IRRIGATION MASTER PLAN FOR PUTRAJAYA

FINAL REPORT

Volume II - Main Report

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IRRIGATION MASTER PLAN FOR PUTRAJAYA

FINAL REPORT

Volume II – Main Report

1. INTRODUCTION

The Putrajaya development boundary encompasses 4,400 hectares and the whole project area is represented by 20 precincts as shown in Map 1 (Volume I - Executive Summary Report).

Putrajaya will be developed in phases viz 1A, 1B and 2, and is expected to complete by year 2010.

The scope covered in this Final Report comprises the following:

- Identification of irrigation areas in each precinct. The irrigation areas had been classified in accordance to use class order and are grouped into public as well as private realms respectively.
- Determination of plant water demand at various growth stage and development phasing from year 2000 to 2010.
- Hydrological studies and assessment of Putrajaya Lake draw down due to various irrigation demand scenarios.
- Identification of water sources including groundwater.
- Water quality assessment.
- Formulation of irrigation and landscape strategies.
- Identification of intake points.
- Evaluation and recommendation of irrigation options and concept design.
- Integrated Irrigation Management System (IIMS)
- Legal requirement on irrigation practices, policy and guidelines for irrigation infrastructure development.
- Checklists for irrigation development approval.

2. HYDROLOGY

Hydrological studies were carried out to assess the climatic conditions in Putrajaya which would affect the crop water requirements of plants in the area and to estimate the flows into lakes, ponds and other water storage system planned for Putrajaya. In addition, the hydrology of Sungai Langat was also examined as it is considered a potential source of external water supply nearby. Hydrology of nearby river basins will serve as a check on results obtained for Putrajaya.

Past studies on hydrology had been carried out for Putrajaya and this include the Putrajaya Lake Development Study by Minconsult et al (1996), the Catchment Development and Management Plan for Putrajaya Lake by NAHRIM et al (1999) and their results were treated as a source of additional information which we could build on under this study and they also serve as a reference for cross-checking our results.

2.1 General Hydrology

Sungai Chuau is the main river flowing through Putrajaya and is the main source of water for the Putrajaya Lake. The catchment of Putrajaya is 32 km^2 at the present temporary dam (phase 1A) and is 60 km^2 if the catchment up to the downstream main dam site (phase 1B) as shown in Figure 2.1 is considered.

The annual rainfall in Putrajaya is about 2200 mm. Rainfall is slightly higher during March, April and October, November, December (see Figure 2.2). Pan evaporation recorded at Prang Besar shows a fairly even evaporation rate of 4.8 mm/day. The potential evapotranspiration (Eto) estimated from Perkhidmatan Kajicuaca's climate data is 3.64 mm/day.

Except for a brief period of data collection (1994), there is no other runoff data available for analysis. Estimates of annual runoff based on other river basins nearby shows that the average annual runoff is 800 mm to 1200 mm.

2.2 Rainfall Analysis

Of particular interest to this study is the distribution of rainfall in Putrajaya, the number of consecutive dry days when irrigation would be required and water storage critically depleted. Rainfall data is also required to estimate flows into proposed rainwater harvesting systems and the Putrajaya Lake.

Daily rainfall data were obtained from Jabatan Pengairan dan Saliran (JPS)'s hydrological database for this study. The rainfall stations are listed in Table 2.1 below.

Table 2.1 Existing Rainfall Station Around Putrajaya

JPS Station number	Location	Average Annual Rainfall
2917001	Stor JPS Kajang	2036 mm
2917106	Ladang West Country	2319 mm
2916001	Prang Besar	2148 mm
2816112	Ladang Galloway	2087 mm

The annual average rainfall is slightly lower than the overall average rainfall in Peninsular Malaysia which is about 2500 mm. The monthly rainfall distribution indicates that rainfall is slightly lower in the months of Jun, July and August but the severity of drought is not as extreme as that experienced in the northwestern part of Peninsular Malaysia.

2.3 No-Rain Days Analysis

Of the four rainfall stations only the stations at Ladang West Country and Ladang Galloway have long-term records for reliable statistical analysis as tabulated in Table 2.2 and 2.3. No rain days analysis shows that on the average the number of consecutive days of zero rainfall is 15 days. The analysis was extended to categorise rainfall less than 5mm/day and 10mm/day as no-rain day. The results of no-rain day's analysis are presented the following Table 2.4.

