have different perceptions, understanding and opinions about the environment. It is interesting to note that the functioning of humans depends on the information they gain (Kaplan and Kaplan, 1989). Although Kaplan's study was based on twenty years of research from various individuals with the same interest, it has developed a very large conceptual base related to this study which leads to one main factor: understanding people and nature.

Other than that, With People in Mind: Design and Management of Everyday Nature (Kaplan, et al., 1998) also gives a clear idea of how people perceive their surroundings. With regards to their study, it is to identify public perceptions and acceptance of SUDS in residential areas. It is interesting to note that they suggest a relationship between environmental aspects and people's experiences. In their study, forty-five patterns were discussed and divided into three different topics. They are approaches to design and management of everyday natural environment, integrating the solution for design and management by considering the context in a natural setting, and decision-making in design and management that can deal with people's response to change. The suggested patterns provided lots of ideas while developing the questionnaires for this study. It also well as gives guidance in selecting and composing images for the research survey of this study.

#### **1.4.2 Cultural Issues and their Connection with Landscape**

Cultural issues have an impact on public opinion, perception and acceptance of surrounding landscapes. The way individuals are raised also their affect their ways of seeing the world (Gifford, 1997). Collin Turnbull's experiences with the Pygmies of Congo region shows that the Pygmies' experiences are obstructed by the size-constancy (Gifford, 1997). Gifford (1997: 22) explains:

*"...this is one example of what has been called the **carpentered-world hypothesis**, which attributes certain differences in perception to the striking discrepancies among the perceptual environments of various societies..."*

A study conducted by Nassauer and Jorgensen is closely related to the argument between the understanding of culture and ecology in the environment. Placing Nature: Culture and Landscape Ecology edited by Nassauer (1997) is a good reference for understanding public response to and awareness of their surroundings. It is suggested that public living space may have an impact on their perception and interpretation of local situation. It discusses the



appropriate role of human in dealing with nature as we dominate this world. The authors' different backgrounds provide a wider range of views and opinions that are comprehensible in various scopes and aspects. This is important in studying culture and ecology in order to understand human perceptions, behaviour and communities. In determining the ecological function, it is important to have knowledge of ecology and its effects on culture because it is believed that human beings and landscape influence ecosystems. Therefore, future landscape could not be predicted without acknowledging human values which differ according to sociological backgrounds, religions and regions of origin collectively known as 'culture'. A study by Gorham (1997), Human impacts on ecosystems and landscapes, suggest that ecological issues are generally understood by many to have been caused by the impact of increasing human population as well as urbanisation which in turn has an impact on industrial activities. However, Gorham emphasizes that the ecological problems are affected by new cultural habits, such as using leaded fuel, the use of fertilizers, pesticides and washing detergent in daily life. Romme (1997) in his study, Creating Pseudo-Rural landscape in the Mountain West, Romme highlights that every patch has its ecosystem function, such as parking space, fields and buildings. Therefore, it is important that each patch should be designed or treated to sustain the needs of the ecosystem. However, there is also a suggestion that civilization can indeed protect nature. On the other hand, Warner and Martin (1997) in their study Urban conservation: Sociable, Green and Affordable, and Nassauer(1997) believe that it is possible to integrate ecological approaches into development as long as the implementation strategies can co-exist with the development processes. Although their study emphasize Western culture, it is beneficial to obtain a basic idea of how culture does influence nature. It is also an advantage to make comparisons between different cultures.

In discussing aesthetics, it is believed to be closely related to nature. The process of creating a landscape should go together with aesthetic elements in order to fulfil people's needs. However, too much aesthetic input without landscape ecological knowledge will detract from the natural characteristics. According to Gorham (1997) Human impacts on ecosystems and landscapes, Eaton (1997) The beauty that requires health and Meine (1997) Inherit the grid, ecological knowledge is important to sustain aesthetic attention to landscape by not only allowing the understanding of nature, but also broadening human experience of landscape and nature. This ecological knowledge would be best integrated with cultural needs in order to display care towards the landscape. Nassauer expresses the view that cultural attitude influences care for the landscape. Cultural attitudes, such as traditions of land ownership, have a great impact on the sense of ownership and the appreciation of nature which, in this study, can be related to a sense of homeownership. There are indeed numerous discussions of culture and nature, and thus it is very important in this study to understand these issues as culture is indeed an important part of ecology.



The social and cultural context of ecological plantings by Jorgensen (2004) in The dynamic landscape edited by Dunnet and Hitchmough (2004) gives a good introduction to the influences of the social and cultural factors in the natural local context. Jorgensen emphasizes that good aesthetic qualities should be accepted by people who live, work and play within the surroundings. There also an argument on human preferences which has two bases; the theoretical and the public responses to perception. An understanding and experience of and access to information the local landscape issues and contexts are important in obtaining human perception. Some have debated that preferences are geared more towards an English landscape which resembles a savannah urban landscape while others are argued that humans prefer a natural setting. Most of the studies focus on visual preferences, which is applicable in assessing landscape preferences. However, there are limitations and weaknesses in the study; for example, the diversity of human needs, experiences and changes of view should be taken into consideration. The way people perceive and appreciate things are very subjective issue as time goes by while experiences change people's opinions and perceptions.

Culture is also a very broad issue. People from different cultural backgrounds and origins possess different experiences and opinions of their local landscape surrounding. For example, the Japanese gardens conceptually imitates nature with elements of rivers, seas and mountains whilst the French garden is more likely to be formal with sculptures and fountains. It is interesting to note that there is a difference between an 'anthropentric' and 'ecocentric' opinion from the public about nature and their surroundings. In general, it is quite difficult to get specific answers for this study as people have different interpretations, perceptions and understanding, and these are also influenced by a number of demographic or personal factors, such as age, gender, educational background and locality. Public involvement in providing a natural setting in an urban area would be a long process. However, sharing information is a good starting point towards the collaboration of ideas. Overall, Jorgensen's studies were based within the English culture, and thus it is felt useful to study the similarities or differences between the English culture and the Malaysian culture. It will provide ideas about how culture between different regions can influence public perceptions of its ecology and landscape. This also act as an opportunity for other researchers to make use of the findings in this study for future research when comparing public and other cultural backgrounds.



### **1.4.3 SUDS and public perceptions**

Apostolaski et al. (2001) conducted a similar study in assessing public perceptions of SUDS in Scotland. In their study, they highlight the role of the public in contributing to runoff pollutions, which is closely related to public awareness. They also stress the importance of education in discovering the public attitudes towards catchment areas. A survey was conducted in 1996, where questionnaires were distributed amongst stakeholders involved with SUDS. This was done in order to get their feedbacks on knowledge and experience of SUDS. Findings show that the stakeholders do possess their understanding of SUDS and had managed to implement the systems. The same approaches were also used later targeted towards householders in three different residential criteria. The studies mainly emphasize two SUDS components which are roadside swale and SUDS ponds. It is interesting to note that almost none of the residents are either aware of the SUDS components or require further information on SUDS. These studies provide assistance for this study in assessing public perception in developing countries such as Malaysia. Furthermore, SUDS is a new application in Malaysia and will be a continuous process.

Research on public attitudes and behaviour for management of urban water systems has been conducted by Ashley et al. (2001). Their study aims to identify public consciousness and action to resist changes in urban water management system. Their study also emphasizes information supply and distribution to allow the understanding of all stakeholders to facilitate their judgement on related issues. It also assists this study in dealing with opinions from professionals involved with SUDS in Malaysia while at the same time identifying similarities in public attitudes towards urban water management.

Research conducted within the Malaysian context is also referred to in order to gain supportive input from earlier studies from the same background. However, research conducted in Malaysia seems to focus more on the relationship between the public and the river systems. Research on SUDS in Malaysia has been conducted mostly on the technical aspect of SUDS application and its suitability within the Malaysian context.

A similar attempt has been conducted by Nordin (1999). He looks at the knowledge, attitude practices in domestic and solid waste by residents along the Juru River basin in Malaysia. His study shows that there exist issues regarding the residents' attitudes and knowledge.

Other than that, focus on SUDS in terms of technical information is also beneficial to this study. Information published by the Construction Industry Research and Information Association (CIRIA), such as Sustainable Urban Drainage Systems: Best Practice Manual (2001) has also



influenced the whole understanding of SUDS practices at the international level. To balance the understanding of SUDS within the Malaysian condition and context, the papers and publications by the River Engineering and Urban Drainage Research Centre (REDAC) and the Department of Irrigation and Drainage Malaysia (DID) provide much appropriate information. There is a similarity in the components discussed in both manuals. However, MSMA seems to focus more on details of the technically based information. Meanwhile there is flexibility in the manual produced by CIRIA which encouraged designers to explore SUDS and continue to collaborate for the design in order to be more efficient. Details about SUDS are presented in the following chapters.

## **1.5 Informed Opinions**

Although this study focuses more on the residential landscape, opinions from other related parties, involved either directly or indirectly in the drainage system and SUDS are also taken into consideration. This also include information covered in the Malaysian context. Feedbacks and comments from other parties are indeed very important in this study. Opinions from others also help to identify better solutions from the experts in this area of study.

In this study, a few organizations and individuals have contributed and shared their experiences in implementing SUDS in Malaysia. This then leads to a better understanding of SUDS application as well as the difficulties and the challenges faced by SUDS in Malaysia, such as those experienced by REDACS, DID, and Putrajaya Corporation.

## **1.6 Research Questions**

Generally, the research questions concentrate on the design criteria, such as public needs, SUDS suitability and the need for enforcement elements in order to apply the system in Malaysia. There are five questions to be answered and the questions have been categorised into two different approaches.

The first three questions are to be answered through theoretical development. The questions are:

1. What are the main components of a sustainable approach to drainage in urban housing schemes as developed in Western countries?
2. What are the main problems associated with urban drainage in Malaysia and what are the solutions?
3. How can the known SUDS principles be adapted to the Malaysian context?

The final two questions, which need to be answered by evaluating and surveying in the study area, are:

1. How is the acceptance to the application of sustainable drainage schemes in Malaysia, and do the design professionals in Malaysia have:
  - a. Knowledge of such systems and,
  - b. Are they willing and able to implement them?
2. How is the perception and acceptance of the Malaysian public towards SUDS application?

## **1.7 Research Aims**

In order to fully explore the research question in this study, there are two aims to be referred to. These would then act as guidelines for the exploration of this study. The aims are:

1. To identify a suitable approach to sustainable urban drainage in the context of residential development in Malaysia. The objectives of Aim 1 are:
  - To understand public opinions in terms of their surrounding landscape.
  - To study the appropriate design solution to the housing surrounding which will emphasize SUDS application.
2. To investigate the extent of public and professional acceptance of sustainable urban drainage in a residential context in Malaysia. The objectives of Aim 2 are:
  - To study the feedback from the residential community and professionals involved in housing developments on the current drainage system in Malaysia.
  - To understand the barriers faced by professionals that need to be considered in developing SUDS in housing areas in Malaysia.



## **1.8 Research Methodology**

The methodology for this study was planned in 2002. This study uses qualitative and quantitative methods. They include a postal questionnaire survey and interviews. The methodology for this study is discussed in Chapter 4.

## **1.9 Limits to the Field of Investigation**

After years of MSMA implementation, there has not been much influence of SUDS application in landscape design, especially in housing development. Great consideration is needed in implementing the system and involvement from a wider range of professionals and the community should be encouraged. However, this study has considered the following influences in order to support this study:

- It has taken into consideration the Urban Stormwater Manual used by all states and its provision in Malaysia. The implementation of all drainage work is monitored by the Department of Irrigation and Drainage Malaysia.
- The geographical factors in Malaysia are almost similar.
- This study only emphasizes the application of SUDS in a housing area in Malaysia.

## **1.10 Structure of Thesis**

The thesis is presented in eight chapters. Each chapter discusses different topics as described below.

An introduction on water and drainage issues is provided, with a general introduction to SUDS in Chapter 2. There is also an introduction to the theoretical frameworks on the basic principles and technical approaches of SUDS. It also reviews SUDS principles implemented in other countries. MSMA is reviewed too and the discussion intends to look into their implementation in Malaysia.

Chapter 3 is the continuing chapter on the theoretical frameworks. It discusses the water scarcity and issues in Malaysia. A brief introduction to the drainage system implemented in an urban housing scheme in Malaysia is also reviewed.

The methodology of this study is discussed in Chapter 4. The methods used for the postal questionnaire survey and the interview for both the public and the professionals are explained.

In Chapter 5, findings from all case studies are presented. This includes a wider discussion of Johor Bahru residential areas, Putrajaya residential areas, and Bio-Ecods implementation in USM Transkrian campus in Penang. This chapter will give an idea of the systems that are currently being implemented in Malaysia. Analysis and results of the survey, conducted in the Summer of 2003 and the Summer of 2004, are discussed in Chapter 6 and Chapter 7. Chapter 6 discusses the qualitative and quantitative data obtained from the public. Chapter 7 discusses the analysis and result discussion obtained from the professional survey.

Chapter 8 discusses the findings of this study and includes the recommendations for SUDS/MSMA improvement. The methodology that has been used is also reviewed, and the advantages and disadvantages are pointed out. The limitations of the findings are also discussed. The summary of this thesis discusses the outcomes which may be beneficial to particular areas of this study. Recommendations for further research on related issues are also included.

## **1.11 Summary**

This chapter is an introduction to this study. The first part of this chapter has explained general information on related issues to urban drainage systems. This covers the descriptions and concepts of the hydrological cycle, people and environmental issues, and drainage system. This chapter has also presented related research issues, research questions and the scope of study. The following chapter thus discusses the first part of the main literature review - water and urbanisation followed by literature review which discusses more on the technical and conceptual aspects of sustainable urban drainage systems.



## **Chapter 2**

### ***Theoretical Development:***

- ***Human and Environmental***
  - ***SUDS Basic Principles and Technical Approaches***
- 

### **2.0 Introduction**

In this chapter, the discussion focuses on introducing us to the understanding of humans, urbanisation and their relations to the need of good drainage systems for housing schemes. This chapter also discusses about drainage systems.

### **2.1 Humans, Urbanization and Water Issues**

Urbanisation has caused rapid development in many cities in the world. In this study, attention is given to the issues and information of developing third world countries, especially Malaysia. Urbanisation in third world countries is believed to have started in the 1970s. This phenomenon has changed the perception of other developed countries in the first and second world (Drakakis-Smith, 2000). According to Drakakis-Smith (2000), development in third world countries is not equally distributed. Some have successfully been urbanised while others are still left far behind in terms of modernisation. Ranson (1991) suggests that many parts of developing countries have encountered problems such as homelessness, slums and poor quality housing due to rapid urbanisation.

It is believed that urbanisation started as a result of early post-war political strategies (Kemny, 1992). For example, in Malaysia, the most rapid urban growth occurred after 1947. It was during the height of the communist threat where people were moved to safer places (Aiken and Leigh, 1975; Agus, 2002; and Pugh, 2001). It was part of the British strategy to weaken the support for communist by resettling the Chinese communities into new village programmes (Agus 2002). However, as time goes by, the scenarios created squatter issues in many major cities. The Malaysian government saw the squatter issues as an environmental problem and it also created a poor urban image for Malaysia. Therefore, the Malaysian government resettled the squatters and slum dwellers in low-cost housing schemes (Aiken and Leigh, 1975; and Agus, 2002). The growth of urban dwellers and the resettlement plan then increased housing



demands. In the 1970s, housing developments were crammed into every available space in urban areas, and there was no consideration of the site designed (Aiken and Leigh, 1975; and Bruton, 1985). According to Aiken and Leigh (1975), the houses were designed with very limited front yards, whilst the backs were opened to the narrow lane (Figure 2.1.1). Nowadays, the housing plans and designs are not much different to those of twenty years ago (Figures 2.1.2 and 2.1.3). In Malaysia, the New Economic Policy (NEP) 1970 played a major role in the economic sector. In turn it influenced urban development greatly. It is legislated that the policy attempted to promote economic growth, redistributing and restructuring society (Bruton, 1985). Rural migration thus occurred in many major cities where migrants compete to grab working opportunities for better life. This thus increased housing demands at the same time. Therefore, the Third Malaysia Plan (TMP) (1976-1980) was outlined to support the NEP in terms of fostering rapid urban growth in urban areas (Bruton, 1985).



Figure 2.1.1: Closely spaced terrace housing at Bangsar Baru, Kuala Lumpur in the 1970's. (Source: Aiken and Leigh, 1975)





Figure 2.1.2: Back lane for service purposes in between two blocks of terrace houses. The hard surfaces have increased the amount of impervious surfaces in a housing area. Picture taken in a housing area in JB



Figure 2.1.3: In another housing area in JB, two blocks of terrace houses were only separated with drainage systems.

Urban issues are commonly related to the increase of urban population from rural migration. Izazola et al. (1998) in their study on urban migration impact on the environmental deterioration in Mexico City suggests that the phenomenon results in difficulties to keep pace with urban infrastructure. Population growth in urban areas and higher housing demand has caused rapid land use changes and contributed to physical environmental deterioration especially on water and soil (Izazola et al., 1998; Bartlett, 1999; and Parkinson, 2003). Concentration on the economy in developing countries has left the urban population lacking in an awareness of



environmental changes especially those related to air and water (Izazola et al., 1998; Bartlett, 1999; Wust et al., 2002; and Parkinson, 2003). Improper drainage sanitation has worsened the impact of poor sanitation systems, which in turn have exposed urban dweller to infections (Cairncross and Ouano, 1991; Bartlett, 1999; and Pugh, 2001). Pugh (2001) points out that the urban demographic patterns are different in developing countries compared to developed countries. The demographic trends in developing countries show higher transitions in rates and volumes due to job opportunities offered in urban areas. This has increased poor housing settlement (such as squatters) and poverty in urban areas (Pugh, 2001; and Parkinson, 2003). The need for proper housing has increased, but the government's need to solve housing issues is limited due to budget constraints. These are indeed the factors that have contributed to an increase of impermeable surfaces and insufficient consideration of proper drainage systems. This then has worsen drainage problems (Parkinson, 2003). Bartlett (1999) highlights that the urban development policy, plan and practice missed the importance of a well-planned water provision, sanitation and social development in reducing accident risks especially amongst children. Living surroundings have been recognized as one of the potential places where many children have been killed or have become disabled with unintentional injuries or careless accidents (Manciaux and Romer, 1991; and Bartlett, 1999).

As a developing country in the South East Asian region, the housing sector in Malaysia is quite different from those in developed countries with earlier and a similar stage of development experience (Pugh, 2001). The impact of demographic transition as discussed earlier means less consideration for the infrastructure and this situation has in turn caused environmental degradation (Pugh, 2001; Parkinson, 2003). Realising the critical environmental condition, rules, regulations and guidelines have been outlined from time to time to improve urban housing situations based on previous experiences.

Malaysia has learned from the developed countries, and has adopted what it has learnt onto the Malaysian situation. These are indeed processes to be improved for a better housing sector and development. According to the Malaysian National Landscape Guidelines (JPBD, 1995), a developer must allocate 10% of the whole development scheme as an open space or a park in a residential development. This guideline is meant to ensure that any development would provide owners with green spaces. However, the limited spaces in the residential design have caused owners to carry out house renovations to allow for bigger living spaces (Figures 2.1.4 and 2.1.5). Although there is an Act to control the renovation activities, many have ignored and maximised the building areas without referring to the act. According to the Street, Drainage and Building Act 1974 (Act 133):



**“70c. Renovation of approval of any plan, specification and permission.**  
*Where a person has been convicted for an offence under section 70b (15), the local authority may revoke the approval of any plan and specification and permission given under this Act and he shall, upon receipt of the notice of such revocation, forthwith cease the whole of the erection of building.”*

**“75. Land to be set apart for back-lane**

*(1) The local authority shall not approve any plan submitted pursuant to section 70 relating to a building unless –*  
*(a) A back-lane if required by the local authority of such width not exceeding forty feet (40’) as may at the discretion of the local authority be required is shown on the plan, or vacant land...”*

According to the Act, anyone who plans to carry out any house renovations needs to apply for an approval. This is because uncontrolled trends in renovations have increased the amount of impervious surfaces in urban areas at present time (Figures 2.1.4 and 2.1.5). It is then suggested that policy makers should revise the current requirements for any house renovations or extensions of back lanes to ensure that it is in line with sustainable development approaches.



Figure 2.1.4: The whole yard area in this house unit in JB has been paved with concrete.





Figure 2.1.5: These two blocks of terrace houses were not provided with a back-lane and, to make matters worse, some renovation over the drainage systems.

According to Ranson (1991), healthy housing has been carried out part of a living condition which offers safe and healthy surroundings and covers every aspect of the environment for the residents, including physical and psychological health. Therefore, Ranson (1991) believes that to achieve healthy housing, it is important to provide a healthy housing design and planning assessment of fitness for human habitation, and also to provide proper resource materials for training and health education in order to boost awareness amongst the urban population.

It has been proven that polluted watercourses lead to health problems such as cholera infections. Poor water quality also attracts rodents which act as disease vectors (Aiken and Leigh, 1975). Rapid urbanisation is also identified as one of the factors that has contributed towards the poor condition of the drainage systems (Aiken and Leigh, 1975; and Parkinson, 2003). Other than that, improper sanitation and drainage system are also responsible for spreading pathogens within the urban community such as parasitic worms (roundworm and hookworm) which cause debilitating intestinal infections (Parkinson, 2003). In Malaysia, the practices of open drainage systems provide breeding sites for *Culex* mosquitoes. The *Culex* mosquitoes transmit filariasis which lead to elephantiasis causing a painful swelling of the legs. *Aedes* mosquitoes which transmit yellow fever, dengue and dengue haemorrhagic fever often breed in places that catch or contain water (Parkinson, 2003). Malaria, transmitted by *Anopheles* mosquitoes, is a disease that could put urban communities at risk (Aiken and Leigh, 1975; and Parkinson, 2003). The *Anopheles* mosquitoes breed in static unpolluted water, such as wetlands, pond or puddle, with poor drainage systems (Parkinson, 2003). Actions to mitigate those water borne diseases has been taken as early as 1941 in Malaysia. Malaria was a big threat during this time (Konradson et



al., 2004). However, the approach taken was in the form of chemical solutions (pesticide control) which in turn has contributed towards water pollution. High ground water levels have always put Malaysia in situations of flooding during wet seasons. Due to this, the drainage systems have also been improved and developed since then as part of the mitigation programs.

### **2.1.1 Factors that Influenced Better Living Environment**

Many aspects or factors should be considered in order to achieve a better housing environment. Researchers have highlighted the importance of water and sanitation in their research which in turn needs to be supported by the local community (Garande and Dagg, 2005; Pugh, 2001; Environment and Urbanization – Editorial, 2003; Parkinson, 2003; Wust et al., 2002; and Izazola et al., 1998).

The '*Rio Summit*', the World Water Forum 1992 and the 2002 Johannesburg Earth Summit are part of world conventions that have discussed the environmental scenarios suffered by almost all major cities in the world. However, governments need support from all stakeholders and participations from the public in taking care of the environment.

Several studies (Stratford, 1995; Jackson, 1998; Basiago, 1999; and Regan and Horn, 2005) have shown that the gender factor also influences awareness. Stratford (1995) suggested that women are usually associated with water in her study on identifying the connection between women and water in South Australia. According to Stratford (1995), the duty of women is in the domestic area and, as mothers, they emphasize the need for water in their daily routines. The spread of water borne diseases amongst children have also given great concern to mothers on the importance of clean water supply (Stratford, 1995). The association between women and water in domesticity is also supported by Jackson (1998). She states that women do play a major role in domestic provisioning. Daily routine can be related to individual experiences which explain how far males and females might be aware of their living surroundings and needs (Ulrich, 1983; Kaplan and Kaplan, 1989; Ulrich et al., 1991; Kaplan, 1995; and Regan and Horn, 2005). Regan and Horn (2005) suggest that experiences related with stress influences the preferences for natural surroundings. Therefore, these experiences have rendered women more alert or aware of issues related to water.

Study conducted by Regan and Horn (2005) and Kearney (2006) show that satisfaction and perception are more influenced by the surrounding forces within the neighbourhood such as stress or community involvement. Regan and Horn (2005), in their survey involving 417



participants in identifying mood states and demographic factors associated with environmental preferences, identify stress as a major factor that influences public preference for natural environment. Those with stress or pressure had chosen natural surroundings in order to ease their stress. Urbanization had caused stress in the community due to many factors such as traffic problems, environmental degradation impacts, or stress in the work place. Regan and Horn (2005) also look at different demographic factors. For example, the age factor had also played an important role in influencing public preferences. The younger ones did not care much for living surrounding changes compared to the adults. The age groups are divided into four wider age bands with different needs in their lives. The four groups are primarily students (18-25 years old), people settling down in terms of career and family (26-45 years old), people starting a new life, such as retiring (46-60 years old) and those who are retired or close to that stage (60 years old and above). Another study is conducted by Kearney (2006) on the development and neighbourhood satisfactions based on the impacts of density. The survey, which was responded to by 261 residents from nine residential development areas, shows that housing density does not influence the personal satisfaction of residential area. In fact, it shows that it is community involvement and one's time spent within the nature which did give satisfaction with regards to living surroundings.

There are various demographic factors that contribute to environmental preferences and awareness. The need for knowledge is very important in ensuring that the public can get a better perception of water issues (Apostolaski, et al., 2001). Environmental degradation can be reduced if society has the knowledge to 'control at source', especially in their daily routine. This includes recycling. Education assists the community concerned by providing knowledge of environmental activities such as recycling (Saphores et al., 2006; and Owen, et al., 2000). Some studies, however, did relate gender significantly with environmental activities (Saphores et al., 2006; and Schultz et al., 1995). On the other hand, other studies agree that age is also a factor that influences environmental preferences (Saphores et al., 2006; Gamba and Oskamp, 1994; Margai, 1997; and Scott, 1999).

## **2.2 Sustainable Urban Drainage System (SUDS): The United Kingdom Experience**

Water is essential for life on this planet, since it is non-renewable (Mwanza, 2003). Currently, a number of water bodies have been identified as facing problems such as eutrophication, salinization, pollution from industrial effluents and chemical run-off, exotic weed infestation, declining fish populations, habitat destruction and loss of biodiversity. Humans are known to be responsible for using pesticides and the disposal of waste which are driven by a variety of



competing human needs. This is the main reason for having sustainable water management in order to ensure that water resources are clean and of good quality.

Actions taken by the authorities in water and sustainable urban development for state governments have been stated clearly in Agenda 21, Chapter 18. A commission headed by the Norwegian Prime Minister, Gro Harle Brundtland, predicted that the world population would be doubled during the next century. As a solution, the commission suggested a new development pattern that was required by the entire planet in order to secure human development. Water is very important to human beings and other creatures. Therefore, it is our responsibility to ensure that the supplies of good quality water are maintained for the entire population of human beings while, at the same time to preserve the hydrological, biological and chemical functions of ecosystems. This is achieved by adapting human activities within the limits of nature and combating vectors of water-related diseases.

The widespread scarcity, gradual destruction and aggravated pollution of freshwater resources in many world regions, along with the progressive encroachment of incompatible activities, demand integrated water resources planning and management (Haman and Brown, 1994). New approaches to water management in the city such as drinking water, wastewater, and runoff water, have now emerged. Some of the concepts of sustainable development include both quantity and quality aspects which pay specific attention to receiving water as well as its potential degradation. This can be carried out with an integrated approach, at the bigger scale rather than a smaller one.

The Sustainable Urban Drainage System (SUDS) concept was introduced to replace the conventional drainage system that contributed to environmental degradation especially on the water system (Bray, 2001). SUDS was designed to balance the impact of the urban drainage system through equal weight of quantity, quality and amenities in the drainage design. In the United Kingdom (UK), the SUDS technical guidance was managed and provided by the Construction Industry Research and Information Association (CIRIA). CIRIA also organised a series of conferences to update information on SUDS source control techniques and Best Management Practices (BMPs). The recent manual published by CIRIA in 2000 is '*CIRIA SUDS Design Manual for Scotland and Northern Ireland (C521)*'. The study was conducted to evaluate SUDS practices in Scotland (McKissock et al., 2003) as it has always been a standard practice there (McKissock et al., 2003; and D'Arcy and Wild, 2002). Qualitative and quantitative methods were used in the study to identify knowledge and understanding, experiences with SUDS, awareness and perception of SUDS options, and awareness and perception of the CIRIA SUDS manual. The study shows that the SUDS guidance is too general and should ideally be updated frequently. The respondents from the study also agreed that the



manual produced by CIRIA gave them lots of information but that more technical detail needs to be added.

According to recent studies, issues that have been pondered about with relation to SUDS include technical and management aspects (Newman et al., 2005). Although SUDS has been implemented for years, good precedent project sources are indeed limited (Newman et al., 2005; Spectrum Research, 2003; and McKissock et al., 2003). There is in fact debates regarding maintenance responsibilities of SUDS implementation (Newman et al., 2005; and Wild et al., 2003). Solutions in SUDS are very important as the system was initially designed to protect water resources while at the same time, gain ecological benefits. These system solutions are achieved by mimicking the natural system (Shaffer et al., 2005). Therefore, drainage is the responsibility of many disciplines (Figure 2.2.1).

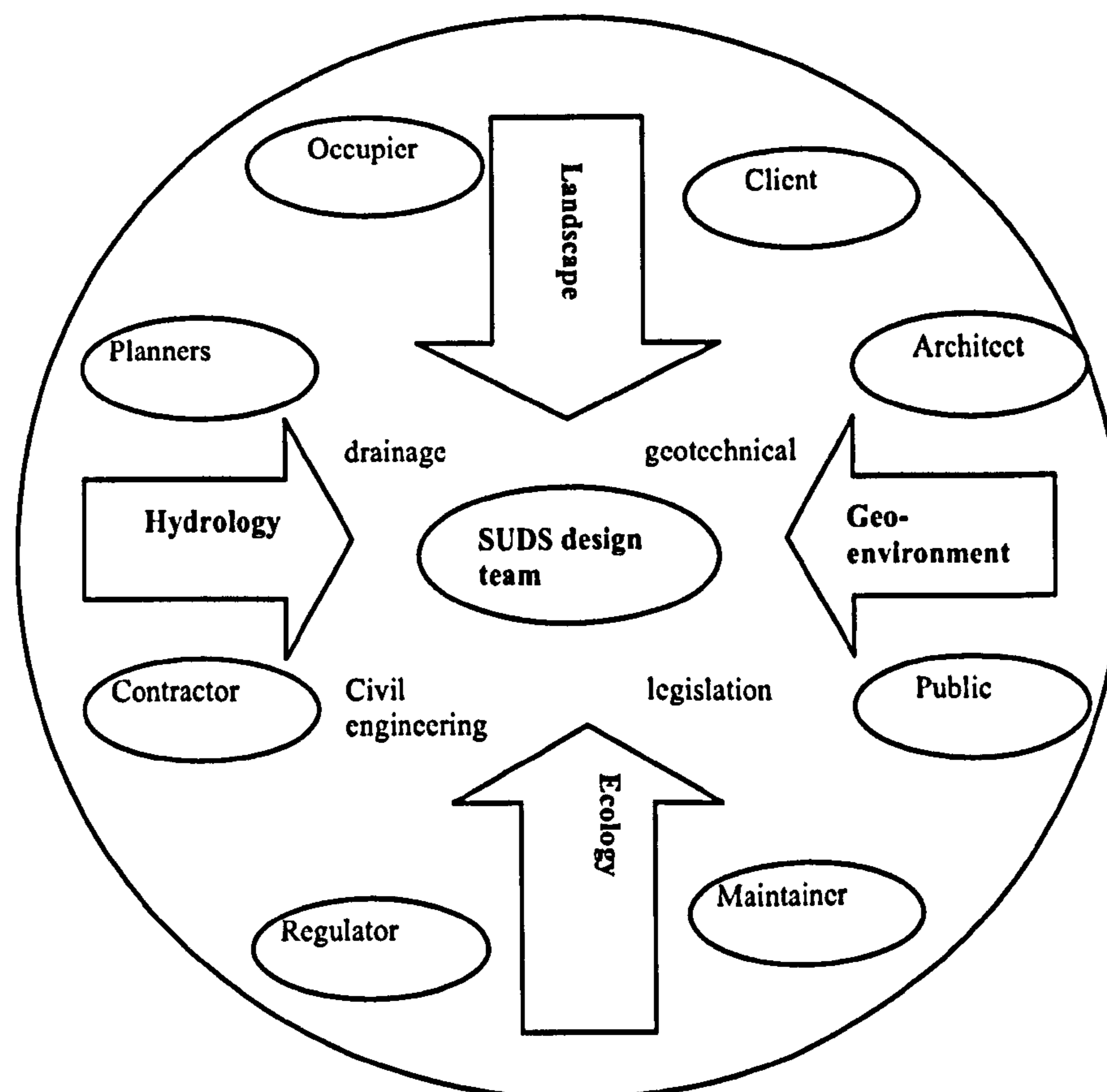


Figure 2.2.1: SUDS design team (Wilson et al., 2004; and Shaffer et al., 2005)

Van Buuren (1991) has highlighted the importance of knowledge and understanding of hydrological base phenomenon, such as water flows, hydrological cycle as well as water interaction between space and time. This application of knowledge integrates with the concept of landscape planning known as the 'hydrological approach to landscape planning'. Understanding the hydrological phenomenon would allow those involved in any development or involved in management or authorities of identifying problems would highlight issues related to this phenomenon.



This framework concept could be best applied based on Malaysian conditions. Different from Netherlands, as researched by Van Buuren with issues highlighted concerning groundwater resources, the drying phenomenon and eutrophication, Malaysia focuses on the surface water. Groundwater is not a source of drinking water in Malaysia as the level is too high (near to the ground surface) and thus is easily contaminated. Therefore, knowledge of the hydrological phenomenon should focus more on surface water related issues. For example, the characteristics of Malaysian rivers could produce much information as it is known that the lower stretches of the rivers suffer heavy sediment loads especially after heavy rains (Embi, 2005).

### **2.3 Principles and Components of the Sustainable Urban Drainage System (SUDS)**

SUDS has been introduced to reduce flood risk and pollution, and also to improve urban environment. SUDS employs three main techniques to reduce the impact of contaminated surface water discharges: source control techniques, permeable conveyance systems and passive treatment systems (Herefordshire Nature Trust). This is shown in Figure 2.3.1.

Therefore, the basic concept of SUDS focuses on decisions regarding drainage on the environment and community. It gives consideration to:

1. Surface run-off quantity
2. Water quality
3. Amenities for users

These techniques have been used successfully in the UK (CIRIA, 2000). Many new development areas are applying SUDS in new surface water drainage systems design. It not only deals with the problems of surface water run-off but also enhances the sites considerably for children and nearby residents.



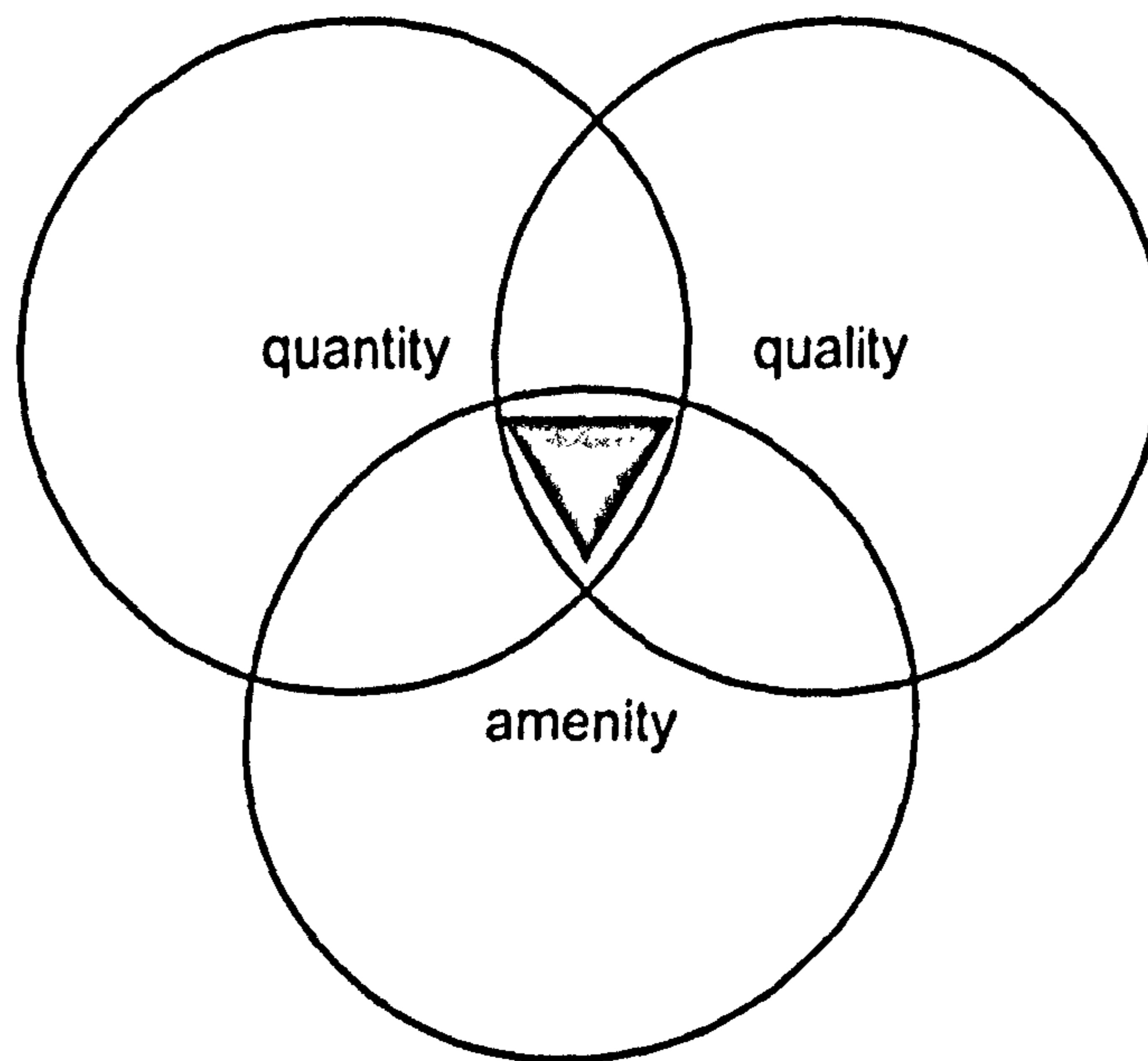


Figure 2.3.1: The urban drainage triangle – balancing the impact of urban drainage on the environment. (Source: CIRIA report C522)

SUDS can be applied to any area in general because the design takes into consideration several urban settings. The design also considers engineering components, such as water run-off and capacity. This will then improve the current amenity and biodiversity. In order to ensure that SUDS are successfully designed, built and maintained, developers need to include them in their plans in the earlier stages of the process. There are three main approaches in SUDS (CIRIA, 2000):

- 1) The first approach is to apply a source control technique that is designed to counter increased discharge from developed sites as closely as possible and to minimise the amount of water discharged directly into the river. In order to get good results, a combination of elements such as porous pavements, infiltration trenches and infiltration basins will be used to support the techniques.
- 2) The second approach is through a permeable conveyance system whereby elements, such as French drains or swale, are used in the design.
- 3) The last approach is to use passive treatment systems. To get a better design, a combination of filter strips, detention basins, retention ponds and wetland can be applied.

The application of SUDS is beneficial order to generate sustainable cities. To ensure that SUDS not only solves drainage problems technically, SUDS should be included in the master plan of the designing stage for aesthetic considerations. Aesthetics is indeed very important as part of enhancing city's image. It can be achieved by a good layout, planning and design stage in the process of landscape design. To ensure the sustainability of the design, the usage of the material should technically be from ecologically friendly material. It is in fact an alternative concept in the planning, design and management of stormwater drainage systems. The system gives equal



consideration to water quality, water quantity and public amenity. This drainage system will satisfy the following basic requirements:

1. The developed area run-off should not be greater than the run-off prior to development
2. The downstream watercourse or habitats should not suffer any downgrading as a result of the run-off from the developed area.
3. Pollution in the developed area should be treated within the area itself.
4. The water resource management should be highlighted as early as the design stage.
5. The wider needs of the community are considered in the development of the design.

One of the basic method applied in SUDS approaches is used in order to deal with run-off in the locality of the rain-fall, to manage potential flooding at its source, to protect water resources from its point as well as and diffuse pollution. Currently, there are four types of devices that are used in most SUDS practices in the UK as outlined by CIRIA. They are filter strip swales, filter drains and permeable surfaces, infiltration devices and constructed wetlands.

### **2.3.1 Filter Strip Swales**

This component (Figure 2.3.2) is one of the easiest and cost-effective methods used in stormwater control measures (Deletic and Fletcher, 2006). The method is derived from the idea of natural principles of drainage systems. According to Deletic and Fletcher (2006), swales are open vegetated grass drains which filter the receiving water from its sources to the downstream. The concept is to allow water to run through a series of filter strips which are vegetated areas or in a shallow channel, after raining. The filter strip will reduce the water flow and at the same time, the water will be absorbed into the uncompact topsoil (CIRIA, 2000; and Deletic and Fletcher, 2006). This method has a cumulative effect if used extensively in catchments. Swales in facts have a quantity control function. The moderate longitudinal gradient or check dams along the swale will impound the water. The vegetation will filter the run-off and it will also trap silt and other solid contaminants. In an urban design, swales and filter strips can be included by integrating them as a basis for green corridors.



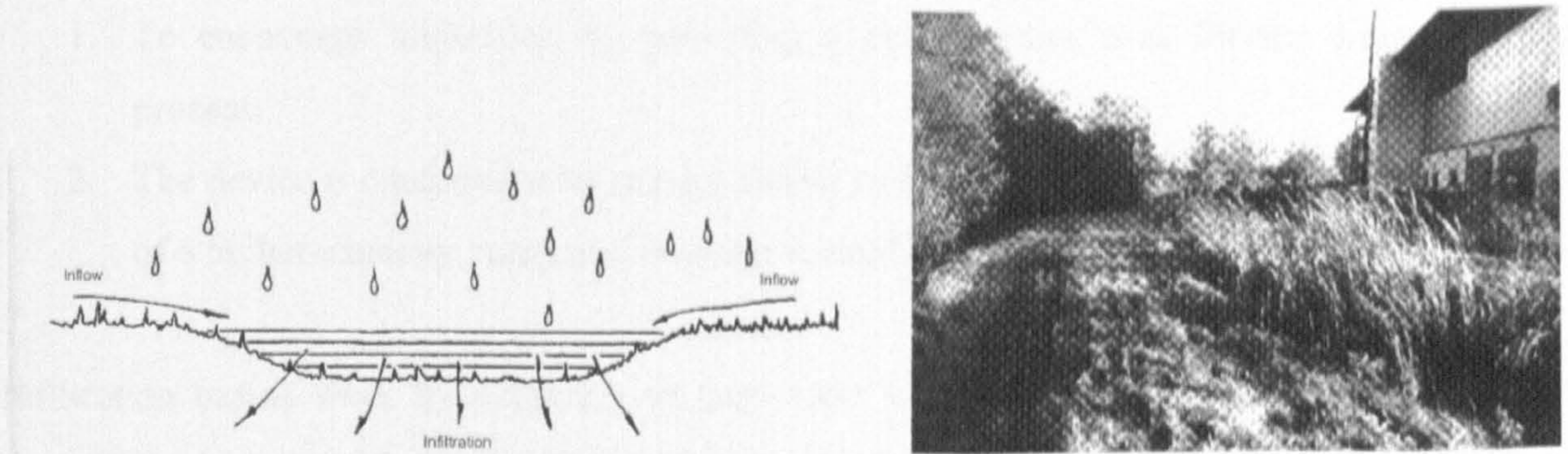


Figure 2.3.2: An example of a filter strip section and its application. (Source: CIRIA, 2000)

### 2.3.2 Filter Drains and Permeable Surfaces

A permeable surface is a surface that allows the passage of water through itself into a permeable sub-base before disposal (Figure 2.3.3). A process of filter drain occurs when the surface water from hard surfaces, such as roads, flows onto the permeable surfaces. Later, the water can be drained slowly to the discharge point or allowed to infiltrate into the ground. As a filter drain, it will let the water move along the drain through the sub-base to the discharge point. The unwanted particles are filtered by the sub-base devices, while the organic matters in the run-off are reduced by micro organisms in the sub-base material. The water stored in the ground can encourage the conservation of water resources, which can later be used for garden watering or other purposes. However, it should be cleared of any medium that can lead to the blockage of the pores and voids on the surfaces or gaps between blocks.

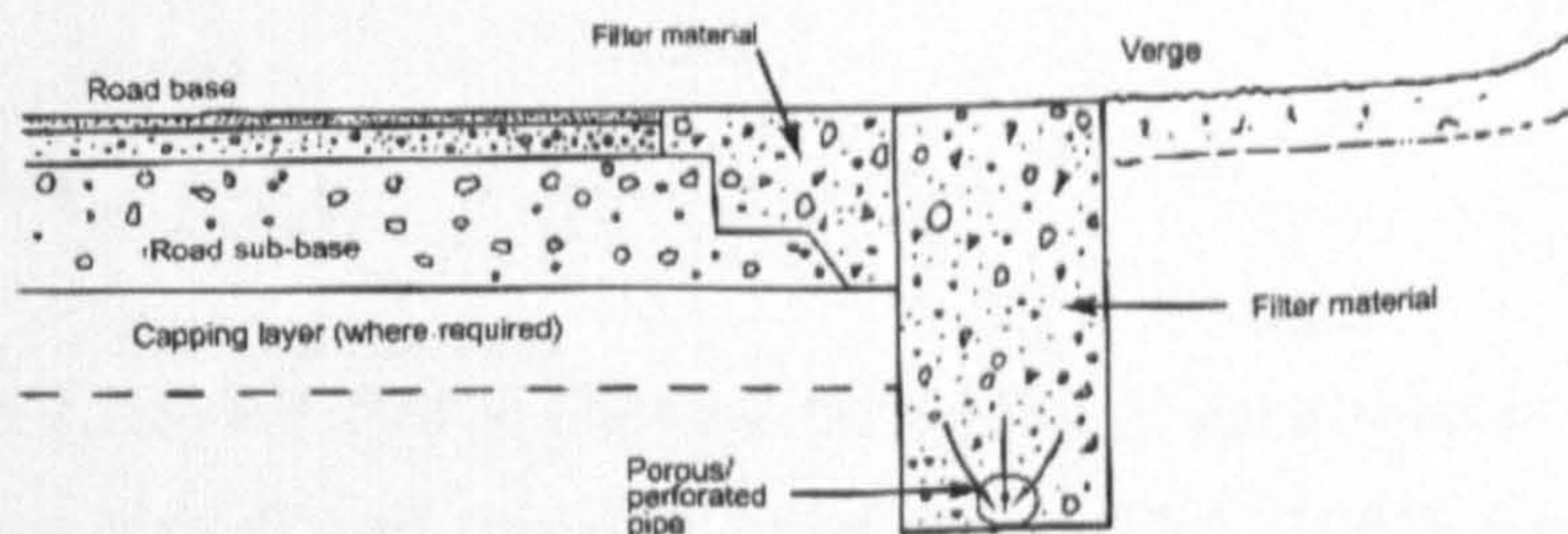


Figure 2.3.3: Example of permeable surfaces in a car park and technical details of a permeable surface. (Source: CIRIA, 2000)

### 2.3.3 Infiltration Device

Infiltration is a process in which surface water dissolves from the surface of the ground. This method (Figure 2.3.4) is based on the ability of the soil and underlying geology to absorb water with two functions:



1. To encourage infiltration by providing a large surface area for the water draining process.
2. The device is equipped with storage ability to detain run-off during heavy rain, which is of a higher capacity compared to water soaked into ground.

Infiltration basins work by detaining surface water before it is later soaked into the ground through the bottom of the basin. This infiltration device will work effectively if it is placed near to the run-off source. It is the best way to maintain the natural drainage pattern and it helps to reduce the amount of water entering the water bodies. The ground layers during the soaking process will filter and reduce organic pollutants biological role due to its. However, the level of pollutants will need to be identified, as it may need to be treated at an earlier stage before entering the infiltration devices.

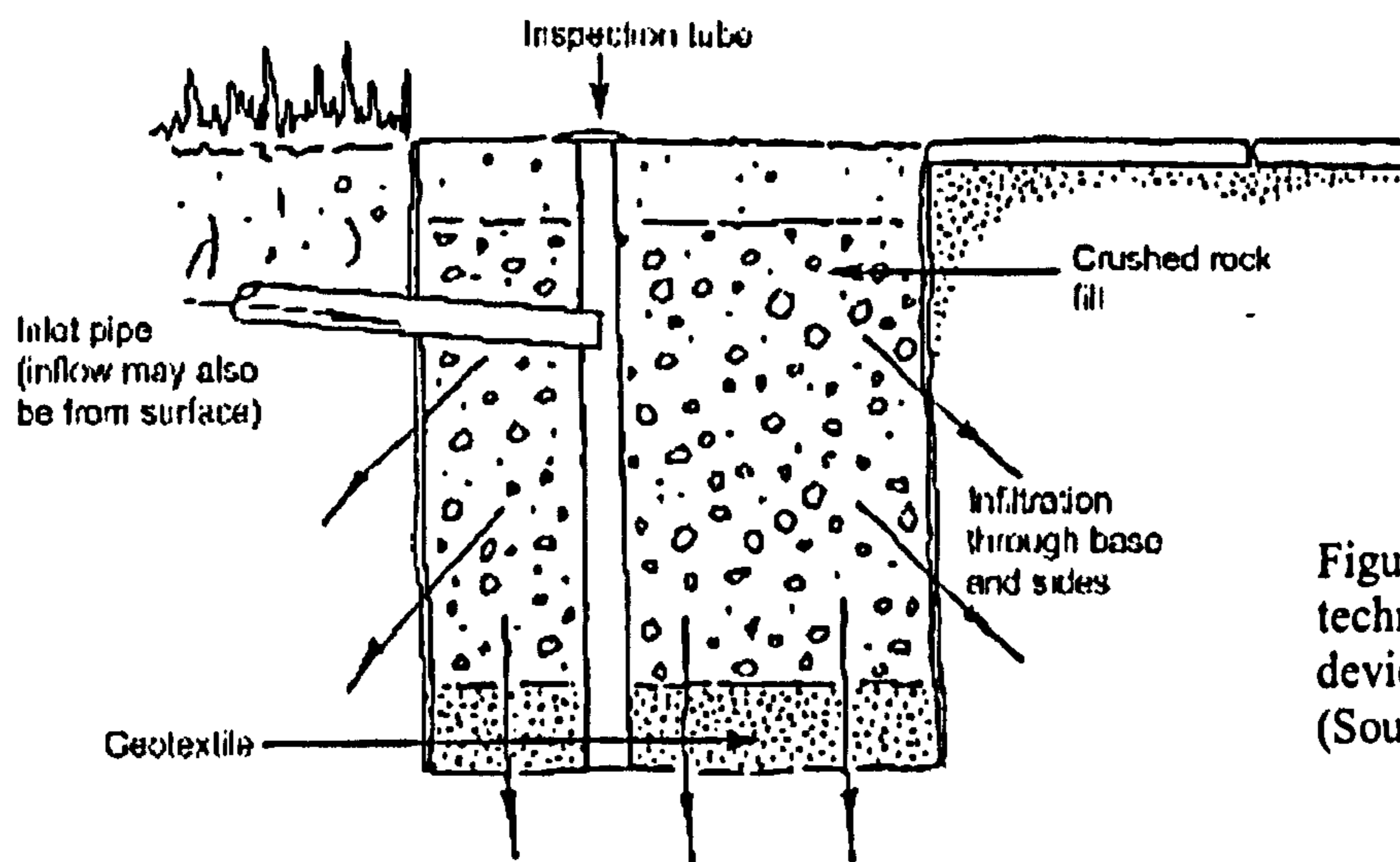


Figure 2.3.4: An example of technical details of an infiltration device.  
(Source: CIRIA, 2000)

#### 2.3.4 Constructed Wetlands

Constructed wetlands (Figure 2.3.5) are used to improve the quality of point-sources and non-point sources from stormwater run-off and domestic waste water (EPA, 2003). Constructed wetland components generally consist of a designed basin that contains water, a substrate and plants. Other support components are communities of microbes and aquatic invertebrates, which normally will develop naturally.

The surface water or run-off water is usually directed into a basin that has an impermeable subsurface layer to prevent the water from seeping into the ground. This criteria has allowed constructed wetlands to be built anywhere (EPA, 2003). Normally, a combination of basins, ponds and wetlands, are designed together as a device to control the water level. These SUDS devices involve an open water area as part of the drainage pattern. It controls the level of water and works as a flood plain store (CIRIA, 2000). The water level of this device can be controlled



to avoid flooding downstream. These drainage basins also contain constructed wetlands for biological water purification.

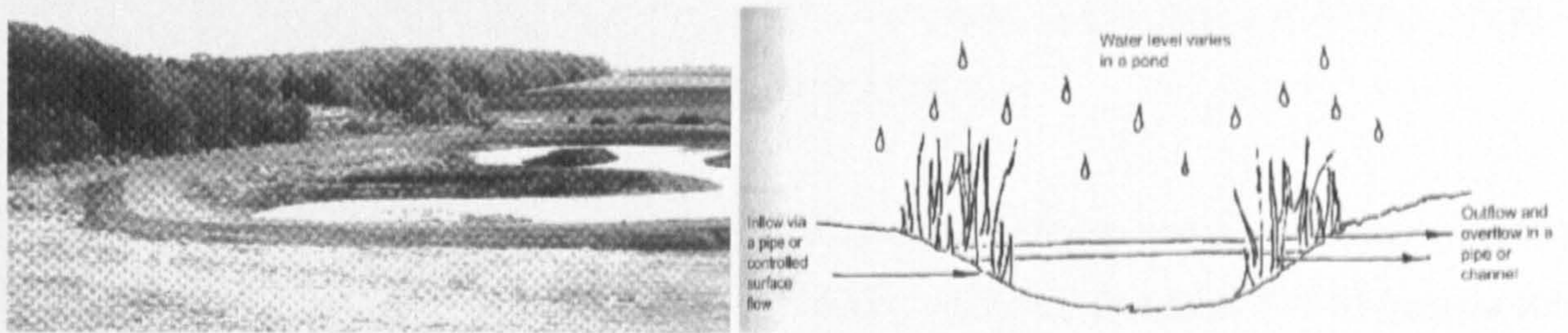


Figure 2.3.5: A wetland under construction and a section of a pond. (Source: CIRIA, 2000)

Two type of plants used in constructed wetlands are vascular (higher plants) and non-vascular (algae) plants. Vascular plants have several functions in treating the wastewater, such as stabilizing substrates and the limitation of channelled flow, reducing the water velocity to allow settlement of suspended materials, and the vascular plants also trap carbon, nutrients and trace elements, to incorporate them into plant tissue. The photosynthesis of non-vascular plants' helps to increase the dissolved oxygen content of the water, which later affects nutrient and metal reactions. Microorganisms and metabolisms are fundamental characteristics in wetland functions (EPA, 2003; and Wetzel, 1993). These microorganisms transform the organic and inorganic substances into innocuous matter, altering oxidation to help the processing capacity of the wetland, and recycling the nutrients. The aquatic vertebrates and invertebrates contribute to the treatment process by fragmenting detritus and consuming organic matter.

## 2.4 Human and Water Needs

Urbanization is a very good contributor to the economy and has provided lots of working opportunities especially in a developing country like Malaysia. It is widely known that people migrate to urban areas to work. This phenomenon has increased the need for residential accommodation and has had an environmental impact due to human activities, especially on water issues.

In general, urban activities and development have changed the basic quality and natural hydrological cycle in two ways. They are as follow:

1. Introducing materials and organism into the water bodies

Water is a molecule made up of an oxygen atom with two hydrogen atoms. However, irresponsible activities, such as household waste or industrial by-product dumped into the water bodies, are polluting the water. Table 1.03 (refer to Chapter 1) shows the list of common sources of pollution that threatens the water bodies.



## 2. Intervening in any phase of the hydrological cycle

These interventions were purposely done to increase the water supply or to use the natural water resources to meet the needs of the increasing population. People need water for household uses (such as cooking, cleaning, gardening and others), irrigating crops, industrial purposes, hydroelectric and others.

Since 1900, human population in urban areas has increased with an average economic growth of 3% per year (RIVM Report, 2000). The RIVM report also mentions that 40% of land on earth have been developed by the year 2000. According to the RIVM Report, most of the urbanized areas are located in the water scarce areas; with 2.5 billion living in areas with more than 50% of the available water used, The figure will keep on increasing from time to time. Choguill (1996) quoted findings by the United Nations which states that the projection of urban growth is 486 mega-cities by the year 2025 in the developing countries with at least one million populations.

Many have been alerted to water scarcity or water issues, and these problems have been viewed globally. Lima and Castro (2005) suggest that the environmental concern is more efficient as a global issue and people usually neglect it at the local level. This phenomenon is known as the 'environmental hyperopia'. The awareness is less at the local level compared to the global issue according to Lima and Castro (2005); with the sources of information at the local level not being as trustworthy as the global ones.

Urbanisation and development cannot be stopped to improve the environment but should be improved ecologically which in turn can benefit human needs (Kaplan, et al., 1998). Water scarcities have forced a need for solution, especially in urban areas. Therefore, two methods in improving the problems are proposed as follows:

1. To improve the current rapid disposal method used in the urban drainage system
2. To introduce the sustainable drainage approaches.