Table 2.4 **Results of No-Rain Analysis**

	Average	10-yr	20-yr	50-yr
Number of consecutive days of rain				
0 mm/day	15	20	22	24
< 5 mm/day	22	31	33	36
< 10 mm/day	29	40	43	47
< 15 mm/day	36	50	55	67
Total days of rain				
0 mm/day	204	–	–	–
< 5 mm/day	264	–	–	–
< 10 mm/day	290	–	–	–
< 15 mm/day	310	–	–	–

2.4 Stacked Frequency Analysis Of Rainfall

Stacked frequency analyses are normally carried out on flow data. The methodology involved is clearly documented in Twort et al (1994). This methodology was extended to analyse cumulative monthly rainfall data so as to determine the cumulative rainfall depth during drought periods of various durations i.e. 1-month, 2-month 3-month etc. The probability distribution used to fit the data is the 3-parameter log-normal distribution. Again only the data from Ladang West Country and Ladang Galloway were analysed as the amount of data from this two stations are substantial. Results of rainfall frequency analysis are as shown in Figures 2.3 and 2.4. These curves coupled with suitable rainfall-runoff relationship could be used to determine flows into proposed storage systems during drought periods.

2.5 Estimation Of Potential Evapotranspiration

Potential evapotranspiration (Eto) values are required for estimation of crop water requirement and hence the irrigation demand. Annual evapotranspiration in the country varies between 1000 mm to 1600mm. The highest Eto in Peninsular Malaysia occurs in the Kedah area.

Eto values were computed using climate data extracted from Perkhidmatan Kajicuaca Malaysia's annual publications. The Penman-Montieth method was used to estimate Eto. Adjustment had to be carried out to reduce the wind speed data to equivalent wind speed at 2m above ground level. (PKM's station measures wind speed at 10 m above the ground level) before being used in the Penman-Montieth equation of Eto estimation. Details on Eto data and its derivation are presented in Table 2.5.

Pan evaporation data from JPS's stations at Prang Besar was also obtained. A factor of 0.75 was multiplied to JPS's pan evaporation values to convert them to Eto values.

2.6 Rainfall-Runoff Analysis

It is necessary to estimate the runoff in Putrajaya as this would be the main source of water to the Lake and to rainfall harvesting ponds. The only runoff data available within Putrajaya is from the pressure bulb recorder at Putrajaya's temporary weir. The daily runoff records between March and November 1994 were extracted by NAHRIM and these values were used to calibrate a rainfall-runoff model for Putrajaya Lake. The main purpose is to derive a long series of daily runoff records, which would be useful for irrigation simulation studies.

The model used is the Institute of Hydrology U.K's lumped catchment model (Blackie and Eeles 1985). A schematic of this model is as shown in Figure 2.5.

Model parameters adopted are tabulated in Table 2.6.

The calibration exercise attempts to fit the simulated hydrograph to the observed hydrograph. The result is as presented in Figure 2.6. In fitting the model, it was found that the observed flow at Prang Besar is extremely low. In order for the model to fit the observed hydrograph better, the evapotranspiration parameters FS and FC would have to be increased and the annual flow would be about 300mm as tabulated in Table 2.7, a value which we felt is unreasonable. Hydrology of nearby rivers indicates that the annual flow in most catchment in Selangor is about 1000 mm. The model adopted at this stage of the study yields 800mm of runoff per annum, which is slightly on the conservative side. Finally the calibrated model was used to generate the daily flows from 1948 to 1998 using rainfall data from Ladang West country. The graph of daily inflows simulated using the model is presented in Figure 2.7.

2.7 Derivation Of Low Flow Sequences

Synthetic low flow sequences of various durations were derived for reservoir simulation studies. The flow sequences were derived using the nested low-flow frequency analysis where low flows of various durations are plotted in a single graph. Detailed documentation of this method can be found in the textbook on Water Supply by Twort et al (1994). The advantage of this technique is that the synthetic drought sequence derived contains within it droughts of every duration from 1 to 12 months all of which has the same drought recurrence interval. No assumptions, therefore, need to be made on the critical duration of drought or the relative severity of historical drought of different durations (Walsh, 1987).

The procedure adopted for deriving the monthly low flow sequence is as follows:

- Annual series of 1-day low flow, 3-day low flow, etc up to 365-day low flow were extracted from historical monthly flow records.