In drainage and water related issues, SUDS was initially introduced to provide a solution to dispose of stormwater in a sustainable way. However, SUDS implementation required holistic approaches, which not only focuses on the design but the whole implementation processes (C523 CIRIA, 2001). SUDS is a concept that gives opportunity to decision-making related to urban drainage systems by considering the environment and community (C523 CIRIA, 2001). The sustainable triangle concept (Figure 2.4.1), shows the need for an adequate balance in the environment for water quality, water quantity and amenity, or better known as Best Management Practice (BMP) facilities. BMP takes account of the following:



1. Surface runoff quantity
2. Water quality
3. Amenity value of water in the built environment

Public perception and acceptance of SUDS in their residential areas would give a clearer picture of their awareness and effectiveness of the SUDS scheme. Water related issues are now attracting worldwide concern. However, according to Lima and Castro (2005), there are two levels of environmental concerns at present. Global environmental issues are in fact more on the rise compared to those at the local level. Therefore, this study will concentrate on related drainage issues in urban housing areas at the local level.

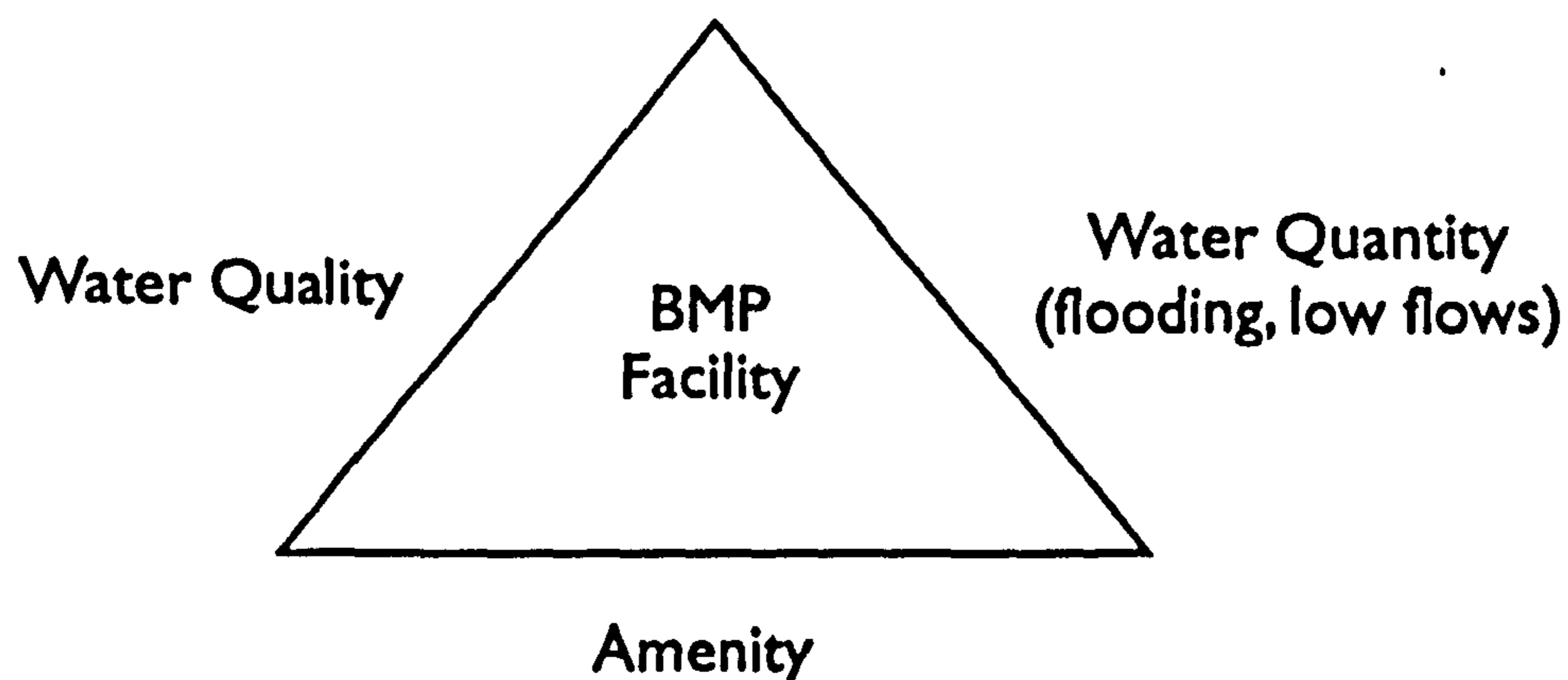


Figure 2.4.1: SUDS triangle concepts (Source: D'Arcy and Frost, 2001)

SUDS has been implemented in many Western countries. However, it is new to developing countries. In Malaysia, SUDS is known as Urban Stormwater Management Manual for Malaysia (MSMA), was officially implemented in 2001. However research related to SUDS had been conducted as early as 1997. Further discussion on SUDS concept has been discussed in an earlier topic (refer to 2.3).

## 2.5 Conclusion

The development of Malaysian housing scheme and systems have been influenced by historical and economic factors. However, the process of urbanisation have highlighted problems that have occurred due to the urban processes, such as planning and facilities strategies, public health and environmental degradation. The need for proper living environment will ensure community wellness. This is because improper planning can cause unhealthy living environment, especially those without proper sanitation, waste and drainage system. Living with appropriate services and facilities will not put the residents at risk of water borne diseases such as dengue, malaria, and pathogen threat. The Malaysian government attempt in supporting the



Local Agenda 21 have been directed to the development and implementation of SUDS. An introduction to basic components applied in SUDS would provide a general idea on how SUDS is developed. Creativity and an understanding of the SUDS principles would help to develop good SUDS within housing schemes.



## Chapter 3

### *SUDS in the Malaysian Context and Water Related Issues*

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#### 3.0 Introduction

'Vision 2020' has been inspired as a nation's vision for Malaysia. It was inspired by Malaysia's former Prime Minister, Tun Dr Mahathir Mohammed. The aim is for Malaysia to be a developed country by the year 2020. Malaysia is expected to achieve the achieved the status of an industrialized nation by then. In realizing this vision, rapid urbanization and industrial activities have been taking place in most major cities in this country. Nonetheless this current situation is believed to have an impact on the environment. The vision would emphasize Malaysia as a leading investment country, a shopping paradise, and a green city with a concept of *A Garden Nation*<sup>2</sup>. However, for a country to become a 'garden nation', the landscape design must be pursued relentlessly in all development undertakings. The need to ensure the concept of total quality living with high quality environment is emphasized in planning and development, and also applied in the care of government initiated projects, such as Putrajaya and Cyberjaya, which have been well received and supported by the population at large.



Figure 3.0.1: Urbanisation in an estuary (Source: DID Website)

Over the past years, water issues in Malaysia have been rarely mentioned and are not at a critical stage (Embi, 2005). This is because the country is characterised by an equatorial climate which has an average annual rainfall of 990 billion m<sup>3</sup>, of which 360 billion m<sup>3</sup>; or 36%, returns to the atmosphere as evapo-transpiration, 566 billion m<sup>3</sup>, or 57%, appears as surface run-off and

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<sup>2</sup> *A Garden Nation* is Malaysia's aspiration to emphasize the sustainable development base in the country and in the hope that, by the year 2005, sustainable development will have been fully implemented.



the remaining 64 billion m<sup>3</sup>, or 7%, goes to recharge groundwater (Abdullah, 1998). However, this situation has changed from one of relative abundance to one of relative scarcity in recent times (Abdullah and Mohamed, 1998). Population growth and rapid urbanisation in the last two decades has put pressure on the environment as discussed in Chapter 2. This is especially true in the west coast of Malaysia (Abdullah and Mohamed, 1998) (Figure 3.0.1). According to Abdullah (1998), the overall water demand is growing 4% annually. Quantitatively, this is less than 4% of the annual run-off but, due to the variations in rainfall, some regions of high water demand are approaching the limits of readily available water. Water stress has become more prevalent over the past few years; culminating in a water crisis in some parts of the country in early 1998. The rapid development of urbanisation and industrialization have contributed to the deterioration of river water quality. This in turn has further aggravated the water supply situation since 97% of the water used originates from the rivers (Figure 3.0.2) (Abdullah, 1998; Abdullah and Mohamed, 1998; and Embi, 2005).



Figure 3.0.2: Examples of water crisis due to urbanisation in Malaysia. (Source: DID Website)

### 3.1 Malaysia's Hydrological Background

Urbanisation has given most residents in housing areas a lot of experience in terms of development and progress. The natural land has mostly been covered by tarmac roads, concrete and cement, and this has caused the rainwater to speed off the land. This then results in flash floods. As a solution, the drainage engineers have for years practised what is known as 'rapid



disposal', where stormwater is quickly channelled from roofs to drains and then to rivers (Figure 3.1.1). Drains have been widened, while rivers have been modified into straight channels so that water can flow unimpeded (The Star, 2000). It has also been mentioned in a study conducted by the Department of Irrigation and Drainage Malaysia (DID) that the 'rapid disposal' method worked well on the beginning, but not in the current urban sprawl. Urbanisation takes 40% of an area to be built up for run-off to double and flow twice as fast. Furthermore, the run-off might be contaminated by the surface ground, such as biological material, oil, grease and others during the process (CIRIA, 2000)



Figure 3.1.1: The engineering solution drainage system (Rapid disposal) and a residential area covered with tarmac and cement.

DID has taken action by widening and increasing the depth of the drains and rivers and by building culverts and bunds to protect water channels. This has been done as a solution to increasing stormwater run-off. However, flash flood problems still persist and aggravate flooding downstream. Realising that the scenario will not reach any conclusion, DID has decided to apply a 'control at source' method which replaces 'rapid disposal' method. This idea is a reverse form of the early method, where the aim is to delay the time for stormwater to reach the stream. The control-at-source method has been included in an earlier discussion in Chapter 2.

In January 2001, the new drainage design manual was officially used as a set of guidelines in development and is known as the 'Urban Stormwater Management Manual for Malaysia' (MSMA). This manual is a sustainable approach drainage system that has been introduced to replace the 25 year-old 'Urban Drainage Design Standards and Procedures' (Figure 3.1.2). On the other hand SUDS is a system guiding the necessary management of disposing of stormwater in sustainable ways. The system shows other sustainable solutions of disposing of water and wastewater into stormwater drains, but integrating a proper cycle for the water before reaching the water bodies. However, to get proper results for this study, it is essential to acknowledge the concept, approach and technical criteria that lay behind the system (MSMA, 2000). This eventually contributes and leads to the relevant aspects of the sustainable drainage system



network in housing schemes. It is anticipated that some concepts would appear in the study as follows:

1. The whole concept and idea of SUDS
2. Drainage system and policy in Malaysia
3. SUDS as practised in western countries

Urbanisation results in the growth and spread of impervious areas and the diversification of urban land use practices with respect to the hydrological and environmental terms.

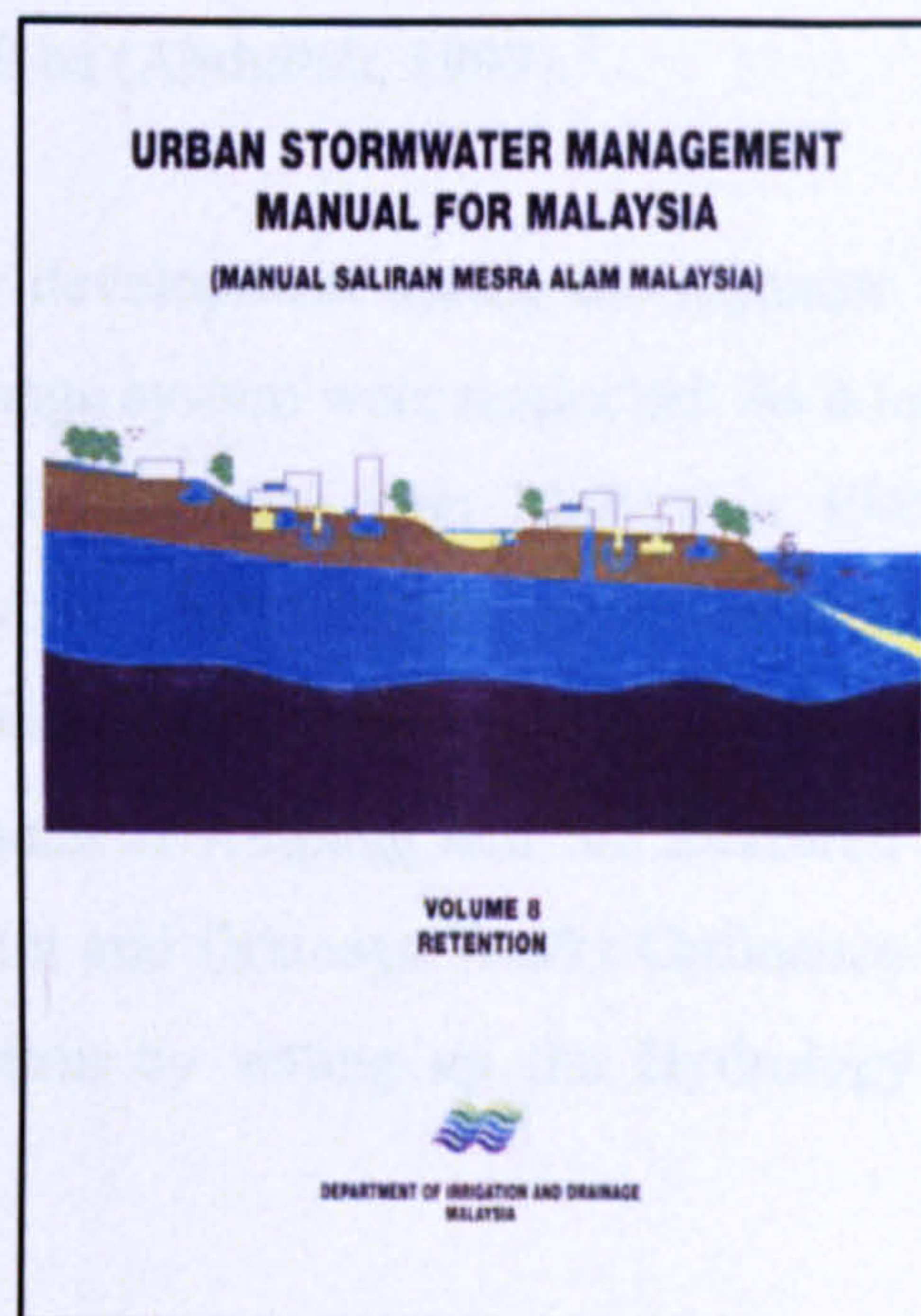


Figure 3.1.2: The new urban stormwater manual

### 3.1.1 The Early History of Hydrology

The drainage system in Malaysia was first created for the purpose of irrigating crops. After going through several system chronologies in its history, the role of the drainage system in terms of facilities and management led to major changes.

In its early days, when Malaysia was then known as Malaya, the Hydraulics Branch of the Public Works Department provided irrigation facilities and drainage work. However, following the slump in the tin and rubber industries in the late 1920s and the worsening rice situation in the country, the then British High Commissioner appointed a Rice Cultivation Committee in 1931 to determine steps to be taken in order to encourage rice cultivation in Malaya in 1930. The Committee conducted a comprehensive survey and published its report. One of its main recommendations was that an Irrigation and Drainage Department should be established. It



would be based in the Straits Settlement and Federated Malay States and absorbed the Hydraulic Branch of the Public Works Department of the Federated Malay States (Aiken and Leigh, 1975).

On 1<sup>st</sup> January 1932, this recommendation was accepted and the Drainage and Irrigation Department was established. The early years of the drainage department were between 1932 to 1942. The department was involved in the development of 20,000 ha of new paddy land and improved the irrigation and drainage facilities to some 50,000 ha of paddy fields. By the end of 1942, the department had taken over the maintenance of drainage work on 40,000 ha of estates and smallholders in Selangor and Perak. These reconstruction works and their extension raised the total area to about 80,000 ha (Abdullah, 1998).<sup>3</sup>

However, there was no new development during the Japanese Occupation from 1942 to 1945, and the areas under the drainage system were neglected. As a result, the drains became silted up and overgrown. When the British took over Malaya in 1945, it saw the beginning of the rehabilitation of irrigation work. Therefore, the government policy was to reduce the country's dependence on imported food supplies, with an emphasis on self-sufficiency in rice. Due to this objective, the Research Branch at Ampang and the Research Station was set up in 1953. In 1954, the Irrigation Areas Act and Drainage Works Ordinance was enacted. Later in 1955, the department took further action by setting up the Hydrology Research Unit (Abdullah and Mohamed, 1998).

After the independence of Malaya in 1957 when Malaysia then became known as the 'Federation of Malaya', the Department of Irrigation and Drainage Federal Headquarters in Kuala Lumpur became responsible for the overall drainage and irrigation matters in the country. Branch offices were set up in all the eleven states and settlements. Greater emphasis was placed on increasing the income and employment opportunities of the rural poor. With this objective, irrigation and drainage programmes were formulated to provide adequate irrigation facilities. This then enables the double cropping of paddy lands and the upgrading of drainage facilities to improve the production of tree crops, especially in smallholdings. Later, after the formation of 'Malaysia' in 1963, additional state branch offices were established in Sabah and Sarawak. Both were officially opened on in 1 January 1967 (Abdullah and Mohamed, 1998).

A national disaster was declared on 5<sup>th</sup> January 1971 when severe floods occurred in many parts of West Malaysia. Following the damaging nation-wide flood in 1971, the Department of Drainage and Irrigation was entrusted to undertake an extensive flood mitigation programme in 1972. Flood Mitigation and Hydrology was designated as a function of the Department of

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<sup>3</sup> Abdullah is the current Director Department of Irrigation and Drainage Malaysia.



Drainage and Irrigation. Subsequent to this programme, dams were constructed, rivers canalised and drains improved to alleviate flooding in both urban and rural areas. Other measures include river diversion, river training and clearing as well as the upkeep and management of river reserves. A flood forecasting system was installed in the Kelantan River, Terengganu River, Pahang River, Batu Pahat River, Muar River and Kelang River basins. The first Hydrological Procedure, 'HP1: Estimation of Design Rainstorm in Peninsular Malaysia' was published in 1973. To improve drainage systems, the Department of Drainage and Irrigation agreed to the formation of the Planning Branch for Project Planning and Feasibility Studies in 1979.

With regards to the new era of the 1980s and the wider scope of management involved, the Coastal Engineering Division was established in the Department of Drainage and Irrigation in 1986. Its scope of duties encompasses not only the physical aspects of managing and protecting nearly 4,800 km of coast in Malaysia from erosion, but also includes the collection and provision of important data and information on coastal engineering matters.

Later, the Department of Drainage and Irrigation have launched the 'Love Our Rivers' campaign on 20<sup>th</sup> February 1993, following by the Rio Declaration on sustainable environment (Abdullah, 1998, Abdullah and Mohamed, 1998, Embi, 2005). The objectives of the campaign were:

1. To create public awareness on the importance of rivers and the roles they play in the lives of each individual so as to create empathy and love and to conserve the rivers.
2. To introduce to the general public the steps and practices that can contribute towards the conservation and preservation of rivers
3. To improve knowledge of river management techniques among relevant agencies responsible for river management to ensure harmonious and sustainable development.

After the re-structuring of the organization of the Department of Drainage and Irrigation in 2000, the Drainage and Flood Mitigation Division was added to the organisational structure. The core area of management was redefined; covering four general areas of 'Water in Agriculture & Food Production', 'Protection of Property and Life from River and Coastal Forces', 'Water in Environment Enhancement' and 'Water as a Resource'.

After facing greater problems in water management, especially in urban drainage, the old hydrology manual was revised. On 21st June 2000, the Parliament of Malaysia approved the 'Urban Stormwater Management Manual for Malaysia' to replace 'Planning and Design Procedures No. 1: Urban Drainage Design Standards and Procedures for Peninsular Malaysia (1973)'. It became effective from 1<sup>st</sup> January 2001 (Abdullah, 1998; and Embi, 2005).



### **3.1.2 Water Issues in Malaysia**

It is widely recognised that land use changes from rural to urban, or industrial areas, have caused local run-off impacts on receiving water flow, quality, and ecology. Apart from the erosion and sedimentation problems associated with development, it has become increasingly apparent that stormwater run-off contributes to receiving waters and is a significant part of total loads of such pollutants as nutrients (including phosphorus and nitrogen), heavy metals, oil and grease, and bacteria. Over the years, flood damage and the adverse impact on water quality, fisheries, scenic river areas, and wildlife habitats have been recognised as shortcomings of the long accepted approaches to the planning, design, and management of storm drainage facilities in urban areas. According to the Malaysia Water Industry Report 2001, 98% of Malaysia's portable water supplies were derived from surface water sources, which were subjected to both domestic and industrial pollution (Pillay and Mohd, 2003)

As a result, lakes, ponds, reservoirs, and estuarine and coastal waters have become sensitive areas to increased rates and volumes of run-off and pollutant discharges. These discharges have posed major issues to many urban and residential centres, particularly in the west coast of the Malaysian peninsula. The problems have become even more aggravated by frequent intense rainfalls, the physiological nature of basins, and the pattern of urbanisation with relatively poor urban services (MSMA, 2000; and Embi, 2005).

Conventional storm drainage has long been the practice in many countries including Malaysia. Local decision makers and professionals have just begun to recognise the need for a new and broader approach to urban stormwater management in the light of development in the country progressing at a tremendous pace (Abdullah, 1998; Abdullah and Mohamed, 1998; and Embi, 2005).

Every professional currently engaged in such development should, therefore, accept the new concept and challenging roles of not only designing satisfactory flood protection facilities but also of controlling and reducing stormwater pollution in urban catchments and receiving waters. The level of technical know-how of our practising engineers and the quality of stormwater data, need to be upgraded in readiness to develop and achieve sound design practices and operational procedures in terms of sufficiency and reliability. This is done in order to deal effectively with existing and future stormwater systems (MSMA, 2000; and Embi, 2005).

Furthermore, to support SUDS practices, Water Agencies from each state in Malaysia should cooperate and standardize rules and regulations, and customize the operation terms, conditions and other related issues. For example, the water tariffs from each state agency at present are not



standardized. This can be seen in the tables below (Table 3.1.1, Table 3.1.2, and Table 3.1.3). This then shows that there is no standard procedure for water management application in Malaysia. According to CIRIA (2000), SUDS application needs involvement from all stakeholders, as discussed earlier in Chapter 2.

<b>SAJ</b>				
Tariff	User categorise	Rates (m <sup>3</sup> )	Charges (MR)	Minimum payment (MR)
1	Domestics	1-15	0.38	4.00/month
		16-30	1.18	
		31-45	1.64	
		46-100	1.98	
		>100	2.01	
2	Trade	1-20	2.22	18.48/month
		>20	2.96	
3	Domestics (bulk meter) – condominium, flats, apartments	Pro rata	1.18	4.00/month

Table 3.1.1: Water tariffs of the Johor Water Company (SAJ) (Source: SAJ)

<b>PBA</b>				
Tariff	User categorise	Rates (litres)	Charges (MR)	Minimum payment (MR)
1	Domestics	1-20 000	0.22/1 000 litres	RM2.50/month
		20 000-40 000	0.42/1 000 litres	
		40 000-60 000	0.52/1 000 litres	
		60 000-200 000	0.90/1 000 litres	
		>200 000	1.00/1 000 litres	
2	Trade	1-20 000	0.52/1 000 litres	RM10.00/month
		20 000-40 000	0.70/1 000 litres	
		40 000-200 000	0.90/1 000 litres	
		>200 000	1.00/1 000 litres	
3	Domestics (bulk meter) – condominium, flats, apartments	> 90 000	0.35/1 000 litres	RM26.00/month

Table 3.1.2: Water tariffs of the Penang Water Company (PBA) (Source: PBA)

<b>SYABAS</b>				
Tariff	User categorise	Rates (litres)	Charges (MR)	Minimum payment (MR)
1	Domestics	1-20 000	0.57/1 000 litres	N.A
2	Domestics (bulk meter) – condominium, flats, apartments	1-20 000	0.57/1 000 litres	NA

Table 3.1.3: Water tariffs of the Selangor Water Company (SYABAS)

### 3.2 Existing Drainage Practices

Present experience indicates that rapid disposal localised, reactive and mono-functional drainage concepts have been widely practised in Malaysia. Although the situation may differ from one country to another, or even by region with regard to development, the rational method is to adopt the standard measurement for most drainage structures. While standard design procedures have been available since early 1970s, the peak discharge estimation method has



been freely used, even for large and complex hydraulic structures in large catchment and tidal areas. As a result, cost effective design and construction have seldom been realised. Practices in Malaysia have thus far relied very much on slight adaptation or even direct use of temperate region-based urban hydrology design procedures and computer modelling.

In Malaysia, urban drainage practice has been largely based on the 1975 DID Urban Drainage Design Manual. The approaches to the design procedure, in terms of the methods and techniques employed, have not been reviewed and upgraded although advances in urban drainage and stormwater management technology are continuing and circumstances have changed as evidenced by the increased frequency of flash floods and water quality problems occurring in many urbanising areas in Malaysian towns and cities.

In relation to the contents of the former manual, some recognised weaknesses were associated with institutional and legal issues, strategic or master planning concepts, discharge estimation, minor and major drainage facilities, computer simulation, and run-off quantity and quality controls. These were inadequately covered or not included in the manual.

### **3.3 Problems in the Conventional Drainage System**

*“Malaysia is becoming more and more a wasteful ‘throwaway society’ every day. Unless ‘Green consciousness’ grows among our people, we will continue to generate more and more solid waste in the years ahead.”*

(Phua and Soo, 2004; 84-85)

Some of the stormwater-associated problems being encountered in Malaysia are caused by human activities. Due to rapid development activities, problems include flash flooding, water pollution and ecological damage, slope failures, traffic disruption, garbage and floating litters (Phua and Soo, 2004).

Major zones that are prone to these problems include urbanised and urbanising centres such as Kuala Lumpur, Georgetown and Johor Bahru. Inland localities normally experience short flash floods while coastal towns face larger, longer duration floods due to expanded basin runoff contributions, flattened floodplains, and tidal influences. Many urban rivers, lakes and ponds are rendered unfit for use, either in-stream or off-stream, as they are flooded and over-loaded with non-point source pollutants in wet periods. In addition, their water bodies experience more concentrated point sources due to reduced base flow contribution in dry periods. An interpretative evaluation of river water quality has revealed that increasing proportions - more



than 60% of the Malaysian inland waters - are failing due to pollution from non-point sources or storm-generated activities, particularly in urban areas (MSMA, 2000; Phua and Soo, 2004; and Embi, 2005).

### **3.4 Traditional Drainage Practices in Malaysia**

As discussed earlier in the previous chapter, the drainage system was first emphasized for crops irrigation. However, during earlier urbanisation of Malaya (as Malaysia was then known) drainage has been seen as a solution towards water borne disease. In 1901, Klang Valley was one of the important rubber and coffee cultivation areas (Konradsen et al., 2004). Therefore, many people migrated to the areas to work in agricultural field. This then increased demands for housing areas. New settlements were opened within the area to fulfil the requirement, which later caused malaria problems. Malaria affected many workers, the government administrators and labourers who were continuously ill. It was found that improper sanitation and drainage system had allowed the mosquitoes carrying the disease to breed. Improvements of drainage systems had been recognized as a method to alleviate the malaria issue. According to Konradsen et al. (2004), the experience from Malaya in vector control has been transferred to the rural areas of the United State of America (USA), Singapore and many parts of Asia.

However, there are many rural parts in Malaysia which still practice the traditional drainage system as it is difficult for the local authority to control them. This because their boundaries of jurisdiction are limited and there is restriction related to the issues of private properties. The scenario, for example is that water from toilets is directed into tanks which are dug behind properties (Figure 3.4.1). Most of the villages in rural areas do not subscribe to proper sanitation systems. New tanks will be dug while the old tank will be covered when it is full. On the other hand, domestic wastes will be drained directly into the nearest water bodies or swamp areas (Figure 3.4.2).





Figure 3.4.1: Toilet wastes are drained into tanks made from concrete culvert.



Figure 3.4.2: Domestic wastes are drained directly onto the ground. It will be left to disperse into the ground or flow into the swamp areas behind the house.

Montada, et al. (2007) believes that environmental protection is a political objective that can only be achieved with full support from the public. Therefore, a formula should be identified to ensure that properties which are governed not under the local authority will also benefit from sustainable development.

### 3.5 Sustainable Solution Drainage System (MSMA) - Urban Stormwater Management Manual for Malaysia

MSMA was published by the Department of Irrigation and Drainage of Malaysia (DID) in 2000. It was officially used in all developments in 2001. It was introduced to replace the earlier guidelines, the Urban Drainage Design Standards for Peninsular Malaysia, which had been in use since 1975.



After more than twenty years of using the old hydrological manual, a number of problems arose due to urbanisation activities. Problems that have been determined by DID are drainage concepts that are not sustainable or suitable, the use of a rational method to size most drainage structures without considering the differences in hydrological factors from each state, and the peak discharge estimation method that has been widely used even though it is not suitable for bigger complex catchments and tidal areas (MSMA, Vol 1, pp.3). DID has identified that some of the problems were closely related to institutional and legal issues, strategy and master planning concepts, discharge estimation, minor and major drainage facilities, computer simulation and run-off quantity and quality problems.

In general, the manual has introduced a number of approaches in stormwater management. This manual is a guide for those who are involved in stormwater management, such as planners, engineers and designers (MSMA, Vol 1. pp. iv). The basic idea for introducing this manual is to aim for better environmental stormwater management. This manual aims to minimise and control flooding and pollution risks. It also takes into consideration wildlife habitats and aims to enhance landscape values (MSMA, Vol 1, pp. 6). It is a good solution that works the other way round from the old manual; with a traditional concept of drainage based on rapid disposal method. The 'post-construction runoff quality controls' and 'special application' parts are the ones newly introduced to the Malaysian system. This is because the area of content is more closely related or similar as discussed in CIRIA C512 (SUDS Manual for Wales and England).

As in CIRIA C512, it outlines three approaches to be taken into consideration in implementing SUDS, quantity, quality and amenity. However, there is a difference in the MSMA SUDS parts. In MSMA, approaches to SUDS are divided into two. The first is the run-off quantity management strategies while the other is the run-off quality management strategies. There are two approaches in run-off quantity management strategies: the conveyance-oriented approach and storage-oriented approach. The run-off quality management strategies have been divided into three 'Best Management Practices'; namely housekeeping BMPs, source control BMPs and treatment control BMPs.

MSMA community involvement and participation values have also been taken into consideration. There are three objectives for the public participation programme. They are to raise awareness of the authority's responsibilities in stormwater management, to gain extra information for stormwater strategic planning and to get the support from the public for stormwater management. The 'housekeeping BMPs' have been emphasized more as a tool to change public attitude in reducing the amount of pollutants that enter stormwater systems. The aim is to control or prevent pollution at source. DID has proposed a number of activities, such



as community education and participation activities, management activities, operation and maintenance activities and improvement of site planning and management.

However, to get the attention of the public is rather difficult since the urban stormwater system is far from public interest. DID in the manual mentions the following;

*“The public generally take the urban stormwater system for granted. Accordingly, public interest and willingness to pay for planning, designing, constructing and operating stormwater systems tends to literally rise and fall in relation to the flooding or other related problems...”*

(MSMA, Vol 3; 1)

In the MSMA, the planning took the public into consideration as described in the ‘social values’. Here, three factors are outlined: public health and safety guidance, recreation and visual amenity.

### **3.6 Public Participation – Public Involvement in Malaysia**

In Agenda 21, it has been stated that one of the factors in supporting sustainable development is public participation in decision making. Therefore, public and all stake holders need to get involved at the early stage of development such as during the Environmental Impact Assessment (EIA). They should also have access to information. The Malaysian Nature Society (MNS) (2005) found that there is still a lack of public participation in Malaysia. Furthermore, stakeholders have only been involved at the final stage of development (MNS, 2005). MNS is one of the non-government organisations (NGO) in Malaysia which claims that the NGO’s role in encouraging public participation is important (MNS, 2005).

The government attempt in emphasizing sustainable development to improve a better living environment is an objective that can only be obtained through commitment by the public (Montada et al., 2007). However, public commitment also needs individual awareness to support community welfare, especially related to environmental issues. Individual interests might differ from one individual to another, therefore, it is important that the public are supplied with sufficient information and can easily access the information portal.



### **3.7 Government Actions – Sustainable Development Awareness In Malaysia**

Sustainable development is an activity of physical development of an area which ensures good planning and provides a healthy physical surrounding for the community (Ministry of Housing and Local Council, August 1999).

In August 1999, a brief session was organised by the Malaysia Ministry of Housing and Local Government for all representatives of Local Councils and the Departments of Urban and Town Planning regarding sustainable development. The guidelines contained a list of fourteen points on the major principles of sustainable planning and development. This was the beginning of an sustainable evolution in Malaysia, which has now been implemented in a few major development projects (Ministry of Housing and Local Government, August 1999). Malaysia's new government administration township in Putrajaya is one of the current developments undergoing sustainable planning. The first phase of the development has finished while the second phase has just started. The project is expected to be completed by the year 2015.

### **3.8 Water Related Environmental and Design Requirement Legislation In Malaysia**

As a result of urbanization, Malaysia has suffered environmental problems especially water pollution. Due to this situation, the Malaysian government has enacted a number of laws and regulations related to this environmental problem. The emphasis was focused more on water issue-related legislation and enactment.

The Malaysian Ministry of Science and the Environment has been given authorization to carry out environmental-related legislation. The legislation has been created to control pollution from various sources. Therefore, there are several legislations undertaken by the Malaysian Government to mitigate environmental problems especially those related to water issues. They are as follows:

- The Environmental Quality Act 1974, and 1984 (amendment)
  - i. This Act was enforced on 1<sup>st</sup> April 1988.
  - ii. This act aims to control environmental issues related to air, oil palm and rubber process activities, vehicles, sewage, and industrial waste.



- **The Environmental Quality Procedure (Oil Palm, 1977)**
  - i. It was first implemented on 1<sup>st</sup> July 1978.
  - ii. This procedure is related to water quality parameters such as sedimentation, pH, temperature and others.
  - iii. The enforcement of this procedure is being conducted in several phases.
  
- **The Environmental Quality Procedure (Sewage and Industrial Effluent, 1979)**
  - i. This procedure was officially used in Malaysia On 1<sup>st</sup> June 1979.
  - ii. In this procedure, the central municipal treatment plant has been enforced in all factories, housing schemes and core businesses, but emphasis is limited to certain covered areas.
  
- **The Environmental Quality Procedure (Bio-Oxygen Demand and Chemical Oxygen Demand Effluent, 1985)**
  - i. It was enforced in Malaysia on 1<sup>st</sup> July 1985.
  - ii. The procedure has made it compulsory for all factories with chemical, biological and oil effluents to be registered with the Department of the Environment.
  - iii. The effluent should be dumped in a special treatment area with processing facilities.
  
- **The Pesticide Act, 1974**
  - i. It is carried out by a collaboration between the Ministry of Agriculture, the Ministry of Health and the Department of the Environment.

(Refer to Appendix C, on water related regulations and acts in Malaysia.)

The requirement for open spaces has also been seriously looked at in order to ensure that the percentage of impervious areas in urban development can be controlled and monitored. Therefore, under the Town and Country Planning Act (Amendment), 1995 (Act A933), 10% of land approved for any development project in urban areas should be designated as open space for recreational purposes (Landscape Architecture Malaysia, Issue No 4).



### **3.9 'Love Our Rivers' Campaign**

Referring to the campaign progress report (DID Website, 2001), this 'Love Our Rivers' campaign has been carried out in three phases. The first phase started in 1993 and has continued till now. The second phase started in 1996, while the final phase was launched in 2000. The first phase consists of five main activities: 'Pet river', 'River monitoring', 'Education and forum', 'Rivers expedition' and 'River caring'.

This campaign was launched on 20<sup>th</sup> September 1993, and the month 'September' has been declared the 'Love Our Rivers' month. Each year, the campaign is celebrated with different meaningful themes. Below are themes that have been presented each year since 1993 ('Love Our Rivers' Website, 2000);

- 1993 - Beautiful and Clean Rivers are My Heritage
- 1994 - River's Cleanliness is Everyone's Responsibility
- 1995 - Rivers: Source of Recreation
- 1996 - Prevention is a Basis of Rehabilitation
- 1997 - Prevention is a Basis of Rehabilitation
- 1998 - Love Our Rivers, Water of Life
- 1999 - Love Our Rivers, Water of Life
- 2000 and onwards - It's My Rivers, It's My Life

In 1996, with the theme 'Prevention is a Basis of Rehabilitation', the campaign stressed the enforcement of river management. Seminars and short courses were carried out to introduce the management team to river management techniques. These management techniques emphasize sustainable management approaches known as 'Best management practice' (BMP). Among the steps taken involving the states and districts are as follows:

1. Organising a task force for river management
2. Preparing an inventory analysis in identifying the causes of pollution.
3. Introducing the task force team with water related regulations and acts
4. Publishing books and guidelines on river related activities

Despite six years of the 'Love our rivers' campaign and extensive media publicity, the effort to improve or even sustain the cleanliness of the one hundred and fifty river systems has been an uphill task and largely unsuccessful (The New Straits Times, 1998). However, the campaign, which was launched to raise public consciousness on the need to appreciate and keep rivers pollution-free, has shown a good response. The 'pet-river' scheme is a scheme where the village security, development committee, school or district needs to select a river for maintenance. The



report mentioned that, from only seventy-three rivers in the early stages, the scheme grew to cover one hundred and sixty rivers as more schools and village committees responded to the idea of river rehabilitation (The News Straits Times, 1998).

Only six states were fully involved in the second phase. The second phase programmes are still being conducted until today. In the year 2000, the third phase was officially launched. This phase involved a programme which emphasizes the commitment and responsibility of related agencies and the public. However, to ensure the success of the campaign, the original objectives have been amended. They are as follows:

1. Emphasizing the responsibility, awareness and appreciation of rivers among the public.
2. Encouraging participation in river conservation activities.
3. Educating the public with information on the rehabilitation and conservation of rivers.

According to Embi (2005), the factor that has been identified as an obstacle to the achievement of this campaign is the incapability to control the source of pollution especially from the industrial area as it is under the jurisdiction of the Department of Environment. Other than that, many sources were under local authorities who were difficult to control due to a lack of the capacity and knowledge to enforce the regulations.

### **3.10 Supporting Roles in SUDS Application**

As discussed earlier in Chapter 2, all stakeholders should play their roles to ensure the success of the application of SUDS. Public roles may start from their home and daily routines, but the roles of the professionals are the most important one. This is because they need to ensure that the public understand the important of SUDS and, at the same time, are comfortable with their surrounding. However, a survey conducted by the Town and Country Planning Department shows that the insensitive approach in providing facilities for the public have resulted in the loss of gazetted open spaces (Landscape Architecture Malaysia, Issue No 4, Town and Country Planning Act (Amendment), 1995 (Act A933)). There is no specific procedure to secure the status of open-space (Landscape Architecture Malaysia, Issue No 4). However, the planner and the landscape architect could play an important role to ensure that the open-space is provided within the required boundary of development. A good collaboration with the development consultant is important in order to produce a better development planning. Embi (2005) suggests that it is important to provide sufficient knowledge through for example, a reliable information portal, seminar and courses, for industrial consultant, developers and enforcing authorities.



### **3.11 Conclusion**

In this chapter, emphasis has been given to issues related to the Malaysian context and how these issues are being taken care of. An introduction to on the history of the hydrological background in Malaysia provides an idea of drainage system development process that has been conducted in Malaysia. Issues related to water has also been highlighted. This includes issues of the pollution and drainage management. These issues have resulted in the replacement of the Hydrological Procedure 1975 with the MSMA. The Malaysian government has shown major concern and made initiative to improve the quality of water in Malaysia. This can be seen through the discussion presented on the campaigns as well as act and regulation that been enacted to protect the environment.



# Chapter 4

## *Methodology*

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### 4.0 Introduction

The methods that have been used to obtain the results in this study consist of questionnaires, interviews and theoretical analysis. The theoretical development covers the first part of the research problems as discussed in Chapters 2 and 3. They comprise three problems as stated below:

1. *What are the main elements of the sustainable approach to drainage systems in urban housing schemes as developed in western countries?*
2. *What are the main problems associated with urban drainage in Malaysia and what are the usual solutions?*
3. *How can the SUDS principles be adapted onto the Malaysian housing context?*

The sample testing that has been conducted is to identify a solution for the second part of the research problems. They are as follows:

1. What are the main barriers to the application of sustainable drainage schemes in Malaysia, and do the design professions in Malaysia have;
  - a. Knowledge of such systems and,
  - b. Are they willing and able to implement them?
2. How acceptable to the public would a sustainable drainage system approach be?

### 4.1 Identifying the Malaysian Study Area

The case studies were conducted in two areas, namely in Johor Bahru and Putrajaya. These areas were chosen based on the drainage system that were applied in the selected housing areas. However, the case study also included the Bio-Ecods in the campus Universiti Sains Malaysia in Penang as it uses a sustainable method drainage system invented by the REDAC that suits a tropical climate.



The town of Johor Bahru is situated on the southern part of Peninsular Malaysia and is the capital state of Johor. It has suffered major pollution problems due to urbanization. In the year 2002, the state government received suggestions from an environment consultant to spend RM945 million (£136million) to implement rehabilitation on three of the four most polluted river in this state.<sup>5</sup> Out of the eighteen main rivers in Johor, only the Mersing River, the Jemaluang River, the Sedili Besar River and the Paloi River are considered clean. Ten others are founded to be moderate and four are seen as badly polluted. A study carried out by the University of Technology Malaysia (UTM) and Asia Water and Environment Private Limited reveal illuminating findings. The study shows that 90% of the pollution affecting Sungai Skudai was caused by domestic sewage while the industrial areas contributed a total of 10%, 70% of the Sungai Segget pollutants were domestic sewage and 30% came from non-point sources, such as garbage swept away by run-off rain water into the river. 71% of Sungai Tebrau was polluted by domestic sewage; 28% by non-point sources and only 1% by industrial waste. The site criteria considered for this study as follows:

1. Johor Bahru town has been one of the most rapidly urbanised town over the past ten years and has suffered lots of environmental problems especially related to water.<sup>6</sup>
2. There are lots of housing schemes in this district and it is reported that domestic sewage is one of the major causes of river pollution.<sup>7</sup>

Putrajaya, on the other hand, is a newly developed township with sustainable approaches. The township implements a different approach to its drainage system and is also equipped with a lake and constructed wetland. As a new government administrative township, Putrajaya was planned together with its residential precincts. Each residential precincts were completed with proper planning drainage systems. The drainage systems in Putrajaya were planned to suit the Putrajaya lake that has been claimed to be safe for any water base activities. There are also rivers which flow across Putrajaya and pasts through the wetland areas. Further discussion on these areas are discussed together with the case studies in Chapter 5.

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<sup>5</sup> As reported by the New Straits Times regarding nine polluted rivers in Johor.

<sup>6</sup> Johor Bahru is one of the towns listed in MSMA Volume 1. Others are Kuala Lumpur, Penang and Ipoh.

<sup>7</sup> Utusan Malaysia (25<sup>th</sup> August 1997) in the article 'Kemas kini sistem perparitan di perumahan' (Re-organise drainage systems in housing areas) highlights that most of the drainage systems in housing areas in Johor is not capable of catering for current development.



## **4.2 Sampling Frame**

The sampling frame was sent randomly via postal survey method to residents of two selected housing areas in Johor Bahru and Putrajaya. They were those who have experience living in urban housing areas which provided either the conventional drainage system or the sustainable drainage system.

## **4.3 Selection of Respondents**

The survey also offered the opportunity to sample to be contacted for further feedback related to the study. This then allowed the researcher to identify sample who were aware of related issues and willing to participate in the study. Those who informed their availability to participate in the study were chosen based on demographic criteria in order to form a smaller focus group. The criteria that had been considered for the focus group respondents were as follow:

- a. The respondents were from various age groups who had lived within the selected site (Johor Bahru and Putrajaya).
- b. They experienced either the conventional or sustainable drainage system in their daily lives.

## **4.4 Research Tools**

Combinations of qualitative and quantitative methods were selected as tools to support the study. The combinations of these two methods are for the purpose to support weaknesses which could come from using a single method (Olsen, 2004). The questionnaires functioned as the primary tools and were piloted earlier to identify any weaknesses. The questionnaire survey was conducted after a few amendments. Results from the questionnaires were analysed earlier to support the development of question or topic that would be used in the focus group discussion in a later stage. Further discussions are presented later in the chapter.

### **4.4.1 Quantitative Research**

Questionnaires have been widely used in social research to assess user's needs, evaluation, and environmental and behavioural research (Bechtel, et. al., 1987; Kuter; and 2001, Robson, 2002). Based on the second part of the research problems as stated earlier it is felt better then for the



researcher to apply a postal distribution methods. However, this method does have its advantage and disadvantage which led this study to observe the following:

- a. This method is the fast and efficient way to get in touch with big scale potential respondents.
- b. This method allow anonymity and encourages respondents to discuss or complain about any sensitive issues.
- c. This method identifies awareness amongst the public to put their effort in replying questionnaires that come together with reply envelope.
- d. This method has a low response rate, which then reflects their willingness to participate in this study.

In this study, data collected from the quantitative method have been analysed using frequencies and correlation. This method is very efficient for the research purposes of this study, as the information is gathered from a large number of respondents.

#### **4.4.1.1 The Significance of the Questionnaire Method**

In this study, there are two sets of questionnaires that have been designed. The first questionnaire had been designed for the public and the other for professionals who were involved with drainage systems. Both sets of questionnaires were designed with a combination of multiple choice questions and open-ended questions.

The questionnaires for the public were distributed to respondents living in urban housing schemes in Johor Bahru (JB) and Putrajaya. The use of this postal-distribution questionnaire method generated 282 responses from JB and 165 responses from Putrajaya. These questionnaires were divided into six sections; with each section representing a different research theme. The themes of each section were as follows:

Section 1 – Personal Background

Section 2 – Satisfaction with the current drainage system

Section 3 – Awareness of drainage-related environment problems

Section 4 – Drainage practices

Section 5 – Improvement to drainage system

Section 6 – Additional information



In Section 1, eight questions on demographic factors were posed. All questions were given multiple-choice answers. For Section 2, questions were given with nine water related issues. The respondents were then required to identify problems that they had experienced and the frequency of the problems occurring in a year. This was also undertaken to discover the public's feelings with regards to drainage or problems related to drainage.

For Section 3, question were designed to identify public awareness of drainage related environmental problems. Questions consisting of eleven problems associated with water or drainage were posed. The public were required to choose answers based on the level of their concern with the given issues.

In section 4, eight activities related to the environment and water were described. Respondents were then requested to choose answers based on their interest to participate in each activity. Section 5 presented the twelfth question of the questionnaire. The respondents were requested to voice their opinions on the needs for improvement on current drainage systems. The final section, Section 6, is the part in which respondents were asked whether they were willing to be interviewed, and to share their contact details.

The second groups comprised professionals who were involved in the development of urban housing schemes. The professionals came from different backgrounds and were from major towns in Malaysia. Thirty-six feedbacks were received from the professionals. The questionnaire for the professionals divided into five sections; with each section representing a different research theme. The themes of each section are as follows:

Section 1 – The Professional's Background

Section 2 – Identification of drainage problems in Malaysia

Section 3 – Knowledge and experience on SUDs components

Section 4 – Opinion on barriers of SUDs application in Malaysia

Section 5 – Additional information

Section 1 was made up of four questions on demographic and working information. In Section 2, two questions were posed, and the professionals were required to list three problems related to the drainage system in Malaysia in general and the residential area in particular.

In Section 3, questions involving eight SUDS components were posed. The professionals were then required to describe their understanding of the respective components. They were also asked to identify the advantages or disadvantages of each component. Other than that, the professionals were also requested to declare their experience pertaining to each component.



Section 4 had eight options of obstacles occurring in a residential area. The professionals were required to choose the options that they think would be the barriers in residential areas in Malaysia. They were also asked about the sufficiency of MSMA information in dealing with a drainage system in a residential area. The last section was reserved for contact information for future correspondence purposes if the need arises.

#### **4.4.2 The Interview Session**

The interview was conducted in two sessions; the first for the public group and the second for the professionals. The interview questions for the groups were based on a combination of structured and open-ended interview questions according to their current housing surrounding experiences. There was also a question posed based on images. Two sets of images were used; one consisted of a set of drainage models images and the other a set of SUD components.

The interview for the professionals revolve around questions based on their idea and views SuDS application in housing areas in Malaysia. Results from the interview were also used to assist in the analysis of data before obtain from the questionnaires.

#### **4.4.3 The Public as a Focus group**

A focus group is a group interview on a specific topic of a related group background (Robson, 2002). In this study, the focus group needs to discuss a topic related to the drainage of a housing scheme they live in, and also how they perceive the application of SUDS. The researcher facilitates the focus groups by acting as the discussion moderator. A smaller group discussion of five to seven people is preferable. The focus group is secondary data collection that cannot be obtained during the postal questionnaire survey. Based on the the results obtained from the questionnaire survey and analysis, questions and topic for discussion can then be formed as a guide during the focus group discussion sessions. This method has been used by Hyland in 1994 to develop a series of quality of life questionnaires (Robson, 2002). In this study it helps to see how the public perceives the quality of their living environment, especially those related to drainage systems.



#### **4.4.3.1 The Objectives of the Focus Group Discussion**

There are three main objectives for conducting focus groups discussions for this study. They are as follows:

##### **Objective 1**

To fill in gaps which occurred during the base line study, the focus group provides an informal opportunity to obtain what is typically qualitative data, which cannot be easily obtained from a questionnaire.

##### **Objective 2**

To get feedback from the residents of an urban housing scheme, age and gender will be the base line factors for identifying the focus group. Other than that, the sample background will be taken into consideration, and the groups will be divided into several categories

##### **Objective 3**

Using images as part of the communication tools during the focus group sessions, the images shown are of various scenes and topics. This is to give an idea to the residents of a surrounding living environment in the respective areas and also in other places too.

#### **4.5 Piloting the Questionnaire**

The draft of the questionnaire has been piloted to test the questions structure and format. An extra section was added to obtain comments and suggestion from respondents so as to allow the researcher to improve the final version of the questionnaire.

In the summer of 2003, a base line study was conducted by means of a postal survey questionnaire. The postal survey began in July for three months and ended in September. A random sampling method was used to gain feedback from those closest to the population mean. The target group was chosen randomly from within the Johor Bahru area. The sampling was gathered through 'postal questionnaires'. A total of seven hundred questionnaires were posted to selected addresses from a telephone book chosen randomly to allow a minimum of two hundred replies. A sampling technique was employed similar to that of Hagerhall (2000), who obtained his sample from every fiftieth name in a telephone directory. Based on his method, addresses were selected randomly from a telephone directory. Every fifth name was chosen



from every letter listed. Forty-five addresses were selected randomly from each letter using a 'draw method'. This was done to ensure that the questionnaires were distributed to all housing areas in the district. However, the selected address would have to fulfil the criteria of being a terrace house. This could be recognised by the number and house location. Usually, in Malaysia, an apartment or flat will state the name of the building in the address. The feedback received was very encouraging. Of the seven hundred postal questionnaires distributed, a total of two hundred and sixty four were returned. The data was then used as a guide to form questions for the focus group session.

The postal method was also used for the distribution of questionnaires meant for the professionals. A total number of one hundred questionnaires were posted to a firm of professional that was chosen based on its location. However, the feedback received was not as encouraging as that of the public respondents. Only twelve responses were returned.

After studying and analysing the data using statistical software (SPSS 12.0), several issues and questions were highlighted. The issues would then form the questions to be used during the discussion as they would later be used to support any possible gaps obtained from the postal survey data. Bonaiuto et al. (1999) in their study consider the socio-demographic and residential factors as the main issues in identifying perceptions on a residential environment. The lists of issues that were identified from the pilot survey are discussed in the next sub-topic on the amendment pertaining to the survey questions.

#### **4.6 Amendment to the Survey Questions**

In October 2003, all the responses received were organised into an SPSS for analysing purposes. Based on the pilot survey, a few amendments were made. In general, the method of distribution was believed to be a practical one to be used in a public survey. However, changes had to be made to the distribution method used for the professionals as the feedback was not encouraging. An opportunity then occurred as the secretariat for RIVERS' 04 gave their permission for the survey to be conducted during their 4<sup>th</sup> conference held in Penang, Malaysia.<sup>8</sup>

In addition, the questionnaires for the public were also restructured to become simpler and more linear in style. Results from the pilot study had shown that the multiple-choice questions

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<sup>8</sup> The RIVERS' 04 Conference took place in Penang, Malaysia from 21<sup>st</sup>-23<sup>rd</sup> September 2004.



directed the public towards a specific answer or conclusion. A few questions related to images were removed from the questionnaire and used in the interview questions instead.

#### **4.6.1 Topics Highlighted in the Questions**

This study aims to identify public perceptions of SUDS in a housing area. After the pilot survey, a few issues were highlighted and had to be included in the survey.

##### **4.6.1.1 Does Age Gap Influence Environmental Awareness, especially in Issues Related to SUDS?**

Age factors may also influence environmental awareness as a certain age group might have its own various needs in the living environment, water usage and receiving information. Friedler et al. (1995) mention that age does give a significant domestic toilet usage pattern. The length of stay in the subject residential area also influence the 'attachment to a place' factor. People who are raised within the living space would be more attached to the place and would not want to migrate or visit other places (Hay, 1998). Residents in a housing scheme are from various age groups and backgrounds. Some were born there; some might have bought a house and decided to stay there and some might be tenants who just stay there for a certain period due to their work commitments. This would give a variety of perceptions as found in Hay's study in which age factors have a possibility of attaching experience to a place. There are various studies that have considered demographic factors, such as age, in identifying preferences for environment (Hagerhall, 2000; Stamps III and Nasar, 1997; Strumse, 1996; and Hidalgo and Hernandez, 2001).

##### **4.6.1.2 How Would the Gender Criteria Affect a Resident's Perception of SUD?**

To what extent do gender factors influence public perceptions of the drainage system in an urban housing scheme? A few studies show that there is a significant link between gender and perception (Statistic Netherlands, 2002; Dietz et al., 2002; Yabes et al., 1997; and Bonaiuto et al., 1999). It is believed that women are more aware of issues related to their surroundings (Statistic Netherlands, 2002; and Dietz et al., 2002). Information gained may produce different feedbacks received from each gender. Both genders might have different perception or opinion



on the drainage issues, which later helps to identify problems and solutions from various points of view.

#### **4.6.1.3 Does the Public Receive Adequate Environmental Information, especially Related to MSMA?**

Kaplan (1989) explains that people will respond to any information that they receive. Yi-Fu Tuan points out that people's attitudes to the environment vary depending on experience and it is suggested that people do receive information from or learn through their experiences cited in Lowenthal, 1968. Turkoglu (1997) also conducted a study on residents' perceptions of their living surroundings and his study was based on the differences of social status and living environment. In Malaysia, experience gained by DID from its 'Love Our Rivers' campaign shows that the campaign still could not attract much attention from the public. This appears to be due to the awareness and education factors (DID 'Love Our Rivers' campaign website). As recalled, the focus group discussion was meant to allow a better picture of public understanding and awareness of environmental issues, especially those related to water and drainage. A good SUDS research does take public opinion into consideration as it will later be beneficial to the community itself delivered through public amenities.

#### **4.6.1.4 How Far did the Images Influence Public Perception of SUDS?**

Using images as a method in research has been done before, especially in relation to environmental perceptions (Kaplan and Kaplan, 1989; Yamashita, 2002; Al-Kodmany, 1999; and Stewart et al., 2003). Collier (1967) believes that images can be seen as an extension of perceptions in anthropological studies. Appleyard, Lynch and Myer collected a series of photographs and sketches that attract their attention while travelling on the highway. They found that those new to the route had appreciated the landscape whilst those who were regulars were most interested in seeing activities or new objects (Lowenthal, 1968; 76). In this study, images were used to identify how residents perceived their surroundings, which included drainage, and what their interests were. Therefore, these images were used to get respondents to give feedbacks on their preferences. However, at the same time, it also allowed the respondents to give their feedbacks on perceptual information they may have experienced through those images. Information on their preferences were based on their fondness or likeliness. On the other hand, the perceptual information was based on the respondent's awareness or observation.



#### 4.7 Image Sets for the Interview

Two sets of images were used in the survey. One comprised a set of two images containing SUDS components that have been implemented in the UK (Figure 4.6.1). Another set of images contained three drainage models; a natural swale, a conventional drainage system and a drainage system implemented in Putrajaya (based on sustainable drainage approach) (Figure 4.6.2).



Figure 4.7.1: SUDS components as implemented in the UK – A combination used of pond and swale (left) and wetland (right)(Source: CIRIA)



Figure 4.7.2: Drainage models in Malaysia – Natural swale (left), a conventional drainage (middle) and a drain in Putrajaya (right).

Images chosen had avoided the ‘low preference criteria’ as suggested by Kaplan, et. al. (1998). According to them, people tend to show different responses of preferences in some scene criteria. It is advisable then to avoid using images with ‘large expanses of undifferentiated landcover’ and ‘dense vegetation and obstructed views’.



#### **4.8 The Survey**

In the summer of 2004, the survey was officially conducted for the public and the professionals. It took almost three months to complete all the survey. It started in early August 2004 with the selection process of residential addresses for the questionnaire distribution. This process took three days to complete. The selection process covered the two study areas which are JB and Putrajaya. One day before a weekend, all questionnaires were distributed to the selected addresses in JB in order to allow respondents to look over the questionnaires and respond to them during the weekend. The distribution of the questionnaires in Putrajaya was conducted a week later and used the same strategy.