- The annual series of flows were ranked in ascending order

- The plotting position of the low flows were computed using the Blom's plotting position formula

$$P = \frac{M - 0.375}{N + 0.25}$$

where P is the probability of non-exceedance
M the rank of the data and
N the number of data

- Attempt was first made to fit a 2-parameter log-normal distribution to the data. The best fit frequency distributions were derived using the frequency factor method (Chow et al, 1988)

If it is visually obvious from the plot that the fitted distribution should not be a straight line,

3. LAND USES

The land uses described in this report are based on information collected from Perbadanan Putrajaya. As the development is ongoing and land used are subject to changes, the discussion on land uses are based on Map 1 (Executive Summary).

3.1 Land Use Distribution

With the prevalent theme of the "City in a Garden", keeping the open spaces within the public and private realms in a reasonable and acceptable "green" condition are paramount. At the public realm level, open spaces are provided in the form of planned metropolitan parks; urban parks like the *dataran, halaman,* street piazzas and courtyards; waterfront promenade; city, local and neighbourhood playing fields and recreational grounds and roadside green connectors or landscaped buffers. At the development parcel level for public facilities, open space is in the form of planned, manicured and landscaped lawns. At the private realm level, open space is in the form of gardens and roof gardens within residential and commercial areas.

Government institutional land uses, comprising areas designated for government reserves and offices, official residences and other institutional use, total about 271 hectares. It is, however, open space (excluding Putrajaya Lake and the wetlands) that remains the largest land use component of the new city comprising approximately 1133 hectares of the overall land use budget. Public amenity facilities take approximately another 400 hectares. These include facilities for religion, education, health, sports and recreation, civic and cultural uses, cemetery, police, emergency response and rescue services and neighbourhoods services centres. Generally, public utility facilities constitute only 71 hectares (excluding the existing Semenyih Water Treatment Plant and planned water detention ponds in Precincts 9, 11, 14 and 20). These facilities include TNB reserves, water reservoir reserves, sewage treatment plants and other utility reserves. Refer to Table 3.1.

Areas designated for commercial use and service industry comprise 151 hectares and 5 hectares respectively. Residential uses make up the second largest category of uses, covering an area of approximately 911 hectares.

Major and secondary roads (U2, U3, U4 and U5) cover approximately 62555m of roadway, within and outside which are landscaped buffer zones and street planting reserves of varying widths.

3.2 Planning Of Irrigation Areas

The amount of water required to maintain these public and private open spaces is tremendous. Drawing upon the Putrajaya Lake system as the major source of irrigation water supply would impose unreasonable pressure on the lake system whose primary design intention is to act as the "ultimate sink and treatment system" for water discharging into the lake from the surrounding urban growth of Putrajaya. Its other key role is to enhance the aesthetics of the whole development including promoting multifarious water-related recreational and commercial activities.

Legislative and planning regulatory controls are presently in place to control activities and use of the Lake and its land reserve and to ensure that the quality and design integrity of both the water and the lakefront are maintained.

Along the same thinking, the current Irrigation Master Plan study aims to formulate rational ground rules for the extraction of water from the lake as well as a physical planning framework and accompanying guidelines to coordinate and regulate land planning efforts with a sustainable and practical irrigation system.

3.2.1 Inventory Of Areas For Irrigation

An inventory of areas in the public and private realms that require irrigation as well as their development schedule within the overall land development programme is listed in Appendix SC.

The land use areas are identified and inventoried by precincts and according to the Use Class Order to facilitate water demand estimation and design of the irrigation system, i.e. locating water intake points, ascertaining the size of each irrigation catchment area and reticulating the irrigation network. Refer to Map 1 (Irrigation Areas by Use Class).

3.2.2 Critical Use Areas And Routes

Not all land use areas within the new administrative city merit the same degree of irrigation intensity or duration. For purpose of rationalizing the distribution of available irrigation water and without placing undue pressure on the Putrajaya Lake system and sewage treatment plants, land use areas within the public realm are to be given priority over the private realm. These public realm areas are to be given priority in the event of severe or protracted drought. These areas include the following:

1. Class II(a) Government institutional facilities in Precincts 1, 2, 3, 4, 10, 14 and 16.
2. Class II(g) Public sports and recreation facilities in Precincts 5 and 11.
3. Class III(a) Metropolitan parks in Precincts 1, 2 and 13
4. Class III(a) Urban parks in Precincts 1, 2, 3 and 4
5. Class III(c) Civic areas in Precincts 1, 2, 3 and 4
6. Class VI(a) Road reserve (only the landscape buffer zones of U5, U4 and U3 roads)

3.2.3 Allocation Of Nurseries

As required by Putrajaya, a nursery is planned and allocated in each precinct. The size of the nursery is either approximately 1-2 acre per precinct or the intended supply requirement of the nursery for example, in Precinct 13 and 20.

4. HORTICULTURAL AND LANDSCAPE STRATEGIES

4.1 Introduction

In addition to the irrigation strategies that has been previously described, it is also important to look at the horticultural and landscape strategies in the study of Putrajaya Irrigation Master Plan. One of the objectives of this irrigation study is to prepare guidelines that would enable Perbadanan Putrajaya to formulate ways to overcome the shortage of irrigation water should the situation arise. The horticultural and landscape strategies that will be proposed shall consider the public realm, which comprised of all public parks and civic areas, government institutional reserves and road reserves.

4.2 Characters of Parks

To have a better understanding of the scope of works involved, the character and theme of each park needs to be studied before the horticultural and landscape strategies can be formulated.

A broad description of each character and theme of the parks has been provided in the Urban Design Guidelines. Therefore, based from the Urban Design Guidelines, the following description shall give a summary of the character of parks in Putrajaya.

Taman

- The taman shall have a lowland rainforest character with a composition of dominant species, hardwood and mixed forest species
- The mixed forest tree species shall provide the middle storey and lower storey lowland rainforest stratification
- Forest regeneration: The higher peaks within the taman shall be reafforested with a broad variety of indigenous lowland rainforest species. The plant material initially planted shall create a basic framework and through succession shall eventually grow into a lowland *rainforest ecosystem.* The planting strategy shall allow for the creation of diverse habitats.
- Examples: Taman Rimba Alam, Taman Warisan Pertanian, Taman Wetland.

Ridge Line Parks

- It is intended that the ridge-line parks shall have a naturalistic landscape character and vegetation species composition.
- Regeneration of a hardwood forest will assist with habitat creation.
- The plant material initially planted shall create a basic framework and through succession shall eventually grow into a lowland rain forest ecosystem.
- Examples: Taman Rimba Desa, Taman Saujana Hijau, Taman Puncak Banjaran, Taman Selatan, Metropolitan parks, Taman Lindungan

Dataran

- The dataran represent a series of special events along the linear boulevard, created by a widening of boulevard and being defined by the surrounding
- The dataran are intended to be places for people in relation to scale and function and shall be punctuated by various events and activities which shall include, water features, sculpture, performance stages and shaded seating areas
- The dataran shall have its own individual characters and themes in order to reflect their location along the boulevard.
- The dataran shall be framed by trees and the paving pattern providing a strong spatial arrangement for the spaces
- Examples: Dataran Putra, Dataran Wawasan, Dataran Putrajaya, Dataran Rakyat and Dataran Khazanah.

Based from the previously described characters and themes of the public realm areas and the level of development that has already taken place, the following paragraphs shall describe the horticultural and landscape strategies that shall be adopted. These strategies shall be considered in relation with the irrigation strategies.

4.3 Public Realm

According to the Use Class Order, the open spaces belonging to the public realm are classified as Metropolitan Parks, Urban Parks, City and Local Parks, Civic Areas, Government Institutional Reserves and Road Buffer. The following paragraphs shall explain the proposed strategies according to the use class order.

4.3.1 Taman

Taman is classified as the metropolitan parks in the use class order. Taman is intended as major public spaces that serve the population of the whole city. The wide-open spaces shall act as a green 'lungs' for the city and consists mainly of naturalistic reforested landscape. It shall have a natural lowland rainforest character with a composition of dominant species, hardwood and mixed forest species.

Strategies

However, the drought tolerance factor of plant species should be considered as part of the design factor in the selection of plant materials. It is a relevant factor to consider since the water demand of these plants is lower and one of the objectives of this study is to find alternatives to save water should there be an event of water shortage or dry seasons. Since there are parks that have not been designed or are still in the early stage of design development, park designers are encouraged to look into this factor in their design.

After reviewing the list of plants as indicated in the Urban Design Guidelines, it is recommended that the following list of plant materials should be considered as an addition to the list due to their drought tolerant characteristics:

1) *Ficus benjamina*
2) *Ficus elastica*
3) *Tamarindus indica*
4) *Peltophorum pterocarpum*
5) *Cinnamomum iners*
6) *Dillenia indica*
7) *Pandanus spp*

A list of drought tolerant plant has been prepared in Table S1 (Executive Summary) and can be used as reference.