In between each process, interview with the professionals were conducted. The professionals had been selected earlier based on their job descriptions and experiences. Correspondences at the earlier stage was conducted through postal or electronic mail to agree on the date of appointment for the interview.

Within four weeks, all the responses were received and respondents who had agreed to be interviewed were listed. Respondents for the interview session were chosen based on certain criteria, such as age, location, homeownership status, gender and length of living in the area. An official letter informing the recipients of the focus group venue and date was posted. The focus groups were conducted in the community centre with assistance from the respective local authority. The focus groups were conducted in the second and third week of September 2004.

As recalled, the RIVERS' 04 Conference was held from 21<sup>st</sup>-23<sup>rd</sup> September 2004. A week before the conference, a meeting was arranged with the conference secretariat to discuss again the method of agreement in distributing the questionnaire for the professionals. During the morning session on the first day of the conference, all questionnaires were distributed to all the one hundred and twelve professionals. An announcement was made to inform the participants about the questionnaire, which they were required to return as soon as possible before the end of the second session of day two of the conference. A reminder announcement was also made at the end of session for the first day and in the early session of the second day. Thirty-six responses were received from the professionals during the conference.



## **4.9 Theoretical Development**

The theoretical development in this study was conducted in order to answer the first three questions presented earlier. The theoretical studies aim to gain information and understanding of the inter-relationship between SUDS and the landscape design of a housing area. The theoretical development can be found in Chapter 2 and Chapter 3 of this study.

## **4.10 Conclusion**

This chapter is the most important one in directing the process of this study. It elaborates the processes involved in conducting the survey, processing the data, analysing the data as well as the reliability of the research findings. The details of each process will be discussed in the next chapter. This study was conducted through two types of survey approaches which are the quantitative and qualitative methods. The target groups were divided into two; the public and the professionals. The questionnaires were piloted before they were distributed officially in August 2004. Postal survey methods were chosen as part of the strategies to identify public participation and awareness. Focus group and professional interviews have allowed respondents to voice their opinions and give comments on the drainage system applications in Malaysia.



# CHAPTER 5

## Case Studies

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### 5.0 Introduction

The case studies chosen are located in two different areas on the west coast of Peninsular Malaysia (Figure 5.0.1). The first area is in Johor Bahru, which is in the southern part of west Malaysia. In Johor Bahru, the study was conducted in the central zone, and three housing areas were chosen based on the residential criteria and location. The second area is in Putrajaya located in the Federal Territory. This township is located 26km south of Kuala Lumpur, the capital of Malaysia. The project first started in 1998 and it was the first sustainable development approach used for a new development area in Malaysia.

Engineering Campus of Universiti Sains Malaysia (USM) in Transkrian, Penang had been included as a part of this study. However, this study only focused on the drainage system. No survey was conducted as it was not a residential area. The drainage system applied there is known as the Bio-Ecods Drain. It is a sustainable drainage approach and was first developed in 1997 with a grant from the DID.



Figure 5.0.1: Map of Peninsular Malaysia with the 3 case study areas.



## 5.1 Johor Bahru (JB)

Johor Bahru is the capital city of the state of Johor. It is located on the southern part of Peninsular Malaysia and is the second largest city in Malaysia. It is one of the bigger contributors in terms of business and industrial sectors as it is connected to Singapore by the 'coast-way'. Furthermore, it has a port in Pasir Gudang which controls all the shipping activities in the southern region of Malaysia.

The study areas are from three housing schemes in Skudai in the Johor Bharu district. They are in the same catchment area which is the Skudai River catchment area. In 1999, it was reported that the water quality of the Skudai River had decreased caused by sewage from the housing areas. The Skudai area is under the authority of the Central Johor Bahru Municipal Council (Figure 5.1.1).



Figure 5.1.1: Map of MPJBT municipal areas (yellow areas) (Source: MPJBT Official Website - <http://www.johordt.gov.my/mpjbt/>)

The introduction of the 'New Economic Policy' (NEP) in 1971 caused many changes in most cities, especially related to the housing development (Agus, 2002). The NEP made housing sectors a trigger towards stimulating economic growth and this has affected cities like Johor Bahru. The NEP also influenced many people to migrate to major cities for working opportunities, and new towns were developed within larger metropolitan areas for the expansion of existing settlements or housing areas and also to develop new economic areas. Therefore, in Johor Bahru itself, Skudai was developed as a new township to cater for urban growth. Skudai is part of the new growth corridor of southwest Johor, which includes the Senai International



Airport, Tanjung Pelepas Port and the proposed new administrative capital of Johor, Bandar Nusajaya. The population ranges between 150,000 and 200,000. The Skudai area has been growing rapidly, especially after the main campus for Universiti Teknologi Malaysia (UTM) was relocated from Kuala Lumpur to Skudai. Now, the Johor Bahru Municipal Council (MPJBT) has forty-six areas under its authority including Skudai. This covers the three study residential areas, namely Taman Tun Aminah, Taman Sri Skudai and Taman Universiti. The three chosen housing areas were developed more than ten years ago. Taman Tun Aminah was opened in the 1970's, Taman Universiti in the 1980's and Taman Sri Skudai in the 1990's.

It needs to be mentioned that the quality of space changes as the residential area becomes more 'mature' in terms of age of development and the quality of life. The trend shows that society has the intention of renovating their properties for a better and more convenient individual living space. These have increased the potential of impermeability in the catchments areas. Furthermore, these 'mature' residential areas not only need regular maintenance, but also need some replacement or improvement of the drainage systems (Figures 5.1.2 and 5.1.3).



Figure 5.1.2: Poor maintenance of drains in a residential area in JB.





Figure 5.1.3: The drainage in residential areas needs improvement and maintenance.

The drainage systems were designed based on the 'Urban Drainage Design Standards and Procedures for Peninsular Malaysia (UDDS) produced by the Department of Irrigation and Drainage Malaysia (DID) in 1975. The procedure has now been replaced by the 'Urban Stormwater Management Manual for Malaysia' (MSMA).

### 5.1.1 Drainage System in Johor Bahru

The principle in the procedure outlined is the urban drainage system considered as a sub-system in the general urban development (UDDS, 1975). The drainage system had been designed in a general development plan to suit the comfort and needs of the urban community. An engineering analysis and study had been included in the planning proposal where consideration had been taken to identify possible flood hazard, location of the proposed detention pond and erosion control measures.

In general, planning for the drainage system should consider the open space and the transportation routes. The open spaces are emphasized to benefit recreational purposes for the urban community, whilst transportation routes need to be equipped with a proper drainage system as preparation during major storms, such as flash floods, erosion, sedimentation and landslides.



Natural channels are also encouraged to be used as storm run-off waterways if possible. However, many have been deepened and straightened and this has had a great impact on the downstream, especially during peak flows. Anyway, these scenarios have been considered as the natural result of or change due to urban development.

### 5.1.2 Water and Drainage Related Issues in Johor Bahru

In JB, the uses of rivers can be divided into two types; beneficial uses and non-beneficial uses. The beneficial uses of rivers are, for example, supplying freshwater for domestic, industrial and agricultural purposes. In some places, the river has been used as a transportation route and for freshwater fish livestock in cages. However, of greater concern is the impact of the non-beneficial uses which have an impact not only on the environment, but most importantly, on freshwater supply. The non-beneficial use appears to be a common practice for many people where the river has been used as a dumping site for domestic and industrial sewage (UNEP Report of Malaysia, 2001). Water pollution is also identified as a major problem in the river systems in JB (Table 5.1.1).

Rivers with TSS	
Numbers of rivers with total suspended solid (TSS)	14
Transportation of pollution	
BOD (ton/y)	16,030
Total AN (ton/y)	1,638
Suspended solids (ton/y)	4,969
Oil (ton/y)	0.138
Industrial sources of water pollution	
Number of sources	689
Agriculture sources of pollution	
Other seasonal crops (ha) - vegetables	15,382
Plantations (ha) – rubber, oil palm, etc	1,011,729
Number of pig farms	93

Table 5.1.1: Water related problems and issues in Johor. (Source: UNEP report of Malaysia, 2001)

There is a critical water issue in JB which have an impact on freshwater water supply for domestic and industrial use as the demand is increasing from year to year in Johor (Table 5.1.2).

	1980	1985	1990	2000
Johor	159	258	338	578

Table 5.1.2: Projected domestic and industrial water demand 1980-2000 (x 000,000 m<sup>3</sup>/y) (Source: UNEP Report of Malaysia, 2001)



### 5.1.3 Drainage Problems in Residential Areas in Johor Bahru

The chosen residential areas in JB are more than 10 years old. Therefore, the quality of the drainage systems is not good. Many factors have influenced the drainage conditions, such as the management, the maintenance, the non beneficial activities by the community and the impact of new development (Figure 5.1.4).



Figure 5.1.4: Siltation and blockage of the drainage system from nearby development activities in a residential area in JB.

The management of drainage systems involves a number of organisations and authorities, which are responsible within different levels of jurisdictions (Figure 5.1.5). However, most of the maintenance work has been privatised by the local authorities to the private parties. There is a need for the respective authorities to carry out frequent monitoring of the maintenance works as some was not well maintained and left unattended (Figure 5.1.6 and Figure 5.1.7).



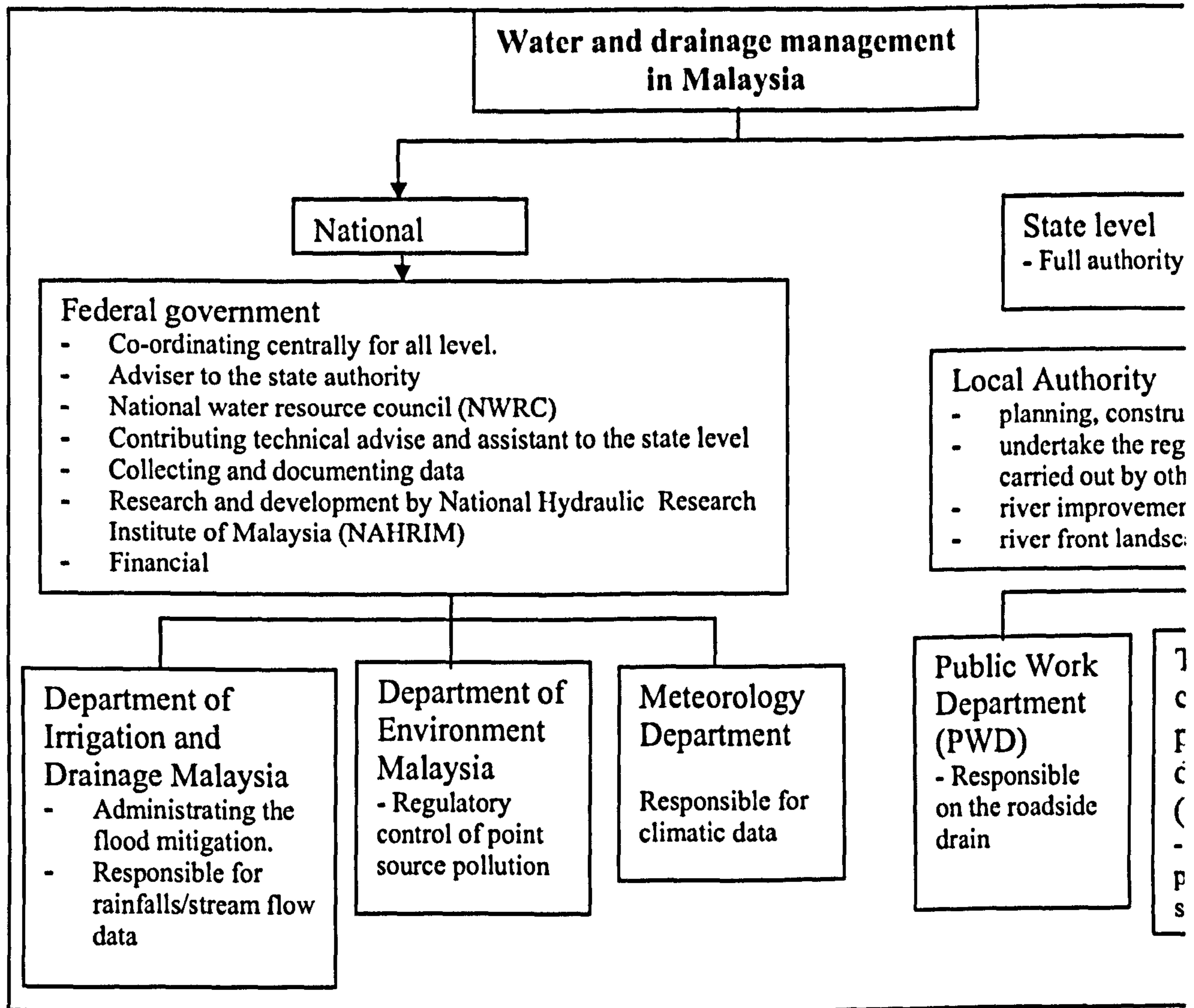


Figure 5.1.5: Organisational Chart of Agencies Involved in Water and Drainage





Figure 5.1.6: This is neither a public toilet nor a sculpture but a consequence of the lack of maintenance by the respective authorities. The toilet bowl was left there by an irresponsible individual in a JB residential area.



Figure 5.1.7: Drainage with improper maintenance in a JB residential area.

The chart (Figure 5.1.5) shows that the management of water and drainage is carried out by different agencies with a different jurisdiction and level of responsibility. However, these inter-department links do not seem to be specific in terms of their limits of responsibility, which sometimes can lead to confusion for the developer. There is also no official clarification of who is responsible for storm drainage which has led developers to refer storm drainage matters to both DID and the local authority (MSMA, 2000). Therefore, it can be seen in the old urban residential area that there is a mixture of design structures for storm drainage.



A shortage of staff to supervise maintenance has been identified as one of the factors for poor maintenance in many residential areas (MSMA, 2000). Some of the drainage components need to be replaced, but it is difficult for local authorities to ensure that all of their responsible areas are monitored regularly (Figures 5.1.8, 5.1.9 and 5.1.10).



Figure 5.1.8: A damaged fence for the drainage resulting from rust in a residential area in JB.



Figure 5.1.9: A collapsed drain wall in need of urgent maintenance in a residential area in JB.





Figure 5.1.10: Waste dumping by irresponsible residents in drainage reserves in a residential area in JB

Siltation is also a problem due to urban development activities. Many drainage systems have been blocked or are shallow. Other than that, siltation also causes the surrounding area to become muddy and this makes the environment unpleasant to see (Figure 5.1.11).



Figure 5.1.11: A drain blocked by silt from a nearby construction site. The road was also muddy.



#### 5.1.4 Public Safety Consideration in Johor Bahru Residential Areas

There is an attempt to provide safety precaution for the drainage system. However, the suitability of the precaution element taken should be reconsidered as it involves various levels of age groups in a residential area. The open channel system is very dangerous especially during heavy rainfall where the storm drain could be very deep and there is a strong current of runoff. In Figures 5.1.12 and 5.1.13, the distance of the residential areas and the storm drains are quite near. Furthermore, the fences provided are not safe enough for children.



Figure 5.1.12: The distance between the residential block and the storm drain are close to each other in a residential area in JB.



Figure 5.1.13: The storm drain is behind a house which is very dangerous especially for children.



Safety precautions are supposed to be considered in the early stages of planning of the residential area in order to reduce the possibility of accidents. Other areas in the residential planning such as the shopping area and the park also need to be looked at in terms of safety because they are part of the resident's living surroundings. As seen from in Figure 5.1.14, a parking site for a shopping area is not provided with fences and the drain is really deep and dangerous for children as well as vehicles. On the other hand Figure 5.1.15 shows a recreational park with the children's playground located very near to the pond. This is very dangerous for unattended children.



Figure 5.1.14: Parking site for this shopping area is not safe in a residential area in JB.



Figure 5.1.15: The children's playground area is too near to the pond and is not provided with safety precautions in a JB residential area.



### 5.1.5 Discussion of Case Study in Johor Bahru

Most of the housing schemes in JB have been provided with conventional drainage system. In general, the drainage will be flowing through to the nearest retention pond before being released into the water bodies. Some will be drain directly into the rivers. During the wet season, the water flows are very high and there is a possibility that some retention pond would not be able to hold the increasing amount of water. Therefore, the water spillage could cause flash flood. Rapid development in JB have put through the retention pond into a situation where it is no longer capable to cater to the increasing amount of water which had been designed for certain areas earlier. In a conventional drainage system, a retention pond is only provided in a bigger scale development as, for the smaller scale development, the water will flow directly into the nearest water bodies or disperse into the ground (Nik Abllah, 1990). These technical design factors worsen the problems with its 'rapid disposal method' which had been designed to ensure that water is transferred from the specific areas in the fastest way. Based on the Uniform By-Law Act 1984, the velocity magnitude for surface running water is between 3-8 feet per second. Refer to Table 5.1 for the suggested gradient that suits the requirement proposed in the government document.

Drainage size (inches)	Gradient	
	Minimum	Maximum
12	1:176	1:16
15	1:260	1:24
18	1:350	1:36
24	1:450	1:48

Table 5.1.4: Minimum and maximum requirement for the drainage gradient (Source: Unniform Building By-Law 1984).

There is a need for proper management of the residential drainage system in JB. The management and maintenance should be revised and studied to accommodate current situation. Most problems appear to be associated with improper maintenance activities. Proper training for those who are involved in maintenance activities needs to be provided on a regular basis. Maintenance has always been under the responsibility of appointed companies by the local authority. However, the only obstacles to this are is the skills and training of the maintenance workers which are hard to be monitored. Therefore, the methods, quality and management of maintenance works might differ from one company to another.

Safety is the most important element when dealing with residential planning. This is because it involves a wide range groups of age in residential areas. It is thus important to ensure that any open channels are provided with safety devices. Areas that children use frequently, such as the playground area or the park should be planned with low accidental risk. The depth of any pond



or swale should be shallow. However, the community also have their own role to play in the supervision of children's activities.

Information on current local situations should also be given to the public. This will then help them to understand their responsibilities. At present, dumping garbage or domestic waste in the drainage systems are widespread in a residential area in JB. This is then believed to be related to their knowledge of environmental issues. The public also seem to be unaware of their role in contributing towards water pollution. The Local agenda 21, an outline of a commitment of the Malaysian Government, clearly states that public participation is the fundamental principle to good governance. In achieving sustainable development, the public needs to participate in environmental assessment procedures and should have access to information relevant to environment and development held by national authorities (Malaysia Nature Society, 2005).



## 5.2 Putrajaya

Putrajaya is a federal government administrative township (Figure 5.2.1). It covers an area of 4,390 hectares. The township was designed to be efficient, effective and intelligent as the country's administrative centre.

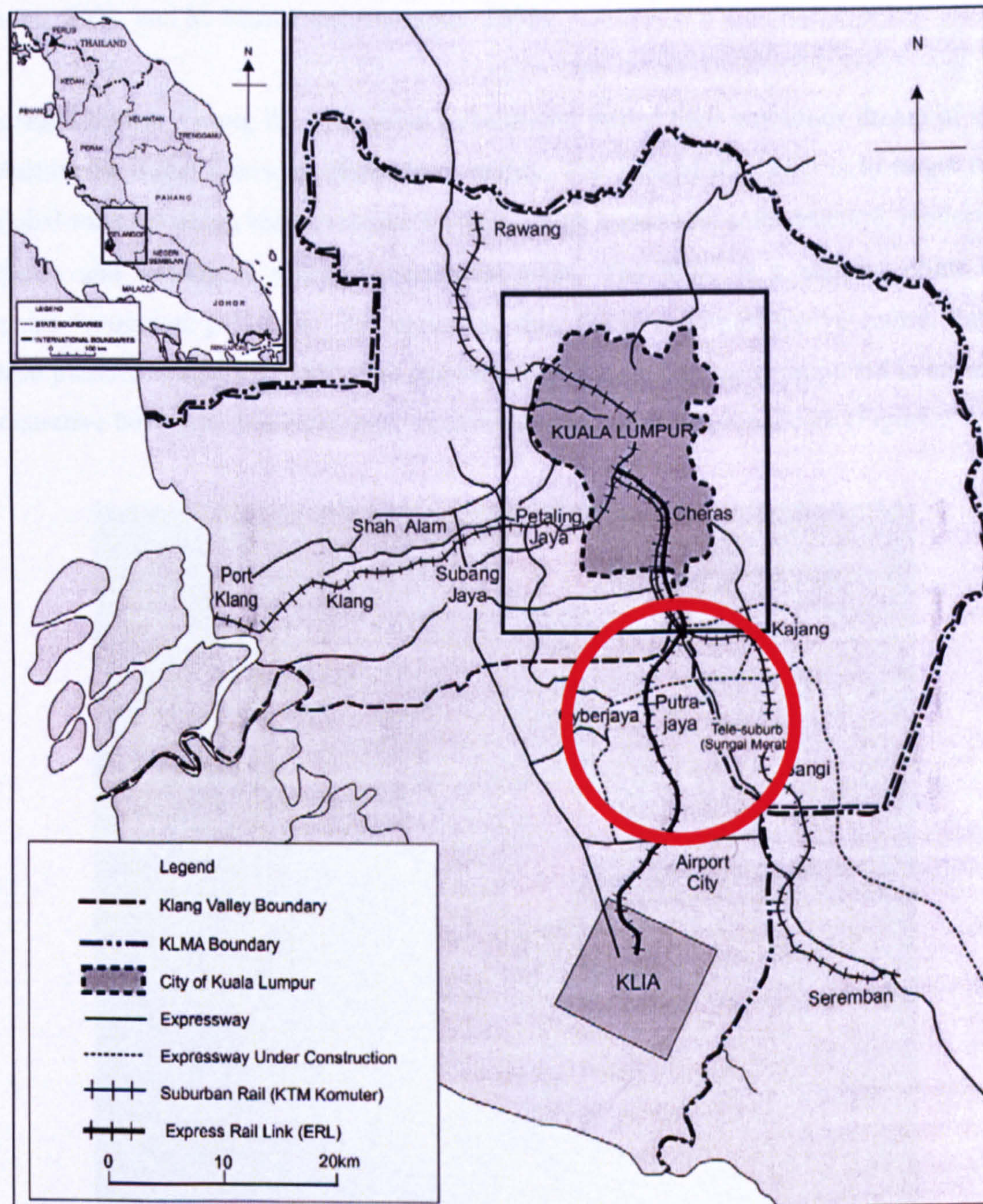


Figure 5.2.1: Putrajaya and Kuala Lumpur city



### 5.2.1 Historical Background of the Planning of Putrajaya

In 1991, the former Prime Minister of Malaysia, Tun Dr Mahathir Mohammed introduced 'Vision 2020'. It aims for Malaysia to be one of the fully developed nations by the year 2020. Vision 2020 requires a concerted development in all areas, such as economics, education, politics and culture. Vision 2020's master plan for Malaysia is modernity (Mohamed, 2002; Uimonen, 2003; and M-Shaluf and Ahmadun, 2003).

Encouraged by this vision, the Malaysian government turned their ambitious dream of creating the Multimedia Super Corridor (MSC) into reality. The idea of the MSC is to target regional and global markets where the government offers a high bandwidth infrastructure, modern office complexes and intelligent planned residential areas. The MSC is a starting point for the Malaysian 'economic paradigm'. In supporting this, the new administrative centre, Putrajaya, had been planned within the MSC. The administrative centre has been completed in terms of the administrative buildings, business core, residential core and recreational core (Figure 5.2.2).

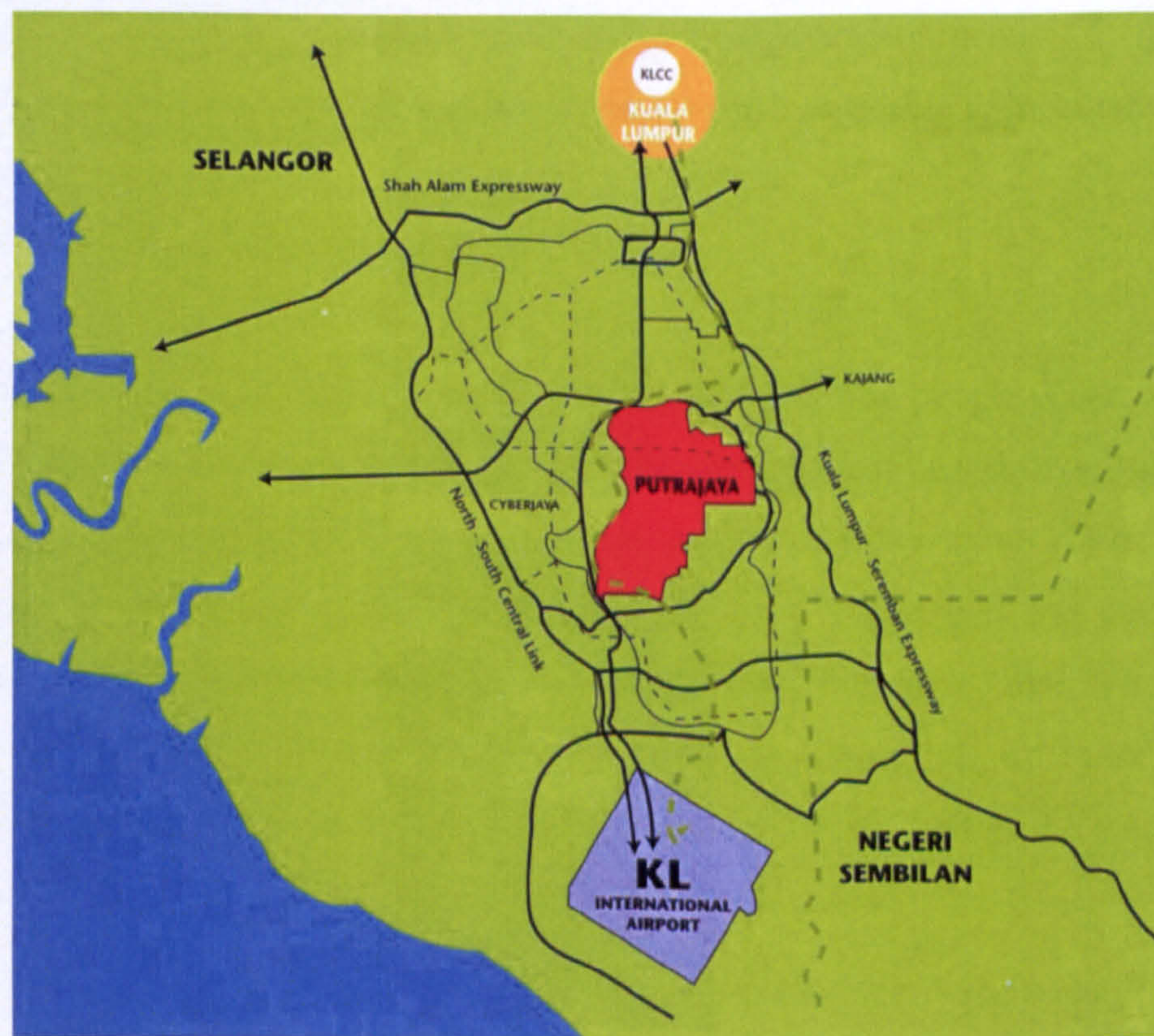


Figure 5.2.2: Putrajaya keyplan shows that Putrajaya is strategically located within the Multimedia Super Corridor (MSC) areas. (Source: Putrajaya Holdings, 2001)



## **5.2.2 Putrajaya Administrative Centre**

Putrajaya is located to the south of Kuala Lumpur (Figure 5.2.3). It is planned and designed with a 'Garden City' approach. Vision 2020 also supports the Rio Summit 1992 where the government has undertaken many attempts to sustain the rain forest. The 'Garden City' is a concept outlined to retain the natural environment within the city planning.

Putrajaya is planned on an agricultural land which had previously oil palm and rubber estates. The site is situated within the River Chau catchment area. Major rivers which can be found there are the River Chau, the River Bisa and the River Limau Manis which flow southward to the River Langat. This administration centre has advantage due to its strategic location. It is located between the Kuala Lumpur International Airport and the MSC centre.

The goals that have been set for the township of Putrajaya are as follows:

- a. To suit the concept of a 'City within a garden' which exposes the attractiveness and images of the Malaysian urban identity.
- b. The inhabitants are safe, secure and vital in a sustainable environment.
- c. Urban surroundings that are sustainable, responsive and adaptable to local needs.
- d. Economically sustainable.
- e. Effective and efficient environmental performance.

Putrajaya was planned to accommodate a population of 0.5million people (Figure 5.2.4). As the first Malaysian sustainable development project, the environment has always become the most important issue to be emphasized, especially those related to water issues. In general, the area receives 2000mm of rainfall yearly and it is generated by monsoonal and convective storm systems. In the centre of the development is the 600 hectares Putrajaya Lake. The lake acts as a central core for the whole development with a catchment area of 51km.<sup>2</sup> Putrajaya Lake and Putrajaya Wetlands were designed to control the water quality as well as the water species and habitats.



# Masterplan



Figure 5.2.3: The Masterplan of Putrajaya. (Source: Putrajaya Holdings, 20



## Putrajaya Statistics & Population of Surrounding Towns

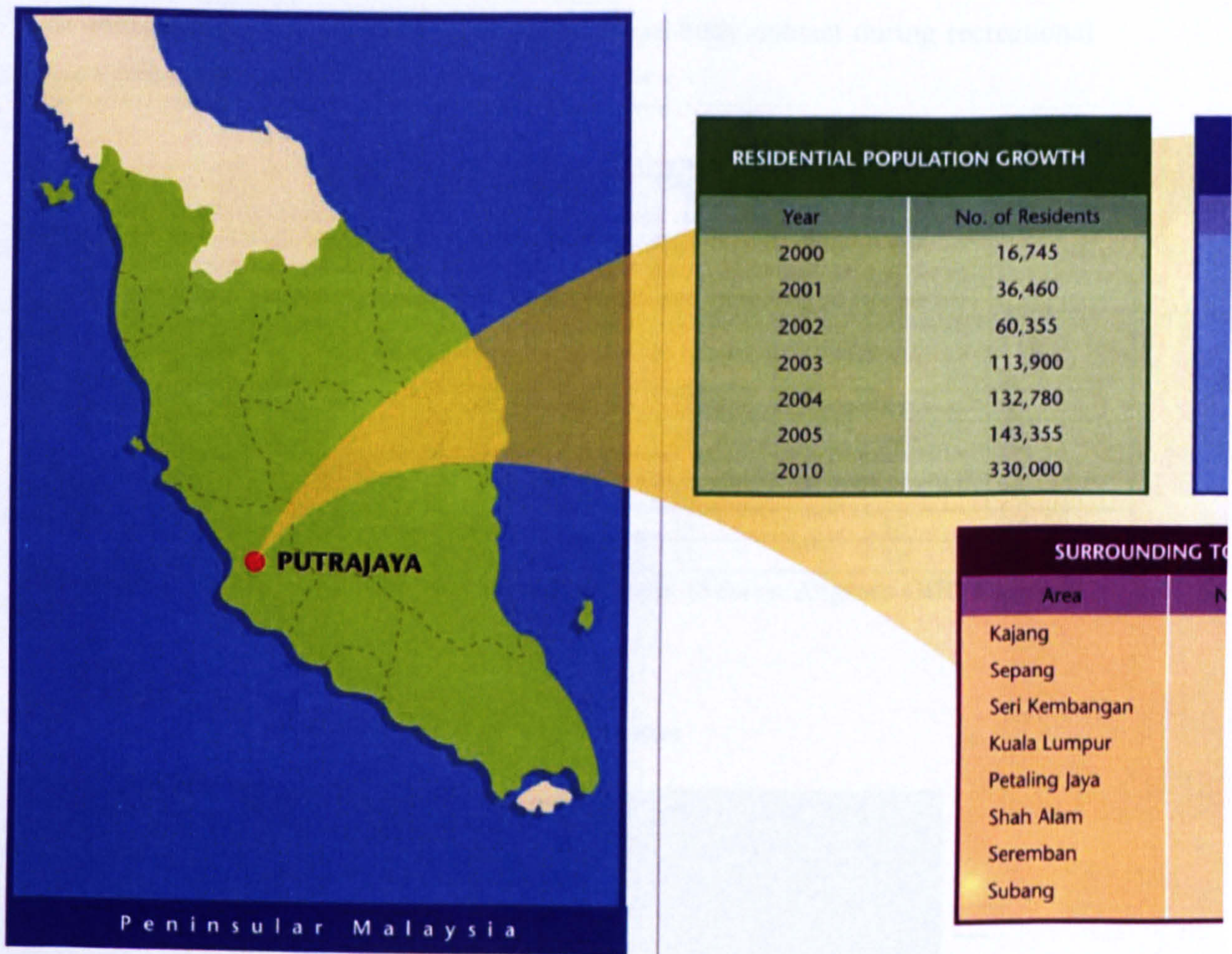


Figure 5.2.4: Putrajaya statistical projection and population of surrounding towns. (Source: Putrajaya Corporation)



### 5.2.3 The Drainage System of Putrajaya

The master planning of the Putrajaya drainage system takes into consideration the proper implementation of water sensitive urban design practices for Putrajaya. This is undertaken in order to avoid uncontrolled urban stormwater and water pollution problems. The lake is required to cater for multi-function activities. The water quality in the Putrajaya Lake is identified to be of higher quality, which is suitable for active body contact during recreational activities (Table 5.2.1 and Figure 5.2.5).

Precinct	Area (ha)	Commercial	Industry	Residential	Roads	Open space
Government offices / complexes	545	60	0	9	9	22
Commercial and business district (CBD)	481	12	23	24	13	8
East residential	462	0	0	71	18	11
North-west residential	952	12	7	55	12	14
North-east residential	772	1	4	42	7	36
Sports and recreation	373	14	1	55	16	14
<b>Total</b>	<b>3585</b>	<b>16</b>	<b>6</b>	<b>45</b>	<b>10</b>	<b>23</b>

Table 5.2.1: Percentage of land use distribution for various precincts. (Source: Angkasa GHD Engineers Sdn Bhd, 1996)

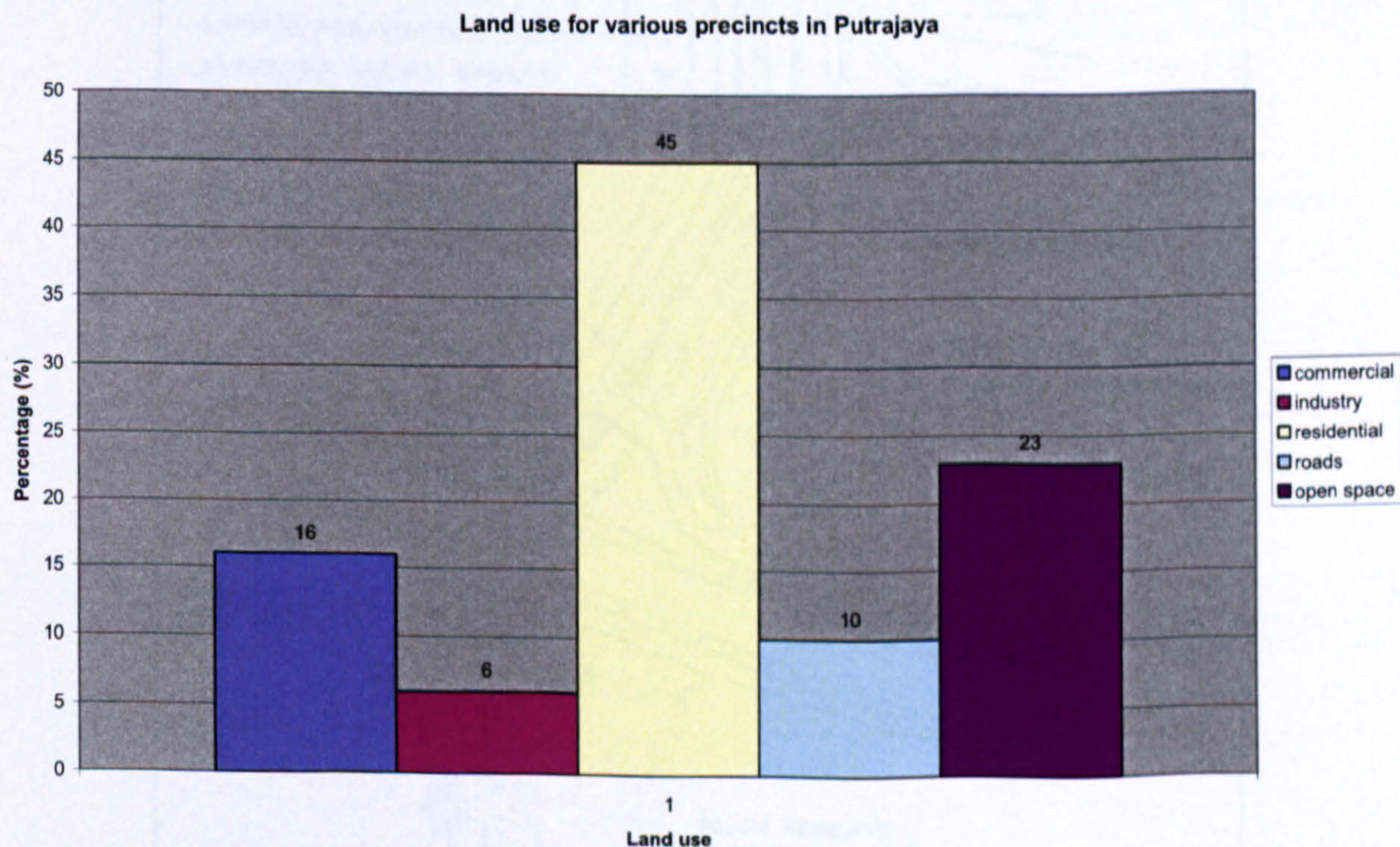


Figure 5.2.5: Bar chart of land use distribution of various precincts in Putrajaya. (Source: Angkasa GHD Engineers Sdn. Bhd., 1996)

In general, the drainage masterplan of Putrajaya involves twenty precincts; most of which are linked directly either to the Putrajaya Lake or the Putrajaya Wetland system. The planning for the Putrajaya Drainage Masterplan was first developed in 1996 by Angkasa-GHD Engineers. The drainage masterplan component was designed based on the 'Urban Drainage Design



Standards and Procedure for Peninsular Malaysia: Planning and Design Procedure No. 1' by the Department of Irrigation Malaysia (DID). It was designed to fulfil the indicative utilisation of stormwater, quality management measures and the appropriate drainage design standard. Besides that, it also fulfils the needs of Putrajaya's sustainable development approaches.

The Putrajaya Urban Drainage system was designed with an innovative stormwater system which can be suited to both built and natural environments. Basically, urban drainage systems designed in Putrajaya take into consideration the flood and rainfall data to get an ideal drainage size, as practiced in many drainage designs. However, in Putrajaya, more consideration has been given to public convenience, flood risk, safety, life cycle cost and environmental impact at the downstream. Other than that, standard practices for major and minor drainage systems were applied. The MSMA manual has been modified from the rational formula of the DID Hydrological Procedure for Peninsular Malaysia 1975.

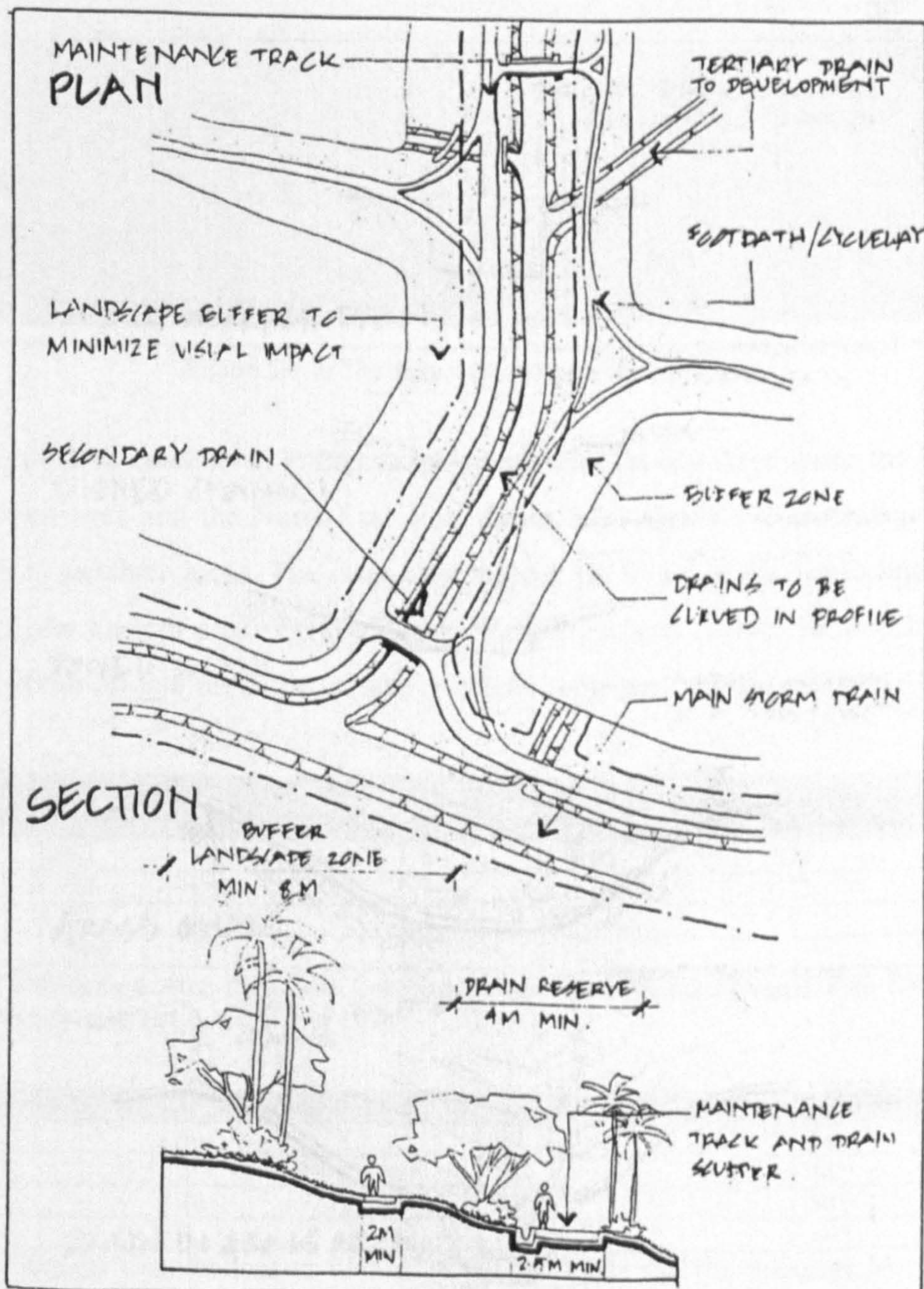


Figure 5.2.6: Drainage planning structure in Putrajaya, (Source: Putrajaya Corporation, 1997)



In Putrajaya, the drainage infrastructure comprises a few trunk drainage channels with different infrastructure dimensions (Figure 5.2.6). The stormwater channels are provided within a closed space network. The open channels are allocated in the green belt area not designed with a park or reserved forest area. All the roads and any access are provided with culverts to cross any open channels. Catchments which have been identified to drain away water from the Putrajaya site without going through the Putrajaya Lake are provided with detention basins to avoid transferring floods or pollution to the downstream. Hundreds of GPTs have been fitted in Putrajaya to trap trash and solid waste. The water pollution control ponds contributes a total between 2.5% to 5% to the catchments area and some are combined with retention basins, also known as mini wetlands (Figure 5.2.7) (Angkasa GHD Engineers Sdn. Bhd., 1996).



Figure 5.2.7: The mini wetland areas in Putrajaya.

The residential developments in Putrajaya have been divided into three areas: the Eastern area, the North-West area and the North-East area. Table 5.2.2 shows the percentage of land use components in the three areas. The large open spaces are found in the North-East area (36%) compared to the Eastern area (11%) and the North-West area (14%). Table 5.2.3 shows the percentage of run-off into the wetland, lake or offsite contributed by the residential areas.

Residential Area	Area Ha	Commercial (%)	Industry (%)	Residential (%)	Roads (%)	Open Space (%)
Eastern	462	0	0	71	18	11
North-West	952	12	7	55	12	14
North-East	772	1.5	3.5	52	7	36
Total	2186					

Table 5.2.2: Residential Area Land Use Components (Source: Drainage Master Plan Study Report for Putrajaya Development Project, October 1996)

Residential Area	To Wetland (%)	To Lake (%)	Off-Site (%)
Eastern	0	46	54
North-West	5	50	45
North-East	18	32	50
Average	9	43	48

Table 5.2.3: Run-off Contributions to Wetland, Lake or Offsite (Source: Drainage Master Plan Study Report for Putrajaya Development Project, October 1996)



In general, the types of drainage provided in the residential areas are small scupper drains, dished channels, paved swale, grass swale and drains in grassy area (Figure 5.2.8). Engineers are responsible for designing all the drainage systems; with a major involvement by the landscape architect on the aesthetics and functions of surface drains so that it is in line with the overall landscape concepts.

#### 5.2.4 Putrajaya Stormwater Management Strategy

The management of stormwater strategy has been carried out by utilising various components of the management train as discussed earlier in Chapter 2. In the Putrajaya stormwater management, the treatment train can be reviewed as follows (Table 5.2.4):

Source control	In-transit controls (Site control)
<ul style="list-style-type: none"> <li>• Community awareness</li> <li>• Landuse planning and regulation</li> <li>• Permissible discharge</li> <li>• Street cleaning</li> <li>• Sewer overflow management</li> <li>• Isolation of high pollutant source areas</li> <li>• Construction site management</li> <li>• Landfill management</li> <li>• Litter traps</li> <li>• On-site detention basins</li> <li>• Stormwater infiltration systems</li> <li>• Buffer strips</li> </ul>	<ul style="list-style-type: none"> <li>• Gross pollutant traps</li> <li>• Swale drains</li> <li>• Detention basins</li> <li>• Ponds and wetlands</li> </ul>
	<b>End-of-pipe controls (Regional control)</b> <ul style="list-style-type: none"> <li>• gross pollutant traps</li> <li>• lakes</li> <li>• floating booms</li> <li>• ponds and wetlands</li> <li>• receiving water management</li> </ul>

Table 5.2.4: Elements of Putrajaya stormwater treatment train. (Source: Angkasa GHD Engineers Sdn. Bhd., 1996)

The stormwater management strategy of Putrajaya is based on the concept of 'major and minor' drainage systems as referred to by the Institutions of Engineer Australia (IEA). It takes into account the economic risk-based approach to stormwater drainage only whilst the stormwater is management of its own initiative.



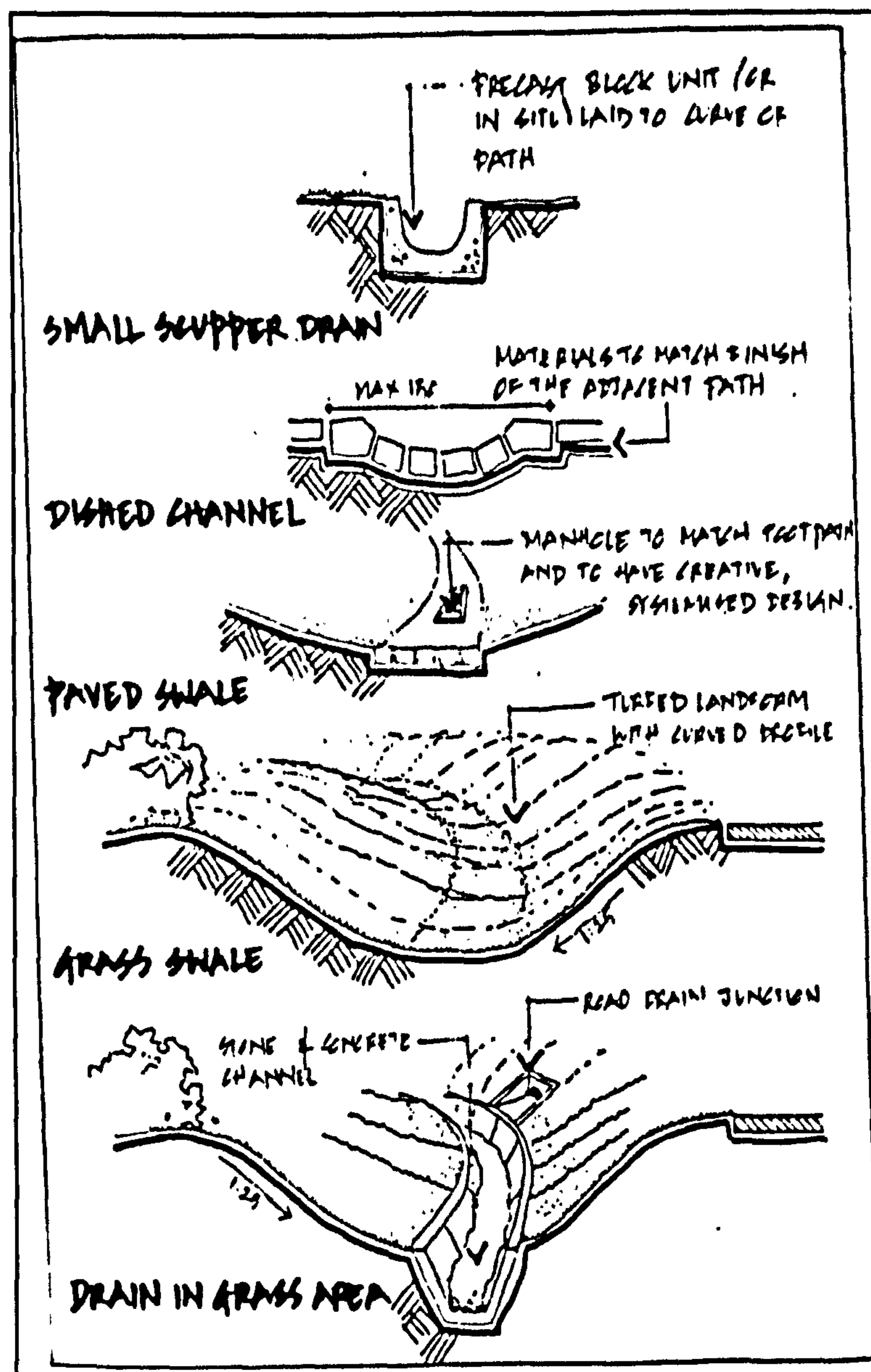


Figure 5.2.8: Types of drainage provided in Putrajaya residential drainage systems. (Source: Putrajaya Corporation, 1997)

#### 5.2.4.1 Putrajaya Minor Drainage System

The major and minor drainage systems refer to the exceeding magnitude of the event served by the two components of the drainage system. The minor stormwater drainage systems is used within the government administrative district and the central business district of Putrajaya. The area is designed for the one-hundred years 'Average recurrence interval' (ARI) event as it is considered as high profile and a high value area. The residential areas are designed with a standard five-year ARI event. The purpose of ARI is to reflect the notion of the current interval of a particular sized rainfall or run-off in the long term. The minor stormwater drainage systems are implemented in all non-green belt areas in Putrajaya. The objective is to prevent inappropriate flooding within the urban catchment. This component of the drainage system is designed to convey higher frequency events without causing any disruption to urban activities.



#### **5.2.4.2 Putrajaya Major Drainage System**

All precincts in Putrajaya are designed with the major stormwater drainage system, where the drainage systems are designed with a one-hundred year ARI event, including the government administrative and business precincts. This involves places with flow path, floodway, and detention basins. The major drainage systems follow the natural terrain catchment. The 'Putrajaya stormwater management design guidelines' states:

*"It is important that the flow paths of major events are identified and provision made for safety conveyance of the stormwater during storm events which are larger than the design event for the minor drainage system."*

(Angkasa GHD Engineers Sdn. Bhd., 1996: 2-12)

#### **5.2.4.3 Stormwater Quality Control in Putrajaya**

The water quality control measures for Putrajaya are adopted from guidelines outlined by the Australia and New Zealand Environment and Conservation Council (ANZECC) (Angkasa GHD Engineers Sdn. Bhd., 1996). The stormwater quality measures of Putrajaya emphasize the gross pollutant and litter load removed from the receiving water and the prevention of oil spills. The Putrajaya Lake water quality is the focus of concern to ensure that the activities organised there are safe for body contact.

#### **5.2.4.4 The Water Quality of the Putrajaya Lake**

The Putrajaya Lake is the core element in the Putrajaya Township. It was planned and designed to accommodate various recreational water activities. The water quality requirements were outlined to meet two criteria as it is also connected with the Putrajaya Wetland ecosystem. The criteria are as follows:

1. To accommodate the recreational and aesthetic requirements.

The Putrajaya Lake has been classified under the 'Primary contact' requirement for recreational activities. The classifications are based on the Australia and New Zealand Environment and Conservation Council (ANZECC) proposal for Australian water quality for fresh and marine water guidelines. 'Primary contact' is interpreted as primary contact activities in which a person comes into frequent direct contact with water. Therefore, the Putrajaya Lake water should be



free from faecal contamination, pathogenic organisms, poor visibility and toxic chemicals as shown in Table 5.2.5 below.

Parameter	Primary contact	Secondary contact	No body contact
Microbiological	X	X	
Nuisance organisms	X	X	X
Physical and chemical			
Aesthetic	X	X	X
Clarity	X	X	X
Colour	X	X	X
Ph	X		
Temperature	X		
Toxic chemical	X	X	
Oil debris	X	X	X

Table 5.2.5: Water quality criteria for recreational and aesthetic requirements by ANZECC (Source: Angkasa GHD Engineers, 1996)

As for the aesthetic requirements of the Putrajaya Lake, the water quality has to be ensured free from the following:

1. Floating objectionable matter (like debris and oil).
2. Substances that produce undesirable colour, odour, taste or foaming.
3. Undesirable aquatic life, such as 'algae blooms'.

2. To consider the protection of the lake's aquatic ecosystem.

It is very important to protect the ecosystems of the lake as they enhance the beauty and aesthetic quality of the lake. Furthermore, the aquatic ecosystems are also associated with the lake and wetland systems. The protection of the lake ecosystem is very complex as it involves aquatic species. To ensure the protection of the Putrajaya Lake ecosystem, focus is given mainly to human activities which can have major impacts on the lake ecosystems, such as follows:

1. Pollution – industrial, urban and agricultural activities.
2. Siltation and sedimentation – from the land clearance activities as Putrajaya is not yet fully developed.
3. Nutrients – uses of fertiliser and detergent.
4. Diversion of flow in the rivers.
5. Exotic species.

The proposed 'Putrajaya Lake Water Quality Guidelines' are not similar to the water quality guidelines that have been provided by the Department of the Environment Malaysia (DOE). The guidelines provided by the DOE are not suitable for the requirement of the 'Primary contact' classification as they are based on the Environmental Quality Act 1974, Amendment 1984, as mentioned in Chapter 3 (Table 5.2.6).



Parameter	Value	Parameter	Value	Parameter	Value
BOD (mg/l)	3	Cr (IV) (mg/l)	0.05	SO <sub>4</sub> (mg/l)	200
COD (mg/l)	25	Cr (III) (mg/l)	-	S (mg/l)	0.05
DO (mg/l)	5-7	Cu (mg/l)	1	CO <sub>2</sub> (mg/l)	-
PH	6.5-9.0	Hardness (mg/l)	100	Gross- (Bq/l)	0.1
Colour (TUC)	150	Ca (mg/l)	-	Gross- (Bq/l)	1
Electric conductivity	1000	Mg (mg/l)	0.05	Ra - 226 (Bq/l)	+0.1
Floatable	NV	Na (mg/l)	-	Sr - 90 (Bq/l)	+0.1
Odour	NOO	K (mg/l)	-	CCE (µg/l)	500
Salinity (%)	1	Fe (mg/l)	0.3	MBAS/BAS (µg/l)	500
Taste	NOT	Pb (mg/l)	0.05	O&G (Mineral) (mg/l)	40; NF
Total dissolved solids (mg/l)	1000	Mn (mg/l)	0.1	O&G (emulsified edible) (mg/l)	7000; NF
Total suspended solids (mg/l)	50	Hg (mg/l)	0.001	PCB (mg/l)	0.1
Temperature (C)	Normal 2	Ni (mg/l)	0.05	Phenol (µg/l)	10
Turbidity (NTU)	50	Se (mg/l)	0.01	Aldrin Dieldrin (µg/l)	0.02
Faecal coliform (counts/ 100ml)	150	Ag (mg/l)	0.05	BHC (µg/l)	2
		Sn (mg/l)	NR	Chlordane (µg/l)	0.08
		U (mg/l)	NR	t-DDT (µg/l)	0.1
Total coliform (counts/ 100ml)	5000	Zn (mg/l)	5	Endosulfan (µg/l)	10
Chlorophyll-a (µg/l)	10	B (mg/l)	1		
Total nitrogen (mg/l)	0.5				
Total Phosphorus (mg/l)	0.05				
Al (mg/l)	-	Cl (mg/l)	200	Heptachlor/	
As (mg/l)	0.05	Cl <sub>2</sub> (mg/l)	-	Epoxide (µg/l)	0.05
		CN (mg/l)	0.02	Lindane (µg/l)	2
Ba (mg/l)	1	F (mg/l)	1	2, 4-D (µg/l)	70
Cd (mg/l)	0.005	Silica (mg/l)	50.00	2, 4, 5-T (µg/l)	10
				2, 4, 5TP (µg/l)	4
				Paraquat (µg/l)	10

Table 5.2.6: Putrajaya Lake Water Quality Guidelines (Source: Angkasa GHD Engineers, 1996)

#### 5.2.4.5 Gross Pollutant Traps (GPTs) in Putrajaya

Gross pollutants traps are installed in Putrajaya to remove gross solids and litter from stormwater. There are three specifications of the gross pollutant traps used in Putrajaya (Table 5.2.7).

<b>GPT Type I</b>	Enclosed unit applicable for in-line minor stormwater conveyance systems, either open drains or underground pipes
<b>GPT Type II</b>	Enclosed systems applicable for underground pipe outfall to receiving waters
<b>GPT Type III</b>	Open systems applicable for open channels

Table 5.2.7: Types of gross pollutant trap. (Source: Angkasa GHD Engineers, 1996)



Gross pollutant traps are a combination of the mechanisms of gross solid interception and retention. In general, the GPTs comprise a concrete lined wet basin and a trash rack with provision for maintenance and cleaning purposes (Figure 5.2.9 and 5.2.10).



Figure 5.2.9: GPT type 3 installed in the main drain to trap solid waste.



Figure 5.2.10: Solid waste traps on the GPT will be cleaned by maintenance workers.



#### 5.2.4.6 Oil, Grease and Grit Traps (OGGT) in Putrajaya

A standard form of OGGT has been used in Putrajaya. This is to ease design, construction and maintenance. In general, 150  $\mu\text{m}$  droplet separations are used to suit the result in an effluent oil and grease concentration of 50-100 mg/l. Putrajaya's receiving water temperature, run-off water temperature and soil density have all been studied to calculate the suitable droplets for the gross pollutant traps in order to ensure their suitability in Putrajaya (Angkasa GHD Engineers, 1996).

#### 5.2.4.7 Detention, Retention and Infiltration Methods used in Putrajaya

Detention and retention basins are generally used to reduce the urbanisation impact of catchments during the rainy season. Detention is a temporary storage of stormwater for the subsequent discharge of receiving water at a lower rate. The detention basin can either be in dry or wet storage components; for examples, wet ponds or dry ponds. Both approaches can be used as multiple objectives. For example, the wet basin can also be used as a recreational pond or wetland whilst the dry basin can also be used for recreational amenities; for examples football field and playground (Figure 5.2.11).



Figure 5.2.11: Wet pond in Putrajaya residential area.

Retention is a removal process through infiltration steps of stormwater to prevent discharge into the receiving waters. It is also a process to control the run-off volume and stormwater quality. There are various methods of stormwater infiltration to the detention tank systems. Three most



common methods that are being used in Putrajaya are porous pavement, infiltration basins and retention overflow wells and trenches.

Porous pavements are commonly used in open car parks, driveways or pedestrian walkways (Figure 5.2.12). In general, porous pavements are efficient in reducing run-off rates and volumes as well as water quality degradation. On the other hand, paving blocks are used to support and retain large areas of hard surface areas for infiltration of rainfall and run-off water. Meanwhile, an infiltration basin is an open water system that acts as a system core where the stormwater is kept in temporary storage to allow subsequent infiltration. Finally retention overflow wells and trenches are non-terminal devices incorporated with overflow pipes to the minor drainage systems.



Figure 5.2.12: Porous pavement used on the pedestrian walkway.

In Putrajaya, issues of public safety due to the application of these systems are taken into consideration. However, to ensure that the public is safe, the open channels are designed for a slower movement run-off (Figure 5.2.13). The side slopes of each component are not steeper than 1:6. As for slopes that are steeper than 1:4, steps and handrails are provided. The depths of the basins are not more than 1.2 metres. However, other alternatives have been provided, such as raised refuge mounds, fences or warning signs, in deeper basins.





Figure 5.2.13: Open channel designed with stepping terrace to reduce the run-off flow.

#### **5.2.4.8 Constructed Wetland Systems in Putrajaya**

The Putrajaya wetland is the first of its kind in Malaysia and was constructed in 1997. The site was formerly an oil palm plantation known as 'Perang Besar Estate' (Wetland International Malaysia, 2001). The wetland systems covers 650ha including the Putrajaya Lake (Figure 5.2.14). As discussed in sections 5.2.2 and 5.2.4.4, it is known that the Putrajaya Lake systems are the central core of the planning structure and also the most sensitive elements. The water quality of the lake is very important as there are twenty-three cells of wetland which have been constructed to act as natural treatment systems in order to filtrate most of the pollutants in the river water before it enters into the Putrajaya Lake systems (Shutes, 2001) (Figure 5.2.15). These cells are structured within six arms. The arms are branches of rivers that form the lake and wetland systems. All the arms, except for the Upper Bisa, are discharged into the Central Wetland, which then flow into the lake in order to clean the upstream water (Salamat and Sahat, 2004).



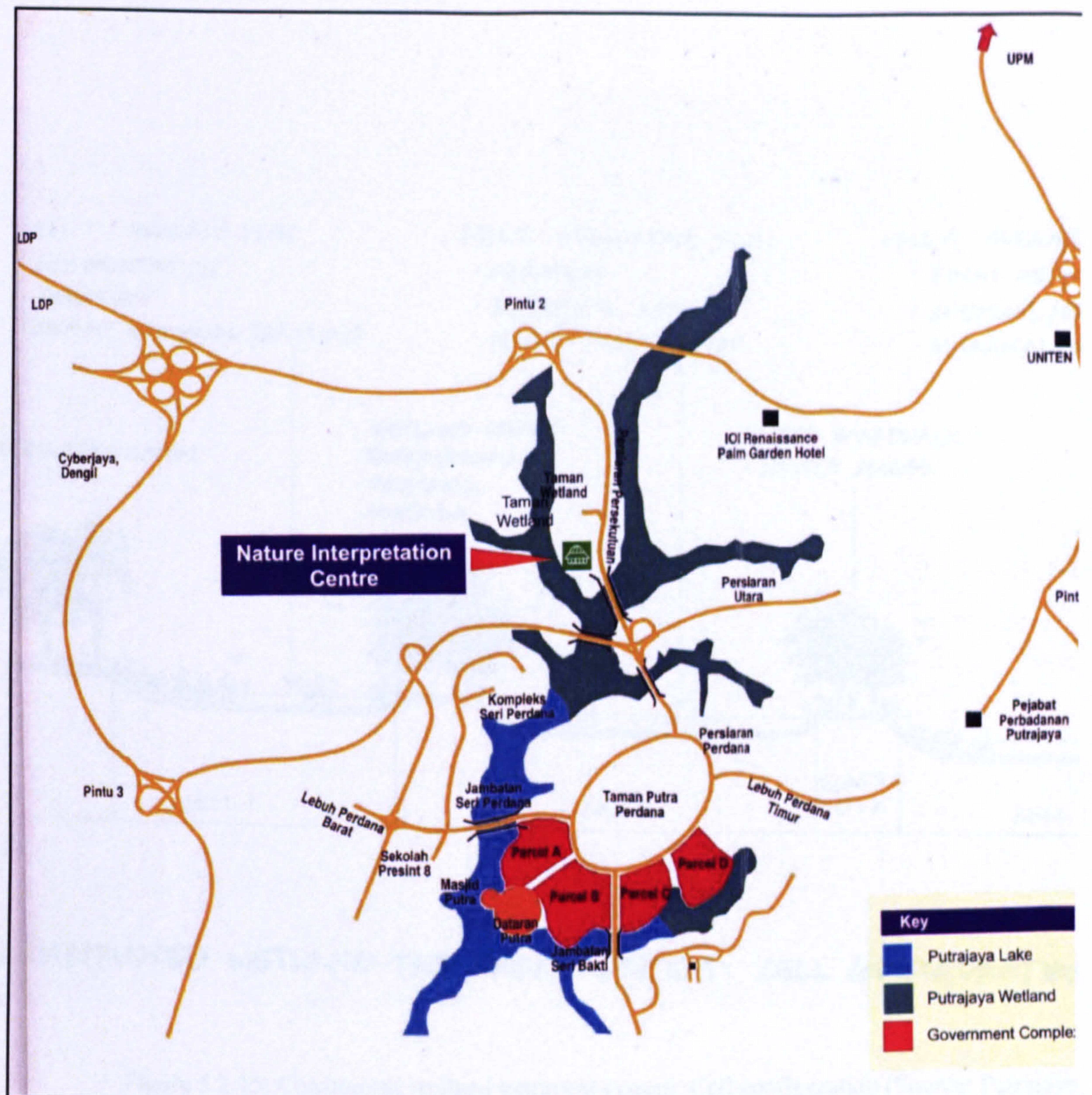


Figure 5.2.14: Putrajaya wetland and Putrajaya lake systems. (Source: Wetlands International)



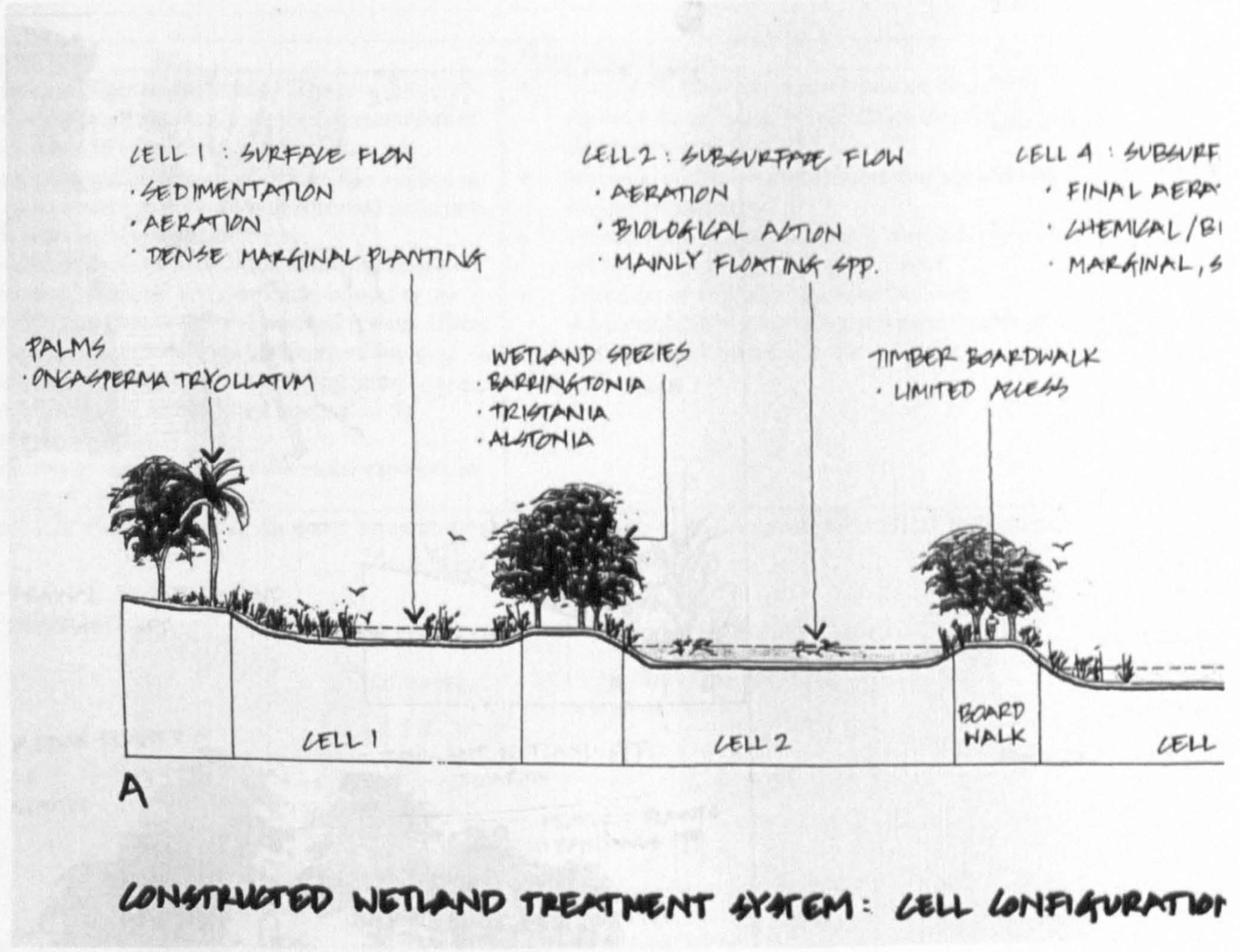


Figure 5.2.15: Constructed wetland treatment system: Cell configuration (Source: Putrajaya)



In general, the wetland system was designed with a package of an initial settlement forebay. This is then followed by a surface flow wetland system and lastly, a settlement pond which can be divided into two zones; the open water zone (pond) and the macrophytes zone (wetland) (Figure 5.2.16). Both zonal components have their own function (Table 5.2.8).

Open water zone	Macrophytes zone
<ul style="list-style-type: none"> <li>• Settlement of coarse materials – The retardation of flow in the pond area facilitate the sedimentation of solids down to coarse and medium silt.</li> <li>• Traps adsorbed pollutants – Silt particles trapped in the pond system may also retain adsorbed pollutants such as trace metals and nutrients.</li> <li>• Provides hydrologic and hydraulic management – Pond areas attenuate and distribute inflows to the macrophytes zone within the wetland system. Often, the open water area located upstream of the macrophytes zone to prevent scouring and remobilisation of settled fined material in the macrophytes zone.</li> <li>• Provision of open water for ultra violet exposure as a means of water disinfection.</li> </ul>	<ul style="list-style-type: none"> <li>• Traps pollutants associated with fine suspended particles by enhance sedimentation and filtration by the vegetation.</li> <li>• Removal of dissolved pollutants by chemical and biological adsorption.</li> <li>• Provides aquatic fauna zones – Wetlands provides an area for predation by aquatic fauna.</li> <li>• Provision of vegetated zones to facilitate oxygenation of the substrata and maintenance of a positive redox potential in the sediment.</li> </ul>

Table 5.2.8: Functions of open water zone and macrophytes zone. (Source: Angkasa GHD Engineers, 1996)

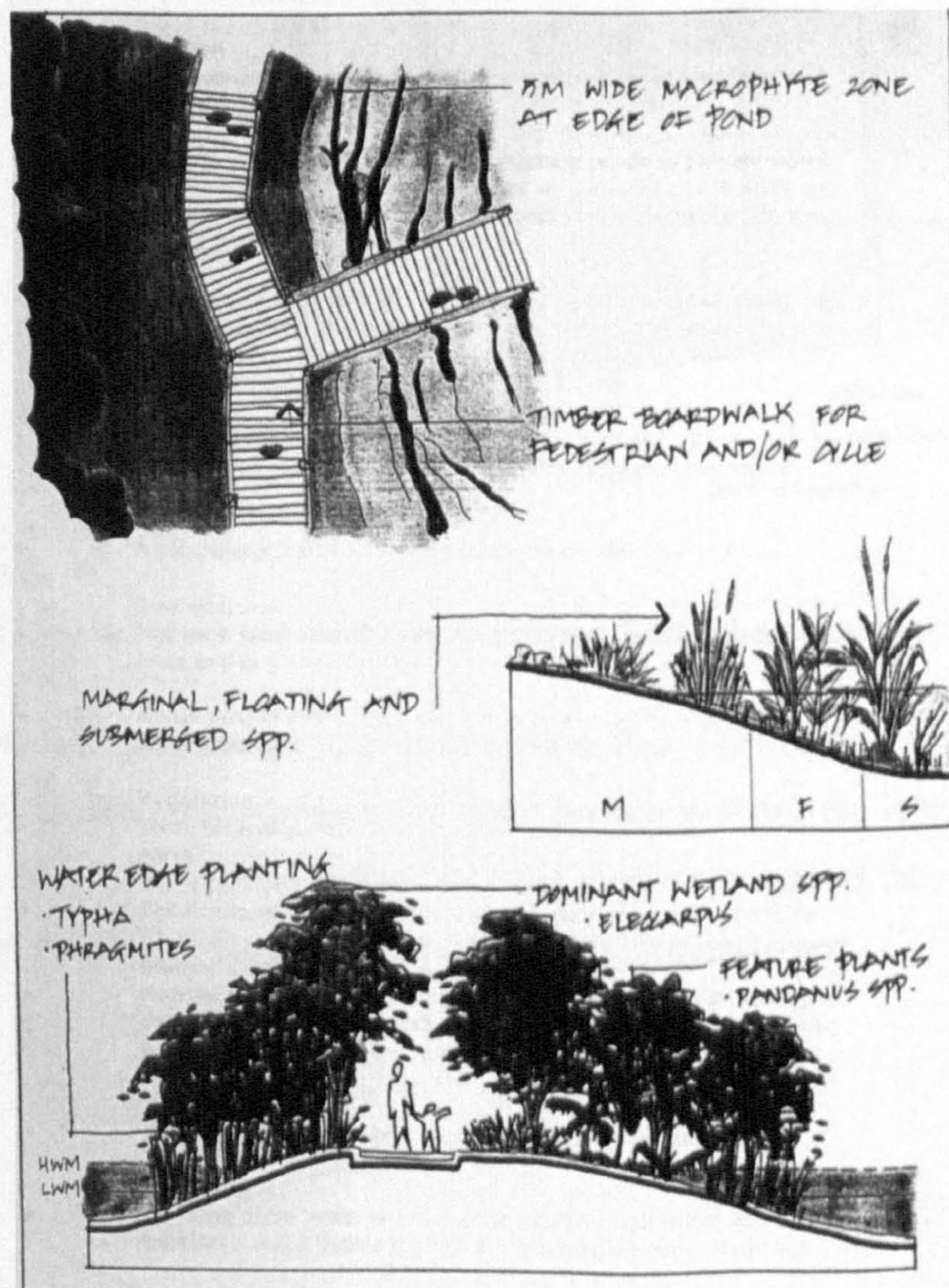


Figure 5.2.16: Putrajaya Wetland design. (Source: Putrajaya Corporation, 1997)



The types of vegetation in the Putrajaya wetland are emergent macrophytes (large plants), rheophytes (floating plants) and freshwater swamp species (Figure 5.2.17). There is a total of seventy plant species in the Putrajaya wetland systems. These plants act as pollutant traps and filtration components (Table 5.2.9).

During based flow	During event flow
Act as substrata for epiphytes – Epiphytes convert soluble nutrients into particulate sediments.	Promote even distribution flows.
Consolidate nutrients trapped in the sediments into macrophytes biomass – This is a medium-term process occurring over months to years.	Promote sedimentation of larger particles.
Return particulate biomass as macrophyte litter for storage in the sediments - This is a long term process occurring over years to decades resulting in the development of organic sediment and peats.	Provide surface area for adhesion of smaller particles.
	Protect sediments from erosion.
	Increase system hydraulic roughness.

Table 5.2.9: Roles of the plants in the Putrajaya wetland. (Source: Angkasa GHD Engineers, 1996)

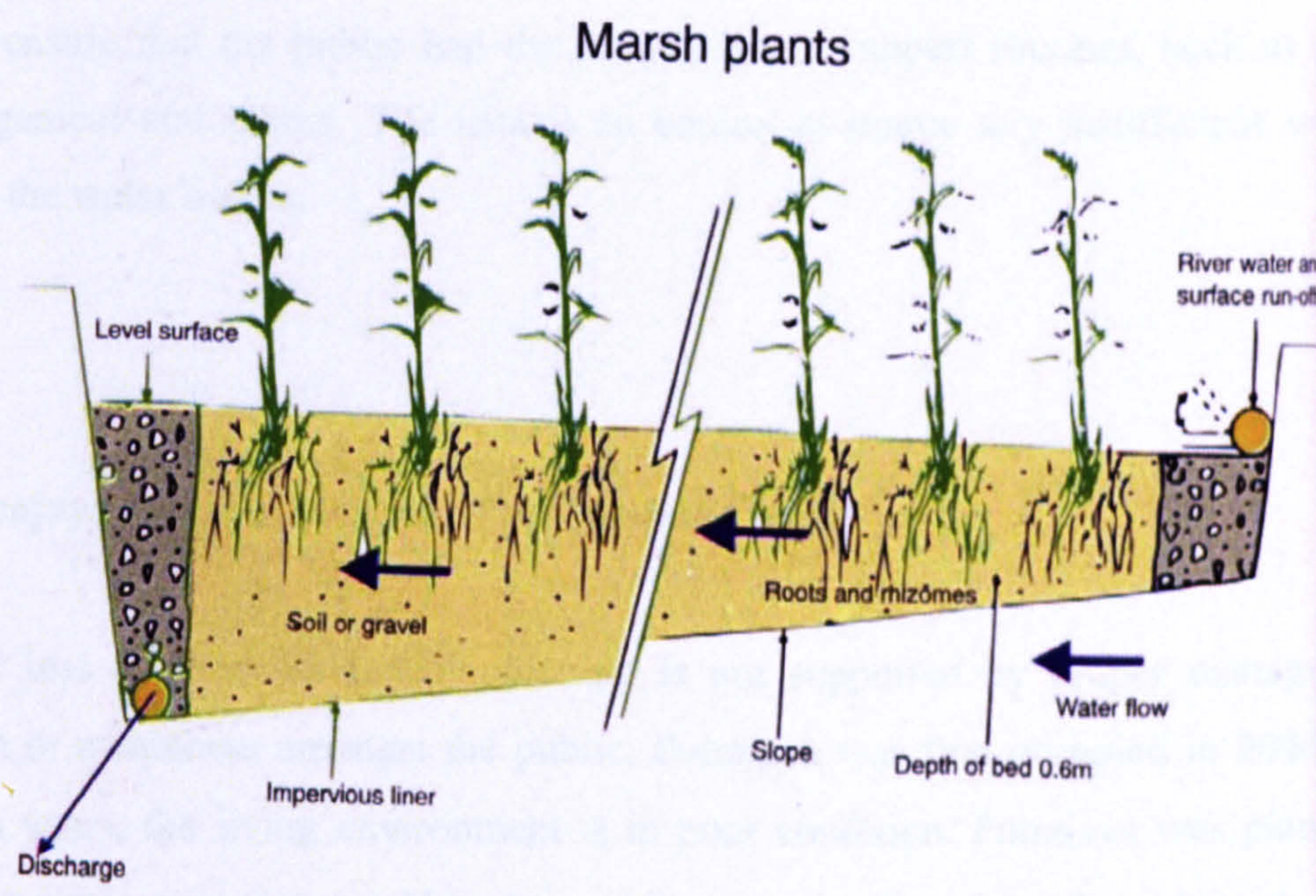


Figure 5.2.17: Reed bed water treatment system. (Source: Wetlands International Malaysia, 2001)

The Putrajaya wetland systems are known as surface flow (SF) or free water surface (FWS) wetland systems. SF is a wetland where the water surface is above the substrate. This type of wetland consists of a shallow basin and soil or other medium to support the plants roots. Water control structures are provided to control the depth of the wetland water.



### **5.2.5 Putrajaya Residential Area: Day-to-Day Non-Storm Drainage System**

As mentioned earlier in Chapter 3, of the Malaysia's 'A Garden Nation' approach, Putrajaya was designed the idea of having 'A city in a garden' (King, 2007);

*'... the new seat of Government and Administration, a garden city catering for 250 000 people [subsequently changed to 300 000]. Designed as a paperless environment in a bold experiment at electronic government...'*

(Ariff and Goh, 1998; 104)

This attempt clearly give a general idea that the city has been provided with sustainable approaches way of living. Therefore, the city planning has included community values and participation in supporting the attempt to provide sustainable drainage approaches. The design of the houses, facilities and infrastructure were undertaken according to the sustainable drainage principles. Added to that, the good day-to-day maintenance was also explained to the residents to ensure that the public had the knowledge to support routines, such as recycling, water management and others. The idea is to control-at-source any insufficient waste from flowing into the water bodies.

### **5.2.5 Putrajaya Residential Area: The Current Condition**

It is a great loss if good residential planning is not supported by proper management and collaboration or awareness amongst the public. Putrajaya was first occupied in 2000 and after nearly seven years, the living environment is in poor condition. Putrajaya was planned along with proper maintenance strategy. However, without cooperation from the public, things would not be improved. Dumping problems are getting worse in Putrajaya and domestic waste is left outside of bins (Figures 5.2.18 and 5.2.19).





Figure 5.2.18: Bags of solid waste left at a bus stop in Putrajaya.



Figure 5.2.19: Solid waste not properly dumped in the proper area.

Therefore, the regulations regarding solid waste disposal need to be revised by the local authority in order to overcome the problems. The public should also be provided with more information about proper waste handling to ensure that the maintenance can be more efficient and to avoid the negative impact on the environment, such as water pollution and the spread of vector diseases (Figures 5.2.20 and 5.2.21).





Figure 5.2.20: Although the waste trolleys are empty, there is an irresponsible attitude of leaving the waste just next to the dumping area.

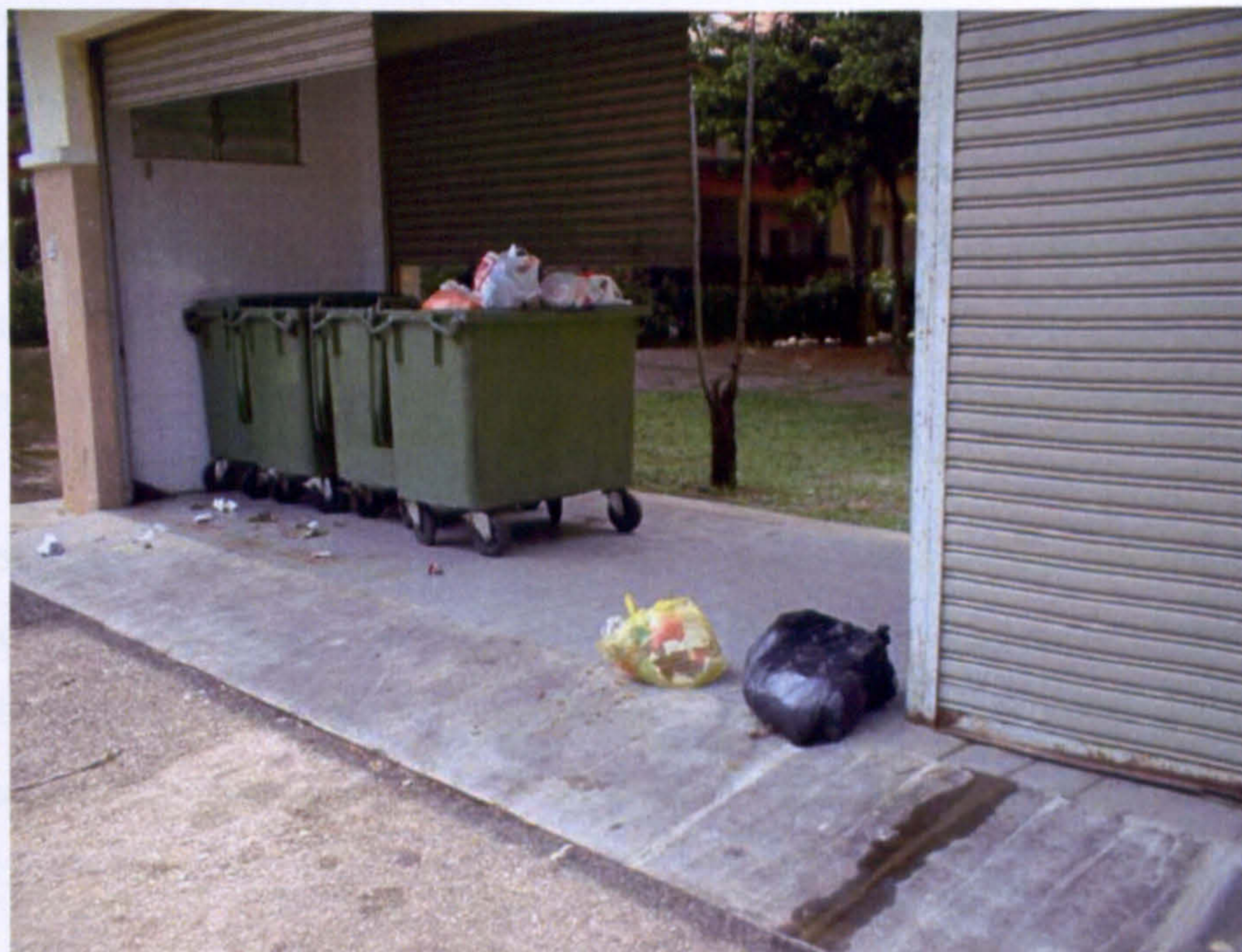


Figure 5.2.21: The dumping area was not fully utilised by the residents in Putrajaya.

Factors that influence the failure to control-at-source are probably due to a lack of understanding and awareness. The public really do not realise how their contributions or participations may effect the surrounding environment. On the other hand, the design of certain facilities should be revised to suit the tools themselves. For example, the dumping area should be designed to make it easier for the public to throw their waste.



### **5.3 Bio-Ecods (Bio-Ecological Drainage System)**

The Bio-Ecods drain was designed based on an open integrated and natural drainage system into multipurpose green corridors (open space). The main approach of Bio-Ecods is 'control at source'. Simulation of the natural hydrology cycle in urban areas was conducted by integrating infiltration processes, online and offline detention storage to delay the flow and also as treatment techniques (Zakaria et al., 2004).

#### **5.3.1 Universiti Sains Malaysia (USM) Engineering Campus, Sri Ampangan, Penang**

Bio-Ecods was a collaboration between Universiti Sains Malaysia (USM) and DID as a first attempt in applying sustainable storm water management in Malaysia. The chosen site for this pioneer project was the USM engineering campus in Sri Ampangan, Penang (Figure 5.3.1). Initially, the project was planned to provide a conventional drainage system. However, the opportunity to implement new ecological drainage approaches came with a grant awarded to the River Engineering and Urban Drainage Research Centre (REDAC) from the DID. The project was first started in 1997 on the new campus site estimated at about 320 acres. The project was completed in December 2002 and was officially launched on 4<sup>th</sup> February 2004.

The Bio-Ecods drain that has been applied on this campus consists of a few basic components. These components were integrated with the ecological systems to allow a complete process for stormwater treatment. Bio-Ecods was designed in such a way as to allow the sedimentation, infiltration and biodegradation processes to reduce the polluted load from stormwater run-off.



- |                       |                          |
|-----------------------|--------------------------|
| A Administration zone | H Progress zone 3        |
| B Academic zone       | I Front zone 1           |
| C Development zone    | J Front zone 2           |
| D Hostel zone         | K Oxidation pond zone    |
| E Recreation zone     | L Ecological zone        |
| F Progress zone 1     | M Reserved jungle zone 1 |
| G Progress zone 2     |                          |

0 200 400m

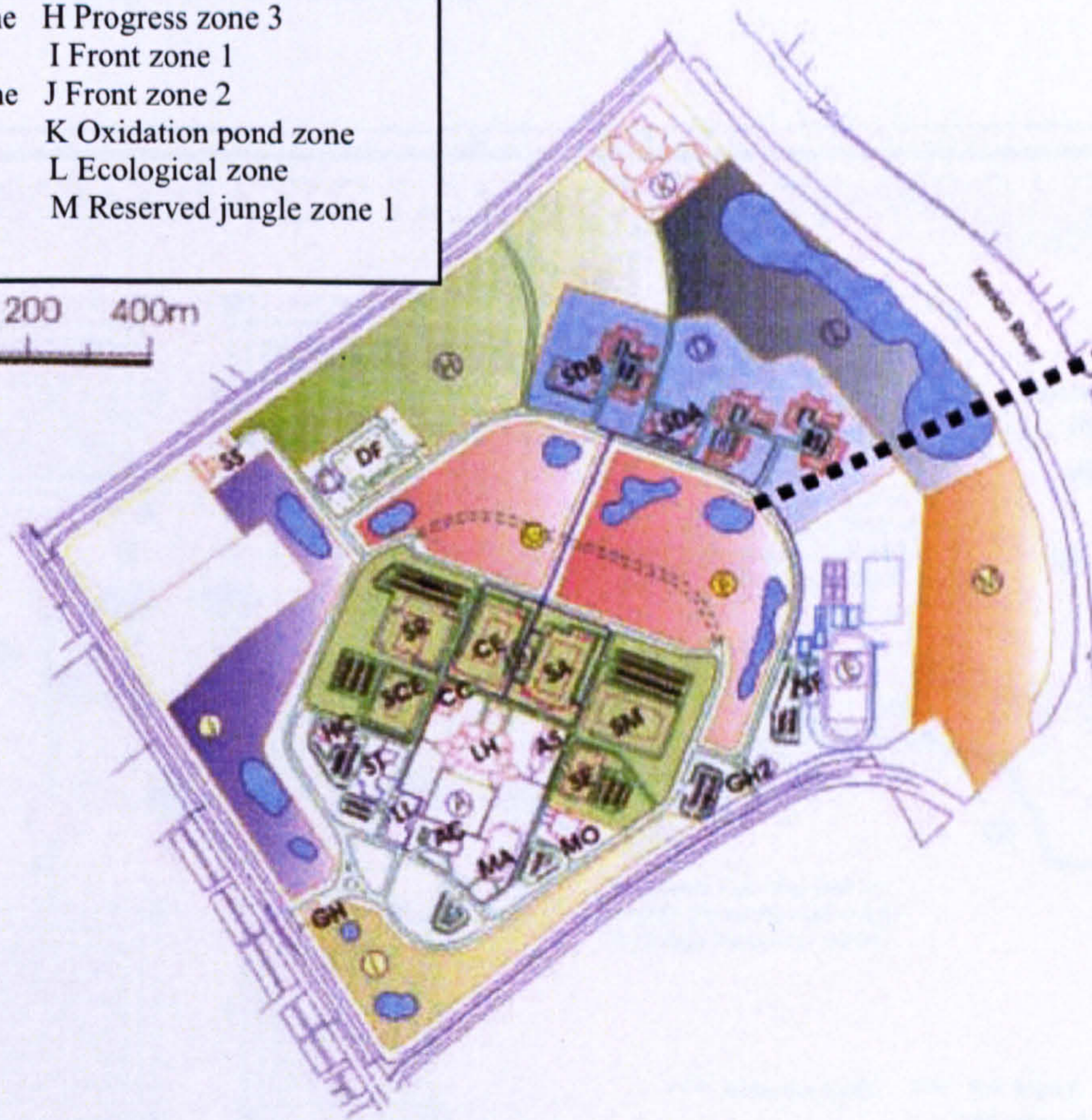


Figure 5.3.1: Map showing the location of the study site (Source: REDAC, 2004)



### 5.3.2 Bio-Ecods System Application in USM

The Bio-Ecods system application was designed in seven steps before the run-off is released into the Kerian River. These steps are described as shown in the Schematic layout in Figure 5.3.2. There are six main components in constructing the Bio-Ecods swale systems; the components are geostrip, module, hydronet filter fabric, clear river sand, top soil and grass (Table 5.3.1) (Figures 5.3.3 and 5.3.4).

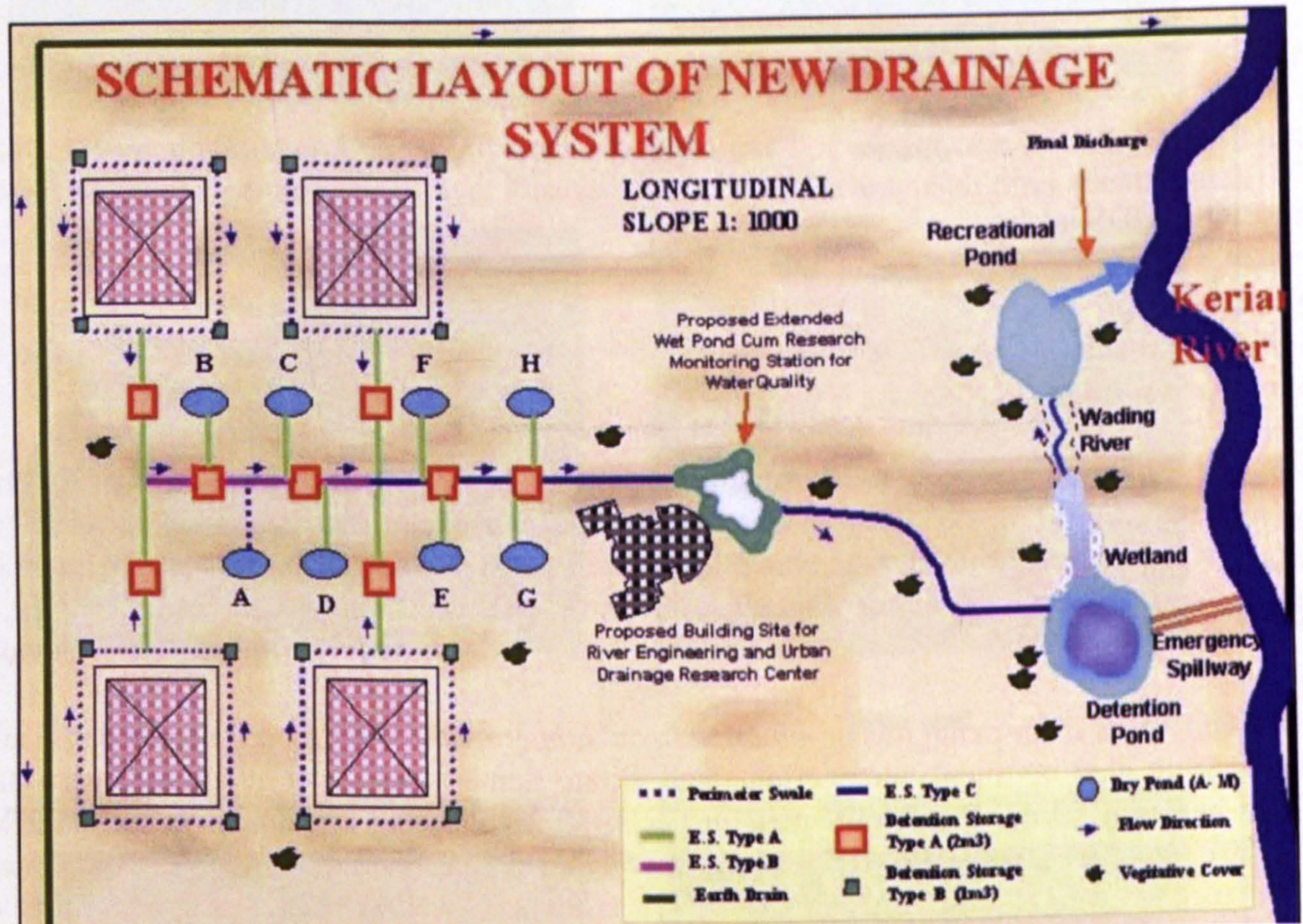


Figure 5.3.2: The Bio-Ecods concept (Source: Zakaria NA, 2003)

Swale components	Specification	Details
Geostrip	Dimension	100 mm x 80 mm x 550 mm
	Flow rate at 1% gradient	80 l/min
	Comprehensive strength	12 tons/ m <sup>2</sup>
	Material	Recycled polypropylene
Module	Dimension	405 mm x 465 mm x 607 mm
	Flow rate at 1% gradient	2280 l/min
	Comprehensive strength	8 tons/m <sup>2</sup>
Hydronet filter fabric	Permeability	9.30 mm/s
	Screening capability	0.38 mm
Clear river sand	Sieve analysis according to BS1377	Mean size between 0.5 mm and 2.0 mm
Top soil	Thickness	1-2 inches
Grass	Species	Cow grass

Table 5.3.1: Basic components for a Bio-Ecods swale (Ghani AA, et. al., 2004)



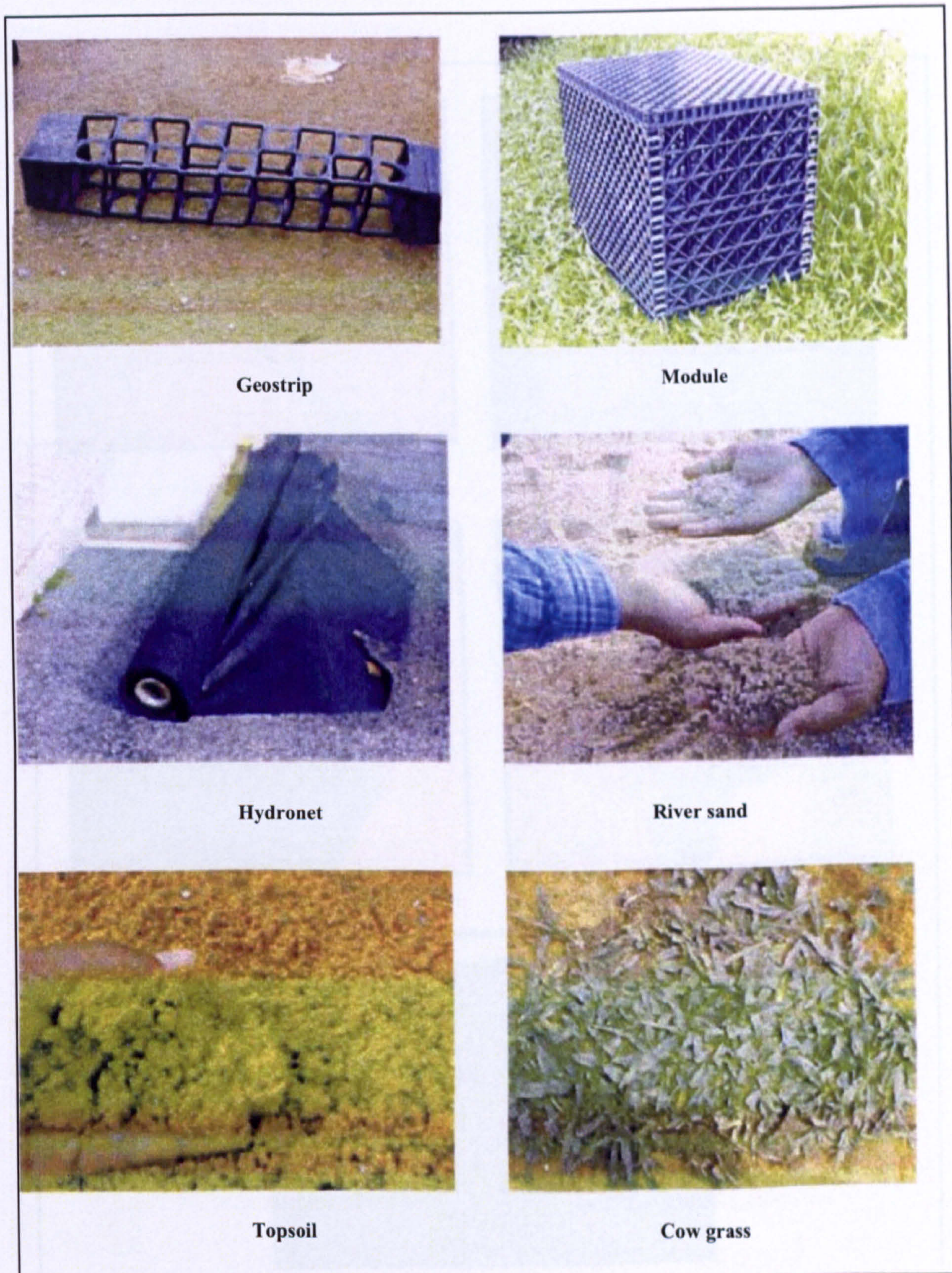


Figure 5.3.3: Materials used in the construction of the Bio-Ecods drainage systems (Source: Ghani, et al., 2004)



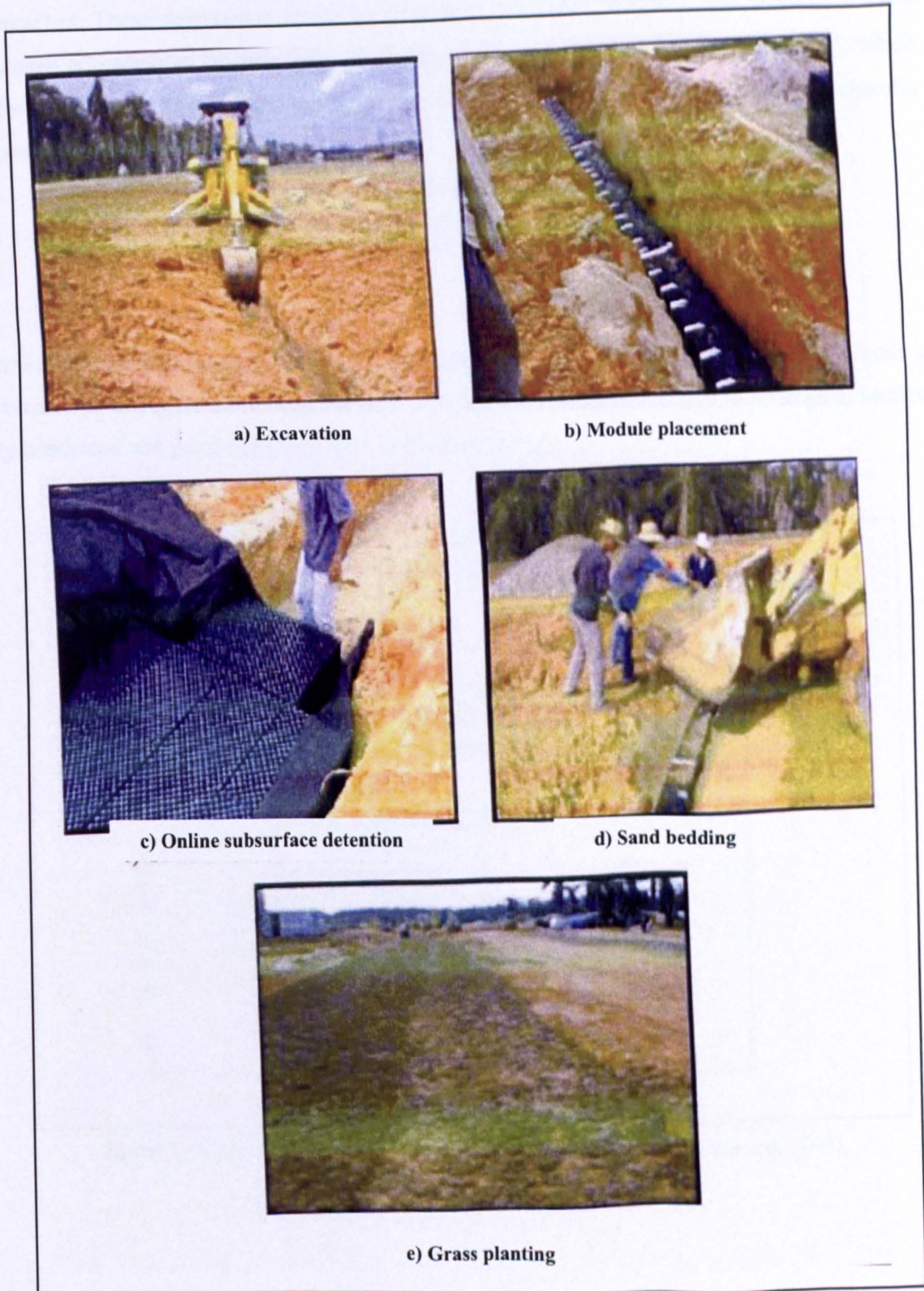


Figure 5.3.4: The Bio-Ecods construction methods (Source: Ghani, et al., 2004)



### 5.3.3 The Bio-Ecods Conceptual Design

Bio-Ecods is generally based on the 'Best Management Practice (BMP's) 'control-at-source' approaches. These approaches are to be integrated into urban planning. The Bio-Ecods drain functions according to the principles of SUDS as discussed in Chapter 2 (section 2.4), which follows the three management trains. It has also been designed to suit Malaysian climatic factors:

*"Although Bio-Ecods are drainage devices that rely on natural processes, Bio-Ecods must be designed, build and maintained in the context of the development control system in Malaysia."*

(Ghani et al., 2004; 1)

From the schematic layout in section 5.3.2 (Figure 5.3.2), the flow sequence of the Bio-Ecods is presented as in Figure 5.3.5. The drainage components consist of a series of ecological swales, dry ponds and wet pond and subsurface infiltration storage.

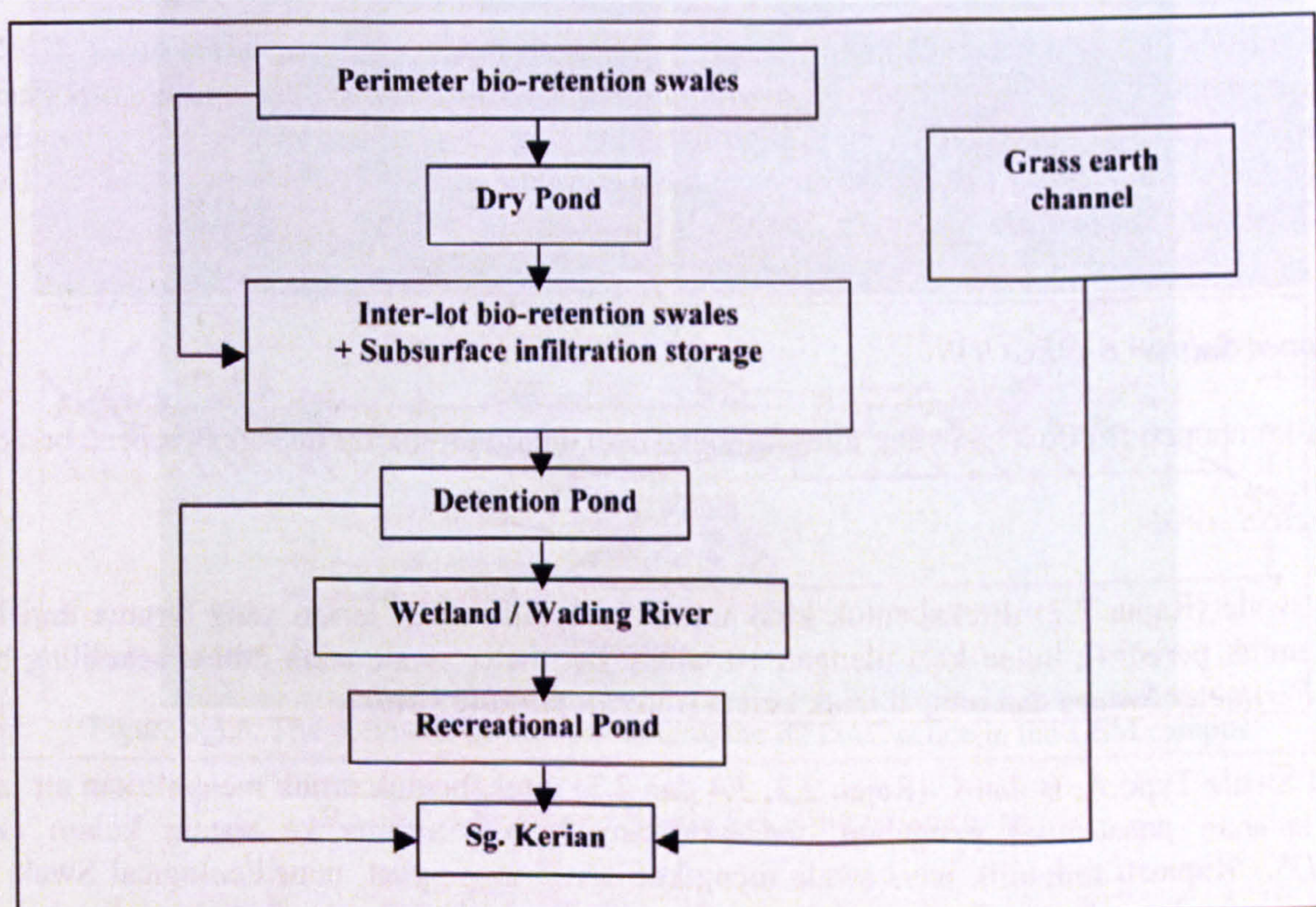


Figure 5.3.5: Bio-Ecods run-off processes sequences (Sources: NA Zakaria, 2003)



### 5.3.3.1 Perimeter Swale and Ecological Swale

The swale in the Bio-Ecods can be defined as a grass-earthen channel combined with a subsurfaced geo-strip enclosed within a permeable geotextile design (Zakaria et al., 2003; and Ghani et al., 2004).

There are two types of ecological swale namely the perimeter swale and ecological swale. The perimeter swales are provided to receive water from various excess, such as from the administrative offices, hostel and academic zone (Figures 5.3.6 and 5.3.7). Flows from the impermeable surfaces will be directed into the individual lot swale known as the ecological swale. In general, the stormwater from the surfaces will be infiltrated into the sub-surface module through a layer of topsoil and river sand. These processes are the pre-treatment devices that screen particulate material by filtration and absorption to filter material.



Figure 5.3.6: The perimeter swale surrounding the REDAC office in the USM campus



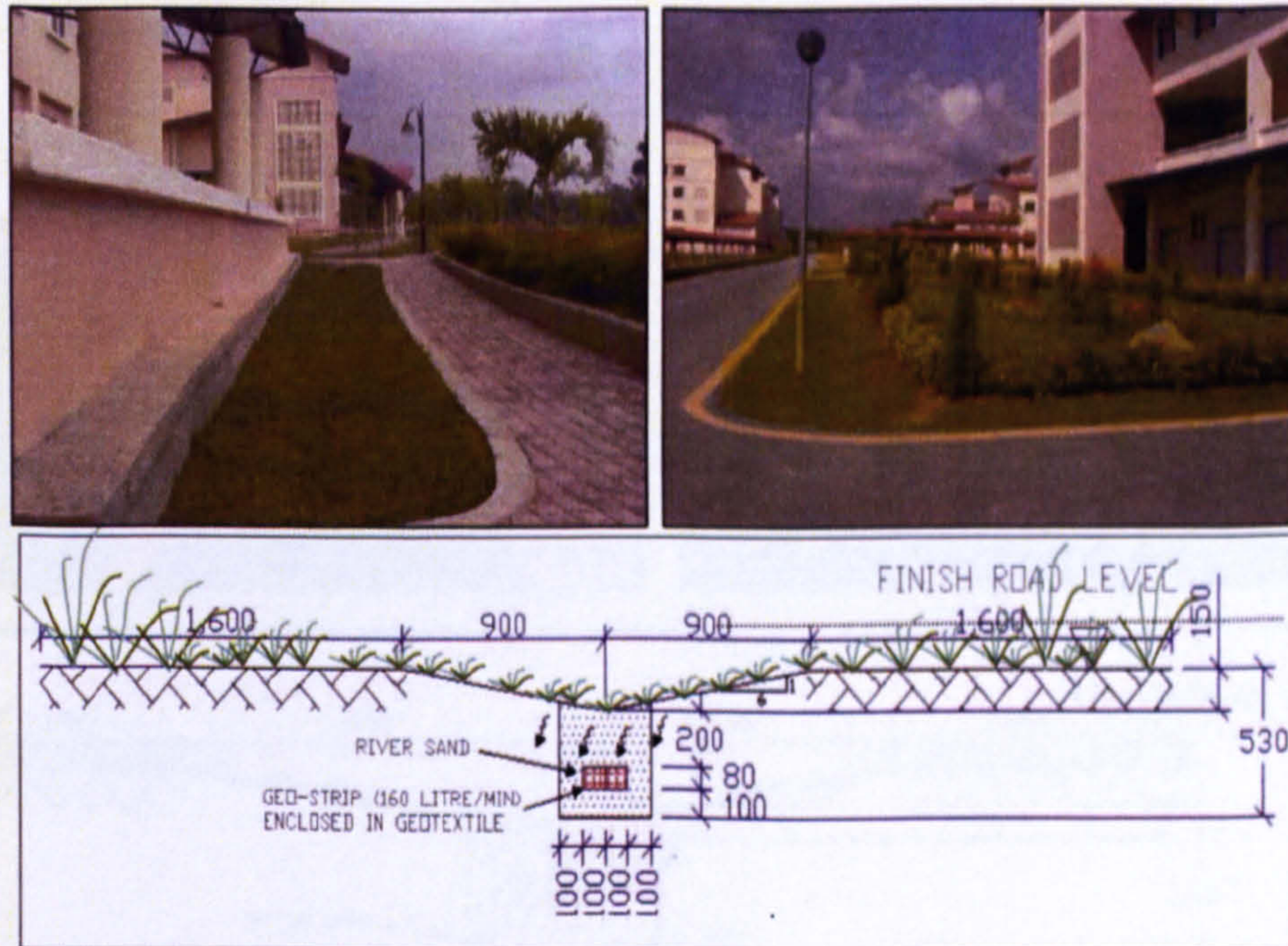


Figure 5.3.7: Cross Section of a perimeter swale. (Source: Zakaria NA, 2003)

The ecological swale works as the main conveyor in this Bio-Ecods system (Figure 5.3.8). It is a grass channel built with subsurface modules. There are three types of ecological swale; the 'ecological swale type A' consists of one single module (Figure 5.3.9), 'ecological swale type B' consists of two single modules (Figure 5.3.10) and 'ecological swale type C' consists of three single modules (Figure 5.3.11). The different types of ecological swales are based on the subsurface module size and capacity of each type (Figure 5.3.12).