The open space categorised as Tamans are as follows:

i) Taman Botani (Precinct 1)

Since Taman Botani is in the advanced stage of development, it is suggested that the existing irrigation system to be used. The landscape design of the Taman Botani need not have to change.

ii) Taman Putra Perdana (Precinct 1)

Similar to Taman Botani in terms of physical development, the irrigation system that has been designed for Taman Putra Perdana shall be adopted for the existing landscape design.

iii) Taman Wawasan (Precinct 2)

The Taman Wawasan is presently being designed together with the irrigation system. Since it is located close to the lake, the irrigation design has been proposed to utilise water from the lake. Wherever possible, it is recommended that the landscape design should consider incorporating drought tolerant plant species if the plants selected could justify the design theme.

iv) Metropolitan Park (Precinct 4, 5 & 6, 17)

Similar to Taman Wawasan, the Metropolitan Parks at Precinct 4, 5 & 6 and Precinct 17 are located near water sources. Therefore the provision of water from the irrigation main should be able to provide sufficient water to the parks. Although the strategy is not intended to curb the selection of plant materials, the park designers are encouraged to utilise the drought tolerant plants where possible without affecting their design to help to conserve water.

v) Lake Valley Park (Precinct 8)

Since it is fully developed and located next to the lake, it is suggested that no change should be done to the landscape area. The lake will supply irrigation water.

vi) Taman Rimba Desa (Precinct 9)

It is located on high and undulating ground that irrigation facilities are hard to install. Therefore, it is suggested that a reafforestation concept be adopted. It is a concept whereby the saplings of forest plant species are planted in between the existing oil palms. The oil palms shall act as a cover to assist the growth of the saplings. Eventually, as the forest plants grow bigger, the oil palms are then removed gradually from the place. Rainfall will be used as the source for irrigation.

vii) Taman Saujana Hijau (Precinct 11)

Due to undulating and high ground of Taman Saujana Hijau, the irrigation system is difficult to design and requires a high capacity pump to bring water to the irrigation network. Therefore, it is recommended that the planting scheme of this park should take into consideration location and physical characters of the landform. Similar to Taman Rimba Desa, the reforestation concept is proposed as the landscape strategy for this taman. Thus, no permanent irrigation facilities will be proposed.

viii) Taman Wetland (Precinct 12, 13)

No amendment is proposed on the landscape design as implementation is currently ongoing it is completed. The plant species selected for both the wetland zone and the zone of intermittent inundation is able to self-sustain and perpetuate themselves after a period of drought. Hence, a permanent centralized irrigation system is not required for both the zone of intermittent inundation and the macrophytic zone.

ix) Taman Rimba Alam (Precinct 14 & 15)

Similar to Taman Rimba Desa and Taman Saujana Hijau, the landscape strategy for Taman Rimba Alam is proposed to adopt the reforestation concept. No permanent irrigation system will be required.

x) Taman Warisan Pertanian (Precinct 16)

Since Taman Warisan Pertanian is in the advanced stage of development, it is therefore suggested that no change is proposed in the landscape design. The designed system will be adopted and irrigation water will be supplemented by trucking where necessary.

xi) Riparian Park (Precinct 16)

Since the design for Riparian Park is completed, it is recommended that the landscape design to be maintained. It is a self-generating park and thus, plants will rely solely on the lake for their water supply.

xii) Taman Puncak Banjaran (Precinct 18)

The development stage of Taman Puncak Banjaran is still in planning stage. Owing to its hilly topography, it is preferred that the park be reforested similar to Taman Rimba Desa such that permanent irrigation facilities are not required. However, currently it has been decided to landscape the park by PPJ. Owing to this strategy, irrigation facilities will therefore be required.

xiii) Taman Lindungan (Precinct 19)

Similar to Taman Puncak Banjaran in Taman Lindungan is still in preliminary stage of planning. Since it is sited on hilly ground, it is preferred that the park to maintain its natural habitat and reforestation concept similar to Taman Rimba Desa, such that permanent irrigation facilities are not required. However, currently it has been decided to reforest the park with bamboo and palm by PPJ. Owing to this strategy, irrigation facilities will therefore be required.

xiv) Taman Selatan (Precinct 20)

Similar to Taman Rimba Desa is still in preliminary stage of development. The park is located on high and undulating ground, it is therefore proposed the landscape strategy to adopt the reforestation concept.