Figure 5.3.8: Ecological swale type C between the roadside and the pedestrian walkway in the USM campus



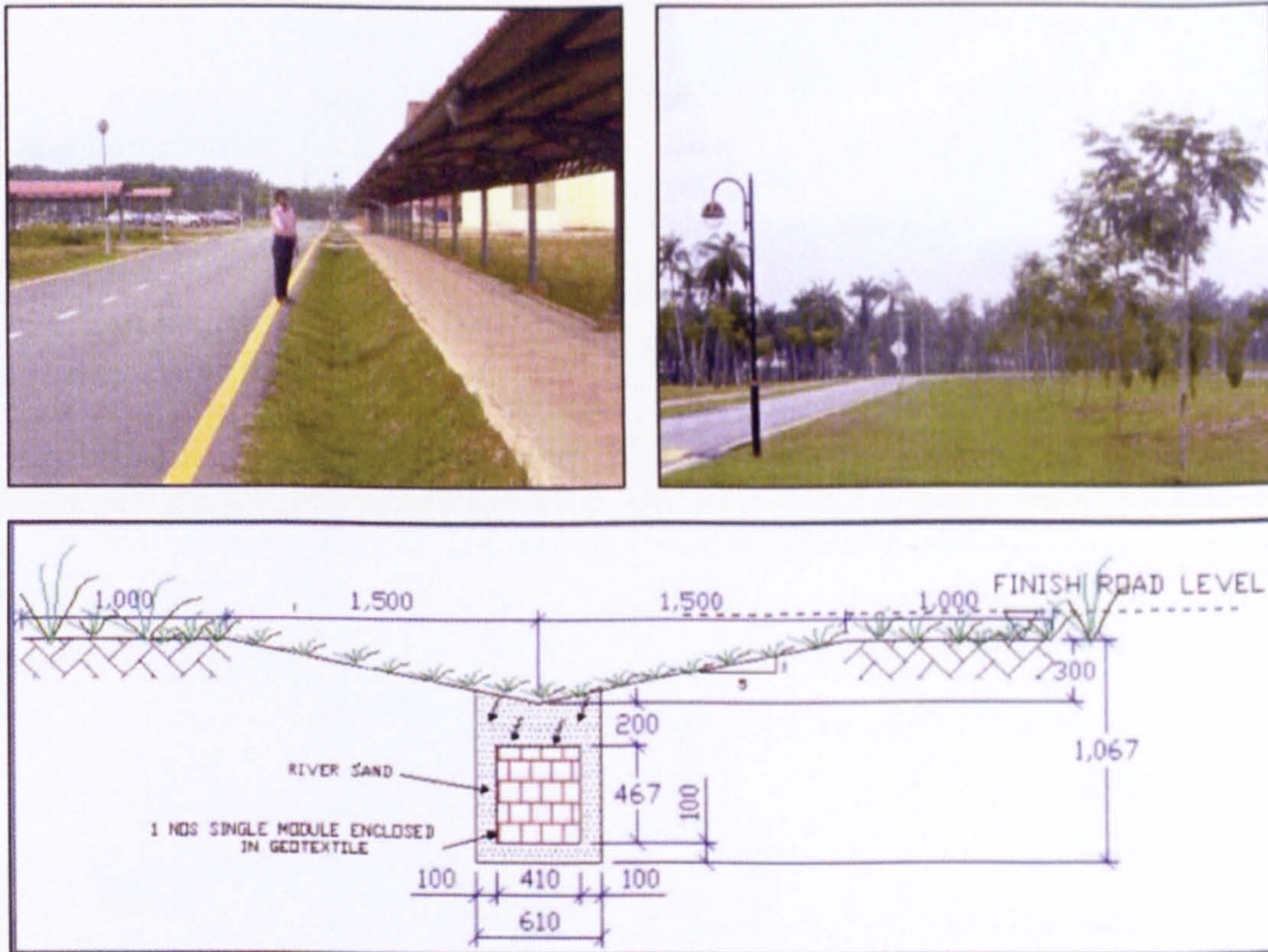


Figure 5.3.9: Cross-section of an ecological swale type A. Type A only use a single module (Source: Zakaria NA, 2003)

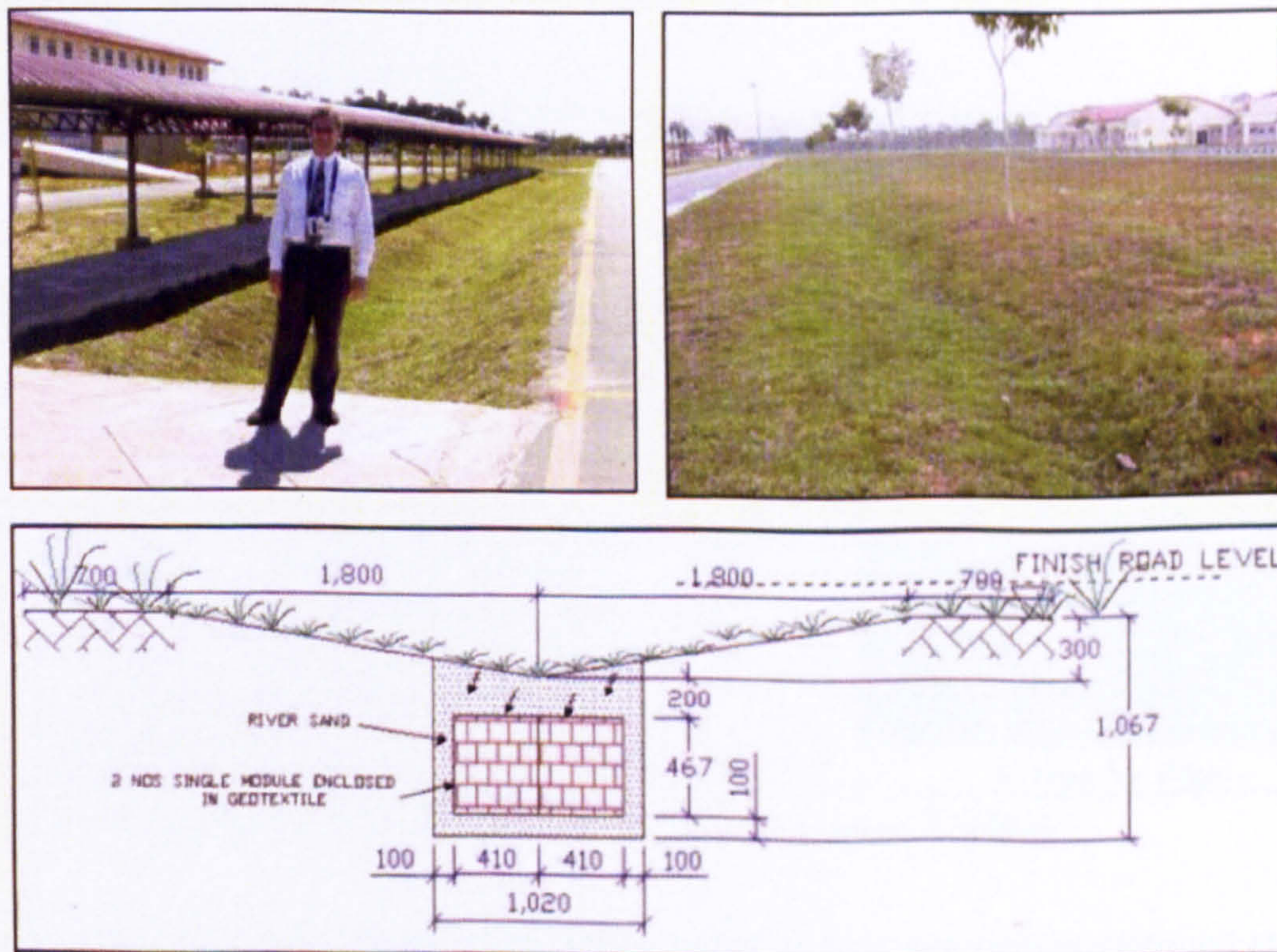


Figure 5.3.10: Cross-section of an ecological swale type B. Type B uses a double module (Source: Zakaria NA, 2003)



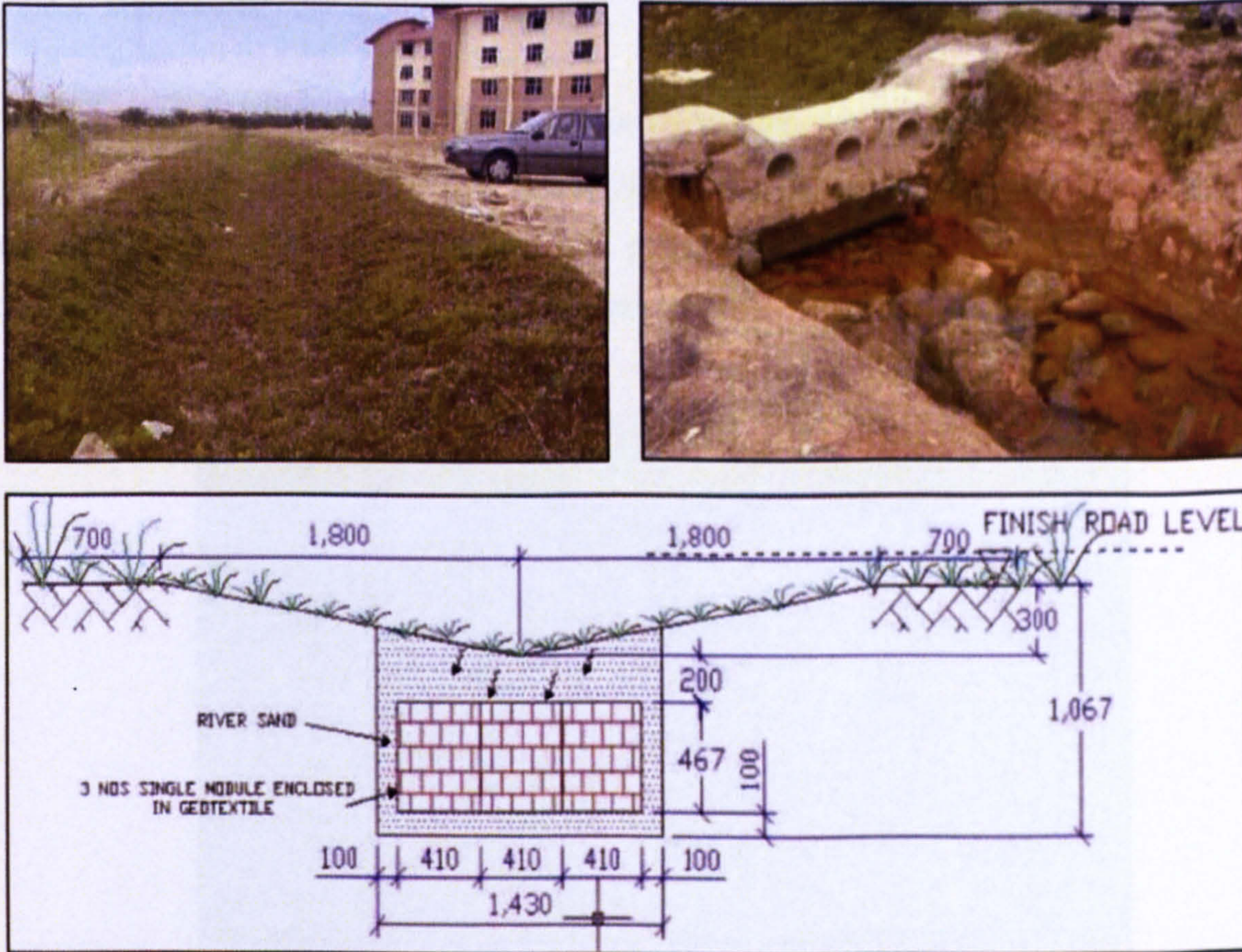


Figure 5.3.11: Cross-section of an ecological swale type C. Type C uses a triple module (Source: Zakaria NA, 2003)

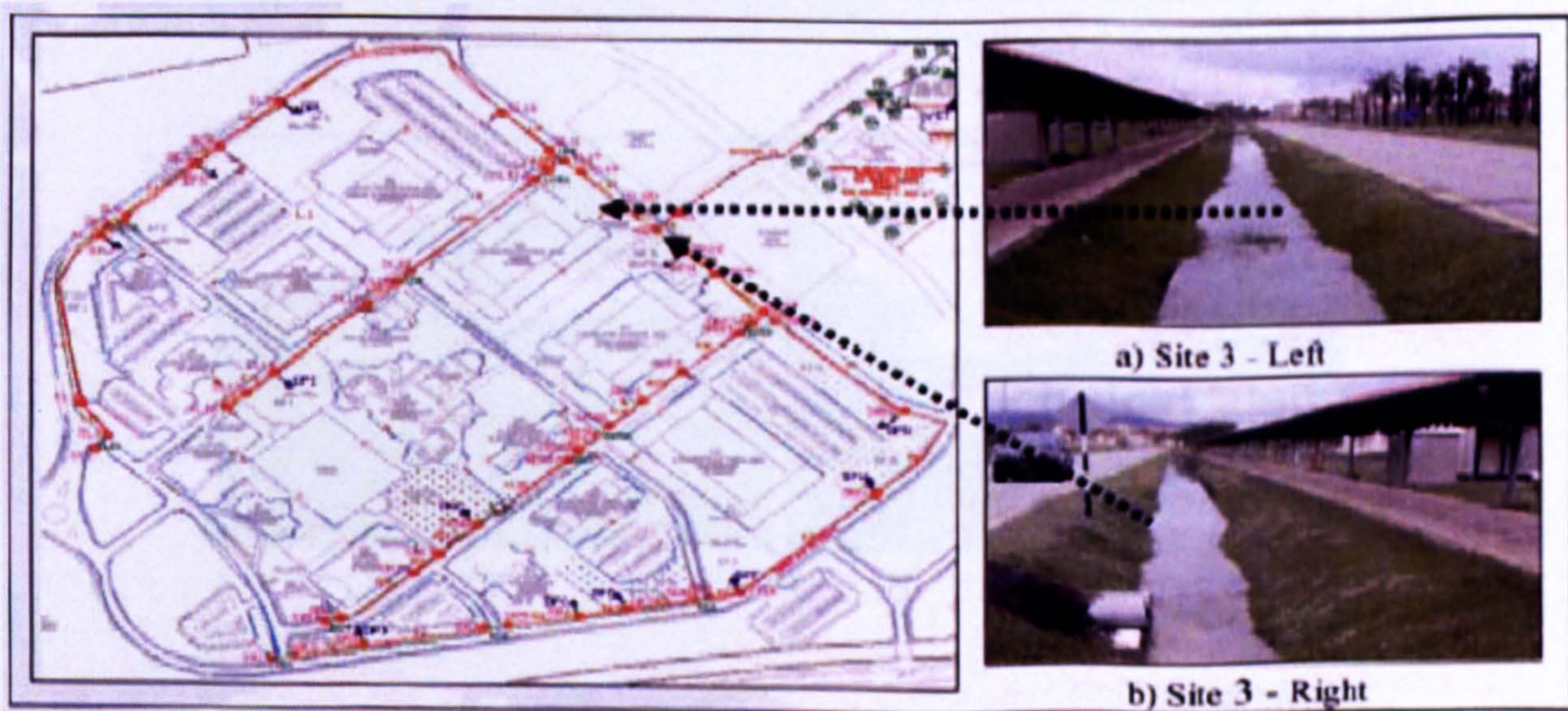


Figure 5.3.12: Ecological swale during the wet season (Source: Ainan A, 2004)

At every connection point, junction and critical point system, subsurface detention storage will be placed to temporarily store the run-off and at the same time, reduce the run-off flow. The detention storage capacities designed are based on the suitability of its conditions by considering the stormwater volume during rainy days at different locations.



### 5.3.3.2 Dry Ponds

Dry ponds are constructed to store excess water (Figure 5.3.13 and 5.3.14). The dry pond is generally a detention basin, which is integrated with the ecological swale in order to store stormwater run-off temporarily. The dry ponds also function as part of the landscape components, such as fields and recreation areas.



Figure 5.3.13: Areas between the ecological swale and the building was a dry pond in the USM campus

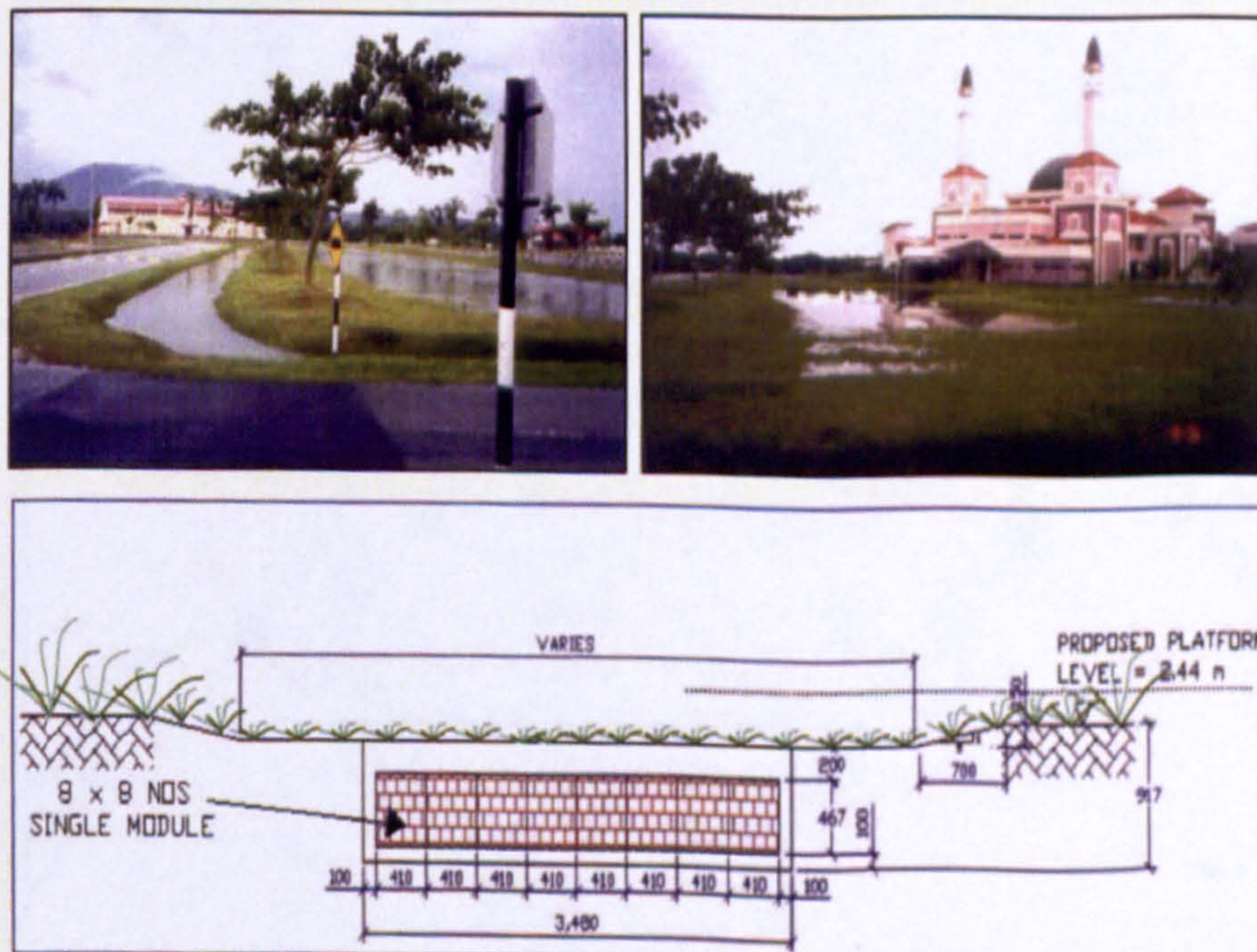


Figure 5.3.14: Cross-section of a dry pond. (Source: Zakaria NA, 2003)



### 5.3.3.3 Wet Ponds

The run-off from the ecological swale will flow into the components of 'Ecological Pond' (ECOPOND), such as the wet pond (Figure 5.3.15) and detention ponds before it flows to the constructed wetland through a wading river and ends in the recreational pond (Figure 5.3.16). The wetland is constructed to treat the run-off. The run-off flows through the wetland vegetation, where the contaminants can be removed by direct absorption into the plant tissues or by the physical entrapment and subsequent settlement on the wetland bed (Zakaria et al., 2003; and Ghani et al., 2004) (Figure 5.3.17).

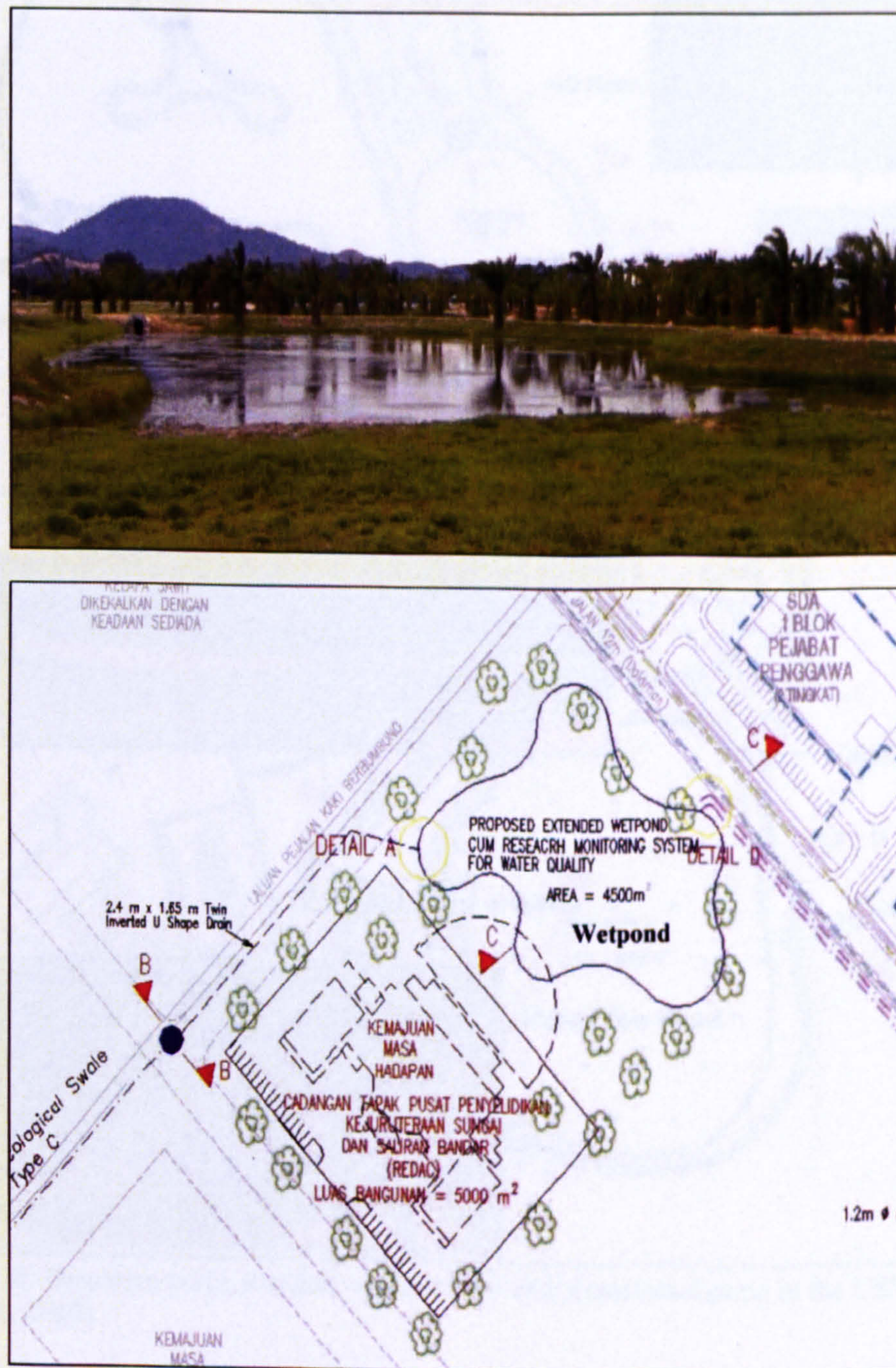


Figure 5.3.15: A site plan of one of the wet ponds in the USM campus. (Source: Zakaria NA, 2003)



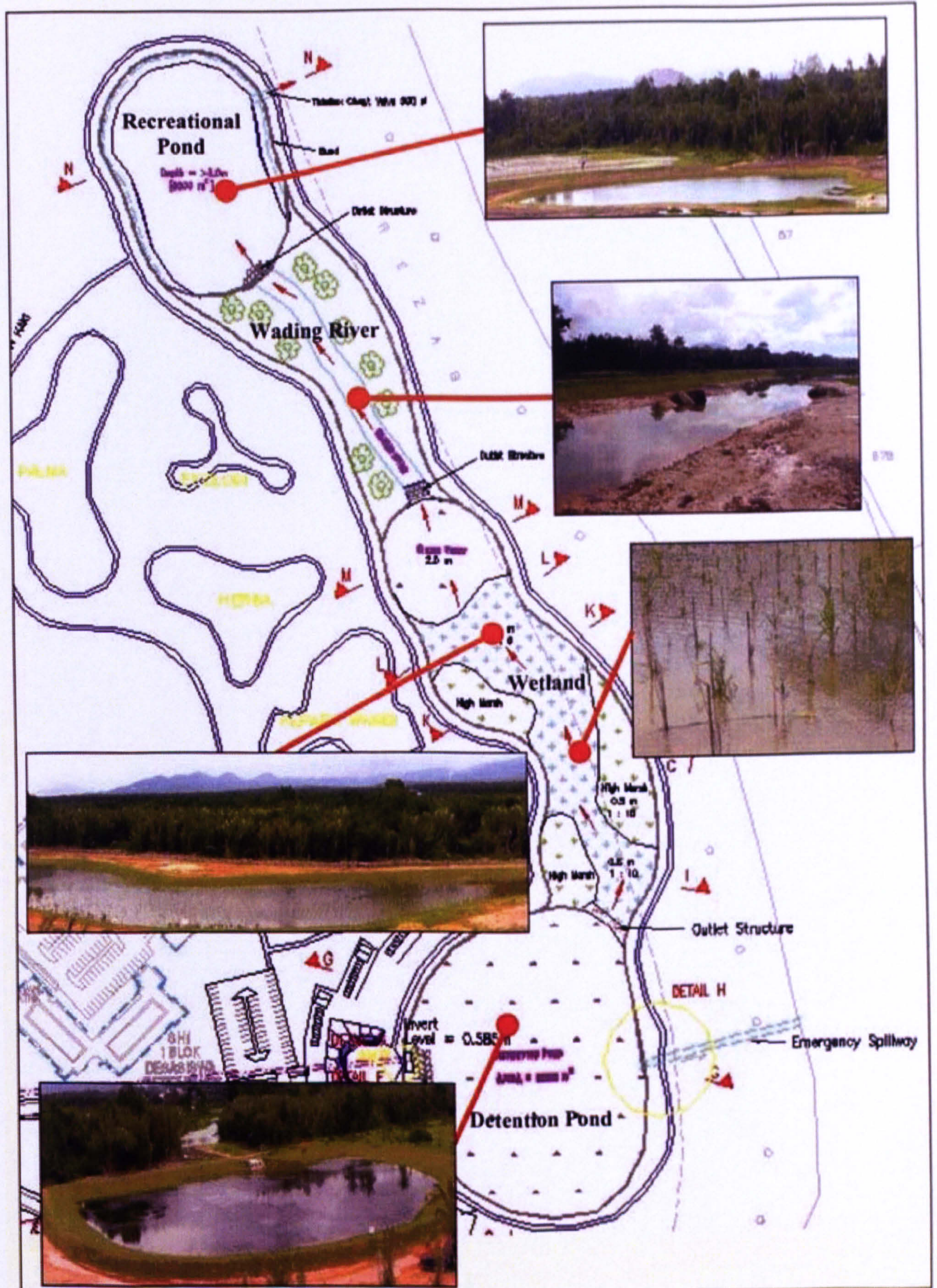


Figure 5.3.16: Detention pond, wetland, wading river and recreational pond in the USM campus (Source: Zakaria NA, 2003)





Figure 5.3.17: The constructed wetland area in the USM campus.

The treated run-off flow into the recreational pond (Figure 5.3.18) before it is released into the Kerian River. Tidal gates are provided as an outlet into the Kerian River from the recreational pond. In the event of floods, excess water will be directed into the Kerian River through the emergency spillway.



Figure 5.3.18: The detention pond in the USM campus (Source: Researcher file)



### 5.3.4 Bio-Ecods Performance in USM Campus

The Bio-Ecods system in the USM campus is expected to reduce surface water run-off volumes by 65% and reduce solids, nutrients and heavy metal loads from 85% to 100% (NA Zakaria, 2003). In an interview session with the Director of REDAC, he mentions that the Bio-Ecods system in the campus has now managed to produce a water quality that is a step lower from the drinking water quality stage outlined by the DOE (Figure 5.3.19). The water quality samples are always taken from time to time to monitor the quality of the run-off in the campus.

*“...the blends of all these approaches have put our final water quality at the stage of 2A DOE standard. Therefore, our water quality is just one step lower to a drinking water quality...”*

- NA Zakaria, Director of REDAC



Figure 5.3.19: The pioneer of Atlantis Company (Sydney, Australia), the main supplier for the Bio-Ecods drainage module, demonstrating that the water from the ecological swale type C is clean and can be drunk.

The construction cost for the Bio-Ecods systems project in the USM campus shows that it can save up to 5% of the cost that is usually spent on conventional drainage systems for similar projects. A life cycle cost analysis (LCC) assessment has been conducted on the Bio-Ecods project in the USM campus. LCC is an economic evaluation to evaluate the sustainability of any project which, in this case, involves a Bio-Ecods drainage system, and compares it with alternatives systems with a differing costs over the project life (LM Sidek et al., 2004). According to Sidek (2004), the comparison of the LCC assessment on the systems capacity to transportation of stormwater can be established from the flow charts of Bio-Ecods life cycle



models (Figure 5.3.20), the life cycle model for the grassed swale system (Figure 5.3.21) and the life cycle model for the open drainage system (Figure 5.3.22).

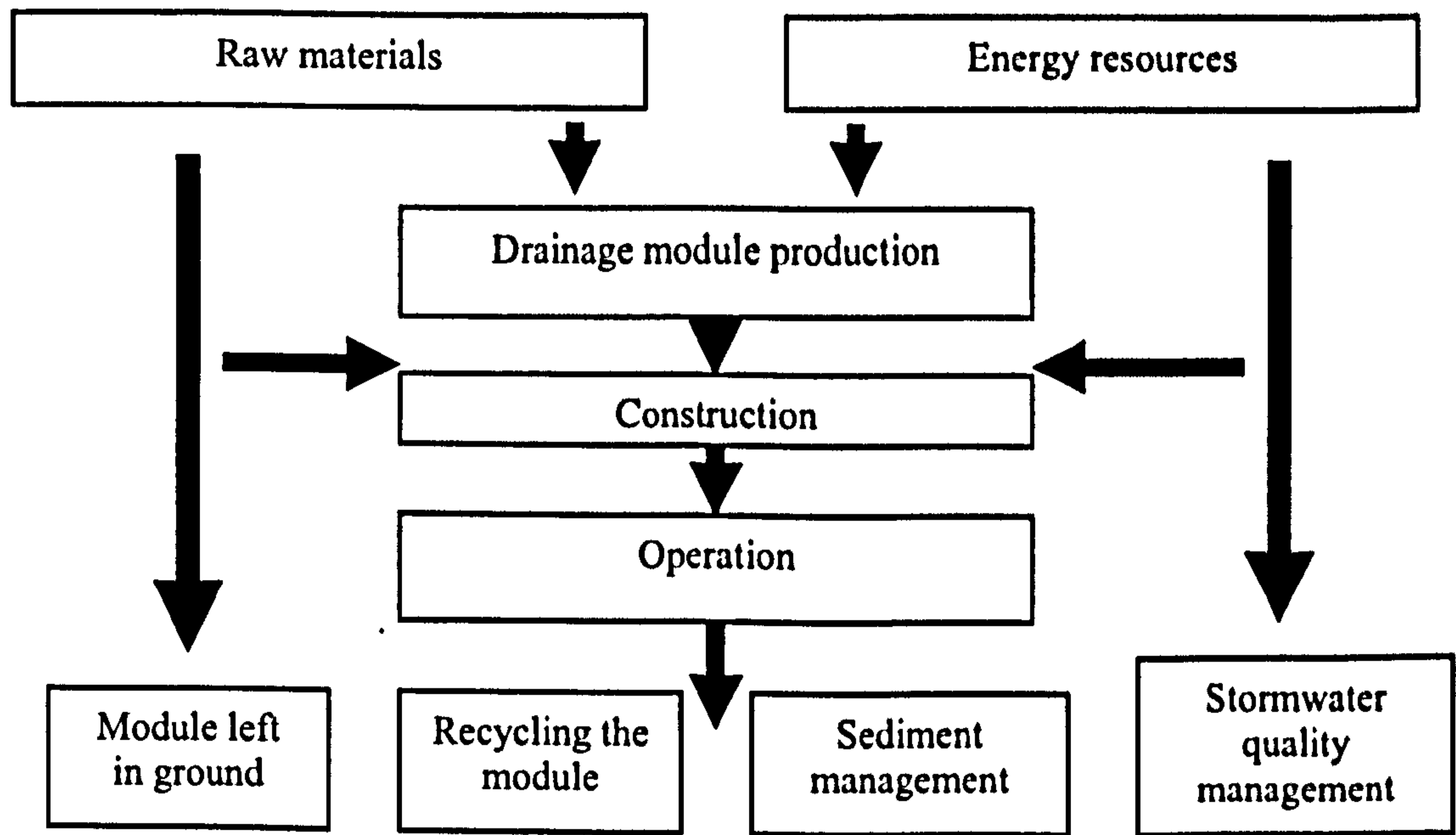


Figure 5.3.20: Life cycle model of Bio-Ecods System (Source: LM Sidek et al., 2004)

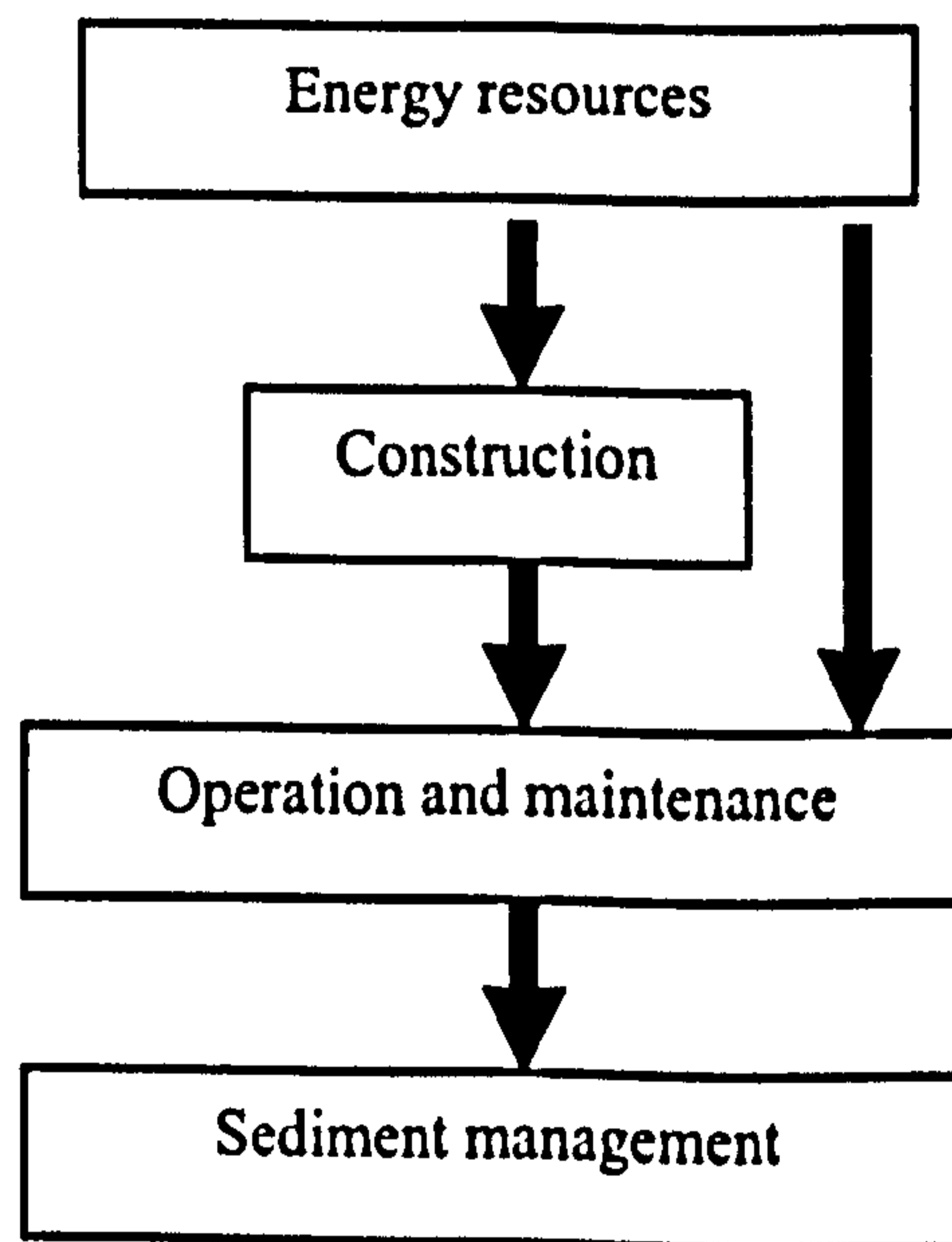


Figure 5.3.21: Life cycle model for grassed swale model (Source: LM Sidek et al., 2004)



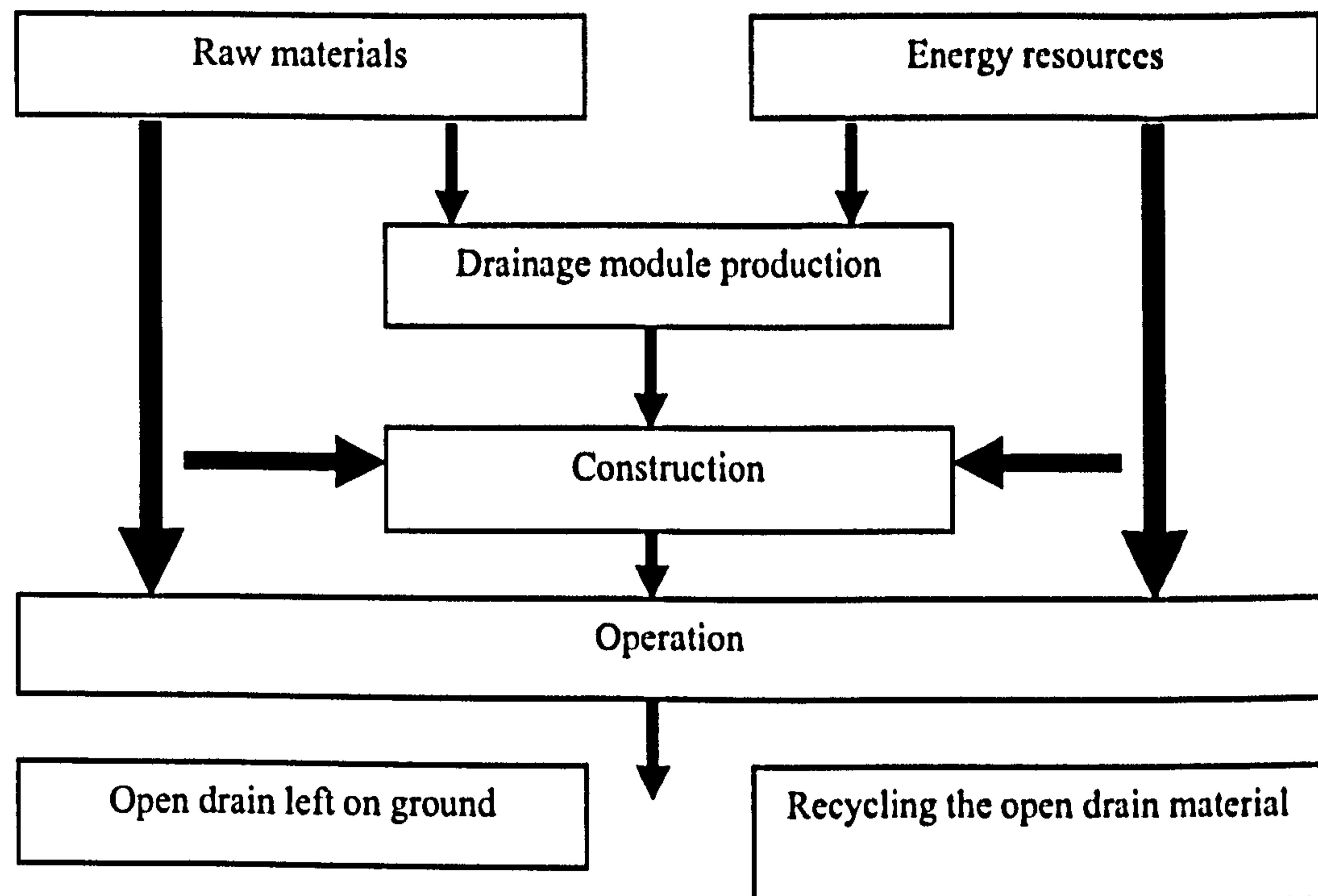


Figure 5.3.22: Life cycle model for open drain system (Source: LM Sidek et al., 2004)

Although the LLC findings show that the Bio-Ecods system implementation costs are lower by 5%, the maintenance costs for the systems are higher. The situation will be decreased over time since the contractor involved with the maintenance work becomes more familiar with the system and, at the same time, there is an improvement in the management skills (Sidek et al., 2004).

### 5.3.5 Discussion on the Implementation of Bio-Ecods

Bio-Ecods has managed to reduce and avoid a few problems faced by the conventional drainage system. Bio-Ecods has improved from various perspectives, such as the management and maintenance of drainage systems, the community, costing and values (Table 5.3.2).



Related parties / issues	Benefits
Related government agencies - DID, DOE, Local Authorities	<ul style="list-style-type: none"> <li>• Prevents pollution (quality) by purification of the stormwater by ecological/biological processes thus reduce the water contamination.</li> <li>• Controls flooding (quantity) by attenuation of flood discharge/zero peak flow contribution</li> <li>• Recharges groundwater by recharging and stabilising the fluctuation of the water</li> <li>• Enhances the environment (amenity)</li> </ul>
The community	<ul style="list-style-type: none"> <li>• Visual amenity</li> <li>• Agenda 21 and biodiversity objectives</li> <li>• Social opportunity for wetland appreciation</li> <li>• Understanding of how drainage works</li> </ul>
Planning	<ul style="list-style-type: none"> <li>• Planning objectives – sustainability targets and demands of statutory consultees are met</li> <li>• New 'greenfield runoff rate' requirements of the DOE are more easily achieved.</li> </ul>
Capital cost	<ul style="list-style-type: none"> <li>• Construction cost are reduced by 10%-50% (depends on site condition and soil suitability)</li> </ul>
Management	<ul style="list-style-type: none"> <li>• Maintenance is simple and cheap</li> <li>• Bio-Ecods is easily understood and avoids expensive specialist contractors</li> </ul>
Value	<ul style="list-style-type: none"> <li>• Bio-Ecods uses natural features in the landscape to create attractive surroundings which add value to development.</li> </ul>

Table 5.3.2: Benefits of Bio-Ecods (Source: LM Sidek et al., 2002)

REDAC was responsible for the development and implementation of Bio-Ecods and the USM campus was the pioneer project. Based on the experiences of REDAC's while handling this project, it would then be a good learning point to be improved upon in the future (Table 5.3.3).

	Problems
Parties involved in development and construction	<ul style="list-style-type: none"> <li>• Coordination among relevant parties need to be understood from the planning and design phase</li> <li>• The developer should be responsible for providing the land, meeting the capital cost and landscaping costs of Best Management Practices (BMPs)</li> </ul>
Planning and design	<ul style="list-style-type: none"> <li>• Construction of temporary earth channel at the site needs to be made. The constructions of swale are made only after the completion of building and landscape phase.</li> <li>• Grass channels do not appear to be effective at reducing bacteria levels in stormwater runoff. Need further treatment by constructed wetland to enhance the stormwater quality.</li> <li>• Wet swale is not suitable under tropical climate which may become a nuisance due to mosquitoes breeding. Dry swale is more suitable for local condition.</li> <li>• If designed improperly (such as, proper slope is not achieved), grassed channels will have very little pollutant removal.</li> <li>• A thick vegetative cover is needed for proper function. Normal grass height should be at least 2" above design flow depth</li> </ul>
Construction phase	<ul style="list-style-type: none"> <li>• Individual grass channels cannot treat a very large drainage area more than 2 ha</li> </ul>
Legal and guidelines	<ul style="list-style-type: none"> <li>• Legal arguments around who is responsible for the long term maintenance are common.</li> </ul>
Public	<ul style="list-style-type: none"> <li>• A public campaigns need to be conducted nationwide to highlight the new concept of drainage system</li> </ul>

Table 5.3.3: Problems encountered and lessons learnt from the USM campus Bio-Ecods project (Source: LM Sidek et al., 2002)

Some problems were encountered during the first stage of implementing the system as it was difficult to persuade the other related parties involved in the development of the USM campus that the systems are worth implementing and may benefit the whole process of development. According to Fadzli, the Project engineer for the USM campus drainage systems:



*“...problem that we have here is that we are not provided with an ample space for the drainage system, as it was first designed to suit conventional drainage systems, and we also are not getting support from our side (The administration of USM). This occurred because they are not familiar or did not really understand what a SUD is all about...”*

*“..This campus was only a branch campus which is not a big campus project. However, the drainage construction project has been broken into fourteen packages for fourteen different contractors. It is really hard for us to handle the various contractors for the whole project...”*

The Bio-Ecods has attracted many parties interested in implementing the system in their projects. This can be seen as a positive change towards a better drainage system in Malaysia. One of the projects that REDAC has been appointed to, as consultant for the drainage systems, is the Forensic Wards Complex (Figure 5.3.23) in Tanjung Rambutan, Perak. Fadzli comments:

*“...we also have just finished the Bio-ecods project in a hospital in Tanjung Rambutan Perak, the outcome of which is much better and nicer.... We've learned a lot from our first pioneer project...”*



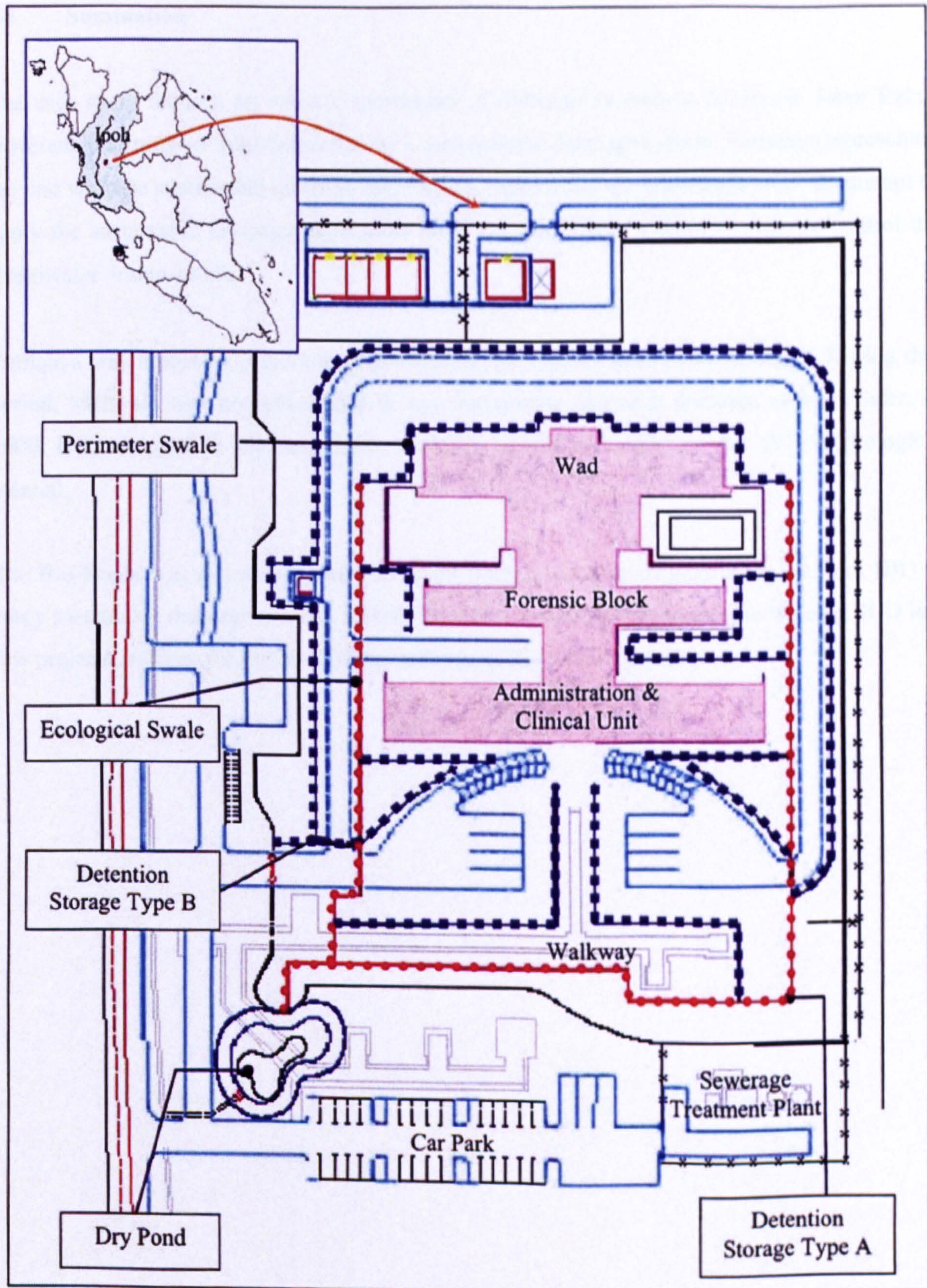


Figure 5.3.23: Site plan of the Forensic Wards Complex in Tanjung Rambutan, Perak (Source: Lau et al., 2004)



## 5.4 Summation

The case study focused on various approaches of drainage systems in Malaysia. Johor Bahru represented a study on implementation of a conventional drainage system. Putrajaya represented the one with the sustainable drainage approaches. Meanwhile the Bio-Ecods were an attempt to apply the sustainable drainage application with various devices system in order to control the stormwater within its site.

Putrajaya was a pioneer project in implementing the idea of sustainable drainage. During that period, Malaysia was not introduced to any sustainable approach drainage system. Later, in 2000, DID changed to the sustainable drainage manual by replacing the 1975 hydrological manual.

The Bio-Ecods was a system developed by REDAC with research grant awarded from DID to study sustainable drainage system. REDAC was then given the opportunity to develop SUD in a few projects, such as the Forensic Ward in Tanjung Rambutan, Perak.



## Chapter 6

### *Public Survey Analysis*

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#### **6.0 Introduction to the Public Survey Analysis**

The public surveys had been conducted using qualitative and quantitative approaches as discussed earlier in Chapter 4. The quantitative method that has been carried out is a public questionnaire survey and focus groups had been used for the qualitative method. These surveys were conducted in Johor Bahru and Putrajaya in the autumn of 2004; from August to October.

The questionnaire consisted of six parts; from A to F. Each part represented a topic, such as personal background, satisfaction with current drainage system, awareness of drainage-related environmental problems, drainage practices, improvement to the drainage system and additional information related to drainage issues. There were thirteen questions altogether; with a combination of multiple choice questions and an open-ended questions.

#### **6.1 Public Response to Survey**

A total of one thousand two hundred questionnaires were distributed within the two study sites - Johor Bahru (JB) area (three residential areas to the east of the district) and in Putrajaya one residential area using self-reply envelopes. Four hundred forty-seven replies were returned, where two hundred eighty-two replies were received from JB, with the remaining one hundred sixty-five received from the residents of Putrajaya (Table 6.1.1). This equals a total of 37% response rate.



	JB	Putrajaya	Total
<b>Response rates</b>	282	165	37%
<b>Respondent's age group</b>			
16-19			5%
20-24			14%
25-34			15%
35-54			58%
55 and above			8%
<b>Respondent's gender</b>			
Male			48%
Female			52%
<b>Respondent's educational background</b>			
Primary			8%
Secondary school leaver			26%
Certificate holder			18%
Degree holder			48%
<b>Respondent's occupation group</b>			
Managerial			18%
Homemaker			17%
Students			13%
Unemployed			11%
Not determined by respondent (missing value)			41%
<b>Homeownership</b>			
Tenant			62%
Owner			38%

Table 6.1.1: Respondents' distribution of demographic factors

A majority of the respondents is between the age group of '35-54 years old' (58%), while the smallest number of response is from the '16-19 years old' age group (5%) (Table 6.1.1). As shown in Table 6.1.1, the respondents aged below 34 years old are fewer compared to the respondents aged between 35 and 54 years old. This is due to the fact that most of the urban population is made up of workers aged between 35 to 54 years old. In Malaysia, the retirement age is 55, 56 or 58 years old. The respondents in younger age group all underwent higher education, with most of them finishing their studies at the age of 24.

The female respondents (52%) showed more interest compared to the male respondents (42%) (Table 6.1.1). Female responses were slightly higher than the male responses (Table 6.1.1). Cultural influence might have contributed towards many of the female respondents spending most of their time at home compared to the males.

Based on the respondents' feedback, 48% are degree holders followed by 27% secondary school leavers, 18% certificate holders and the remaining 8% are primary school leavers (Table 6.1.1). The distribution of the respondents based on their professions is shown in Table 6.1.1. The most responses received were from the managerial group (18%) followed by the homemakers (17%)



and students (13%). The least responses were received from the unemployed group (1%). Overall, most of the respondents have stayed in the residential area for over ten years (37%) (Table 6.1.1) and most of them own a house (62%) (Table 6.1.1).

However, to get a clearer picture of the perceptions of the respondents, analyses of the data shall be discussed based on the respondents' experiences in the following section.

## **6.2 Survey Analysis from the Public Respondents**

All the data received were analysed using the SPSS 2005 Version 12.0 software. The data were then organised into a data file, which contains the data of all the public respondents from JB and Putrajaya. The frequencies of all the variables from the data are shown in this sub-topic, and a Chi-square test is used in order to assess the validity of the relationship between the two variables. The result of the Chi-square ( $X^2$ ) test shows a degree of association between the two variables. In this study, it is used to identify the significance of the variable's relationships in a contingency table.

A relationship is only assumed to be statistically significant if the probability level is 0.05 or less. A significant relationship only indicates the degree of association and not what the association is; for example, whether it is positive or negative.

This study aims to identify if the percentages of those who have not experienced stagnant water in the two locations, which are JB and Putrajaya – as seen in Table 6.3.2, which is based on the data and analysis. The data are tested and the result shows the computed Chi-Square ( $X^2$ ), the degrees of freedom ( $df$ ), and significant level ( $p$ ). For example, the 'location' factors based on Table 6.2.2, and its association with the 'stagnant water' issue is 68.530, the  $df=1$ , and the significant level is  $p=0.000$ .

Based on this result, it can be seen that the results are significant because the percentages of 'those with experience of stagnant water (Yes)' and 'those without experience of stagnant water (No)' are different in each location. Thus, this difference is large enough to be significant. 14% experienced stagnant water in Putrajaya and 86% experienced stagnant water in JB. Meanwhile, 'those without experience of stagnant water' has a reversed pattern with 52% in Putrajaya and 48% in JB.



The formats for the quantitative results discussion for each topic are presented with a table of percentage of the responses received for each subtopic. Tables from Chi-square test are also shown to give the idea of the relationship in every topics.

### 6.3 Problems Associated with the Current Drainage System

During the survey, respondents were asked to identify their experiences of the given problems associated with current drainage system in the study areas, such as stagnant water, floods and others. (Table 6.3.1). The result shows that mosquitoes, littering and odour are the most serious problems as seen from their ranking. Surprisingly, flash floods and careless accidents are not considered to be serious issues among the respondents. However, rapid urbanisation in many major cities in Malaysia has suffered from the flash flood due to the rapid development (refer to 3.0 in Chapter 3).

	Yes (%)	No (%)
Still water / Stagnant water	40	60
Mosquitoes	83	17
Flash flood	18	82
Careless accident	14	86
Littering	48	52
Overload	34	66
Drainage blockage	40	60
Smelly	41	59
Other	8	92

Table 6.3.1: Respondents' feedbacks on their experience of current drainage problems

In a tropical climate like Malaysia, vector diseases are a great threat to the community. Problems associated with mosquito-borne diseases are related to problems as a result of rapid urbanization (Aiken and Leigh, 1975; Parkinson, 2003; and Banda et. al., 2007). The *Culex*, *Anopheles* and *Aedes* mosquitoes transmit various dangerous diseases. As discussed in Chapter 2, various factors, such as open drainage channels, standing or stagnant water, and blockage drain provide breeding sites for the mosquitoes (Parkinson, 2003).

These water health impacts depend on a few factors, which vary from the source of water to the handling of the domestic setting (Banda et. al., 2007). There is a possibility of socio-cultural factors influencing the public knowledge, attitudes and practices in managing their daily water usage (Brick et.al., 2004;Clasen et.al., 2006; and Banda et.al., 2007). As a multi-racial country, the differences in multi-traditional culture might be an obstacle for the responsible agencies to control the handling of domestic water. Therefore, it remains uncorrected.



However, as discussed in the earlier section (refer to 3.2.4 in Chapter 3), there is less consideration amongst the public on urban stormwater issues as there seem to be a lack of awareness over it. This could be the result of rapid landuse changes from the population growth, which cause difficulty in keeping pace with the urban infrastructure (Izazola et al., 1998) (refer also to 2.1 in Chapter 2). Feedbacks received from the focus group respondents do not show that they were alert of water-borne diseases (further discussed in sections 6.7-6.10, in Chapter 6). According to Lima and Castro (2005) as stated in section 2.1.2 in Chapter 2, the level of concern on global environmental issues is higher than local issues. This then might be an important issue that has influenced the results of the survey.

### 6.3.1 Stagnant Water Problems in the Current Drainage System

Poor drainage system and improper sanitation management cause stagnant water. This problem leads to various other problems that could threaten the public with water-borne diseases, such as the contamination of drinking water as well as providing potential areas for parasitic worms (Figure 6.3.1) (Cairncross and Ouno, 1991; Kolsky, 1999; and Parkinson, 2003). Problems associated with stagnant water are related to the respondent's location, age, gender, education, homeownership, occupation and length of living time factors (Table 6.3.2).

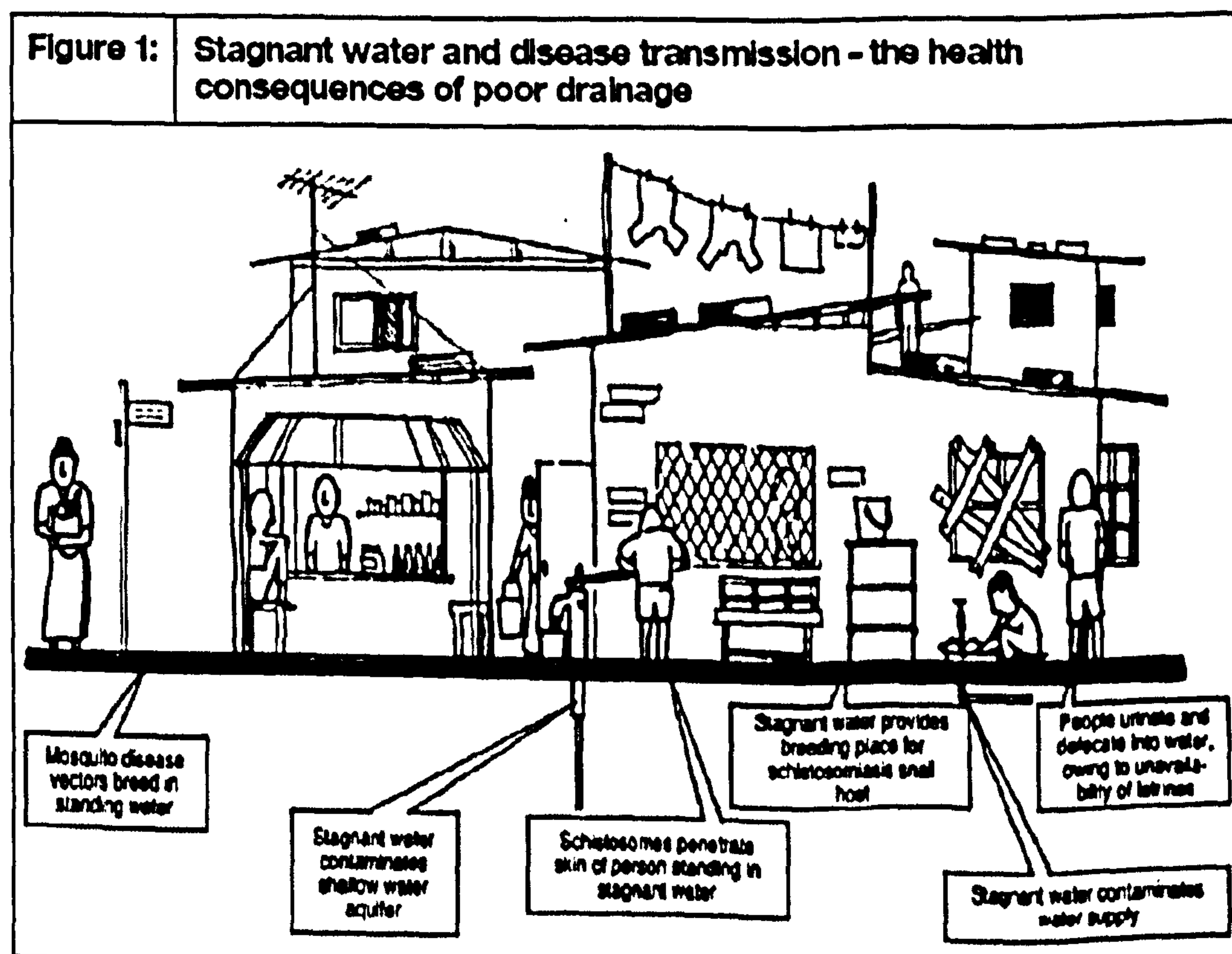


Figure 6.3.1: Stagnant water and disease transmission – The health consequences of poor drainage (Cairncross and Ouano, 1991; and Parkinson, 2003)



Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=68.530$ ; $df=1$ ; $p=0.000$	
Age	Chi-Square	$X^2=25.916$ ; $df=4$ ; $p=0.000$	MC
Gender	Chi-Square	$X^2=5.639$ ; $df=1$ ; $p=0.018$	
Education	Chi-Square	$X^2=40.478$ ; $df=3$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=29.309$ ; $df=1$ ; $p=0.000$	
Occupation	Chi-Square	$X^2=75.021$ ; $df=11$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=42.749$ ; $df=4$ ; $p=0.000$	MC

Table 6.3.2: Respondents' experiences of stagnant water problems and its association with demographic factors.

The respondents' feedbacks on stagnant water vary significantly according to the study area (Table 6.3.2). Better drainage systems in Putrajaya have reduced the possibility of residents facing the problems compared to the JB respondents.

The results between the 'age groups' and their association with stagnant water issues show a significant difference (Table 6.3.2). This is because the percentage of 'residents with experience of stagnant water' and 'residents without experience of stagnant water' is different for each age group. Concerns about stagnant water is the highest for the age group of 35-54 years. This might be because this age group is made up of the main occupiers of houses. Other groups show less response to experiences regarding this issue.

Female respondents are more concerned about stagnant water issues compared to the male respondents. According to Fadda and Jiron (1999), men and women perceive the environment differently. They have different roles and activities in their daily life which force them to look at or be aware of different needs and elements (Rico, 1993; and Fadda and Jiron, 1999).

The secondary school leavers are the group with the most experiences regarding stagnant water problems. This could be related to the living surroundings of the middle class worker. It is stated in the 'Property Market Report' (2004), that terrace houses (priced RM180k and below) continue to dominate the property market by 78.4%, and only 2.8% of high-end houses (priced RM500k and above) was in demand in the same year. This shows that most of the residential dwellings in urban areas were provided to satisfy the demand of the lower income groups or working groups.

The surveys on stagnant water problems and their association with homeownership status show that house owners are more alert about or aware of the stagnant water issues within their residential area. Homeowners do have the tendency to show more awareness compared to tenants, which resulted from their interest in being satisfied with the residential areas (Saunders, 1990; and Elsinga and Hoekstra, 2005). Saunders (1991) describes this scenario as people's 'possessive instinct', which leads to a tendency of having satisfaction in their marked territories



or boundaries. In the case of the Malaysian housing residents, they have shown their awareness of stagnant water issues, which may lead them to seek further solutions to ensure that their living boundaries live up to their expectation. This issue has also been discussed in Chapter 2.

Students and homemakers appear to be more aware of stagnant water problems within their living area. This may be due to the higher time spent in their houses or living areas compared to other groups of occupation. In Malaysia, students spend a single session in school, which is either from 7am-12.45pm for the morning session or 1.00pm-6.30pm for the afternoon session. Furthermore, those who are involved in education are more exposed to the environmental issues and information. The managerial and executives groups, which can also be considered as office workers, showed less concern about stagnant water issues. This might be influenced by the time that they spend at home. Officially, the office hours in Malaysia are from 8.30am-5.30pm, and most of them arrive home after an average of a 1-hour journey. Barter (2002) points out that the increasing impact of traffic in urban areas on the quality of life takes the form of vehicle congestion and interruption, and the environment (Bunnell, et. al., 2002). Therefore, since they spend more time in the office and on the journey, this leaves limited time to be spent at home.

Respondents who have been staying longer in their homes are more aware of the issues. Based on the survey, it shows that respondents who had lived in the studied areas for more than six years have experienced stagnant water. This is related to familiarity, which helps a person to feel the level of comfort (Kaplan, et. al., 1998). The tendency for comfort has alerted them towards level of discomfort, such as stagnant water. As discussed earlier, according to Saunders (1991) and Elsinga and Hoekstra (2005), people will seek satisfaction elements, such as improving any problems that can disturb the satisfaction level of their living boundaries. On the other hand, residents who had lived there for less than six years are still undergoing the process of familiarisation with the living space (Kaplan, et. al., 1998). There is also a possibility that residents staying less than six years are tenants, who, according to Elsinga and Hoekstra (2005), have less awareness of the living surroundings compared to the homeowners as mentioned in the earlier discussions.

### **6.3.2 Flash Flood Problems in the Current Drainage System**

According to the respondents' feedbacks on flash flood issues, the result shows that concern is related to the study area, educational background, occupation and length of time in the house (Table 6.3.3).



Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=14.162$ ; $df=1$ ; $p=0.000$	
Education	Chi-Square	$X^2=54.376$ ; $df=3$ ; $p=0.000$	MC
Occupation	Chi-Square	$X^2=31.565$ ; $df=11$ ; $p=0.001$	MC
Length of living time	Chi-Square	$X^2=32.838$ ; $df=4$ ; $p=0.000$	MC

Table 6.3.3: Chi-square test of respondents' experiences with flash floods based on demographic factors

Based on the survey analysis, from one hundred and sixty responses received from Putrajaya, 9% responded that they experience flash floods compared to 23% of the two hundred seventy-three replies from JB respondents. The JB respondents experience more flash flood problems due to its rapid disposal drainage approaches compared to the sustainable drainage approaches that have been implemented in Putrajaya.

The result shows that the respondents with certificate have most experience more flash flood problems. This result might be due to the household income, location or the age of the development area as discussed also in Chapter 2. Cities in Malaysia are considered as post-industrial area so housing is important in order to support the labour market (Marcuse and van Kenpem, 2000; and Bunnell, et. al., 2002). Therefore, housing development projects are also influenced by housing demand patterns that came from every occupational background, especially lower income groups (Morshidi, 1997). The need to provide infrastructures and trends of higher purchase houses with a growing population demand towards cheaper accommodation have influenced urban development (Ahmad Zakki Yahya, 1997; and Bunnell, et. al., 2002). Residents with good qualifications mostly could afford a better housing scheme, which provides a good sanitation and drainage system; with better management and maintenance facilities. However, the increasing value of urban land has resulted in most units for the lower income groups being in high-rise buildings (Bunnell, et. al., 2002). The certificate holders were mostly medium class workers who were more interested in the medium cost housing schemes, which are more affordable. On the other hand, families without the necessary funding to purchase a house would prefer rented houses. All these social and economic forces, and the rapid urban development have influenced the residents' experiences of flash flood water and the flash flood event itself.

The homemakers, clerical officers, students and the self-employed are in the groups that were most concerned about flash flood issues in this survey. It is interesting to discover that the managerial and professional group have less experience in facing the flash flood issues compared to the general workers. This issue might be due to the location of residential area itself, and the household income, which influence whether an individual can afford to own a better living place as discussed earlier on educational background. On the other hand, the government policy developed after Independence in 1957 had allocated housing for low-income



households (Agus, 2002). This is also a reason why most of the respondents come from lower income groups.

A respondent's length of living in the area and its association with flash flood events might be influenced by various factors. Those who have lived less than three years have had less experience of flash floods. Respondents who have lived more than three years in their homes have had experiences of flash floods in the year. On the other hand, residents who have lived more than ten years have responded that they have less experience of flash floods. There are a few possibilities that may have influenced the results. They are as follows:

- a) In recent years, the housing development trend has changed to a new development area a bit farther than the developed urban areas. This is known as new township developments. This trend has given advantages to the urban population in terms of the prices, which are much more affordable. The trend developed since the post-independence period to cater for the housing needs and there is an expansion of existing settlements and also the creation of new settlements (McGee, 1976 and 1982; and Agus, 2002). New towns, such as Shah Alam, Bandar Baru Bangi and Skudai had been developed near the larger metropolitan cities, such as Kuala Lumpur and JB; promoting the intermediate cities near the bigger cities (Mohammad, 1983; and Agus, 2002). Therefore, the environmental pressures are much less as the areas are still newly developed and without pressures or forces from nearby developments. This resulted in the residents having less experiences of flash flood.
- b) Those who have lived longer in their living area experience the impact of continuous urban development. The rapid development processes have disturbed the living environment due to the construction from nearby developments as well as the urbanisation impact. Problems due to development activities, such as sedimentation and erosion, are factors that might have influenced the flash flood. Therefore, the chances of having experienced the flash flood are much higher from time to time. For example, one might not have any flash flood problems at the early of occupancy, but as the surrounding areas undergo development processes, the problem might then occur. This is considered as a new experience since the residence might not have experienced the problems before.
- c) Older developed areas have the tendency to be influenced by surrounding developments as the area might have been fully developed. Therefore, they do have the advantage of going through maintenance processes to improve the living areas by the respective authorities. This factor might have influenced the results of having less experiences of flash floods by residents who have lived there for more than ten years.



- d) The new housing schemes may also have the advantage of a new drainage system or MSMA that has been used officially since 2000. These housing schemes have been provided with the SUDS approach. The same influence on the result may have also affected respondents from Putrajaya, which itself has been provided with SUDS.

It had been predicted that the old residential might experience worse problems compared to a new residential that had been provided with better drainage solution. However, this prediction did materialise as seen from the result. It is interesting to note that, in sustainable drainage approaches, the new project has the opportunity to be provided with SUDS.

### 6.3.3 . Careless Accidental Problems in the Current Drainage System

An awareness of careless accidents related to the drainage system is significantly associated to the study area, age group, the gender, education, homeownership status, occupation and length of living time (Table 6.3.4).

Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=42.208$ ; $df=1$ ; $p=0.000$	
Age	Chi-Square	$X^2=26.898$ ; $df=4$ ; $p=0.000$	MC
Gender	Chi-Square	$X^2=11.212$ ; $df=1$ ; $p=0.001$	MC
Education	Chi-Square	$X^2=35.402$ ; $df=3$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=7.420$ ; $df=1$ ; $p=0.006$	
Occupation	Chi-Square	$X^2=68.109$ ; $df=11$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=61.019$ ; $df=4$ ; $p=0.000$	MC

Table 6.3.4: Chi-square test of respondents' experiences with careless accidents based on demographic factors

Surprisingly, all responses on careless accidents were from the JB respondents. This might be due to the fact that the JB residents had lived there for over ten years, and there is a higher need for maintenance and improvement in order to reduce the risk of accidents. On the other hand, Putrajaya is a new residential area. Therefore, the risk of accidents is very rare and low. The 'length of living' and 'homeownership status' seem to have influenced residents' awareness of any indicator that may lead to accidents especially those involving children. This shows a higher level of awareness among people who are attached to their living spaces. For example, ownership of residential homes is considered as tantamount to holding a legal title to the properties. Thus, owners will take more care of their properties (Nassauer, 1997; and Kaplan, et. al., 1998).

Stratford (1995), Jackson (1998), Basiago (1999) and Regan and Horn (2005) show that gender do contribute to the level of awareness. This has also been discussed earlier in section 2.1.1.1 in



Chapter 2. The female respondents show more awareness of careless accidental problems compared to the male respondents. A woman's duties in domestic areas have increased their concerns about water issues compared to the male subjects (Stratford, 1995).

On the other hand, a resident's daily routine affects individual attachment and experience of space (Ulrich, 1983; Kaplan and Kaplan, 1989; Ulrich et al., 1991; Kaplan, 1995; and Regan and Horn, 2005). These are the reasons that have influenced certain people in the occupation group to show less awareness of water issues or problems. Furthermore, this is also caused by the time they spend with the community within the living area. Respondents living less than a year have no response for careless accidental problems which, according to Nassacur (1997), can be related to the individual sense of attachment to a place.

#### 6.3.4 Littering

The problem of littering significant based on the respondents' location, age, gender, educational background, homeownership, occupation and length of living time (Table 6.3.5).

Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=81.495$ ; $df=1$ ; $p=0.000$	
Age	Chi-Square	$X^2=28.139$ ; $df=4$ ; $p=0.000$	MC
Gender	Chi-Square	$X^2=3.964$ ; $df=1$ ; $p=0.046$	
Education	Chi-Square	$X^2=36.822$ ; $df=3$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=51.269$ ; $df=1$ ; $p=0.000$	
Occupation	Chi-Square	$X^2=45.262$ ; $df=11$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=45.000$ ; $df=4$ ; $p=0.000$	MC

Table 6.3.5: Chi-square test of respondents' experiences with littering based on demographic factors

The results from the respondents' feedbacks on littering show that it is significant according to the study area (Table 6.3.5). The littering issue is higher in JB and could have been influenced by the residents' educational backgrounds, which are also related to having less source of information supplied to them.

This is an illuminating result based on the age factor and littering problems. Although most of the respondents responded positively, the Chi-square results show that the expected count of those who are not having problems with littering is higher than the observed, accepted result from the group aged between 25-34 and 35-54 years. These are the 'working' age group; most of whom have less time to spend in their living surroundings. Therefore, they have less sense of space to influence their awareness (Nassacur, 1997).



The secondary school leavers, certificate holders and degree holders are the group that gave higher responses based on their experiences of difficulty with littering problems in their living surroundings. However, there is a higher response among the degree holders that shows that they have no experience of littering. This maybe due to the fact that they live in better residential areas. This also includes the daily routine factor which affects the time spent within their living areas as discussed earlier.

The executive and managerial workers show a higher percentage of those who do not face this problem in their living areas compared to other groups of occupation. This may due to the time spent within their living surroundings which is less as the office working hours in Malaysia are from 8.00am to 4.30pm.

### 6.3.5 Overflow of Drainage Capacity

The respondents' feedbacks on the overflow of drainage capacity is significantly high based on their location, age, gender, education, homeownership, occupation and length of living time (Table 6.3.6).

Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=56.104$ ; $df=1$ ; $p=0.000$	
Age	Chi-Square	$X^2=29.971$ ; $df=4$ ; $p=0.000$	MC
Gender	Chi-Square	$X^2=3.940$ ; $df=1$ ; $p=0.047$	
Education	Chi-Square	$X^2=38.764$ ; $df=3$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=22.044$ ; $df=1$ ; $p=0.000$	
Occupation	Chi-Square	$X^2=37.822$ ; $df=11$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=43.311$ ; $df=4$ ; $p=0.000$	MC

Table 6.3.6: Chi-square test of respondents' experiences with insufficient amount of drainage capacity based on demographic factors

The respondents' feedbacks on the insufficient amount of drainage capacity issues show that it is significant according to the study area. The insufficient amount of drainage capacity issues are higher in JB because of the conventional drainage system, which was designed based on rapid disposal approaches. This approach is used to transfer water run-off as soon as possible to the downstream.

The 35-54 years old age group shows the highest response of not experiencing insufficient drainage capacity problems in their living area. They are respondents who live in a new and well-developed residential area, whilst the other age groups still live within the old development residential scheme.



Respondents with academic qualifications higher than secondary schools are more alert about the insufficient amount of drainage capacity within their housing areas. However, the degree holders have less experience of the insufficient amount of drainage capacity in their living areas. This could be due to the fact that they live in better housing areas. Same scenarios can be related to workers associated with office-working environment, such as executives, managerial staff or academicians, who experience less insufficient amount of drainage capacity within their living areas.

### 6.3.6 Drainage Blockage

The responses on drainage blockage are significantly high based on the respondents' location, age, education, homeownership, occupation and length of living time (Table 6.3.7).

Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=77.047$ ; $df=1$ ; $p=0.000$	
Age	Chi-Square	$X^2=16.461$ ; $df=4$ ; $p=0.001$	MC
Education	Chi-Square	$X^2=35.704$ ; $df=3$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=24.002$ ; $df=1$ ; $p=0.000$	
Occupation	Chi-Square	$X^2=42.866$ ; $df=11$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=40.079$ ; $df=4$ ; $p=0.000$	MC

Table 6.3.7: Chi-square test of respondents' experiences with drainage blockage based on demographic factors

The respondents' feedbacks on drainage blockage are related to the respondents' location (Table 6.3.7). The JB respondents are highly responsive to issues that might be associated to the insufficient amount of drainage capacity and littering issues that have been discussed in the earlier section (Table 6.3.5 and Table 6.3.6). as recalled, Putrajaya was planned with a sustainable approach to the drainage system. Components such as filter strips and permeable surfaces, do help to reduce water run-off. Furthermore, the residential areas were provided with covered drainage systems which protect drainage from debris problems. This concept is based on control-at-source techniques that have been introduced in SUDS.

The respondents' feedbacks on drainage blockage seem to be related to their age (Table 6.3.7). Respondents aged between 25 to 54 years old are highly related to issues which might be caused by the fact that they are the largest age group that occupy both areas and also in responding to the questionnaire. However, respondents aged 16-19 years old and 55 years old and above show higher frequencies. This could be due to the fact that they are the age groups that spend most of their time at home. The 16-19 year old age group consist mostly of secondary school level, whilst the 55 years old and above age group consist of the retirement group.



The respondents' feedbacks on drainage blockage appears to be related to their homeownership (Table 6.3.7). Based on the residents' experiences of facing drainage blockage problems, homeowners seem to be more aware than tenants. This might be influenced by the sense of belonging, with the owners being more aware of their living environment (Nassacur, 1997).

As for those who responded that they did not face drainage blockage problems (Table 6.3.6), homeowners also show a higher response compared to tenants. Nowadays, people are more aware and have knowledge of buying good comfortable houses in terms of planning and design.

The respondents' feedbacks on the drainage blockage seems related also to their occupations (Table 6.3.7). The number of responses on never having drainage blockage problem is higher among the executive and managerial workers. This could have been influenced by the daily routine, where most of the time is spent in the office and less at home.

The respondents' feedbacks on the drainage blockage also appear to be significantly related to the respondents' length of time living in their home (Table 6.3.7). The result shows that those who had occupied their homes longer have most experiences with the drainage blockage problems compared to those who had lived in the residential area less than three years.

### 6.3.7 Bad Odour From the Drainage System

The respondents' feedbacks on bad odour from the drainage system appear to be related to their location (Table 6.3.8). The JB respondents show a higher response to bad odour from the drainage, which can be associated to the insufficient amount of drainage capacity, littering and blockage of drainage systems that have been discussed earlier in sections 6.3.4, 6.3.5 and 6.3.6.

Variables	Test	Result Exact Significance = E
Bad odour from the drainage systems	Chi-Square	$X^2=82.956; df=1; p=0.000$

Table 6.3.8: Insufficient amount of drainage capacity problems and its association to respondents' location

## 6.4 Awareness of Drainage Related Environmental Problems

The lists consisting of drainage related environmental problems have been included in the questionnaire (Appendix A), and respondents were asked to note the level of concern about respective issues. Most of the significant subjects that seem to have influenced the respondents'



awareness of drainage related environmental problems are almost similar, especially on water quality deterioration (see section 6.4.1), water related diseases (see section 6.4.2), the decrease in fresh water species and vegetation (see section 6.4.3).

#### 6.4.1 Water Quality Deterioration

The respondents' awareness of water quality deterioration seem to be significantly related to their location, gender, educational background, occupation and length of time living in the area (Table 6.4.1).

Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=43.237$ ; $df=4$ ; $p=0.000$	MC
Sex	Chi-Square	$X^2=15.521$ ; $df=4$ ; $p=0.004$	MC
Education	Chi-Square	$X^2=58.900$ ; $df=12$ ; $p=0.000$	MC
Occupation	Chi-Square	$X^2=171.168$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=110.158$ ; $df=16$ ; $p=0.000$	MC

Table 6.4.1: Water quality deterioration

The percentage of respondents who are less concerned or who are not concerned at all about the water quality deterioration issue is high in JB. This could be due to their educational background and source of information on the related issues. Respondents with lower educational qualifications were mostly from JB, whilst the Putrajaya residents mostly had highly qualified educational background. This might be due to the fact that the Putrajaya township itself was developed as administrative centre of the Malaysian government.

The percentage of female respondents concerned or who are very concerned about the water quality deterioration issues is high. This result correlates with findings in Eisler, et. al. (2003) and Jorgensen (2004) who founded that females are more aware of environmental issues than males.

The respondents' occupation (Table 6.4.1) seem to be related to their awareness on water quality deterioration. The individual interaction, attachment and time spent in their surroundings are very important in examining the perception or awareness of any environmental issues.

The percentage of the respondents' length of living time in their houses shows a highly significant relationship with their awareness on water quality deterioration. The length of time in the living area appear to be associated to the individual attachment to the place. People are



more involved or aware of the place once they have more connection and engagement with the place (Nassaeur, 1997; and Kaplan, et.al., 1998).

#### 6.4.2 Water-Borne Diseases

In a tropical region, such as Malaysia, communities are threatened by water-borne diseases, especially malaria and dengue. In this study, the awareness of water-borne diseases seems related to the respondents' location, education, occupation and length of time living there (Table 6.4.2). This result could also due to the factors that have been discussed in section 6.4.1.1 on location, education, occupation and length of time living and its association with water quality deterioration.

Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=20.474$ ; $df=4$ ; $p=0.000$	MC
Education	Chi-Square	$X^2=66.359$ ; $df=12$ ; $p=0.000$	MC
Occupation	Chi-Square	$X^2=158.215$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=74.730$ ; $df=16$ ; $p=0.000$	MC

Table 6.4.2: Water-borne diseases

#### 6.4.3 Decrease of Fresh Water Species and Vegetation

Putrajaya residents showed more concern than the JB respondents on the issue regarding the decrease of water species and vegetation (Table 6.4.3). This might be due to the township planning where residents are exposed to the nature. For example, people in Putrajaya can easily reach the Wetland Park, Botanical Garden and Heritage Park. This then gives Putrajaya residents more exposure to nature compared to the JB residents.

Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=26.185$ ; $df=4$ ; $p=0.000$	MC
Education	Chi-Square	$X^2=62.402$ ; $df=12$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=13.160$ ; $df=4$ ; $p=0.009$	MC
Occupation	Chi-Square	$X^2=126.026$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=46.149$ ; $df=16$ ; $p=0.000$	MC

Table 6.4.3: Decrease of fresh water species and vegetation



Other factors that are significant appear to be education, homeownership, occupation and length of living time. The homeownership factor is also related to the 'length of living time' factor, which at the same time is associated to the individual connection with the place.

#### 6.4.4 River Sedimentation Due to Development Activities

Responses on river sedimentation due to development activities seem significantly related to the respondents' location, gender, education, homeownership, occupation and length of living time (Table 6.4.4). It has been suggested that rapid urbanization has been a major contributor towards environmental problems in Malaysia (Haron, Paim and Yahaya, 2005). Migration to urban areas has increased the need for housing, which forces the development of many new housing schemes (Brunnel, et.al., 2002). Rapid developments in urban areas have caused river sedimentation, which is also a factor in flooding (MSMA, 2000).

Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=35.646$ ; $df=4$ ; $p=0.000$	MC
Sex	Chi-Square	$X^2=27.054$ ; $df=4$ ; $p=0.000$	MC
Education	Chi-Square	$X^2=45.178$ ; $df=12$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=13.299$ ; $df=4$ ; $p=0.007$	MC
Occupation	Chi-Square	$X^2=128.451$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=83.100$ ; $df=16$ ; $p=0.000$	MC

Table 6.4.4: River sedimentation due to development activities.

#### 6.4.5 Sewage and Domestic Waste Discharge Into the River

An awareness of sewage and domestic waste discharge into the water is significant based on the respondents' location, education, homeownership, occupation and length of living time (Table 6.4.5). There is no significance between the issues and the respondents' gender. Improper sanitation systems appear to be a major factor in this issue. It has been found that people living in slum areas are exposed to this problem. Many cities in developing countries face slum-related problems, such as sanitation and sewage problems (Ranson, 1991).

Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=43.237$ ; $df=4$ ; $p=0.000$	MC
Education	Chi-Square	$X^2=63.463$ ; $df=12$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=21.692$ ; $df=4$ ; $p=0.000$	MC
Occupation	Chi-Square	$X^2=128.451$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=83.100$ ; $df=16$ ; $p=0.000$	MC

Table 6.4.5: Sewage and domestic waste discharge into the river



#### 6.4.6 Floods and Flash Floods

Flash floods or floods are the main hazards in most areas in Malaysia (Weng, 2002). Flood awareness among respondents seems highly significant based on location, gender, education, homeownership, occupation and length of living time (Table 6.4.6).

Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=13.168$ ; $df=4$ ; $p=0.009$	MC
Sex	Chi-Square	$X^2=14.626$ ; $df=4$ ; $p=0.003$	MC
Education	Chi-Square	$X^2=45.464$ ; $df=12$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=13.727$ ; $df=4$ ; $p=0.006$	MC
Occupation	Chi-Square	$X^2=136.522$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=65.889$ ; $df=16$ ; $p=0.000$	MC

Table 6.4.6: Floods / flash floods

Most cities in Malaysia with dense development have been experiencing flash floods. Since this problem is getting worse, the government has allocated a budget to mitigate flood problems in the 9<sup>th</sup> Malaysia Plan as discussed in section 1.0 in Chapter 1.

#### 6.4.7 Litter in Waterways

Litter in waterways or solid waste contributes to the deterioration in water quality through the presence of decayed organisms in most waterways in Malaysia (Kuang and Jusoh, 2002). Location, age, gender, sex, education, homeownership, occupation and length of living time are factors that are of high significance in relation to the respondents' awareness of solid waste issues (Table 6.4.7).

Variables	Test	Result Exact Significance = E Monte Carlo = MC	
Location	Chi-Square	$X^2=14.829$ ; $df=4$ ; $p=0.003$	MC
Age	Chi-Square	$X^2=46.017$ ; $df=16$ ; $p=0.000$	MC
Sex	Chi-Square	$X^2=10.928$ ; $df=4$ ; $p=0.024$	MC
Education	Chi-Square	$X^2=42.760$ ; $df=12$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=21.738$ ; $df=4$ ; $p=0.000$	MC
Occupation	Chi-Square	$X^2=114.166$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=144.682$ ; $df=16$ ; $p=0.000$	MC

Table 6.4.7: Litter in waterways



#### 6.4.8 Algae Growth and Weed Infestation

Algae growth or weed infestation is an organic contributor towards river pollution (Maznah and Mansor, 2002). These are due to domestic waste, farms, industrial and agro-based industry. Factors of location, gender, education, homeownership, occupation and length of living time are highly linked to the respondents' awareness of algae growth and weed infestation (Table 6.4.8).

Variables	Test	Result Exact Significance = E Monte Carlo = MC
Location	Chi-Square	$X^2=33.490$ ; $df=4$ ; $p=0.003$ MC
Sex	Chi-Square	$X^2=23.657$ ; $df=4$ ; $p=0.000$ MC
Education	Chi-Square	$X^2=88.981$ ; $df=12$ ; $p=0.000$ MC
Homeownership	Chi-Square	$X^2=17.769$ ; $df=4$ ; $p=0.001$ MC
Occupation	Chi-Square	$X^2=152.637$ ; $df=44$ ; $p=0.000$ MC
Length of living time	Chi-Square	$X^2=76.455$ ; $df=16$ ; $p=0.000$ MC

Table 6.4.8: Algae growth and Weed infestation

#### 6.4.9 Heavy Metal in Waterways

The impact of urban activities has altered the biochemical and geochemical cycles and balance of some heavy metals, such as Pb (plumbum), Fe (ferum) and Al (aluminum) (Saphira, et. al., 2004). An awareness of heavy metal in waterways is significantly high based on the respondents' location, age, education, homeownership, occupation and length of living time (Table 6.4.9).

Variables	Test	Result Exact Significance = E Monte Carlo = MC
Location	Chi-Square	$X^2=36.354$ ; $df=4$ ; $p=0.000$ MC
Age	Chi-Square	$X^2=41.259$ ; $df=16$ ; $p=0.001$ MC
Education	Chi-Square	$X^2=57.550$ ; $df=12$ ; $p=0.000$ MC
Homeownership	Chi-Square	$X^2=20.065$ ; $df=4$ ; $p=0.000$ MC
Occupation	Chi-Square	$X^2=124.600$ ; $df=44$ ; $p=0.000$ MC
Length of living time	Chi-Square	$X^2=105.285$ ; $df=16$ ; $p=0.000$ MC

Table 6.4.9: Heavy metal in waterways

#### 6.4.10 River Bank Erosion

An awareness among respondents on river bank erosion issues is significantly high based on the location, age, sex, education, homeownership, occupation and length of living time (Table 6.4.10). This might be the result of the previous 'Love our rivers' campaign.



Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	X <sup>2</sup> =15.294; df=4; p=0.003	MC
Age	Chi-Square	X <sup>2</sup> =41.738; df=16; p=0.001	MC
Sex	Chi-Square	X <sup>2</sup> =17.199; df=4; p=0.001	MC
Education	Chi-Square	X <sup>2</sup> =43.783; df=12; p=0.000	MC
Homeownership	Chi-Square	X <sup>2</sup> =10.614; df=4; p=0.028	MC
Occupation	Chi-Square	X <sup>2</sup> =107.978; df=44; p=0.000	MC
Length of living	Chi-Square	X <sup>2</sup> =75.978; df=16; p=0.000	MC

Table 6.4.10: River bank erosion

## 6.5 Public Acceptance or Willingness to Participate in Water Related Environmental Activities

At present, public participation in water-based activities is not fully organized by respective agencies. This is believed to be caused by the lack of experience in organizing such activities in Malaysia (Mohkeri, 2004). In this survey, eight issues on water-related environmental activities are listed. They are as follow:

1. Recycling household waste – Sorting waste according to materials, such as glass, and paper for recycling purposes.
2. Using bio-degradable detergent/washing products - Bio-degradable materials are capable of being destroyed by the action of living organisms, heat, light, radiation, oxidation or a combination of these factors
3. Animal droppings (collect and dispose of animal drops in a bin) – Animals dropping from pets contain bacteria and nutrients. To prevent the waste from being washed into the drain the best way is by collecting the waste and disposing of it in a dustbin.
4. Organic matter or leaves (using an organic bin – composting) – Organic matter and leaves can block drains, which can cause flooding, whilst rotting organic matter pollutes waterways with excess nutrients.
5. Reducing water use activities – Irregular water-based activities, such as car washing and irrigating garden plants.
6. Fertilizers and pesticides – Avoid using fertilizers and pesticides in areas where they could be readily washed away into drains.
7. Water recycling – Recycle used water from the kitchen for gardening and others.
8. Rainwater tank – Storing and using rainwater. Using rainwater stored in a container for washing, gardening and others.



### 6.5.1 Recycling Household Waste

Recycling household waste among the respondents shows a high significance based on the respondents' location, age, gender, education background, homeownership, occupation and length of living time (Table 6.5.1). In Malaysia, recycling campaigns have been conducted by providing the '3R (Recycle, Reduce, Reuse) bin' concept

Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=52.765$ ; $df=4$ ; $p=0.000$	MC
Age	Chi-Square	$X^2=43.045$ ; $df=16$ ; $p=0.000$	MC
Sex	Chi-Square	$X^2=14.939$ ; $df=4$ ; $p=0.004$	MC
Education	Chi-Square	$X^2=62.800$ ; $df=12$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=25.773$ ; $df=4$ ; $p=0.000$	MC
Occupation	Chi-Square	$X^2=115.775$ ; $df=44$ ; $p=0.000$	MC
Length of living	Chi-Square	$X^2=65.089$ ; $df=16$ ; $p=0.000$	MC

Table 6.5.1: Recycling household waste

Recycling household waste is an important activity to be developed as there is an increase in waste generation from 5.6 million tons in 1997 to 8.0 million tons in 2000 (Gatke, 2003). Gatke (2003) reports low recycling activities despite relatively high rates of awareness of recycling (82%), but only very few actually practise it.

### 6.5.2 Using Bio-Degradable Detergents

Table 6.5.2 below presents the results of the Chi-square test on respondents' responses on the use of bio-degradable detergents. A high significance shows that factors which influence the results are location, age, sex, education, occupation and length of living time. Location and length of living time could well influence respondents' decision because there is limited availability of bio-degradable based products in certain places in Malaysia. Age and gender appear to be almost related because washing products are usually provided by an older person in the household. Education and occupation seem related to the respondents' knowledge and information that they receive about bio-degradable-based products.



Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=16.536$ ; df=4; p=0.002	MC
Age	Chi-Square	$X^2=37.583$ ; df=16; p=0.002	MC
Sex	Chi-Square	$X^2=16.115$ ; df=4; p=0.003	MC
Education	Chi-Square	$X^2=56.535$ ; df=12; p=0.000	MC
Occupation	Chi-Square	$X^2=82.968$ ; df=44; p=0.001	MC
Length of living time	Chi-Square	$X^2=42.218$ ; df=16; p=0.000	MC

Table 6.5.2: Chi-square test on respondents' responses on the use of bio-degradable detergents or washing products

### 6.5.3 Managing Animal Droppings

The results of the Chi-square test show that there is a high significance of respondents' feedbacks based on location, education, occupation and length of living time (Table 6.5.3). However, there is also a small significance on the age factor based on responses to managing animal droppings.

Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=32.739$ ; df=4; p=0.000	MC
Age	Chi-Square	$X^2=26.858$ ; df=16; p=0.043	MC
Education	Chi-Square	$X^2=35.604$ ; df=12; p=0.000	MC
Occupation	Chi-Square	$X^2=87.513$ ; df=44; p=0.000	MC
Length of living	Chi-Square	$X^2=64.325$ ; df=16; p=0.000	MC

Table 6.5.3: Chi-square test on respondents' responses to managing animal droppings

### 6.5.4 Using Organic Bins for Organic Matters or Leaves

The responses on using organic bins for organic matters or leaves show a high significance based on location, age, gender, education, homeownership, occupation and length of living time (Table 6.5.4). Guidelines on managing organic matter were given in the MSMA, but there is still no source of information provided to the public on managing their bins.

Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=52.765$ ; df=4; p=0.000	MC
Age	Chi-Square	$X^2=43.045$ ; df=16; p=0.000	MC
Sex	Chi-Square	$X^2=14.939$ ; df=4; p=0.004	MC
Education	Chi-Square	$X^2=62.800$ ; df=12; p=0.000	MC
Homeownership	Chi-Square	$X^2=25.773$ ; df=4; p=0.000	MC
Occupation	Chi-Square	$X^2=115.775$ ; df=44; p=0.000	MC
Length of living time	Chi-Square	$X^2=65.089$ ; df=16; p=0.000	MC

Table 6.5.4: Chi-square test on respondents' responses on managing organic matter



### 6.5.5 Reducing Water-Based Activities

Age, gender, education, occupation and length of living time are significant factors in respondents' feedback based on the issue of reducing water activities (Table 6.5.5). The individual time spent at home, daily activities and the knowledge or information gained regarding water issues vary based on the factors as presented in Table 6.5.5.

Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Age	Chi-Square	$X^2=80.707$ ; $df=16$ ; $p=0.000$	MC
Sex	Chi-Square	$X^2=17.262$ ; $df=4$ ; $p=0.001$	MC
Education	Chi-Square	$X^2=22.858$ ; $df=12$ ; $p=0.026$	MC
Occupation	Chi-Square	$X^2=112.193$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=76.876$ ; $df=16$ ; $p=0.000$	MC

Table 6.5.5: Chi-square test on respondents' responses on reducing water use activities

### 6.5.6 Fertilizers and Pesticides

Gardening involves the use of fertilizers and pesticides. Based on the significance test, responses received are high based on the respondents' location, age, sex, education, occupation and length of living time (Table 6.5.6).

Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=28.340$ ; $df=4$ ; $p=0.000$	MC
Age	Chi-Square	$X^2=38.733$ ; $df=16$ ; $p=0.001$	MC
Sex	Chi-Square	$X^2=10.413$ ; $df=4$ ; $p=0.034$	MC
Education	Chi-Square	$X^2=69.210$ ; $df=12$ ; $p=0.000$	MC
Occupation	Chi-Square	$X^2=138.712$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=60.032$ ; $df=16$ ; $p=0.000$	MC

Table 6.5.6: Chi-square test on respondents' responses on reducing the use of fertilizers and pesticides

### 6.5.7 Water Recycling

The result shows high significance in the respondents' responses based on their age, sex, education, and length of living time (Table 6.5.7). The information and knowledge issues are believed to have influenced these factors.



Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Age	Chi-Square	$X^2=27.981$ ; $df=16$ ; $p=0.029$	MC
Sex	Chi-Square	$X^2=25.376$ ; $df=4$ ; $p=0.000$	MC
Education	Chi-Square	$X^2=62.800$ ; $df=12$ ; $p=0.000$	MC
Occupation	Chi-Square	$X^2=120.739$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=58.221$ ; $df=16$ ; $p=0.000$	MC

Table 6.5.7: Chi-square test on respondents' responses on water recycling

### 6.5.8 Rain Harvesting

Responses on rainwater harvesting are highly significant based on their location, age, gender, education, homeownership, occupation and length of living time (Table 6.5.8).

Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=45.813$ ; $df=4$ ; $p=0.000$	MC
Age	Chi-Square	$X^2=47.025$ ; $df=16$ ; $p=0.000$	MC
Sex	Chi-Square	$X^2=29.100$ ; $df=4$ ; $p=0.000$	MC
Education	Chi-Square	$X^2=81.308$ ; $df=12$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=19.075$ ; $df=4$ ; $p=0.000$	MC
Occupation	Chi-Square	$X^2=118.905$ ; $df=44$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=101.318$ ; $df=16$ ; $p=0.000$	MC

Table 6.5.8: Chi-square test on respondents' responses on rain harvesting

### 6.6 Drainage Improvement

Responding to the needs of drainage improvement, the test shows that there is a high significance based on the respondents' location, gender, education, homeownership, occupation and length of living time (Table 6.6.1).

Variables	Test	Result	
		Exact Significance = E	Monte Carlo = MC
Location	Chi-Square	$X^2=26.482$ ; $df=1$ ; $p=0.000$	
Sex	Chi-Square	$X^2=4.296$ ; $df=1$ ; $p=0.038$	
Education	Chi-Square	$X^2=21.946$ ; $df=3$ ; $p=0.000$	MC
Homeownership	Chi-Square	$X^2=7.084$ ; $df=1$ ; $p=0.008$	
Occupation	Chi-Square	$X^2=49.513$ ; $df=11$ ; $p=0.000$	MC
Length of living time	Chi-Square	$X^2=18.454$ ; $df=4$ ; $p=0.001$	MC

Table 6.6.1: Chi-square test on respondents' responses on drainage improvement



## 6.7 Respondents' Responses to Drainage Issues

In order to obtain respondents' feedbacks on their current housing areas and drainage systems, focus group interviews were conducted. There were forty people from JB and Putrajaya who participated in four different focus group sessions.

Feedbacks received from the focus group on their current drainage systems and housing areas vary, and seem to be influenced mostly by their experiences. Though the survey result shows that 44% of the respondents agreed that the drainage systems in the housing areas are in manageable conditions and do not need any improvement, 66% of the respondents agreed that their current drainage systems need improvement.

## 6.8 Respondent's Feedbacks On their Current Housing Areas and Drainage Systems

Respondents were asked to give their feedbacks on the current drainage system in their housing areas. Responses received from Putrajaya showed a level of satisfaction with the drainage systems. However, respondents from JB did express their problems and comments on their current drainage systems.

Based on the focus group session, most of the residents in JB believed that their current drainage systems need to be improved in terms of maintenance and design. Not many are aware of the drainage systems, and some have put all the responsibility on the local authority. The responses received from the JB resident show that they are very disappointed compared to the responses from the Putrajaya residents.

*"...The drainage system is very poor. That the drainage has been blocked for a few years and the water is stagnant. Some of the residents have canalised the drainage for their house renovation. Even worse is when some piled up the drainage and this then make the drainage condition worse. The problem have caused the rear of my house to be flooded by the overflow coming from the drainage system. It really put me in a very bad situation, as the sullage water will flow into my kitchen. I always thought that my housing area is a very bad example of an urban housing planning. Action should be taken as the drainage problems are getting worse from day to day..."*

(ZH, Johor Bahru)



*"...I am aware of the failure in the drainage construction behind my house. The level for the drainage is a bit weird, where the runoff cannot flow smoothly and thus create a puddle. This resulted in very bad smell and a horrible scene. It has been more than twenty years, but there is no initiative to improve the drain. Debris thrown by the neighbours always creates a blockage..."*

(IT, Johor Bahru)

*"...The perimeter drains for every unit are very shallow. The drains in front of the house are bigger and deep, but the sad thing is that it has no road reserve. It is very dangerous because vehicles may accidentally slip into the drain..."*

(ZA, Johor Bahru)

Responses received from the Putrajaya focus group are more positive and satisfying. Most have voiced their satisfaction with the support for the drainage systems to be implemented in other places too. The drainage system is designed to blend in with the surroundings and it is safe.

*"...I am satisfied with the drainage system in here. We do not face any major drainage problems since we moved here..."*

(KA, Putrajaya)

*"...I do not have any problems related to the drainage systems. Within the housing area itself, drainage systems are all invisible..."*

(CTC, Putrajaya)

*"...I like the covered drainage approaches here because I can still remember during my childhood, I used to accidentally fall into the drain when playing with my friends. I am glad now that my kids are brought up in a very safe place. There is not much to comment about the drainage system. As far as I am concerned, I have not yet faced any problems regarding the drainage system..."*

(NH, Putrajaya)

## **6.9 Respondents' Daily Water Usage and Their Willingness to Participate in Water-Saving Exercises**

Responses on water usage appear to be similar in the two areas. The same goes for the willingness to participate or to be involved in any water-saving exercises. The scenario seems to be influenced by the information that is received by the public in response to their drainage systems. Furthermore, the education system does not supply sufficient information on environmental issues, especially on water.



The respondents mostly used water for hygienic or other purposes, and only a small amount of water is used for cooking and drinking. Activities such as washing cars, watering plants or washing for hygienic purposes are among the those conducted by the residents.

*“ ...Most of my water usage is for planting and housing chores. To be specific, I use water mainly for planting and cleaning the house... the best ration that I can give is  $\frac{3}{4}$  is for cleaning and planting purposes whilst the other  $\frac{1}{4}$  is for food and drinking...”*

(ZH, JB)

*“ ...I use water for bathing and other cleaning purposes, and I wash my car twice a week... I think my water usage are 20% for cooking and 80% is for other usage...”*

(HI, JB)

*“ Water is very important in my daily life. I need water for cooking and drinking. I also need water for other cleaning purposes such as washing my car twice a week, cleaning the fish tank every fortnight, and I also use water for watering my plant which I do twice a day, morning and evening.”*

(AA, Putrajaya)

None of the respondents showed interest in water-saving exercises. Most of them argued that the ‘water-saving’ equipment is too expensive compared to the ordinary equipment even though the functions are similar. On top of that, they also claim that the water supply rates are still low and affordable compared to other expenses, such as household and food.

*“ ...I do not think that I can afford to provide my house with equipment like front-loading washing machine which are expensive compared to the upper-loading washing machine. Although it saves lots of water, water supply rates are cheap. I think collecting rainwater does not seem really practical ...”*

(RS, JB)

*“ ...I am not interested in buying that type of equipment as the one that we have in the house is still in good condition. Furthermore, in the future, if I have to replace my equipment, I am not sure that I really know what this energy saver equipment is all about...”*

(HI, JB)



## **6.10 Satisfaction with Current Drainage System**

It is important to distribute information on the drainage system to the public as a form of basic knowledge for them to understand about their living environment. Kaplan and Kaplan (1982) believe that knowledge and understanding could give a tentative conception of the living surrounding which will lead to public awareness and satisfaction.

In the survey, respondents from the two areas were asked to share their experiences of and satisfaction with the drainage systems in their living areas. Comments given during the focus group session appear to be influenced by their location and drainage systems as well as their previous experiences.

During the focus group sessions, the respondents from JB and Putrajaya were asked about the following:

- a. Length of living time in the residential areas and the most significant place in the area that they like most.
  - This question allowed them to share their familiarity of the place. As discussed earlier in Chapter 1 in section 1.0.1.3, human perceptions may differ from their daily experiences. Therefore, the length of living time really does influence their opinions regarding their living surroundings.
- b. Descriptions of their current drainage systems in their housing areas.
  - They were asked to comment, give opinion, and share experience and ideas in describing the condition of their current drainage systems.

### **6.10.1 Satisfaction with the Current Drainage System amongst Johor Bahru (JB) Residents**

Responses received from respondents vary from one to the other. Living in the areas for a long period have made them feel attached to the surroundings, as mentioned by Kaplan and Kaplan (1989). Therefore, some may respond that they feel satisfied and comforted because they are used to the conditions (Table 6.10.1).

Positive feedbacks received during the focus group session focuses more on describing their personal feelings for the place, which most of them are attached to and which makes them feel comfortable. However, the negative feedbacks about their feelings towards their living areas cover various issues. Concerning the impact of urbanization and public attitude, many felt uncomfortable and dissatisfied with the current situation in their living areas. Furthermore,



comments given seem to more geared towards describing the living surroundings as a whole. Nobody mentioned the drainage system directly. The next few questions had to be added to allow them to share some experiences of drainage systems in their areas.

<b><i>How long have you been living here? And what are the best parts of the residential area that you like most?</i></b>
<b>Positive feedback</b>
<p><i>"...I have no comment on the overall surrounding of this housing area. As for me it is comforting, and nothing should be changed..."</i></p> <p style="text-align: right;"><i>(RS, Female, 31 years old)</i></p> <p><i>"...This area is well-planned and all the residents are provided with good facilities. The park from my house is within walking distance. It is really a pleasure to have a park for the children to play as our lawn is not wide enough for them to play on..."</i></p> <p style="text-align: right;"><i>(VR, Male, 35 years old)</i></p> <p><i>"...It has been twenty-one years. The housing area is clustered into a small area, which makes it look much, organised and not too crowded..."</i></p> <p style="text-align: right;"><i>(IT, Female, 26 years old)</i></p> <p><i>"...I also feel really satisfied here and nothing should be changed. I have not encountered any problems since the first day I stayed here..."</i></p> <p style="text-align: right;"><i>(HI, Male, 54 years old)</i></p>
<b>Negative feedback</b>
<p><i>"...I really like living here as the area is very peaceful and the neighbourhood is very friendly. However, for the past few years, things have changed slowly as there have been new development nearby. The housing area is now stuck in the middle of an urban housing development. It is quite an upsetting change, and it will not be comforting after the next few years..."</i></p> <p style="text-align: right;"><i>(SH, Female, 56 years old)</i></p> <p><i>"...I don't feel really comfortable staying here but I have no choice. Before this, the location of the housing area is at the edge of the town, but, after twenty years, when the nearest area was developed, the housing area seems to be stuck in the middle. I feel really uncomfortable with the living surrounding, and it is not suitable for those at my age..."</i></p> <p style="text-align: right;"><i>(ZH, Female, 58 years old)</i></p> <p><i>"...Before this, it is just an ordinary housing area situated in a modest urban area. However, now this area is situated in the middle of a town, and there is still development within the area. We have to face the impact regarding all these developments..."</i></p> <p style="text-align: right;"><i>(ZA, Female, 32 years old)</i></p> <p><i>"...The only thing that I am still concerned about is the monsoon drain that flows in the middle of the housing area, which during the wet season is full and dangerous..."</i></p> <p style="text-align: right;"><i>(SS, Female, 32 years old)</i></p> <p><i>"...There is not much to tell about my housing area. This is because it is situated in the middle of a town and is not well maintained. The neighbourhood is not very aware about the drainage system, where some have done house renovations until the system is blocked and does not function at all. It is really upsetting because the conditions have caused problems like bad smell, blockage, stagnant water and overflow of sullage..."</i></p> <p style="text-align: right;"><i>(AA, Female, 21 years old)</i></p>

Table 6.10.1: Positive and negative responses regarding living surroundings.



Most of the feedback received do not show respondent awareness of the existence of drainage systems. Only very few feedbacks were received regarding the drainage systems. This might be due to the fact that the respondents have been tolerant of their drainage conditions as they have lived there for quite some time. The conventional drainage systems in the housing areas were found to be sufficiently maintained (Table 6.10.2). The residents were not exposed to or supplied with appropriate information to allow them to understand their roles in ensuring that their drainage systems are in good conditions. The responses also show that the female respondents are more aware of the condition of the drainage systems compared to the male respondents.

<b>Could you please describe a little bit about the drainage system in your housing area?</b>
<p><i>"...The drainage system is very poor. It has been a few years that the drainage has been blocked, and the water is stagnant. Some of the residents have canalised the drainage for their house renovation. Even worse when some have piled up the drainage and it makes the drainage turn worse. The problem have caused the rear of my house to be flooded by the overflow from the drainage system. It really gives me a very bad situation, as the sullage water will flow into my kitchen. I always thought that my housing area is a very bad example of an urban housing planning. Action should be taken as the drainage problems have getting worse from day to day..."</i></p> <p style="text-align: right;">(ZH, Female, 58 years old)</p>
<p><i>"...As I said earlier, the condition of the drainage system in my housing area is very poor. It has been so many years since the last time I opened my back door. This is because the smell is very bad and the rear of our house has become so damp and water is blocked by the debris. This condition is not very healthy. Nothing much can be done by the local authority as it involves a permanent structure from the house extension/renovation. I do hope that the responsible organisation can take the issues into their consideration as it is getting worse from time to time..."</i></p> <p style="text-align: right;">(AA, Female, 21 years old)</p>
<p><i>"...I also have the same opinion. I know nothing about drainage system. Issues on drainage systems are not issues that used to be discussed in our community meeting. However, we always highlighted about the cleanliness of our living are, where I think drainage is one of the issues that can be discussed in future. Not many people are aware of the drainage system as it is not part of their residential responsibilities. Many depend on workers from the local authority..."</i></p> <p style="text-align: right;">(PTK, Male, 58 years old)</p>

Table 6.10.2: Responses regarding drainage systems

### **6.10.2 Satisfaction on the Current Drainage Systems amongst Putrajaya Residents**

The focus groups respondents from Putrajaya experience a sustainable approach to drainage systems (Table 6.10.3). However, most of them have also experienced conventional drainage system before they moved to Putrajaya over the past six years. This then allows them to compare the current situation with their previous experiences. Therefore, the feedbacks really influenced their perception of the current condition of drainage systems. On the other hand, it also triggers their awareness of drainage issues.



<i>How long have you lived here? And what are the best parts of the residential area that you like most?</i>
<i>Positive feedbacks</i>
<p><i>"...Buying a house here is a big opportunity to me. I do not give any second thought after we were given this opportunity. It was almost ten years ago, when they launched their first housing scheme, and I have stayed here nearly eight years. I like the green environment here. The planning is really different compared to other places. They have everything here; from a nature park to a big shopping complex. I enjoy going to the Heritage Park..."</i></p> <p style="text-align: right;"><i>(NH, Female, 30 years old)</i></p>
<p><i>"...I am proud to be part of the community here. It has a very nice environment and is very different to the place that I once lived before..."</i></p> <p style="text-align: right;"><i>(KH, Female, 22 years old)</i></p>

Table 6.10.3: Positive and negative responses regarding living surroundings.

## 6.11 Analysis from Drainage Components Images

The image-projective method has been applied during the focus group session. The respondents were shown images of a sustainable pond and ecological swale, and a wetland. The respondents were asked to give their comments of the components shown in the images. They were also given three images of different drainage models, which are the natural drain, conventional drain and Putrajaya main drain. They were then required to give their opinions and comments on the models.

### 6.11.1 Public Responses to the Three Sustainable Drainage Components

It is interesting to note that experience can influence people's awareness or concern, and gender also contributes to different ideas towards the opinion of those components (Jorgensen, 2005). In this study, the respondents from Johor Bahru are more sceptical about the sustainable components, compared to the respondents from Putrajaya. This occurred as both areas experience different drainage systems; with Putrajaya using a sustainable approach drainage system. This gave the residents the opportunity to compare this approach with their previous experiences with conventional drainage systems.

As discussed earlier in the results on gender relations with awareness of drainage issue, female respondents comment more and were more aware of drainage system compared to male respondents. Female respondents tend to comment not only in terms of comfort, but also on safety issues.



### 6.11.1.1 Wetland



Figure 6.11.1: Images of wetland components (Source: SUDS CIRIA)

Responses received focused more on the safety factors, as the images show (Figure 6.11.1) that there are no fences or elements that can protect children from having access to the wetland area as the distance from the buildings is also limited. However, respondents from Putrajaya also shared some of their experiences as Putrajaya also has this component. The responses are positive and encouraging since it had been introduced as part of sustainable drainage components in Malaysia.

*“...Putrajaya is well known for its wetland park. As part of the community here, I feel that the wetland is a good approach to a good living environment, especially since it functions as a recreational park. However, there is a need for supervision and maintenance of the park itself. Currently, the park does not look very well-maintained. Many hardscape elements have been ruined due to lack of maintenance and vandalism...”*

(NH, Putrajaya)

*“...I would like to add a few more comments regarding the wetland in Putrajaya. I realized that there is a small pocket of mini wetland within the residential area. If we looked on the safety aspects, it is safe, because the local authority has taken the responsibility to build fencing around the whole area. Therefore, there is no access for the public, especially young children, into the wetland area...”*

(HLA, Putrajaya)

Responses received from Johor Bahru respondents are more negative as they tried to relate their experiences of the components. This resulted in discouraging factors in that the component does not seem to be suitable for a residential area. Most of the feedbacks are caused by public attitude.

*“...Seriously I do not think that I like the component. It is too open and very dangerous. I think the plants should be mown regularly. It looks like an abandoned space...”*

(SS, Johor Bahru)



*“...this is not a good component to be implemented in a housing area. People may use this area to dump their waste. Based on my experience, people in my neighbourhood have dumped all their waste in a pond next to this housing area. The area is really disgusting and the smell is very bad. It is hard to get public participation in taking care of the surrounding. The best way that used to be applied here is to appoint a maintenance company to do all the cleaning, and the local council pay them...”*

(AA, Johor Bahru)

*“...I do not think that it is suitable to be applied within a housing area. It may be done far from a residential area like the Wetland Park that they did in Putrajaya, because it encouraged wildlife, and I am afraid that poisonous species like snake will live within the area...”*

(ZA, Johor Bahru)

#### **6.11.1.2 Pond and Swale**



Figure 6.11.2: Images of pond and swale components (Source: SUDS CIRIA)

Responses received on pond and swale components are more encouraging compared to the wetland component (Figure 6.11.2). Most of them offered the opinion that these components are much neater compared to the wetland component. However, some do not agree to having an open water component as they feel that it is dangerous.

*“...I would not encourage having these components in a housing area, as it is dangerous for youngsters. Dumping should be another problem to be considered...”*

(ZH, Johor Bahru)



*"...It looks neater compared to the first image. I think it is dangerous as it has no fences. If these components were to be implemented in a housing area, it would be better if the water could be maintained clean and clear, because it would be nicer and comforting. The most important thing that I would like to emphasize here is that the depth should be shallow and fences should be provided to avoid unexpected accidents. The most important thing that I would like to stress here is that safety is the main factor to be considered if you want to apply any component in a housing scheme..."*

(IT, Johor Bahru)

On the other hand, there are also those who mentioned the importance of considering a shallow pond as it is safer. It is important that the users or residents know their roles and ensure that children are not left without supervision in parks or places that have water elements.

*"...Nowadays, we see new housing developments providing a park with pond like this. However, it is nice to have a component like this, but it should be located far from the children's playground. If this component is shallow, I do not think it would be dangerous because children usually go to the park with their parents, and the older children usually know their boundaries, so there is nothing to be worried about..."*

(PTK, Johor Bahru)

The Putrajaya respondents are more positive in responding to this question. Their experiences of living within this component has allowed them to voice positive opinions and comments.

*"...The swale components are very good as its edges are soft (grass edges) and I don't have to worry that kids may fall into the open drainage systems. Sometimes, kids with bicycles may accidentally fall into the drainage system. But with the swale component, it is very shallow, even we can walk across them during dry seasons..."*

(FO, Putrajaya)

*"...it is good to have a pond and swale component within the landscape. It creates a more natural environment. However, any danger can be avoided if we took our responsibility to look after the kids and surrounding..."*

(NH, Putrajaya)

### **6.11.2 Public Responses to the Three Drainage Models**

Images of the three drainage models were shown to the respondents. Various opinions and comments were highlighted. Most of the respondents seem to prefer to have closed drainage systems.



### 6.11.2.1 Model 1 – Natural Drain



Figure 6.11.3: Image of natural drain (Source: Researcher file)

The image of this natural swale was taken in the Johor Bahru area, where the swale flows in between housing schemes and a traditional village (Figure 6.11.3). The respondents do not seem to like having this drainage system within a housing area. It is not believed to be suitable as it cannot cope with the amount of water flowing from nearby housing schemes. There is also a suggestion to deepen and widen the swale.

*“...It would be better if this natural swale edges had been cleared to avoid people from falling into the swale because the shrubs have covered the edges and it is dangerous. This swale also does not seem able to cater to the amount of water runoff. Thus it would be better if it could be deepened. If this is allowed it may cause flooding to the nearby residential areas...”*

(SH, Johor Bahru)

*“...If this natural swale would like to be retained in an urban area it would be nice because it would enhance the natural scene of this area. However, the respected authority should control the development within a certain distance from the swale edges...”*

(ZA, Johor Bahru)

*“...I also think that the natural swale is no longer suited to remain due to its natural flow. In an urban area, the drainage runoff is high and there is a need for a drainage system, which could flow water as fast as possible to avoid problems like flash flood. Furthermore, the concrete channel is much easier to be maintained...”*

(VR, Johor Bahru)

The Putrajaya respondents highlighted the same issues as the Johor Bahru respondents, with emphasis on safety factors.

*“...The images shows that the drainage models cannot afford to cater to the sufficient amount of water during wet season. It seems very dangerous as it is*



*too near the residential area. Furthermore, the surrounding did not look well-attended and less seem convenient. It is better if the drainage model could be improved...*

(MM, Putrajaya)

Feedbacks received shows that the public are concerned about the quality of maintenance that need to improve the drainage system showed in the images of Model 1. Issues raised were on safety and aesthetic factors in setting a good urban image. In 'Era Hijau' (Green Era), a quarterly magazine published by the DOE issues on the impact from 'the river were a public owned areas' were raised (Fathahi, 2007). It is difficult to maintain the river from being polluted as the areas do not belong to anybody. Therefore, since the sense of ownership is lesser, it is harder to bring all individuals together to play their parts in maintaining the rivers.

#### 6.11.2.2 Model 2 – Conventional Drain



Figure 6.11.4: Image of conventional drain (Source: Researcher file)

This model is of a conventional drainage system used in housing areas (Figure 6.11.4). Comments received emphasized the maintenance and safety factors. Many preferred this drainage system as it has fences. However, their experiences of living in surroundings which provide this drainage system could have influenced their opinions.

*“...This model seems alright to me because this is a current system that we have within our living area. However, from the picture, the model should be maintained frequently and the damage fences should be replaced for safety reasons...”*

(SH, Johor Bahru)



*“...This model is better than the first model. It is much proper and safer. I do think that this is a suitable drainage system in a housing scheme as implemented currently here...”*

(RS, Johor Bahru)

*“...This is the typical drainage system currently applied in an urban housing scheme. I think it is too rigid and does not blend in with the landscape naturally. Furthermore, it is too wide open, which is very dangerous for children without assistants...”*

(ZA, Johor Bahru)

Responses received from the Putrajaya focus group are very interesting. Their comments and opinions are based on their previous experiences with conventional drainage systems and their current experiences with sustainable drainage systems.

*“...Before I moved to Putrajaya, I lived in a housing scheme that is provided with this similar drainage model. Based on my experience, I think this model is not suitable for a residential area because it is exposed to any eye-catching element (debris), which is bad for living surroundings. The responsible authority should try to improve it by providing a closed drainage system...”*

(CTC, Putrajaya)

*“...The model looked very annoying as it does not seem to be well-maintained very well. It is not suitable anymore to be implemented in a residential area. They should try to implement a closed drainage model. This drainage model seem very rigid and does not blend very well with the surrounding...”*

(KA, Putrajaya)

### 6.11.2.3 Model 3 – Putrajaya Main Drain



Figure 6.11.5: Image of Putrajaya Main Drain (Source: Researcher file)



Respondents voiced different opinions and perceptions of this drainage model (Figure 6.11.5). Positive opinions received related to the design, which blended very well with the housing scheme. However, comments were also received regarding the width, which is believed to be excessive and dangerous.

*"...The drainage edges are too steep and dangerous because there might be a risk to unassisted children who could fall down into the stream. However, it looks more attractive compared to the current drainage model. Although it is a drainage system, it is designed to blend into the housing landscape very well..."*

(IT, Johor Bahru)

*"...The model is different compared to the current system drainage model that is applied in my housing scheme. It is more attractive and blends very well with the surrounding landscape. Furthermore, it does not look very rigid like the current system. However, I still think that the edges are too steep and dangerous..."*

(SH, Johor Bahru)

Some of the Putrajaya respondents shared the same opinion on this model; saying it is too wide and steep. However, they believed it is a good attempt towards a new drainage approach.

*"...It might be shallow if the drainage model are more wider but more space needs to be reserved for drainage purposes. However, I like the attempt of putting stones in the drainage system within the water flows; it look like a rock garden..."*

(HK., Putrajaya)

*"...it is dangerous as it is located quite near to a residential area and the main road too. Cars might accidentally bump into the drainage system. I prefer if the authority can provide a closed drainage instead this big and wide drainage system..."*

(SR, Putrajaya)



## 6.12 Discussion

The sub-topics were outlined based on the survey questions and research objectives. It discussed the idea of having a sustainable drainage system and its impact on the public.

*"...The Malaysian government is taking the wrong approach to solving the country's water woes. It is investing some RM60 billion (\$16 billion) for more dams and pipelines, while nothing is done to preserve the vital catchment areas that are the sources of our water. Twenty-three of the 27 drinking water sources in Selangor are heavily polluted with industrial and animal waste, heavy metal and sewage. The individual consumer is blamed for water wastage - 36 percent of the total in 2000 - although the biggest users are industry, golf courses, hotels and agriculture..."*

(Friends of the Earth International,  
<http://www.foei.org/publications/link/water/12.html>, (24/10/2005))

### 6.12.1 Problems Associated with the Current Drainage Systems

Based on the survey results, the highest potential current drainage problems are mosquitoes, littering and bad smells. In general, the climatic factors had the greatest influence on the issues of mosquitoes. However, the public is responsible for preventing mosquitoes from breeding. Unattended puddles may become the potential place for breeding mosquitoes.

Littering is not only bad for the surrounding environment but it is also one of the factors which causes drain blockage. Blockage not only produces bad smells due to the debris and domestic waste but it also causes inconvenience for living activities, such as recreation, sports and leisure.

Blockages of drainages are mostly caused by littering or poor maintenance. It can also result in stagnant water and spilt drainage run-off. These are the problems that have been identified as medium-ranking problems.

Flash floods are currently considered as a major threat in the city. Urban development processes have led to the issue of insufficient drainage capacity. These problems have caused run-off to be spilt which ends up as flash floods especially during peak rainy seasons.

It is interesting to note that urban development is something that is hard to resist. Selman (2004) explain that human modification or development in landscape is a universal phenomenon. Therefore, it is important that development activities and urban environment must be controlled by proper regulations. With regards to water and drainage issues in Malaysia, an "Integrated



Water Resources Management" (IWRM) has been formed to plan the water management and water resources based on the "Best Available Techniques" (BAT) and "Best Environment Practices" (BEP) (Loh et. al., 1999). Other than that, the government and DID have also enforced MSMA as guidelines for new sustainable drainage systems. Despite good attempts made in the regulation and management, there is a need for community or public contributions and cooperation to ensure it can support all the objectives.

Public participation and their involvement in supporting MSMA are very important. Involving the public means support from various stakeholders, which may include professional bodies and organizations who share the same interests. According to Selman (2004), there is benefit for having various stakeholders together with the public participating in environmental activities, especially those related to water and drainage issues. .

*"...The benefits of participatory management in land care are now well publicized – sharing responsibility, negotiating benefits, incorporating a wide corpus of lay and professional knowledge, enhancing capacity for implementation, increasing trust between stakeholders, reducing the deadweight of enforcement, improving understanding and awareness, facilitating policy integration and increasing public commitment..."*

(Selman, 2004; 366)

In Malaysia, attempts have been made to encourage participation from various parties. Realizing the importance of water - the resources of which 90% originates from densely covered forest areas, and the threat from development and environmental mismanagement - an integrated river basin management approach has been outlined (Ramadasan et al., 2004). A number of aspects have been taken into consideration as provisions that need to be established to ensure non-destructive human activities would not affect the river basins. These include 'improving database information, information availability and exchange', 'legislation and enforcement' and 'public involvement in resource use, planning and management'.

Issues related to information availability and access are very important. Surveys conducted by Sidek (2004) on 'An assessment of stormwater management practices using MSMA manual in Malaysia' indicate that there is not enough information distributed. The main obstacle to the implementation of MSMA is lack of public participation (Sidek, 2004). There is a need for good information distribution amongst the public and professionals as the results from the survey show 21% of the respondents are still not aware of MSMA. Responses received during the interview session also show lack of understanding of basic drainage systems. However, positive interest has been shown to images of SUDS components, which were expected to be an improvement on the current drainage systems. Respondents from Putrajaya showed satisfactions with the drainage systems provided for them. It would be better if the residents were provided



with knowledge in terms of SUDS drainage system and clean water issues as they will further understand their roles to ensure that the drainage system will be well maintained and in good condition. Nordin (1999), in his study on the attitudes, knowledge and practices of residents in the Juru River basin, shows that 74% of the residents did not know that the Juru River was one of the four most polluted rivers in Malaysia. This scenario is very upsetting as 23.3% of the feedbacks received admitted that they were responsible for throwing their domestic wastes into the rivers. Indeed, 96.6% of them mentioned that it was the most convenient place to throw their waste (Nordin, 1999).

MSMA has been seen as an approach which shows the government being one step forward in involving legislation and enforcement to ensure the quality of water and also to manage more sustainable drainage systems. However, information distributed to the public is not sufficient or accessible. The results of this survey show that public awareness is very poor, and the willingness to participate in activities related to environmental and water issues is not encouraging as shown in section 6.9. It is thus important to provide updated and accessible information as it may help to improve or educate the public on the environment and, most importantly, about drainage systems. Public participation is indeed very important. However, to get public involvement is very difficult especially if it involved personal commitment (Apostolaski et al., 2001). There is a need for a proper education plan which will raise public awareness on water quality issues and problems, and allow messages or information to reach everybody in the proper way.

Public participation in activities or campaigns related to 'control-at-source' management is not encouraging. Mohkeri (2004) explains that Malaysians still lack experience in organizing or conducting such activities. The cleanliness of our drinking water and living surroundings depends on natural ecosystems (Mi Hua, 2001). Although MSMA manual Volume 14 (2000) outline eight daily activities that could be controlled in order to reduce possible pollution sources from affecting the downstream, less than half (43%) of the respondents recycling household wastes. However, 58% are still not practising recycling and claim that they need further information on the activities. The respective organizations and local authorities have indeed provided recycling bin centres but no many can really understand how to manage their bins at home. Mi Hua (2001) highlights that human well-being can be improved by managing the waste and style of living, and China has taken steps to encourage their society to practise recycling.

Improper development and drainage planning layout and strategy may cause accident cases. There are a few alternatives which have been suggested to be practised by the professionals and



public in the MSMA manual to ensure that the attempt to introduce the sustainable drainage system within Malaysian living areas is successful.

In MSMA Volume 14 (2000), it listed eight issues on daily activities that the community can help to control through their daily practices. They are as follows:

1. Bin it securely (Recycling waste management)

The government has made an attempt to introduce a recycling campaign in 1993, but did not receive good receptions from the public. However, this attempt is looked upon as a starting point in introducing recycling in Malaysia after revising the advantages and disadvantages of the earlier campaign, the results of which are not encouraging:

*“Recycling programs are currently (2002) still at an initial stage and based on communal collection with centralized recycling stations. With only 0.25% of the household waste recycled, recycling plays an insignificant role in the waste system. However, resources are meant to be spent in order to achieve a recycling rate in the range of 20% by 2020.”*

(Forti and Hansen, 2003; 107)

The recycling campaign has been integrated into the school education system, as it can be found through the Internet, and WebPages produced by students reporting on the recycling campaigns that they have carried out. As reported in a local newspaper, the recycling campaign was launched to highlight indeed, environmental issues and waste disposal problems (Harian Metro, 8<sup>th</sup> January 2005), the younger generation has more exposure to recycling activities. Therefore, it would be better to provide an educational campaign for the school-leaver group as the survey result shows a very high significance in the relationship with their willingness to participate in recycling activities. The distribution of recycling information and knowledge should be fair in order to allow good responses in the partnership towards recycling community.

It is important to have proper waste management to avoid solid wastes or biological wastes from being dumped into the water systems. Problems of drainage blockage due to debris issues can be sorted out if wastes from the household are managed efficiently. The survey result shows that only 42% of the respondents practise recycling, whilst 58% did not practise it and need more information. It shows that the information on recycling is not well distributed. Therefore, are those practising recycling doing it in the correct way?

It would be better if there was a committee that can conduct and supervise recycling campaigns, methods and techniques to ensure that the recycling objectives are achieved. Lessons on recycling techniques can be adopted from the West. There are very good recycling practices that have been used, such as recycling shopping bags or carriers, using recycling products (for



example, using degradable plastic carriers), and recycling household items (such as conducting carboot sales or selling through online auction). Recycling-based activities can be adapted to suit the needs of the Malaysian public.

## 2. Animal droppings

In 1998, the outbreak of the “Nipah” virus in Malaysia killed one hundred and five people. This virus is associated with pigs and pork that can cause death and illnesses to humans. The outbreaks severely affected both public health and the trade of animal and meat products in these areas. The Sabah state government thus devised the ‘Livestock Farming Rules 2000’ as a mitigation procedure to reduce the environmental issues caused by the livestock farming. However, the important issues and challenges with regard to regulation and guidelines that they have to face are public awareness and implementation of the regulation; the willingness of the farmers to adopt new technology, high capital investment and repair; and maintenance of the treatment plant.

Animal droppings management is very important as it is reported that thirty-three rivers have been polluted by the amonical nitrogen gas from animal farming and domestic wastes (Zakaria et al., 2004). However, this issue does not point only to livestock farming but it should be the responsibility of pet owners too. However, there is no information or material distributed on these issues aimed at individuals with pets. The respective agencies then should start to introduce proper pet waste disposal management.

In Malaysia, a pet’s owner is not restricted to any regulation. Cats and dogs are pets usually owned by pet lovers. However, due to a lack of control regulation, amount of pets owned by some individuals are too many. These pets are not caged because, for the examples some dogs, also act as guard dogs. Therefore, the animals are mostly left to roam free outside of the owners’ compounds. This has caused difficulties on controlling animal droppings.

The survey shows that only 32% practise animal dropping collection. It is an upsetting scenario that 68% do not participate in proper animal dropping management. However, from the study conducted there is no information gained regarding this practice. Most of the information obtained emphasizes livestock farming management. Therefore the respective authorities should also involve the public in this campaign. It seems that without proper information, the public is not aware of the impact of their pets’ wastes on water quality.

## 3. Waste management, painting clean-up, car-wash and changing motor oil

The issues raised are related to the waste management system applied in Malaysia. People use various types of products in their daily life, such as adhesive, perfume, paint, batteries and



others. Without realizing that these products contribute to hazardous wastes in the environment. Many people are not aware that household products can also be categorised as hazardous wastes. This is where sufficient information should be emphasized and distributed to ensure that people will play their role in managing household wastes. According to Gatke (2003), there is no specific definition or classification of household wastes and all wastes (including organic and hazardous household waste, garden waste, and light commercial waste) are collected by compactor-lorries.

Paint from painting activities, detergent from washing materials and oil or grease contain chemical materials. Without proper management, it can result in contamination in water systems. Only Putrajaya has been designed with a proper place with activities based on oil and grease, such as repair workshops, car wash areas and others. In other places, these kinds of material-based activities are still not properly planned or controlled. Other than that, places, such as food courts which generate organic wastes, should be given more attention as there are many stall types in food courts still implemented in Malaysia. A proper and sufficient disposal collection point should then be provided (Figure 6.12.1).



Figure 6.12.1: Waste from food stalls are dumped into the drainage systems (Source: DID webpage)

In general, waste management is becoming important in Malaysia as the generating of waste is growing from time to time. Waste generation increased to 8.0 million tons in 2000 compared to 5.6 million tones in 1997. This means there is an increment of 2.4% in three years (Gatke, 2003; and Hamid et al., 2003) (Figure 6.12.2).





Figure 6.12.2: Cartoonist's impression of five million tons of solid waste once produced in Kuala Lumpur (Source: Malaysia DOE webpage).

#### 4. Fertilizer and pesticides

The use of fertilizers and pesticides is still uncontrolled. Many people are still using chemical-based fertilizers and pesticides, which really need to be assessed in controlling the amount of use, compared to organic-based products. This may occur due to lack of information distributed by the respective authorities regarding the impact of chemical-based products. The survey shows that only 40% are willing to reduce the use of pesticides and fertilizers whilst 60% are still not willing and need further information.

#### 5. Landscaping and construction

Maintenance is needed in landscaping activities. However, good maintenance management is very important. Without good management, proper training and practices, it can worsen the situation. Dr. Wan Nor Azazi of REDAC, USM, shares his experience on the Bio-Ecods implementation in USM during the interview session:

*"...The only thing that I would like to highlight here is that, when we have a BIO-Ecods system, the grass-cutting should be monitored, or a new guideline should be regulated for it. This is based from the experience that we faced here in USM, where the waste from the grass-cutting should be collected and disposed of immediately, but was not being done..."*

(Dr. Wan Nor Azazi, REDAC, USM)



### 6.12.2 Awareness of Drainage-Related Environmental Problems

Awareness of drainage-related environment issues is growing but it needs good collaboration amongst the stakeholders who have the same interests, the capability to provide skills and knowledge (by contributing and sharing), and are willing to invest any needed resources (Borrini-Feyerabend, 1999; and Selman, 2004). This survey shows that the public in Malaysia is less involved with environment-related activities, especially drainage issues. It is important to quote from Selman (2004):

*“...it is often difficult for communities to become involved in very ambitious landscape-scale plans, ‘landscape features’ can be quite specific, making it more practicable for groups to take responsibility for custodianship...”*  
(Selman, 2004; 378)

In Malaysia, there are non-governmental organizations (NGO), which are involved in environmental issues, such as the Malaysian Nature Society (MNS), and the Penang Consumer Association (CAP). However, there is limited involvement between the NGOs themselves on this issue as there are certain barriers that restrain them from being more involved.

Various mediums have been used to distribute information related to the issues. However, the limitation of the services and facilities capabilities have restrained information from being distributed. These sources should be used as a knowledge distribution method and should not only be limited in the form of multimedia technologies but should also be organised in activities that can attract the public to be involved together with other stakeholders. Although efforts, such as the DID approach involving school children can be seen with the activities based on the ‘Love Our Rivers’ campaign, the adult group should also be involved to ensure that knowledge of environmental issues, especially those related to drainage systems, is also given to the community.

Based on findings in Kaplan, et.al. (1998), Nasseaur (1997) and Jorgensen (2004), it is best to conclude that public participation, awareness and opinion are generally influenced by their experience and familiarity with the areas they are involved in or live in. The familiarity of the individual with their living space allows them to identify their sense of comfort. A higher level of comfort will make them feel satisfied with their living environment but a lower level of comfort will make them aware of the factors that cause their discomfort (Figure 6.12.3).



## **EXPERIENCE + FAMILIARITY\* = COMFORTNESS**

**+VE COMFORTNESS = LEAD TO SATISFACTION**

**-VE COMFORTNESS = DISATISFACTION**  
**= INCREASE LEVEL OF AWARENESS**

**\*Note:**

**Familiarity may also influence individual towards surviving factors, where the factors may in turn be caused by demographic factors, such as household income.**

Figure 6.12.3: Relationship that influence public awareness based on their experience and familiarity of their living surroundings.

### **6.13 Conclusion of Public Survey**

Involving the public in the planning and management of drainage issues is difficult as it involves a wide range of expertise and knowledge. There is no specific or ideal solution to integrating public participation as a wider range of commitment and belonging is needed (Selman, 2004). However, being a part of the process could trigger and develop public interest in drainage related issues and they may individually contribute their roles especially starting from managing water use in their own households or premises. Although it seems the first step might look very basic, it will be a greater help in controlling the problems 'at-source' if it does involve the whole community.

The obstacle to sustainable approaches is that the public are not aware that they are part of the contributors as highlighted in the Local Agenda 21. The public should be involved in making decision. However, without proper understanding and knowledge, it is difficult to get them to participate in any development processes. Many attempts have been made by the government to support sustainable development approaches. A good strategy by the government in distributing information and knowledge, would be appreciated by the public. Understanding is the key requirement for the public to accept any actions taken, especially those related to environmental issues.



## Chapter 7

### *Analysis and results of Professional Survey*

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#### 7.0 Survey Analysis from the Professional Respondents

The questionnaire for the professional group involved in the construction industry was distributed during the Rivers'04 Conference in Malaysia. Only thirty-six replies were received from one hundred and twelve participants. The data was then analysed using the SPSS software. The output from the data gathered was used to get the frequencies of all the responses based on the questions in the survey form. Frequency is the only method used as it would help the researcher to discover the objectives of the professionals' knowledge and willingness to apply SUDS.

#### 7.1 Questionnaire Responses

Based on the total of thirty-six professional responses from the professional group, replies from the female respondents were much higher (64%) compared to the male professional respondents (36%) (Chart 7.1.1). The feedback was distributed according to the respondents job title; with six groups of different occupations listed. The professional respondents who answered the survey were developers (36%), engineers (25%), architects (17%), landscape architects and town planners (8%), and surveyors (6%) (Chart 7.1.2).

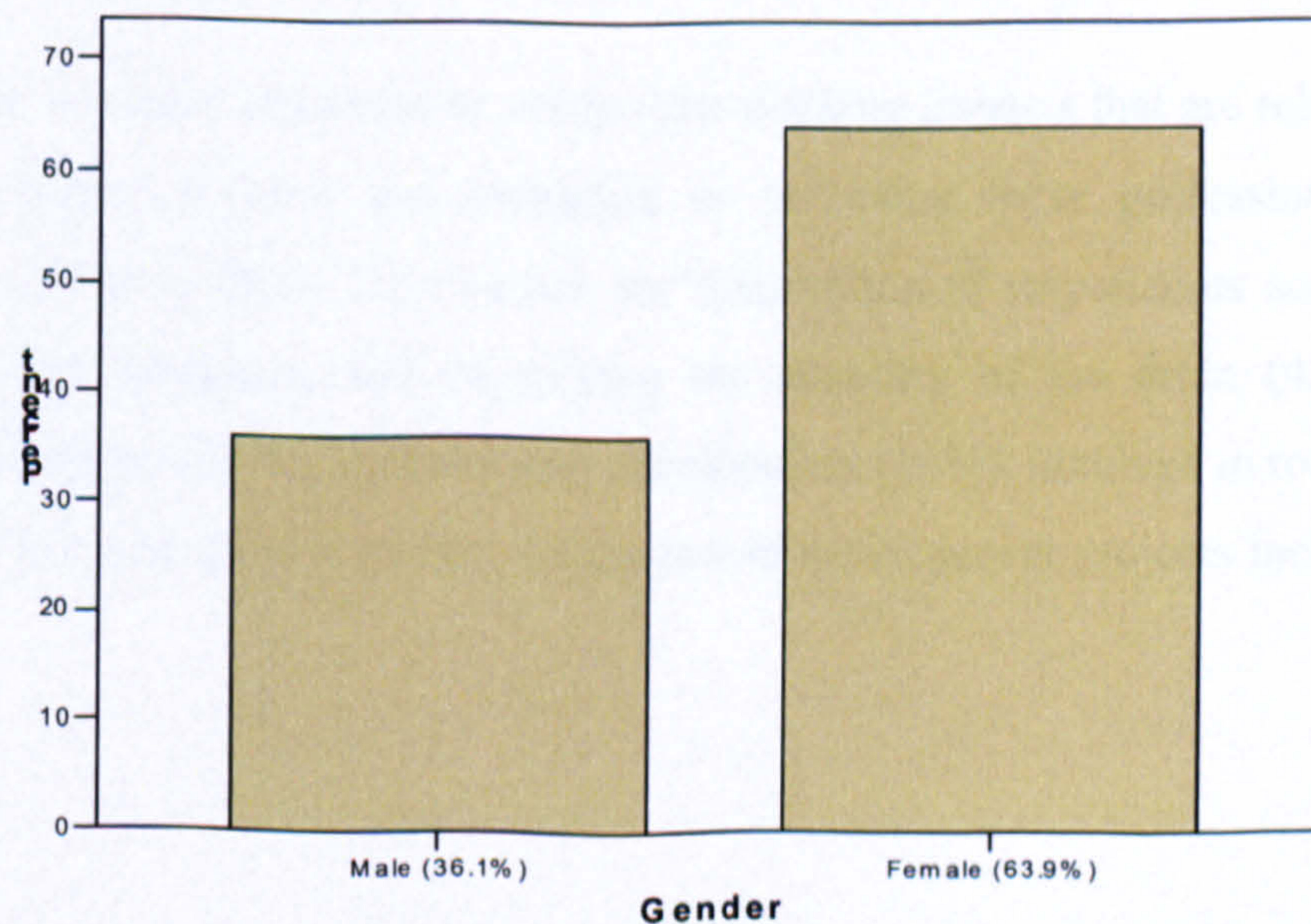


Chart 7.1.1: Professional respondents based on gender distribution



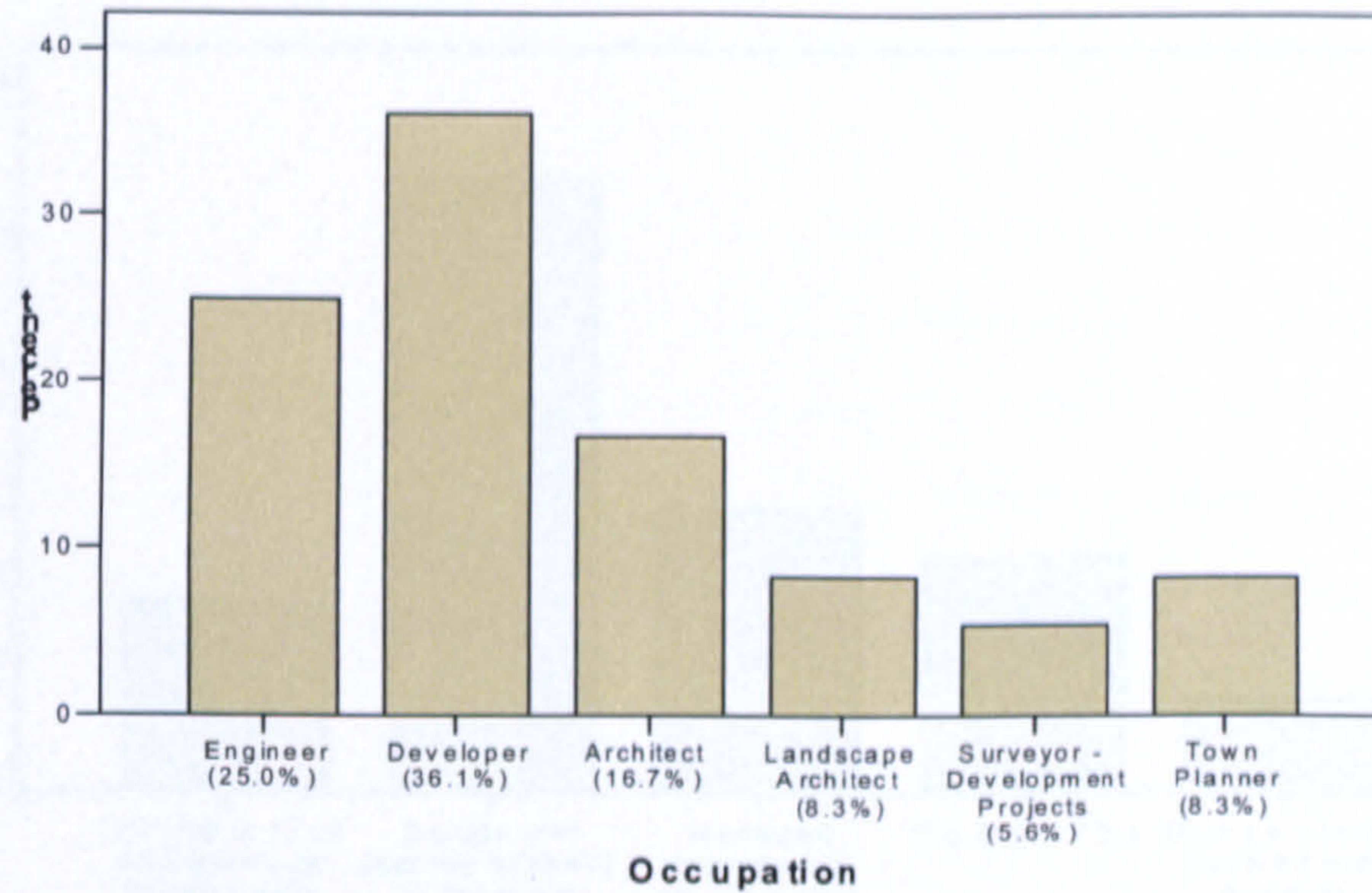


Chart 7.1.2: Professional respondents based on occupation distribution

Chart 7.1.3 shows the distribution of the respondents' working experiences. Most of the respondents had worked between three to five years in the construction industry (33%) while 25% had more than eleven years' experience. Respondents who had experiences between six to ten years are 22% and 19% of the respondents had worked less than two years.

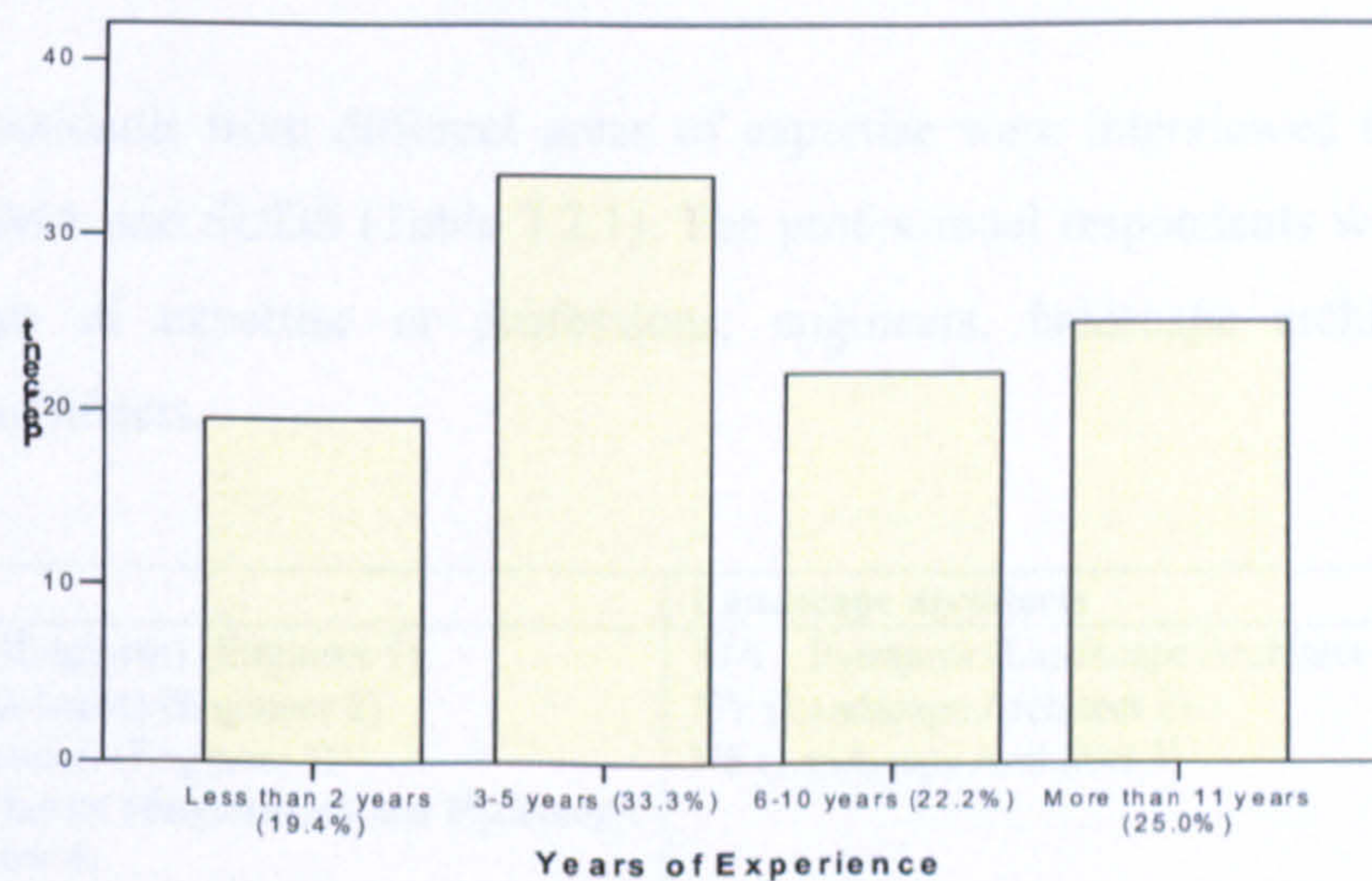


Chart 7.1.3: Professional respondents based on working experience distribution

The respondents were also requested to verify their working impacts that are related to drainage systems. Five scope of work was identified as reflecting these professionals. Based on information presented in Chart 7.1.4 below, the distribution of respondents according to their scope of work are designing and identifying the usability of the drain (43%), managing residential development (20%), research and development (17%), involved in road and drainage construction (13%), and involve in cost evaluation in development projects including drainage systems (7%).



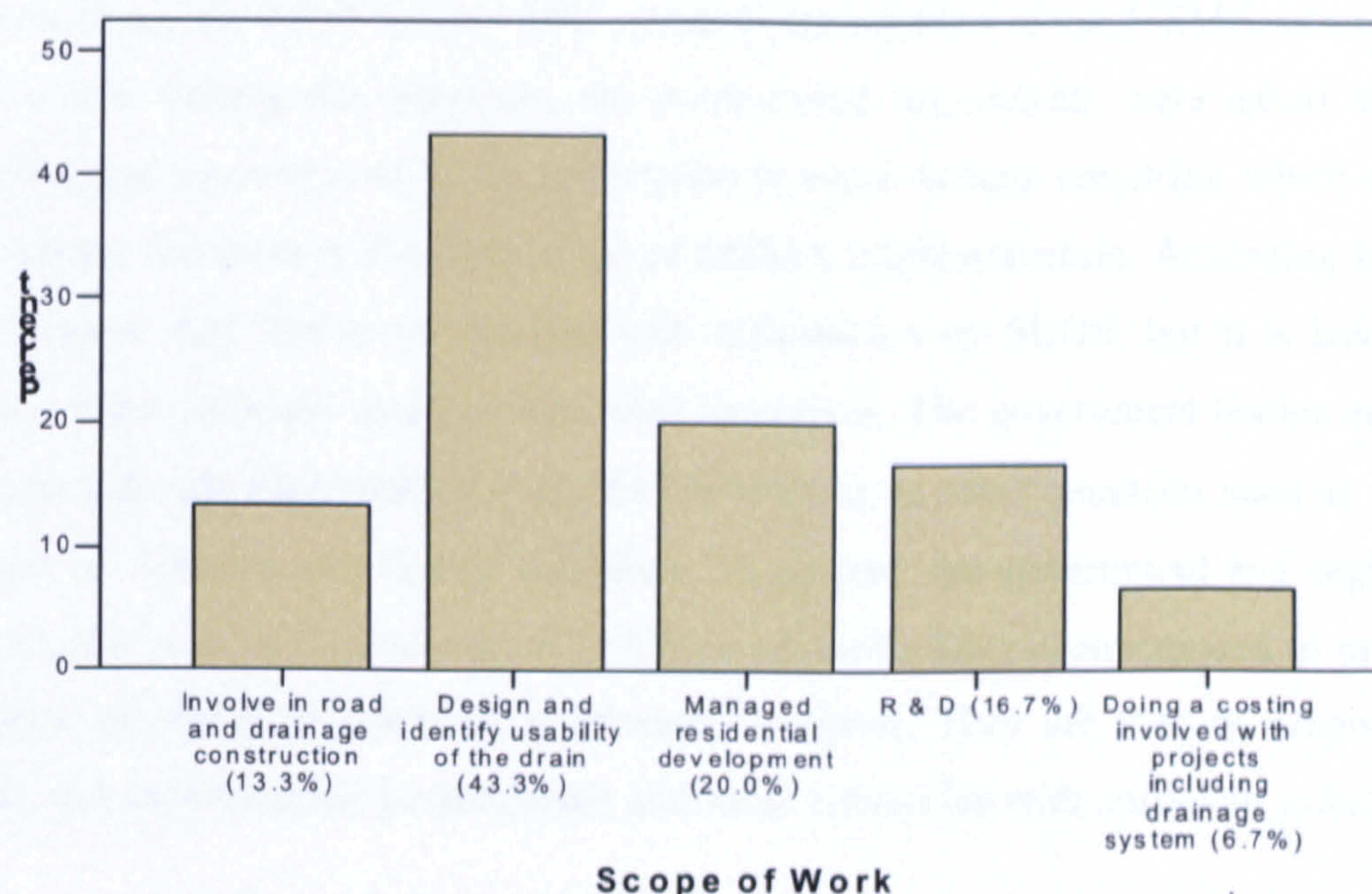


Chart 7.1.4: Professional respondents based on the scope of work distribution

## 7.2 Interview Session with the Professional Respondents

Groups of professionals from different areas of expertise were interviewed to obtain further opinions on MSMA and SUDS (Table 7.2.1). The professional respondents were then divided into four groups of expertise or professions; engineers, landscape architects, planners, developers and architects.

<b>Engineers</b>	<b>Landscape architects</b>
JB Local Authority (Engineer) (Engineer 1) DID (Engineer/Hydrologist) (Engineer 2) REDAC (River Engineer) (Engineer 3) Putrajaya Local Authority (Engineering and Hydrology Department) (Engineer 4) Paremba Group (Engineer 5) Site Engineer (Engineer 6)	SJA – Putrajaya (Landscape Architect 1 ) NY (Landscape Architect 2) NS (Landscape Architect 3)
<b>Architects</b>	<b>Planners/Developer</b>
MS (Architect 1) ZS (Architect 2) RI (Architect 3)	LY (Planner / Developer 1 (PD1)) NMI (Planner / Developer 2 (PD2))

Table 7.2.1: List of professionals participating in the interview session

### 7.2.1 Awareness and Understanding of SUDS Application in some Western Countries

In Malaysia, SUDS was first implemented in Putrajaya in 1997. In 1998, REDAC from USM collaborated with DID to implement Bio-Ecods in the USM campus. MSMA was implemented by DID in 2001 as a step towards a new sustainable drainage approach in Malaysia. All



development approvals dated January 2001 onwards are required to use MSMA as a referral for drainage system. During the interview, the professional respondents were asked about their understanding and awareness of SUDS application in some western countries, which could be a good precedence for them at the early stage of MSMA implementation. According to some of the professionals, they had been supplied with information on SUDS, but it is based on the government or the company management team incentives. The government bodies and private organisations had sent their staff to study SUDS projects in other countries such as Australia, United State of America and United Kingdom. In general, the government and organisations involved directly with the application of SUDS in Malaysia have been exposed to information and examples of SUDS as practised in Western countries. They are then be responsible for distributing and supplying the professionals and local authorities with sufficient information on SUDS.

*"...Some of the top management have been send to Australia, and they have conducted a seminars to introduce us to SUDS..."*

Engincer 1, JB

*"...I had the opportunity to visit a Bio-Ecods site in Sydney Olympic Stadium in Australia, and the system was very good there..."*

Engincer 3, REDAC

## **7.2.2 Knowledge of and Opinions on the Main Components of SUDS**

In looking again at feedbacks, SUDS has not been used much except at Putrajaya and the Bio-Ecods in USM. At the local authority level, the executers still lacked understanding of SUDS or MSMA application. In an interview with a senior engincer in JB, he mentioned that they still use the techniques of canalising but he was actually referring to the MSMA requirement. This seem to contradict SUDS approaches. He also commented that the implementation of MSMA does not help very much in flash flood issues.

*"... in some certain areas, we still use a concrete drain canal to solve a flash flood problems..."*

Engincer 1, JB

*"... I am not familiar with MSMA or SUDS. I have only been involved with building perimeter drain; the rest of the drainage system was built by the engineering consultant ..."*

MS, Architect 1,



*"...I am currently involved with a SUDS project. However, I am not quite familiar with it as it is very new to me..."*

LY, PD 1,

*"...I think SUDS is a very good approach. My experience with the Putrajaya project has shown lots of advantages and it could also help to improve the water quality..."*

Engincer 5,

It is disheartening to note that some of the professionals do not show any awareness or knowledge of SUDS whereas, they are responsible for the application of drainage systems. On the other hand, comments from the architects show how most of them provide the design only up to the perimeter drain stage, and then leave the rest to the responsible consultant engineer. In order to ensure that the professionals would produce good design and planning for the community, especially in residential developments, it is better then for them to improve their knowledge of SUDS.

Furthermore, not much feedback shows an understanding or awareness level amongst the professionals except those who have been connected with DID or have an interest in research on SUDS. The professionals who were involved directly with site works are better informed compared to those based in the office. However, the engineer involved in the USM campus project had shared his experiences on SUDS. According to him, it is difficult to supervise contractors because they have very little understanding of SUDS and were not trained for the construction of SUDS.

On the other hand, the developers have the opposite opinions of SUDS. This findings arose when they referred to how much SUDS would cost in terms of land use. They claimed that it is difficult for them to bear the cost as conventional drainage would save them more land use and money.

*"...to answer your question, I need to know whether this system will require an extra land area. If the answer is yes then it would not be an advantage on our part..."*

NMI, PD 2,

*"...I do have difficulties to supervise all the fourteen sub-contractors in the project because they do not have any exposure on SUDS..."*

Engincer 6, Site Engineer



### 7.2.3 The Idea of Sustainable Approach to Urban Drainage System in Residential Areas

A residential area developed before 2001 is provided with a conventional drainage system. As discussed in section 7.2.2, insufficient knowledge of SUD by professionals has raised the difficulty of implementing this drainage system in residential areas. Although it has been more than five years since 2001, that MSMA was implemented, there is still not much application of SUDS to be seen. The professionals are not well versed enough to argue on this kind of issue. However, there are also good examples which have been suggested in order to improve the education system regarding the environmentally-related issues at all community levels.

*"... It is better if we could retain the previous civic subject in our education system and include 'Loves Our Rivers' as a sub-topic..."*

Engineer 3, REDAC

*"...the education system does not supply enough information on environmental issues. The environmental issues are discussed in general without emphasizing the water-related issues..."*

RI, Architect 3

However, there are those who believe that the public should take the responsibility to allow drainage systems to be more efficient. They should not blame others and hope that the local authority or other responsible organisations will carry out maintenance work. Furthermore, there is also a suggestion for responsible agencies to supply information in order to educate the public. However, this suggestion is no longer practised by DID as a result of the previous 'Love Our Rivers' campaigns which did not turn out to be a success as expected.

*"...the 'Love Our Rivers' campaigns were not well-received by the public. Therefore, we are now going to change the approaches to mitigate the river problems and issues through doing it as a regulation, which is a must for us to do..."*

Engineer 2, DID

*"...if only the would take the responsibility of taking care of the residential surrounding, it will then help the authorities and other organizations a lot to maintain the drainage systems..."*

NS, Landscape architect 3



Unlike practices in many western countries, the landscape architects are not involved at the early stage of planning and design of any development except when requested by the client. They are only appointed once all the planning and early design stage is over in order to design certain plots of land that have been reserved for landscape purposes. Therefore, it is difficult to plan a more sustainable planning which can emphasize a single detail, such as the planting detail itself. For example, trees species also play their roles in providing a certain degree of foliage to slower the rain before it reaches the ground. Therefore, the landscape architects might give some advice in terms of choosing a different layer of planting. It is for this reason that each species have different life periods. A good planting design may lower the risk of ground exposure without any foliage covering once the main plant no longer exist as it will be covered by the secondary trees.

Thus, this really shows that there is a need for good team cooperation between the professionals because each of them has a very important role to ensure that development would benefit all stakeholders.

#### **7.2.4 Main Problems Associated with Urban Drainage Systems in Malaysia**

The main problems mentioned during the interview session are those related to public participation and acceptance, and also the implementation of new regulations related to sustainable drainage systems. The residential drainage systems also had similar problems to the urban drainage systems, which are the public attitude, technically-related issues, uncontrolled development and poor management of the drainage systems themselves.

According to Engineer 3, the engineer for the Peremba Construction of the Putrajaya project, the public is not provided with sufficient information. Therefore, they seriously lack understanding of issues related to the drainage systems. There should then be a programme conducted by the respective authorities or organisations to heighten the public understanding and awareness. Engineer 2 of DID informed that they would no longer continue with the 'Love Our Rivers' campaign as it had not fulfilled expectation target. They will soon be enforcing regulations and guidelines as a strategy to mitigate drainage issues.

Lariyah Sidek, a presenter during the Rivers04 Conference and also an engineer involved with the Bio-Ecods Drain stated that there is confusion regarding data provided in MSMA, the data was originally designed for Australia but had been mistakenly used by the professionals where to design the drainage systems in Malaysia. As a result, the design required a bigger space



whereas the actual space needed is less. These issues have been mentioned by developers as a loss for development projects. This was also mentioned by MNI (PD 2), a managing director for a developer company. She also pointed out that, as a developer, they will maximise land use for each development. She also admitted that she was not well versed in MSMA and all drainage system-related issues would normally be handed over to the appointed engineer.

Although MSMA was officially launched in 2001, all developments were permitted before that will still continue with drainage systems that had been approved which is the conventional systems. MSMA will only be enforced in projects that had been given approval after January 2001. There are still developments which do not have MSMA guidelines. Therefore, there are some professionals who have no experience working with MSMA. It would then take more time to allow MSMA to be practised as a whole. According to the Assistant Director of the DID, it would need more than twenty years to practise sustainable approach among the public and professionals, for which a large number of organisations should be involved in terms of education, environment, development and many more.

In Malaysia, SUDS is a new approach and not many people can appreciate the advantages of SUDS compared to the conventional system. Therefore, it is really difficult to persuade and convince people to support this system. Politicians also do not really understand the idea of SUDS implementation. In fact, a Bio-Ecods project was once turned down once by the administrative board of USM.

*“...at the early stage of this project, I had difficulties to get support from the administrative board because they do not want to take any risk on the new drainage module...”*

Engineer 3, REDAC

It has been suggested that decisions in local planning involve many individuals who lack formal training in planning (Kaplan, et.al., 2008). It is a very big task to explain everything involved with technical decisions to those who do not possess knowledge in the respective field. On the other hand, these individual were mostly people in local authorities that are responsible to highlight upon development issues to the public. This constraint also contributes to the difficulties faced in encouraging public involvement in any development.



### 7.2.5 Opinions on the MSMA

In general, the feedback on MSMA shows that it is still not widely used. Design professionals in the construction industry do not show any interest in enhancing their knowledge about SUDS. They are also not aware of the advantages of SUDS and how this system can make the surroundings look better. Engineering consultants keep using the conventional drainage system although SUDS has been introduced.

*"... We have a special unit that conducts a seminars on MSMA, However, the receptions from the professionals are very poor. Nothing much can be done because all the seminars are not compulsory and the professionals attend on their own initiatives..."*

Engincer 2, DID

Some of the professionals are not aware of the seminars conducted by DID, and they also have also said that they feel unsecure about the success of the success of the system. Difficulties in getting information have also arisen.

*"...I am not sure about other sources of MSMA or SUDS, but in our organization, we are lucky because the management are providing us with courses and seminar on SUDS..."*

Engincer 5, Paremba Group

*"...Sorry, I really do have difficulties to provide you with information on MSMA. Personally, I am not quite familiar with the system and also have not heard about it before..."*

ZS, Architect 2

On the other hand, many believe that MSMA is not a good stormwater control as it cannot solve flash problems. They prefer the conventional system because it offers a faster solution to the flood problems.

*"...I do not think that MSMA is the best solution and it is not suitable to be implemented in urban areas. This is because, based on my experience, if there is flash flood in this area, there would be a very long traffic jam, within 5 minutes. Can you imagine if we provide MSMA here, which would take at least an hour to allow water runoff..."*

Engincer 1, JB

However, the professionals also raised the advantages and disadvantages of MSMA during the interview session. They also suggested that MSMA should be improved or updated from time to time. This is in conjunction with the drainage system technologies, which are always improving.



Furthermore, most of the feedbacks received, especially from the designer background professions, stated that the respondents were not aware of approaches effected in their scope of work.

#### **7.2.6 Improvement of MSMA to Suit the Needs of Housing Schemes in Malaysia**

As found in the interviews with the public, most residential areas with conventional drainage systems faced many problems. Thus, there is an urgent need for proper action in order to improve the situation. Unlike the SUDS application, the conventional system does not provide a separate drain for sullage and rainwater. The professionals have then been asked for their ideas to improve the housing schemes in Malaysia in terms of better drainage systems. The local authorities have been chosen to take full responsibility for the system application in housing schemes.

*“...MSMA should be more stressed by the authority in order to control any development. Therefore, all coordination and supervision of the development can be more effective...”*

MS, Architect 1

The public or residents in an urban housing scheme should also take the responsibility to ensure that the system can be improved. Their understanding would be a great advantage in order to implement MSMA because the system will work efficiently with good public support and participation.

*“...It would be best if the public could help in taking care of the drainage system within their residential area. The understanding on how to keep the drainage runoff from the grey water is very important...”*

ZS, Architect 2

*“...The public should be supplied with sufficient information on SUDS, and also the importance of saving the rivers. It seems that they are not aware because they do not really understand the importance of their roles in maintaining the drainage system...”*

NS, Landscape architect 3



### 7.2.7 Opinion on Public Awareness of Problems Associated with Drainage Systems

The public does have an important role to play in relation to the drainage systems. However, in Malaysia, the residents seem to be unaware of the problems that could be caused by poor drainage systems. When asked about public awareness of drainage issues, many professionals believe that the public have not played its proper role.

*"...I believe that our public does not really play their role to ensure that the problems associated to drainage systems could be mitigated..."*

Engincer 5, Paremba Group

*"...I have seen people throwing their unwanted foods from the kitchen window, it really make things worse..."*

ZS, Architect 2

However, it is believed that blame should not be put on the public only. There is also a lack of information and insufficient campaigns by the government and related parties on problems associated with drainage such as water-borne diseases, water pollution and flash floods. On the other hand, there is a need to update the public on the latest issues related to water because this may attract their attention to change their attitude towards a better understanding of water-related issues.

*"...The public should be supplied with lots of information on daily usage of water. The respective organisations should be responsible for taking actions on these..."*

NS, Landscape Architect 3

*"...I am involved with a project which has a sustainable drainage system approach. However, I have difficulties obtaining information on it. Where should I go for further information?..."*

NY, Landscape Architect 2

Public participation in activities related to the environment is not encouraging. Thus, there should be proper strategies to tackle the professionals and arouse public interest although it would take a very long time to change attitudes. Due to the critical stage of drainage-related issues DID has taken more drastic actions by making regulations the major strategy to solve the problems. The 'Love Our Rivers' campaign will no longer be a major event and the public will be less involved.



### **7.2.8 The Barriers that Discourage Awareness Amongst the Public about Problems Associated with Drainage Systems**

The education system has been seen as one of the reasons which discourages public awareness. Education is supposed to be the easiest method of supplying the public with water and drainage related issues. However, the education syllabus does not include sufficient information on the environment and therefore should be updated frequently.

*"...I do not think that we are taught properly on the subject of environmental education. The environment is discussed in general but not specifically on topics like water and others..."*

NMI, PD 2

*"...We should now start to provide students with environmental education from a level as low as the primary school..."*

Engineer 3, REDAC

Although the professionals do not deal directly with the public, they still think that public attitudes should be changed because they are seen as a major obstacle to developing awareness of problems associated with drainage systems. The maintenance cost for drainage systems is increasing due to the deterioration of drainage conditions. Drainage has become a dumping area; therefore, the change in public attitude is very important. In Putrajaya, the authorities do not face any difficulties with the public because they have been provided with proper information regarding the system.

*"...We faced problems during the early stage when the public were still not familiar with the system. They threw wastes into the system. And it took us quite sometime to give them the information related to drainage systems. Feedback received said that they thought that the responsibility of taking care of the drainage system is under the local authority because, as residents, they pay their fees to us..."*

SJA, Landscape architect 1

*"...A major problem that we discover during flash floods is that the runoff cannot flow to the downstream because there is a blockage due to dumping of wastes..."*

Engineer 1, JB



Information on drainage is not widely distributed and do not reach the public. Therefore, the public is not aware of any new procedures or guidelines related to drainage. On the other hand, the information is quite difficult to access and is not updated frequently.<sup>9</sup> The public does not know where they can get the information from. The communication tools are not fully utilised in order to provide the necessary information to the public.

*“...As a member of the community, I admit that I do not have any idea of SUDS. As far as I am concerned, I have not received any information that can be related to water or drainage system...”*

NMI, PD 2

*“...I admit, I do not have a clear idea of SUD and any complication that can be caused due to a problem with the drainage system...”*

RI, Architect 3

The tools used in the application of SUDS components are expensive. It is then up to the public's own initiative to apply SUDS components such as rainwater harvesting tanks, or using equipment with low water usage. Other than that, the equipment is expensive too and beyond the reach of many in the community. This is because the systems are new in Malaysia, which means the public needs more time to be familiar with the system.

*“...Although the Bio-Ecods module is expensive, I took my own initiative to provide Bio-Ecods in my own house. This is the way that I would like to show my support for SUDS...”*

Engineer 3, REDAC

*“...There is no approach to rain harvesting system in Malaysia. However, I installed it in my house...”*

Engineer 2, DID

### **7.2.9 Suggestions for Public Involvement in Drainage Solutions**

DID or the respective organisations concerned with water are urged to increase activities that would allow the public to participate. There should be an intensive element that would encourage the public to take part in environmental activities. Added to that, the campaign should include a seminar or exhibition that would help to boost public awareness and

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<sup>9</sup> Most of the information is published in electronic journals and on the web whereas a majority of the public has limited access to the Internet. In 2005 the internet users in Malaysia were only 2.1 million for dial-up services, while the broadband users numbered 495,000 (TMnet 2005 Annual Reports, 2005). This number is very small Internet access compared to the whole population.



knowledge. Activities conducted by the community services or groups would encourage more people to participate in various activities with a theme that is related to water and drainage. The 'Love Our Rivers' campaign should be continued and the campaign should be organized with a variety of activities in order to retain public interest.

Various communication approaches should be used to ensure that information would be easily accessed by the community. In a country like Malaysia, not all communities have access to electronic communications. Therefore, a road show, exhibition or fliers would also be useful to grab public attention. Organising competitions can also attract the public to participate in campaign.

#### **7.2.10 Suggestions for Better Management for Better Drainage Solutions**

It is suggested that the current system should be revised because the regulations and guidelines are very confusing and not well linked between organisations on issues related to drainage systems. Thus, there should be better communication between organisations. These improvements would then reduce the chaos and uncertainty surrounding drainage issues. In particular, there is a need to restructure the management of SUDS in Malaysia.

Although MSMA is new to the Malaysian construction industry, frequent updates on the information are reliable. This then provides easy access for professionals to obtain facts and information related to drainage systems.

### **7.3 Discussion of Professional Survey**

This study involved conducting interviews with those involved with drainage systems: the regulators, researchers, local authorities and the professionals in the construction industry, such as architects, engineers, landscape planners and surveyors.

Information on MSMA was distributed based on a 'pyramid method'. MSMA was designed and regulated by the top management of DID, and information on the implementation was later distributed to the respective departments in the various government agencies involved in drainage systems. The departments later forwarded all the information to their respective staffs in the department involved in the enforcement based on their area of authority. As for the



professionals, they are encouraged to attend a short course conducted by DID on MSMA according to their own initiatives.

The professionals are still hoping to obtain information from each other on the new drainage approach. Reception among the professionals is also very poor according to DID. When asked their opinions on the SUDS implementation in Malaysia, half of the respondents claimed that they do not receive enough information on MSMA. This really reflects the professionals' attitude towards the implementation of SUDS as DID always announced and advertised their MSMA seminars on the DID official website. It is really upsetting to discover that all these professionals did not show any initiative to obtain any further information from the numerous sources available on SUDS. Although DID had decided to enforce regulations as a part of their effort to monitor water quality, 55.6% of the respondents agreed that the difficulty with the existing regulations or guidelines related to drainage and water is the main barrier in implementing SUDS in Malaysia.

Over half of the professional respondents pointed out that the proposed drainage system in MSMA is much more expensive than the conventional drainage system. During the question and answer session in the Rivers'04 Conference in October 2004, Lariyah Sidek justified this by saying that the problems in designing the drainage are due to the data supplied in MSMA which is not being suitable for Malaysia as the data was adopted from Australia. Therefore, the design of the drainage system became too wide and it needed more space to be reserved.<sup>10</sup> Information provided in MSMA should then be revised in order to avoid difficulties in relation to the implementation of SUDS in Malaysia.

Currently, most of the existing housing developments are provided with conventional drainage systems. Putrajaya was the first area to be installed with a sustainable development approach in Malaysia. Therefore, the drainage system applied in Putrajaya is based on SUDS approaches and was implemented before MSMA was legislated. There are also others example of SUDS applications that have been developed; for example, the USM engineering campus in Penang and the Tanjung Rambutan Hospital in Perak.

Various opinions had been voiced by the professionals. Many seem very disappointed with the information supplied as they claimed that there is insufficient information. A number of them depended more on the design provided by the consultant rather than their own understanding of SUDS itself. On the other hand, the developers are more sceptical about the 'life cycle cost'

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<sup>10</sup> Data related to climatic factors need to be collected before an ARI graph for a drainage system that is suitable for a Malaysia can be obtained. The ARI graph will influence drainage design calculations.



(LCC) of SUDS implementation as they claim that it will increase the cost of development. All the feedbacks do not show a good understanding of SUDS amongst the professionals involved in the construction industry and those from different backgrounds have different understanding of the implementation of SUDS.

Many professionals agree that public resistance to change is the most common barrier in implementing SUDS. This might occur due to a lack of information and understanding amongst the public. Furthermore, there are also problems in terms of the community's way of life. The daily routine does not encourage sustainable environment, especially in the management of drainage systems. The enforcement of legislation alone without education for the public, would not result in any changes in the future. This results in a longer period to change the current scenario.

There is very little research on this area emphasizing the Malaysian conditions and not much available expertise has resulted in the liability cost of the drainage systems. However, there are many professionals at present who have shown an interest in this subject. Many studies have been conducted by a few organisations related to river engineering, such as REDAC and DID. Nevertheless, there is still sceptical feedbacks from professionals involved in development that the implementation of SUDS has raised their costs. Lariyah Sidek suggested that, based on her experience of SUDS, it can be seen that SUDS has reduced the cost of drainage systems by 0.5% of the total budget cost in the USM project as discussed earlier in section 5.3.4 of Chapter 5.

MSMA has now been implemented for more than five years in Malaysia. However, there is a lack of information on SUDS received by the professionals. Thus, it would be better if the professionals could support the government's intention to improve the current drainage system by showing their interest. There are plenty of sources available which they can employ in order to obtain more exposure to the application of SUDS in other countries, especially from the West. MSMA is a manual which provides a general outline of SUDS. The professionals should then be creative in developing good SUDS by applying their knowledge, skills and creativity. It is an unhealthy scenario when there is still a number of professionals who rely more on the respective authorities such as DID and the local authorities to take further action in order to facilitate their work.



According to the Assistant Director of DID, Ahmad Fuad Embi, there is a mismatch amongst the enforcement bodies which has led to difficulties in enforcing regulations. In Malaysia, DID authorisation only covers rivers and drainage management. The Department of the Environment (DOE) controls water quality while the management of buildings, drainage and sewage systems is enforced by the Public Works Department (PWD). Therefore, it is difficult for DID to distribute sufficient information and also to enforce regulations thoroughly. On the other hand, not many professionals have attended DID seminars and courses on MSMA based on their own initiatives. This phenomenon is thus not an encouraging scenario and will not guarantee the future of SUDS application in Malaysia. Other minor barriers include the climatic and geological aspects, the safety aspects of the open water element, the lack of expertise in ecological engineering, and a lack of interest amongst professionals.

The lack of professional interest can be clearly seen as there were not many professionals who have shown interest and willingness to be contacted for further survey information. The feedback that was received is also not encouraging although the survey was conducted in a conference attended by those who are involved and have interest in drainage systems.



## Chapter 8

### *Findings and Conclusions*

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#### 8.0 Introduction

This chapter concludes the research findings that have been discussed in the previous chapters. The discussion will relate to the research questions and will be followed by suggested topics for future research that can be expanded from this study.

#### 8.1 The Adaptation of Principles and Elements of SUDS in Western Countries Onto the Malaysian Context

A number of western countries have been developing SUDS for many years. A very good example can be seen in the United Kingdom. It can be clearly seen that they have implemented SUDS very well. Based on the CIRIA guidelines on SUDS, four basic components have been introduced: ponds, wetlands, impermeable surfaces and filter strips and swales. These components have been used and integrated very well into the landscape design by the respective designers (Figure 8.1.1).

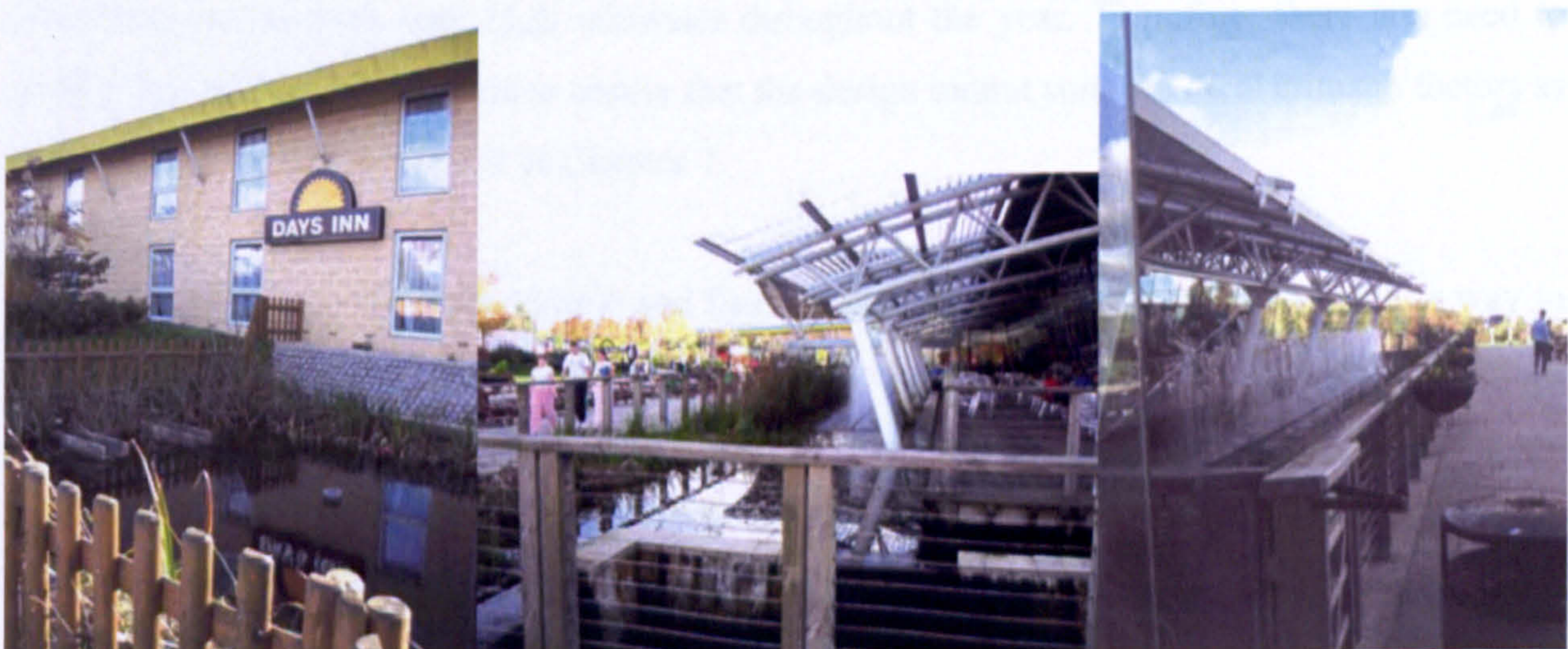


Figure 8.1.1: M42 Welcome breaks by Robert Bray.

In Malaysia, MSMA has also introduced the same components of SUDS. However, there are limited examples to be seen. The components are translated directly onto the landscape (Figures 8.1.2 and 8.1.3). It would then take more time for the professionals, especially designers, to become familiar with the components and explore them in their designs.





Figure 8.1.2: A mini wetland located between the residential area in Putrajaya.



Figure 8.1.3: A constructed wetland and a swale in the USM Engineering campus.

SUDS components are not much different in terms of their functions or technical specifications. It can be implemented almost everywhere, including in Malaysia. The differences that occur relate to the ‘ARI graph’, which is based on the local annual rainwater distribution. A country like Malaysia receives very high rainwater throughout the year. Therefore, there is a need to modify the existing SUDS data to ensure that the design output suits the local climatic factors as discussed earlier in section 7.3 of Chapter 7.

The components are generally simple and flexible and need to be explored in a creative way in order to blend them with the landscape design. Therefore is a need for a responsible authority, such as the Drainage and Irrigation Department (DID) to provide training and courses for the professionals on the implementation of SUDS. Latest information should also be supplied efficiently. It is better then for Malaysia to study SUDS management systems that has been developed in western countries. The understanding of SUDS components and their implementation will generate more benefit and applicability to the environment and community. It is a very good approach then to have an organisation that is responsible for the implementation of SUDS, such as CIRIA.



Many of the western countries are experienced in formulating good drainage management. This is thus the most valuable experience that should be looked into in order to improve the present drainage management in Malaysia.

## **8.2 The Culture of Malaysians in Relation to Sustainability Issues and SUDS**

Malaysia is a multi-racial country. The three most majority ethnic groups in Malaysia are Malay, Chinese and Indian. Each ethnic groups has different culture which influences the way of life. The way each ethnic group perceive water itself highlights the differences. This might be due to the traditional geomancy inherited from their ancestors, such as the Chinese belief of *Feng Shui*<sup>11</sup> that could influenced their lived or the Malay community whom believes in *Tajul Muluk*<sup>12</sup>. The traditional geomancy reflects the daily lives of each community.

On the other hand, adaptability of childhood lifestyle or common daily practices also has great influence in the culture of the community. As discussed in Chapter 3, the examples presented are related to the traditional drainage system. Most of the community in the rural areas have been familiar with the surrounding environment and the drainage system used within their living areas. Therefore, it is difficult to change the system unless they are exposed to proper drainage systems and supplied with sufficient information related to water and drainage systems.

## **8.3 Problems Associated with Urban Drainage Systems in Malaysia**

Aesthetic values are very subjective. The way people appreciate the landscape in their living surrounding varies. Based on the focus group as discussed in Chapter 6, most of the public consider artificial landscape more acceptable than natural landscape. Less appreciation is shown towards a natural setting.

Public attitudes are universal. The way people react or perceive any matter or subject is almost similar. It is universal that people show their care, appreciation and awareness to the element that they like most. A drainage system is an element which is considered by many people as a

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<sup>11</sup> *Feng Shui* is the Chinese geomancy in giving guide to the ancient arts of placement in daily life (Hale, 2001).

<sup>12</sup> *Tajul Muluk* is the Malay geomancy parallel to the Chinese *Feng Shui* (Andrew Sia, The Star, March 16<sup>th</sup>, 2008).



'service element'. It is considered by people in terms of its functionality but not as part of elements that contribute towards the landscape. Therefore, to ensure the success of the implementation of SUDS, the people's knowledge should be broadened and their attention captured. Nassauer (1997) suggested the need for people's attention in order to allow the landscape to survive, which is known as 'cultural sustainability'.

A clear example of people's attitudes towards their own surroundings in this study is the homeownership status. The homeowners are more sensitive to their own homes compared to tenants. The homeowners are more alert about things happening within their living surrounding. Unfortunately, there is a limitation of appreciation that influences most of the residents in Malaysia. The appreciation and awareness were only perceived within the borders of the individual house. Homeowners do not understand their surroundings in a larger context (Karasov, 1997). The residents were mostly trying to do their best for their individual living space, which in this case, is their house. It is unacceptable to say that it is a big mistake to place the drainage system outside the residential border. The drainage system would be under the individual's responsibility if it were seen to be part of the individual property. This example refers to the perimeter drain built on the border of the residential areas. In other examples, other open spaces would be treated the same if it were not valued by the people, such as parks, playgrounds and playing fields. It is difficult to make the public's sense of belonging borderless which would then lead the people to extend their appreciation. This would also act as a trigger for the public to begin protecting their living surroundings.

### **8.3.1 The Issue of Common Values Held by the Community**

The influence of culture is very complicated especially since Malaysia is a multi-racial country. The issue of sensitivity should be looked at from many factors, such as racial, religious and cultural (Tan, 2008). For example, pig farming is a very sensitive issue to the Malays who are them Muslims. Their religion, which Islam, forbids them from consuming pork. Therefore, a recent, issue regarding developing a centralised pig farm does not only concerns the environment, but also triggers religious sentiments. Hindus on the other hand do not eat beef as they believe that the cow is a sacred animal. Issues on Backbenchers Club of Malaysia highlighted a mass slaughter of a cow in July 2007 which highlighted this sensitive issue among the Hindu community.

On the other hand, in looking at the everyday way of life and culture the sanitation and drainage system were not properly managed especially in rural traditional villages. Most housing



settlements near water edges had built toilets at the river banks. Thus is difficult to control because it had been practiced by the community for ages. The river bank reserve of one hundred feet is therefore not easy to enforce as the village lands belonging to the villagers are inherited from their ancestors. Usually, the greywater from domestic use in a traditional house will flow into puddles behind the house. It will then disperse into the ground. There is also a possibility that the greywater flows to the nearest water bodies. The greywater will then be left without any treatment.

The main obstacle that prevents the respective authorities from providing proper sewage and drainage systems is the political boundary. The local authorities are only responsible within their authorised boundary. However, there is also improvement in villages in that the political boundaries have been included under local authority jurisdiction.



Figure 8.3.1: A cartoon published in the News Straits Times Press by Zoy on water issues. (Source: NSTP, 2001)

Educating the public on environmental issues is very important in order to sustain drainage systems especially an urban housing areas. The public plays an important role in protecting their living environment (Figure 8.2.1). A knowledgeable society would result in better and healthier environmental expression. Expressions are important in order to allow the public to show their appreciation of the surrounding landscape. For example, most of the public responded in a very unencouraging way towards the wetlands component as they are not well versed in its functions within the environment as discussed in Chapter 6. However, the way the public perceives the wetland may change if they know its role. This would then allow them to appreciate it more readily. Apostolaski, et.al. (2001) suggest education as an important tool in improving public perceptions of SUDS. This study shows that drainage problems, such as blockage, bad smell or stagnant water, may occur in any place. The problem can then be solved if the public is knowledgeable about their roles as well as and the importance of the SUDS application. Overall, the public should not be blamed for any environmental issues which occur.



### **8.3.2 The Extent to which Sustainable Design and Behaviour can be Influenced by Information and Education, and the Limitations of this Approach**

The understanding of a basic concept of sustainability is very important in identifying the limitation of approaches that should be put to the public. Basically, the key concept to sustainability is to minimise resources degradations and disturbances to a limit where the natural processes and functions of the system can counteract and be preserved (Jaafar, 1992). Therefore, it is better to identify criteria which encourage sustainability such as the following:

1. recycling
2. using minimal non-renewable resources
3. exploiting renewable resources
4. reducing waste generation
5. using resources efficiently

These criteria should be emphasized in terms of information and method that can be achieved at the public level in order to ensure that they understand their responsibilities and the implication that may be contributed due to their awareness. They are at a level which could help the 'control-at-source' method to control resources degradation especially water. For example, recycling has been introduced in Malaysia for the last few years. The public had been provided with recycling bins, which were located at very limited sites. These step then encourages the public to participate in recycling. However, the recycling management system should be upgraded where garbage should be segregated earlier and should not be mixed during the collection process.

At the educational level, the school syllabus should be revised and updated with information on environmental issues. This should be done in order to develop environmental awareness at an early stage of education. Education in Malaysia is generally more geared towards classroom orientated approach. It would be better then if students were allowed to interact more with nature. It is thus a very good move if students were given the opportunity to observe nature and eventually learn to appreciate it.

### **8.4 The Role of the Professionals in the Practice of SUDS**

Dealing with environmental issues is the responsibility of all stakeholders. Landscape, ecology and sustainability are very broad issues that need the involvement of all professionals. Knowledge and understanding of societal, cultural and environmental factors are important for



better SUDS implementation. Flexibility in SUDS components, skills and creativity would assist professionals in the search for a better drainage and landscape solutions for urban housing areas.

Current and updated information should be supplied to allow the professionals to obtain a clearer idea of SUDS. The method of information distribution should be revised in order to allow easy access to all. There is also a need for multi-sourcing and unlimited information as people depend on a variety of sources to obtain information. It is better then for responsible organizations to diversify methods of information distribution on MSMA.

### 8.5 Political Interference in the Supporting of SUDS Application in Malaysia

The public generally personalise their individual spaces and individual areas within very limited contexts. Examples have been discussed in earlier sections; as can be seen in the strong relationship between homeownership and the surrounding area. However, it is suggested by Karasov (1997) that every piece of land has it value in terms of ecological and educational functions, and it is thus important to view the wider context. According to Karasov (1997) in the article 'Politics at the scale of nature', the landscape should be preserved in order to allow people to take responsibility for it.

The process of urbanisation has created landscape destruction without anyone realising its impact (Figure 8.4.1). The experiences of the earlier generation with regard to local natural surroundings are no longer experienced by the younger generation. At present, land and property values are very high and therefore people tend to maximise land use. As a result, many parks are situated far from the public. This has caused the public to be less aware of natural spaces. The park itself is less appreciated by the public because of the distance. Therefore, these environmental challenges have also become a political challenge as their borders of jurisdiction are now located within a broader context.

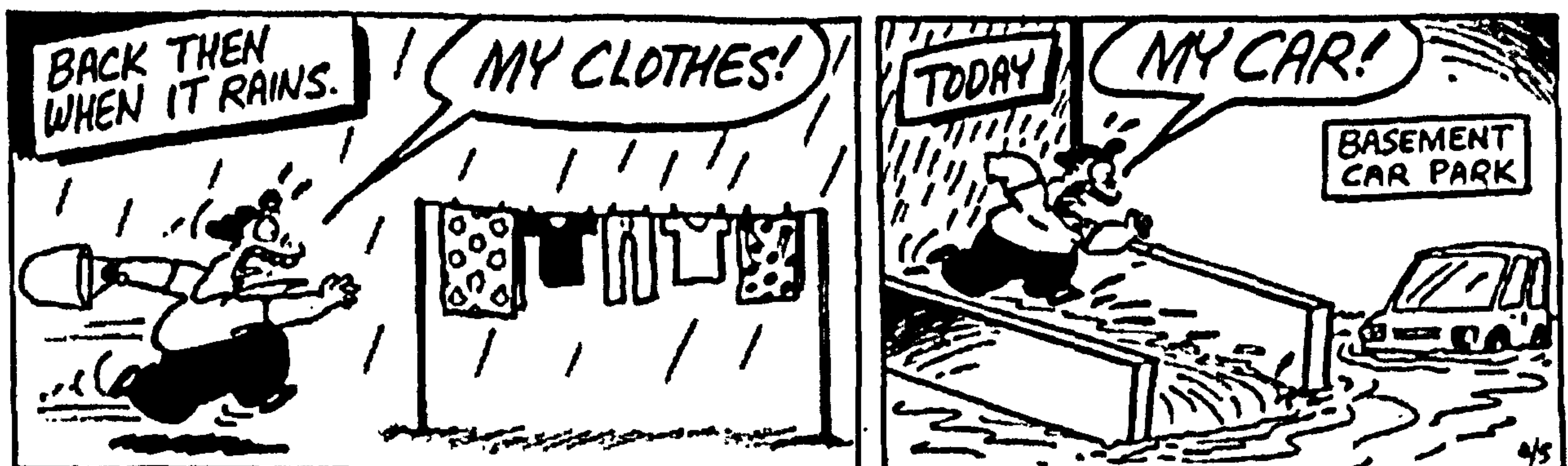


Figure 8.5.1: A cartoon published in News Straits Times Press by Zoy on flash flood issues. (Source: News Straits Times Press, 2004)



MSMA is a good attempt that has been made to mitigate water issues. However, much is needed to improve the implementation, especially the management side. The management should also involve acts and regulations. They should be updated together with new attempts or approaches to allow the actions outlined to be concurrent with the latest information and application. A new approach should also be considered in order to encourage the public to be involved and to participate in activities related to the surrounding environment. The public should be allowed easy access to any green areas; for example, there should not be any barriers in the mini wetland areas of Putrajaya.

The political system also influences the regulations and acts related to drainage and water managements. The government supports the idea of implementing a sustainable drainage system, which leads to the outline of MSMA replacing the old hydrological manual. However, there are certain actions taken which were not reflected in the guidelines MSMA. One of the examples is the Stormwater Management and Road Tunnel Project (SMART), which is a solution in the form of a dual function tunnel to improve flash flood problems in Kuala Lumpur.<sup>13</sup> The tunnel was built to transfer the 'overload' water to the downstream as quickly as possible. These solutions, on the other hand, would later create other problems in the downstream.

#### **8.5.1 Water Management Problems due to Non-Sustainable Schemes, Poor Detailing or Maintenance.**

Technologies and systems are not static; it is dynamic. It will be improved and developed for a better performance and benefit. Therefore, according to Butler and Parkinson (1997), the effectiveness of an urban water system is highly influenced by maintenance techniques and procedures. This was suggested in a study on investigating a feasibility of a sustainable-water chain by Van der Graaf (1997). The study was conducted to find answers on unsustainability factors that could be reduced through different techniques and approach developed related to urban water system. It shows that each techniques or components were applicable at their most efficient way depending on many factors, such as the climate, cost, and others.

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<sup>13</sup> The SMART tunnel was constructed in 2003. The main objective of this tunnel is to solve flash flood problems in Kuala Lumpur. The 9.7km length tunnel project was led by the government, including the Malaysian Highway Authority (LLM), and DID, and a joint venture pact between Gamuda Berhad and Malaysia Mining Corporation Berhad (MMC). On 7<sup>th</sup> April 2007, this tunnel was officially opened to motorists.



As Malaysia is still at the stage of developing urban drainage systems, there is still room to identify techniques, components or approaches that might best suit the Malaysian context. Butler and Parkinson (1997) propose three strategies that may lead to good strategies in developing sustainable urban drainage systems. They are as follow:

1. Reduction of reliance on water as the medium of transport for waste.

The conventional drainage system does not utilise water efficiently (Eiswirth et. al., 2000). Daily water usage could demonstrate the level of water usage. It is encouraged to minimise water usage. One may use low-flush toilets or a front-loading washing machines, as they are designed with minimum water requirement. On the other hand, water recycling also helps to reduce water usage. In this study, as discussed earlier in Chapter 6, respondents were asked about their willingness to participate in water-related environmental activities such as reducing water activities, rainwater harvesting, recycling and others. Although encouraging responses were given, they would also appreciate if they were assisted and supplied with information to assist them in managing water usage efficiently.

2. Elimination of the mixing of industrial wastewater with domestic wastewater.

Separating the municipal waste and industrial waste is critically important (Butler and Parkinson, 1997; Eiswirth et.al., 2000). However, it is a bit difficult for Malaysia to develop a system that can organise waste within a very limited phase. Malaysia is a country highly involved in the production and agricultural industries. However, improper management of hazardous wastes can cause an increase in heavy metal wastes in the water system. On the other hand, the outbreak of the '*Nipah*' virus in 1998 as discussed in Chapter 6, has alerted many people to the importance of proper waste management in livestock farm.

The latest issue that had triggered Malaysian sensitivity is the pig farm which had cost RM100million to be built in Sepang, Selangor (Tan, 2008).<sup>14</sup> The farm was planned with the aim of being the first to be equipped with an environmental-friendly waste treatment techniques, which can also be categorised as 'control-at-source' methods. However, this issue had provoked the sensitivities of many with regard to environmental issues. According to Tan (2008), the attempt was made with the aim to centralise pig farms and to control farming activities. Pigs are known to be prone to heat stress. Therefore, they need to be washed regularly in order to cool them down. Thus there is an immediate need for proper waste management in order to control the discharge of effluent and waste water. In this case, the government had made the effort to hire foreign experts to conduct an in-depth study which is meant to support the Environment Impact Assessment (EIA) study conducted earlier (News Straits Times Press, 2008).

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Support and understanding are needed to encourage development in the improvement of environmental friendly techniques in Malaysia, especially concerning a more sustainable drainage systems. A study on the domestic waste and industrial waste management should also be carried out to identify environmental-friendly approaches that may benefit many parties.

### 3. Separation of stormwater runoff from flows of polluted wastewater.

In many western countries, the application of combined sewer system helps to improve the quality of water runoff. It was designed to split the runoff from the wastewater. However, an open sewer system has been implemented instead in Malaysia. Therefore, it is difficult to control the surface water runoff from mix with the polluted wastewater. An alternative approach should then be identified to discourage the problems from continuously polluting the water system. The public and stakeholders should thus play their roles. Problems, such as waste dumping in the open channel and improper sanitation system which flow directly into the drainage system, must be avoided.

Actions should then be taken to support sustainable drainage systems. SUDS alone cannot solve these water issues. There is thus a need to 'control' activities so that the implementation of SUDS can proceed without any threat.

## 8.5.2 Issues of Legal versus Voluntary Compliance

Many are unaware of their rights and responsibilities in contributing to environmental issues. Public participation has not been encouraging as they do not know how to be involved. This might be due to a lack of exposure as well as information supplied. Legal act, enactment and regulation can hardly be understood by a layman without any assistance from the expert. These are some of the obstacles that restrain the public from getting involved in any development planning. Malaysia Nature Society (MNS) (2005) highlights that public participation is very important for the following reasons:

### 1. Legal rights in human law

- As discussed earlier in Chapter 3, there are laws and regulations that have been enacted to protect public welfare, such as the Environmental Quality Act 1974 (Amendment) 1985 where the public is given forty-five days to comment on detailed EIA report. The Town and Country Planning Act 1976, Section 9, 12A and 13 provides one to two months to the public to protest any draft or development plan.



## 2. Basic human rights

- It is the rights of humans to practise freedom of speech and to obtain information. The most important is the rights of humans to live in a clean environment.

## 3. Social obligation

- The public is free from any political responsibilities, which makes them the best monitoring agents. Public involvement would promote transparency in government decision making. Thus, it is better to involve the public in development planning and to improve the EIA based on the comments, ideas and opinions obtained from the public

However, the obstacle that might influence public participation is accessibility to information. For example, the EIA report would usually be announce in newspaper and the DOE website. For a detailed EIA report, it can be bought at the price between MYR500 to MYR800 (£80 to £150) (Malaysian Nature Society, 2005). Accessibility seems to be limited to internet while the public themselves are stopped from contributing to the EIA. In addition, the price of a detailed EIA report is expensive, which would then make the public less interested in purchasing the report.

## 8.6 Further Recommendations for Future Research

Research related to SUDS and the public perception, acceptance, awareness and participation is very broad. It can be examined in various aspects. However, based on the areas that have not been touched on, it is best to give emphasis to the subjects listed below:

### a. SUDS components in landscape design in Malaysia

SUDS implementation in Malaysia needs further improvement. Further research on SUDS components in landscape design is needed. The research can be extended to include finding solutions to the best components that can be applied in designs as well as contributions towards sustainable landscape. The research area can also be broadened to cover other issues, such as identifying the factors that influence the acceptance of components used for design.



**b. Towards better 'Best Management Practices' in Malaysian drainage and water management**

Research should be conducted to improve management issues related to drainage systems. Improvement on the management of SUDS is important to obtain better drainage systems. The management issues should be cover various topics; from technical to maintenance.

In addition, Malaysia is well-known for its multi-racial society, which has led it to become a multi-cultural country. The culture of any society is very important in influencing the ecological landscape. Research on Malaysian culture is thus encouraged in order to identify a better approach to manage the responsibilities for living surroundings.

**c. Sustainable urban landscape: Retrofit to the current urban landscape in Malaysia.**

Most of the major cities in Malaysia suffer from environmental problems. Hard surfaces have dominated almost all urban settlements. Improvements should then be identified in order to reduce environmental problems while at the same time to improve the quality of urban areas.

## **8.7 Final thought**

Issues on global environmental degradation attract many attentions. In one year we celebrate various days related to the environment such as 'World Water Day' and 'Earth Day'. The World Health Organisation of United Nation recently announced the year 2008 as an 'International Sanitation Year'. These are efforts made by specific organisations in order to boost awareness on environment. However these efforts made at the macro level. At the micro level, respective government agencies, NGOs, and stakeholders have also made initiatives to involve the public with environmental-base activities. For examples, SHELL Malaysia Limited and the New Straits Times Press, in partnership with the Ministry of Education, have collaborated in an awareness campaign at a primary and secondary school levels (New Straits Times Press, 2008). The attempt is aimed at raising the awareness of environmental issues amongst students.

In general, everyone should be aware of the importance of clean water. Most of health and environmental problems originate from the bad quality of water supply. Water-borne diseases such as malaria and dengue, polluted water diseases, such as Japanese Encephalitis (JE) and the 'Nipah' virus, as well as cancer, are caused by water. Global warming issues, now focused on many topics such as heat island phenomenon and green house effects, but not many are aware



of the basic need of water to regulate temperature of the Earth. Water is needed also to sustain the world's population and the ecosystems that support life on the planet.

It is difficult to change a person's attitude, especially regarding environmental issues. Forcing changes is not a good solution but a good strategy with soft approaches may lead to a beneficial ending. Sometimes, it takes longer to make a change and to improve a situation. However, good intentions would normally be accepted in the long run. Malaysia is a developing country and it is advantageous for all to apply sustainable approaches along with development.

It is believed that SUDS has a good future in Malaysia but time is needed to make changes in total. There is an urgent need for good educational methods to educate the public and to supply them with information and issues on the environment. The public should also be encouraged to be involved in development proposals.



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## Appendix A: Public Questionnaire

### PUBLIC PERCEPTION AND ACCEPTANCE OF SUDS APPLICATION IN HOUSING SCHEME IN MALAYSIA

A recent investigation by the Malaysia Department of Environment into the quality of river water reported that there has been a significant increase in the number of polluted rivers throughout Malaysia. This situation has been compounded by a dramatic increase in urban flooding, which has been partly attributed to changes in urban morphology and specifically new areas of housing. Concerns regarding the contamination of rivers are particularly significant in the Malaysian context because 97% of water used originates from rivers. The Department of Irrigation and drainage has introduced a new practice manual for sustainable urban drainage or MSMA.

This questionnaire is part of a research project based at the University of Sheffield, United Kingdom, into alternatives to conventional drainage systems within housing schemes in Malaysia that aim to improve water quality, reduce flood risk and potentially increase amenity value. Such environmental-friendly systems may significantly change the visual quality of a residential area; involving greater use of open water channels, vegetation and collecting ponds. We are therefore very interested in public opinions of both the current situation and the proposed new system.

The aim of this questionnaire is to establish levels of satisfactions with current residential drainage systems. Confidentially is guaranteed. I would then be very grateful if you could spend a few moments to complete the questionnaire. If you have any questions or queries, I can be contacted as follows:

(Kajian kualiti air yang dijalankan oleh Jabatan Alam Sekitar Malaysia telah menunjukkan bahawa terdapat perincatan pencemaran air di beberapa buah sungai di Malaysia. Masalah sistem saliran di Malaysia kini telah bertambah runcing ekoran daripada peningkatan kes-kes banjir kilat di kawasan bandar. Situasi ini juga telah menyebabkan perubahan terhadap perancangan dan pengurusan di kawasan-kawasan perumahan. Hal ini perlu diberi perhatian ekoran 97% daripada sumber air bersih datang dari sungai. Jabatan Pengairan dan Saliran Malaysia telah merancang bilangan langkah bagi mengatasi situasi ini dengan memperkenalkan pelaksanaan 'sistem saliran mesra alam' (MSMA).

Sebagai kajian selidik ini adalah sebahagian daripada penyelidikan FHE di University of Sheffield, United Kingdom dalam mengkaji pandangan serta pemerhatian anda terhadap pelaksanaan sistem saliran mesra alam di kawasan perumahan. Sejalan dengan tujuan kajian ini adalah rahsia dan tidak berkaitan dengan sebarang perubahan yang akan datang. Maklumbalas yang diberi perlakuan kerahsiaan peribadi di kawasan perumahan ini. Sebarang pertanyaan dan informasi yang berkaitan dengan kajian bolehlah diajukan ke alamat yang disertakan dibawah ini:

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#### A. Personal Background (Latar belakang)

Please fill in the blank \_\_\_\_\_, or tick (✓) the suitable box, for appropriate answer. (Sila isikan ten pat kosong \_\_\_\_\_, atau tandakan (✓) pada jawapan yang bersestailar)

This information will help build up an accurate picture of the opinion of people from different backgrounds.

1. Location (Lokasi):

- Putrajaya  
 Others (Lair-lair ten pat) : \_\_\_\_\_

2. Age (Umur) –

- |  |   |
|--|---|
| <input type="checkbox"/> 16-19 years old (16-19 tahun) | <input type="checkbox"/> 35-54 years old (35-54 tahun)            |
| <input type="checkbox"/> 20-24 years old (20-24 tahun) | <input type="checkbox"/> 55 years old and above (55 tahun keatas) |
| <input type="checkbox"/> 25-34 years old (25-34 tahun) |   |

3. Ethnicity (Etnik):

- |   |   |
|---|---|
| <input type="checkbox"/> Malay (Melayu) | <input type="checkbox"/> Indian (India)           |
| <input type="checkbox"/> Chinese (Cina) | <input type="checkbox"/> Others (Lair-lair etnik) |



## Appendix A: Public Questionnaire

4. Sex (Jantina) –
- Male (Lelaki)  Female (Perempuan)
5. Educational background (Latar belakang pendidikan)–
- Primary school leaver (Tanah at sekolah rendah)
- Secondary school leaver (Tanah at sekolah menengah)
- Certificate holder (Tanah at kursus persijiliran)
- Degree holder (Graduate Universiti)
6. Homeownership status (Status penilikan rumah):
- House owner (family members included) (penilik rumah atau ahli keluarga)
- Tenant (Pegawa rumah)
7. Occupation (Pekerjaan):
- Executive (Eksekutif)  Student (Pelajar)
- Managerial (Pengawai/Pengurus)  Self-Employed (Pekerja sendiri)
- Academic (Pendidik)  Unemployed (Tidak bekerja)
- Services/Customer Support (Pelayan atau Pelanggan)  Retired (Pensara)
- Clerical/Administrative (Pegawai/Pertadbiran)  Homemaker (Surirumah)
- Tradesman/Craftsman (Penaip/Pertukangan)  Others (Lain-lain Pekerja):
- 
8. How long have you lived here? (Berapa lama telah anda tinggal di kawasan ini?)
- Less than one year (Kurang daripada setahun)  6-10 years (6-10 tahun)
- 1-2 years (1-2 tahun)  Over 10 years (Lebih daripada 10 tahun)
- 3-5 years (3-5 tahun)

### B. Satisfaction with the current drainage system (Sistem perparitan di kawasan anda)

9. Have you had any experience with the drainage problems listed below within your living area? Please tick (✓) on the appropriate answer. (Adakah anda pernah mengalami masalah perparitan yang tersenaraikan di bawah? Tandakan (✓) pada pilihan jawapan anda.)

For example, if you used to face problems with stagnant water from the drainage behind your house. It happens usually during the monsoon season, which is twice a year. (Contohnya, jika anda biasa mengalami masalah perparitan yang bertukang di belakang rumah, di mana ia kerap berlaku pada musim hujan iaitu 2 kali setahun)

	Yes (Ya)	No (Tidak)	Frequency of events (per year) (Kekerapan masalah yang dialami dalam setahun)			
			1	2	3-5	>5
Example: Still water/stagnant water	✓			✓		

	Yes (Ya)	No (Tidak)	Frequency of events (per year) (Kekerapan masalah yang dialami dalam setahun)			
			1	2	3-5	>5
a. Still water/stagnant water (Air bertukang)						
b. Mosquitoes (Nyamuk)						
c. Flash flood (Banjir kilat)						
d. Careless accident (ex. A child fell into the drainage system) (Keclaiar - Contohnya, kakak-karak terjatuh ke dalam parit)						
e. Garbage / Litter in the drain (Pembuangan sampah di dalam laluan)						
f. Drain could not absorb sufficient amount of water runoff during rainy season/days (Sistem parit tidak dapat menyerap air pada waktu/musim hujan)						
g. Drainage blockage (Parit tersumbat)						
h. Bad smell (Eau yang kurang berbau)						
i. Others (Lain-lain masalah):						



## Appendix A: Public Questionnaire

### C. Awareness of drainage-related environment problems (Kesadaran masalah berkaitan sistem perparitan)

10. Below is a list of subjects related to water, tick (✓) for the level of your concern due to your individual interest. (Daftar berikut adalah subjek yang berkaitan dengan air, tandakar (✓) pada pilihan anda berdasarkan kecerdasan perhatian anda)

		Not concerned at all (Tidak berminat)	Less concerned (Kurang berminat)	I am neutral (Tidak menyukai setarag percepat)	Concerned (Berminat)	Very concerned (Sangat berminat)
a.	Water quality deterioration - Water pollution / Oil and grease in waterways (Kerusakan kualiti air akibat daripada pencemaran)					
b.	Water-related disease – diarrhoea, cholera, dengue, malaria, and etc. (Penyakit berpunca daripada air – cirit birit, cholera, denggi, malaria, dll)					
c.	Decrease/damage of fresh water species and vegetation (Kerusakan sepesis hidupan darat dan tumbuhan air)					
d.	River sedimentation due to development activities (Pengendapan lumpur akibat aktiviti pembangunan)					
e.	Mosquitoes – A vector that spread malaria, filarial, brain fever and other viral fevers. (Nyamuk – vektor penyebaran penyakit seperti malaria, dll)					
f.	Sewage and domestic waste discharge into the river (Pembuangan sisa buangan domestik ke dalam sungai)					
g.	Flood / Flash flood event (Banjir/banjir kilat)					
h.	Litter in waterways (Pembuangan sampah ke dalam sistem air)					
i.	Alga growth / Weed infestation – Large uncontrolled weed beds can lead to reduced habitat diversity, deoxygenating and environmental perturbations. (Pertumbuhan alga dan rumput air – Tumbuhan seawater yang kawalan akar dan peredaran keupasan kepelbagai habitat air, serta gangguan kitaran alam sekitar?)					
j.	Heavy metals in waterways – A higher level of metals (lead, copper etc) in the waterways may cause an impact to drinking water quality. (Pembuangan sisa pepejal ke dalam sistem air yang mungkin mempengaruhi kualiti air)					
k.	River bank erosion (Erosi tebing sungai)					

### D. Drainage practices

11. Control-at-source is one of the techniques that needs the support of the public. The basic idea that has been described by the Department of Irrigation and Drainage in the Manual and Guideline for storm water management:

"... It is better to reduce, and where possible eliminate the causes or sources of pollution by good housekeeping (in-house management) and source control (**controlling the pollutant at its possible sources**), rather than treat the effects downstream..."

As a member of the public, how far would you be willing to participate in the list of issues raised below? Please tick (✓) on the appropriate answer and tick (✓) also if you did practice the listed method in your daily life.

For example, if you are interested to participate but need to know more or how to conduct proper waste management.

(Kawalan awal daripada punca buangan terencana diperlukan penabitan dari umum. Secara asasnya seperti yang terkandung dalam 'Manual Saliran Mesra Alam' oleh Jabatan Perairan dan Saliran:

"... adalah lebih baik berurusan punca pencemaran pada peringkat awal iaitu dengan melaksanakan pengurusan setempat dan kawalan punca, berbanding dengan melaksanakan proses penuliran pada sungai-sungai yang bermula..."

Sebagai anggota masyarakat, sejauh manakah anda akan terlibat dalam isu-isu yang disenaraikan? Tandakar (✓) pada pilihan jawapan anda dan tandakar juga jika anda sedang melaksanakan. Contohnya, anda berminat untuk melaksanakan sistem pembuangan yang betul, tetapi ingin mengetahui lebih lanjut berkaitan dengan pelaksanaannya)



## Appendix A: Public Questionnaire

	I am currently practicing it (Secang lakukan)	I am practicing it but need additional information about it (Secang lakukan tetapi masih n en erlukan n aklun at berkaitan cengan perlaksanaannya)	I will participate but I need more information about it (Fkan n elakukan, tetapi n en erlukan n aklun at berkaitan cengan perlaksanaannya)	I will participate (Fkan n elakukan)	I am not willing to do it (Tidak akan n elakukannya)
<p>Example:</p> <p>Recycle household waste – Sorting waste according to material, such as glass, paper and etc for recycling purposes. (Crtch: Fen buang san pat kitar sen ula – San pat dibuang derang n ercahkar n erikut bahan seperti kaca, dar kertas lrtuk dikitar sen ula)</p>			✓		

	I am currently practicing it (Secang lakukan)	I am practicing it but need additional information about it (Secang lakukan tetapi masih n en erlukan n aklun at berkaitan cengan perlaksanaannya)	I will participate but I need more information about it (Fkan n elakukan, tetapi n en erlukan n aklun at berkaitan cengan perlaksanaannya)	I will participate (Fkan n elakukan)	I am not willing to do it (Tidak akan n elakukannya)
a. Recycle household waste – Sorting waste according to material, such as glass, paper and etc for recycling purposes. (Fen buang san pat kitar sen ula – San pat dibuang derang n ercahkar n erikut bahan seperti, kaca dar kertas lrtuk dikitar sen ula)					
b. Using bio-degradable detergent/washing product - Bio-degradable materials are capable of being destroyed by the actions of living organism, heat, light, radiation, oxidation or a combination of these factors (ex. Non-bio washing detergent).(Fercuraar bahan peruci 'bio-degradable' – Bahan 'bio-degradable'n an pu dilupuskar n elalui tindakan sen ulajadi (Crtchrya: bahan peruci anti-bio))					
c. Animal droppings (collect and dispose animal drops in a bin) – Animal droppings from pets contain bacteria and nutrients; to avoid from throwing into the drain. A better way to prevent is by collecting the waste and dispose it in a dustbin. (Majis biratarg peliharaan/terrakar – Majis biratarg n ercahkarci bacteria dar nutriert; elakkar daripada n en buang rajis ke dalam system perparitar keraria bcleh n ercen ar kebersihar air)					
d. Organic matter or leaves (practicing organic bin – composting) – Organic matter and leaves can block drain which can cause flooding whilst rotting organic matter pollutes waterways with excess nutrients. (Fen buang bahan crgaric dar daun-daun – Bahan-bahan iri bcleh n eryebabkan system perparitar tersumbat dar bahan yarag replt jlca bcleh n ercahkar percen ar air)					
e. Reducing water-based activities – Irregular water based activities, such as car wash, irrigating garden plants, etc. (Fercuraar aktiviti berasakar air – Merjinar percuraar air, seperti n eruci kereta, n eryiran taran ar dar lair-lair)					



## Appendix A: Public Questionnaire

f. Fertiliser and pesticides – Avoid using fertiliser and pesticides in an area where they could be readily away into drains. (Eaja dar racur serarccca – Elakkar perccurraar bahar iri di kav asar yarcc berhan pirar derccar purca air n erccalir)					
g. Water recycling – Recycle used water from the kitchen for gardening and etc. (Cura sen ula air – Merccurakar sen ula air, seperti air dari n erccuci bahar n akarar urtuk dicurakar n eryiran taran ar)					
h. Rainwater tank – Storing and using rainwater. Using rainwater stored in a container for wash, gardening and etc. (Merakurc air hujan – Merccurakar air yarcc ditakurc baçi tujuar n erccuci kereta, n eryiran taran ar dar lair-lair.					

### E. Improvement to drainage system (Cacarccar r er ccertaiiki syster perparitar sedia ada)

12. Do you think that the current system in your living area should be improved? Please tick (✓) on the appropriate answer . (Ferlukah syster perparitar sedia ada diperbaiki? ? Tandakar (✓) pada pilihan jawapan anda)

- No (Tidak)  
 Yes. If 'yes', how could it be improved? (Ya. Jika 'ya', bagaimanakah ia perlu diperbaiki?)

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### Additional information (Maklumat tambahan)

13. As part of the research, we are interested in meeting with some of the residents who have completed the questionnaire. This meeting will provide an opportunity for the researcher to give more detailed information about the design and layout of an environmental friendly drainage system. There will be an opportunity for you to discuss how the new approach may affect your living environment. If you are willing to meet the researcher, please complete the section below.

Note: It may not be possible to meet each person who has confirmed their availability. However, you will be contacted to confirm whether you will or will not be interviewed, and where appropriate to agree to a suitable time to meet.

(Kani berniat untuk mendapatkan maklumat lanjut derccar n erccadakar perjunpaar derccar pihak anda. Ferjunpaar iri adalah urtuk n erccadakar n aklun at yarcc lebih terperinci berkaitan derccar syster perparitar dikav asar anda. Jika anda berniat untuk turut serta, sila isikan maklumat dalam kotak yarcc disediakan dibawah.)

Note: Pihak kani akan menghubungi anda untuk menetapkan maklumat berkaitan derccar perjunpaar.)

- No (Tidak)  
 Yes. Please fill in the required information in the box below. (Ya. Sila isikan maklumat yarcc diperlukan dibawah)

I would like to be contacted via (Please tick (✓) on the appropriate answer ), (Saya sedia dihubungi melalui, . (Tandakar (✓) pada pilihan anda))

- Email. (Please indicate your email address in the box below) (Email)  
 Phone call. (Please provide your telephone number in the box below) (Telefon)  
 Address. (Please provide your contact address in the box below) (Alamat surat-menyurat)

**THANK YOU** for your participation. Your contribution is very helpful to the study of Sustainable Drainage System application in the landscape of a housing scheme in Malaysia.

**TERIMA KASIH** di atas kerjasaan anda dan maklumat yarcc telah anda berikan. Segala sunbangan anda amatlah dihargai dan diharapkan dapat menubantu dalam penyelidikan Sistem Saliran Mesra Alam dalam aplikasi landskap dikav asar perumahan.



## Appendix B: Professional Questionnaire

### Survey of the Professionals Perception And Awareness of Sustainable Urban Drainage System (SUDS) Application in Housing Schemes in Malaysia

A recent investigation by the Malaysia Department of Environment into the quality of river water reported that there has been a significant increase in the number of polluted rivers throughout Malaysia. This situation has been compounded by a dramatic increase in urban flooding, which has been partly attributed to changes in urban morphology and specifically new areas of housing. Concerns regarding the contamination of rivers are particularly significant in the Malaysian context because 97% of water used originates from rivers. The Department of Irrigation and drainage has introduced a new practice manual for sustainable urban drainage or MSMA.

This questionnaire is part of a research project based at the University of Sheffield, United Kingdom, into alternatives to conventional drainage systems within housing schemes in Malaysia that aim to improve water quality, reduce flood risk and potentially increase amenity value. Such environmental-friendly systems may significantly change the visual quality of a residential area; involving greater use of open water channels, vegetation and collecting ponds. We are therefore very interested in public opinions of both the current situation and the proposed new system.

The aim of this questionnaire is to establish levels of satisfactions with current residential drainage systems. Confidentiality is guaranteed. I would then be very grateful if you could spend a few moments to complete the questionnaire. If you have any questions or queries, I can be contacted as follows:

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Sheffield  
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E-mail address: [lza\\_tukiman@yahoo.co.uk](mailto:lza_tukiman@yahoo.co.uk)

Please fill in the blank, or tick the suitable box , for an appropriate answer.

#### Section

1. Sex  
 Male  Female
2. Job title and nature of work:  
\_\_\_\_\_
3. Years of experience in these area:  
 Less than 2 years  6 – 10 years  
 3 – 5 years  More than 11 years
4. What areas in relation to residential drainage and management do your work impact upon?



## Appendix B: Professional Questionnaire

### Section

5. What do you consider to be the major problems with the current urban drainage systems in Malaysia? List the three most significant.
- i. \_\_\_\_\_
  - ii. \_\_\_\_\_
  - iii. \_\_\_\_\_
6. What do you consider to be the three most important problems related to drainage in residential developments in Malaysia?
- i. \_\_\_\_\_
  - ii. \_\_\_\_\_
  - iii. \_\_\_\_\_

### Section

7. Do you consider that any of the following components of sustainable drainage systems have potential in residential development? Provide a description of your general understanding of what these components are as well as their advantages and disadvantages.

	Please describe this component based on your understanding. (You may leave it blank if you do not have any description).	What are the principle advantages of this component in residential areas?	What are the principle disadvantages of this component in residential areas?
<b>a. Green roof</b> A roof with plants growing on its surface.			
<b>b. Rainwater tank system</b> A system that collects rainwater from where it falls rather than allowing it to drain away.			
<b>c. Temporary storage pond</b> To function as a water reservoir and a natural drainage basin during wet season.			



## Appendix B: Professional Questionnaire

	Please describe this component based on your understanding. (You may leave it blank if you don't have any description).	What are the principle advantages of this component in residential areas?	What are the principle disadvantages of this component in residential
<p><b>d. Natural filtration system</b> Constructed wetland e.g. reedbed.</p>			
<p><b>e. Bio-engineering techniques</b> – ex. Using vegetation as a material for stabilising sloped area.</p>			
<p><b>f. Swale</b> A shallow vegetated channel designed to conduct and retain water.</p>			
<p><b>g. Balancing pond</b> A pond designed to attenuate flows by storing runoff during the peak flow and releasing it at a controlled rate during and after the peak flow has passed.</p>			
<p><b>h. Permeable surfaces</b> A surface that water can penetrate.</p>			



## Appendix B: Professional Questionnaire

### Section

8. In your opinion, what are the main barriers to the wider application of sustainable urban drainage systems in residential areas in Malaysia? Tick (✓) any of the answer listed and please specify if you have any other suggestions or reasons.

- Public resistance to change
- Problem with diseases related to water
- Safety aspects of open water element within a housing scheme
- The climate and geology aspect is not suitable for these techniques
- There is not enough information available on how SUDS can be implemented
- Lack of interest amongst professionals
- Too expensive compared to conventional techniques
- Lack of expertise in ecological engineering in Malaysia
- Difficulty with regulations or guidelines related to drainage and water
- Others. Please specify:

9. Did you receive sufficient information on sustainable drainage system (SUDS) as outlined in MSMA for residential area?

### Additional Information

As part of the research, we are interested in meeting some of you who have completed the questionnaire. This meeting will provide an opportunity for the researcher to give more detailed information on the environmental friendly drainage system. If you are willing to meet the researcher, please fill in the information below.

Name: \_\_\_\_\_

E-mail address: \_\_\_\_\_

Correspondence address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Phone number: \_\_\_\_\_

- This research might be extended for further information. Please tick (✓) in the box if you do not wish to be contacted by the researcher.

**THANK YOU** for your participation. Your contribution is very helpful for the study of Sustainable Urban Drainage System application in the landscape of a housing scheme in Malaysia. All information will be treated with the strictest confidentiality.



## **Appendix C: Act and Regulations Related to Water in Malaysia**

### **Malaysian River and Water Legislation**

There are many acts and enactments with regards to Malaysian water and river. Some date back to over eighty years and are updated from time to time. Some are listed below:

**1. *Federal Constitutions:***

9<sup>th</sup> schedule, Item 6 of the State List (Section 5, NCL). The State Authority has absolute ownership of all lands within the boundaries of the state, and such ownership of the land includes ownership of all rivers, stream and watercourses.

**2. *National Land Code (NCL) 1965 And Waters:***

Section 5: Definitions of rivers.

Section 13: Alienation of land within fifty meters of river banks, lakes, drains or coast lines (power to alienate)

Section 49: Effects of advance or retreat of rivers, etc.

Section 62: Gazetting of river reserve for public utility (river reserves).

Section 135 (advice): Land conversion/sub-division – need to have sufficient river/drain reserves and outlet drain.

Section 70,71, 72, 73 and 74: Mining requirements.

**3. *Water Acts 1920 (Cap 146) (1989): Control Of River And Streams***

Malacca, Negeri Sembilan, Pahang, Perak Selangor and the Federal Territory of Kuala Lumpur.

The states of Kelantan, Terengganu, Johor, Perlis and Kedah have their own similar Water Enactments.

The power to issue licenses for certain purposes is with the state authority (water abstraction, diversion, etc.).

Section 2: Definition of rivers. Gazetting.

Section 3: Entire property in and control of rivers in any state is vested.

Section 4: Restoration of river banks

Section 5: Prohibits acts affecting rivers such as felling of any trees into the rivers, obstruct or interfering with any river, building any bridge, jetty or landing stage over or beside any river (width more than 20 feet) except under license.

Section 7: Prohibits diversion of water from rivers except under license.

Section 7a: Prohibits pollution of rivers, inland waters and subterranean water resources. (License, State Secretary, and Appeal Board: DID is a member)

River classification (Beneficial uses): River or stretches of river classified according to certain beneficial uses, then the required river conditions and water quality to be maintained and achieved through integrated and regular enforcement and monitoring.

Section 8: License needed to divert water which may authorize interference with state or alienated land.



## **Appendix C: Act and Regulations Related to Water In Malaysia**

**Section 14: Restriction on constructions of walls and buildings on river banks (50ft.) or within flood channels.**

For Sarawak, Sarawak Land Code (Cap 81): The State owns sole property in rivers, streams, lakes and water courses. The Sarawak Riverine Transport Bill (1993) also addresses water issues in Sarawak and management of them.

For Sabah, The Sabah Land Ordinance(Cap 68): State has sole property of rivers.

**4. *Ministerial Functions Act 1969: The role of DID in river management is on flood mitigation and river conservancy.***

**5. *Local Government Act (1976): (Peninsular) – Similar acts for Sabah and Sarawak.***  
Section 69, 70 and 71: Power for local authority to recover any expenses incurred in carrying out any work as a result of any person who commits a nuisance or deposit any filth and to also preserve public health.

Section 73(a)(ii) and (b)(i): Gives power to make amend or revoke by-laws to keep public places (including rivers) free from filth and also to preserve public health.

Section 101(ee): Power to divert, strengthen, define and canalize the course of any stream, channel and watercourses subject to the consent of the appropriate authorities.

Section 101(v): Local authority is given power to do all things necessary for or conducive to public, safety, health and convenience.

**6. *Earthwork Bylaws:***

Power for local authority to control earthworks being carried out so as to prevent soil erosion, disturbance and pollution (air and water).

Need to be gazetted by the State Government and adopted by individual local authorities.

**7. *Streets, Drainage and Building Act 1974 (1994):***

Section 50: Local authority to construct and maintain drains and watercourses.

Section 51: Local authority may recover cost of improving and making drains and watercourses.

Section 52: Prohibition against building unless provision made for drains and water courses.

Section 53: Local authority to repair and alter of discontinued, closed or destroyed drains and water courses.

**8. *Town and Country Planning Act 1976:***

Section 8: Preparation of draft structure plans (incorporation of river reserve, river frontage development, flood levels, etc.)

**9. *Environmental Quality Act 1974 (1985)***

Section 21: Power to specify acceptable conditions for the discharge or deposit of wastes

Section 25: Inland water pollution control. Prohibits any discharge or deposit of any wastes (unless licensed) into any inland water including rivers, streams, drains, lakes, etc. Prohibits any raising or lowering of receiving water temperature by more than the prescribed limits.

Section 51: Power to make regulations.

**10. Environmental Quality Regulations (Prescribed premises, Sewage and In Effluent): Crude Palm oil (1977), Raw Natural Rubber (1978), Sewerage Industrial Effluent.**