4.3.2 Urban Parks, Civic Areas and City and Local Parks

The urban parks, civic areas and city and local parks refer to public open space that shall be accessible to the public.

- The plant of that type of space shall be hardy but with high visual impact as the environment is harsh.
- Strong architectural formed plant species shall be used in the pedestrian malls and plazas.
- Palm trees shall be used for tight urban spaces.

Strategies

Horticultural and landscape strategies for urban parks, civic areas and city and local parks shall be based on the above characters. These strategies shall be considered in relation with the irrigation strategies.

Similar to the strategies proposed to the Taman, the long term planning of Urban Parks, Civic areas and City and Local Parks shall take into consideration that only shrubs will be irrigated continuously. Trees, palms and grass will not be irrigated upon their establishment and shall depend on rainfall.

Drought tolerant plants shall be considered as part of the design factor in the selection of plant materials to reduce the demand for irrigation water as well as to reduce the cost for irrigation.

The recommended plants for those areas are as follow:

i) *Bauhinia pupurea*

ii) *Caesalpinia ferrea*

iii) *Swetenia macrophylla*

iv) *Tabebuia pentaphylla*

A list of drought tolerant plant has been prepared in Table S1 (Executive Summary) and can be used as reference.

The area includes:

i) *Urban Park (Precincts 1, 2, 4, 5 & 6, 8, 9, 16, 18, 19)*

a) Development was completed and existing irrigation system was installed. It is suggested that no change shall be done on landscape and existing irrigation system will be used for irrigation purpose – Precinct 1.

b) The development is still in preliminary stage. Although its location is nearby to the irrigation main line, it is recommended that drought tolerant species be planted. Irrigation water will be tapped from supply main for irrigating the plants. – Precinct 5 & 6

c) Development is in the progress of planning. Its location is adjacent to the irrigation main line or lake; drought tolerant species will help reduce demand. Irrigation water will be tapped from supply main or lake. – Precinct 2, 4.

iii) *City and Local Park (Precincts 2, 4, 5 & 6, 7, 8, 9, 10, 11, 12, 14/15 & DE, 18, 19)*

a) It is surrounded by construction or road system. JBA water or pipeline where possible is recommended to be used as irrigation water source. – Precinct 7, 8, 9, 10

b). The planning and construction of the area is still in progress. Drought tolerant species are suggested to be planted to conserve water. Irrigation water will be supplied by trucking or JBA main – Precinct 11 c). Where water sources/lake or pipe mains are adjacent to the landscape areas, irrigation water will be supplied by nearby supply main or lake – Precinct 2, 3, 4.

d). Planning is still in preliminary stage. Due to its location nearby to the irrigation main line or storage pond, no constraint in the selection of plants is required. However, park designers are encouraged to select the drought tolerant plants in their design to reduce the water demand. Irrigation water can be tapped from the irrigation supply main. – Precinct 5 & 6, 12, 14/15 & DE, 18, 19.

iii) Civic areas (Promenade Precinct 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 16, 17, 18 & 19) and Boulevard (Precinct 2, 3 & 4)

a) Refers mainly to the promenade and the boulevard. Due to the importance of the areas as in the case of the boulevard, and the close proximity to water source for the promenade, in areas yet to be developed, it is not necessary to impose constraints to the landscape designer in the selection of plants. This is due to the proximity of water supply for irrigation to the area. However, park designers are encouraged to select the drought tolerant plants in their design to reduce the water demand. Irrigation water can be tapped from supply main or lake.

4.3.3 Government Institutional Reserves

Government institutional reserves are broadly classified as public amenities and public utilities facilities.

4.3.4 Public Amenities

Public amenities (all precincts except 1 and 13) refer to hospitals, schools, universities, police station, fire station, cemetery and sport facilities. They shall have the landscape with both functional and aesthetic resources. The planting within public amenities shall be a combination of Ethno-botanic and ornamental species.

- The planting shall integrate the institutional developments with their surrounding and diminish the institutional appearance.
- Mixed and dominant species shall be used at the planting at educational establishment.

- Buffer zone shall be provided for the police station.
- Aesthetically pleasing large umbrella shaped trees shall be provided for sport facilities.

Strategies

Similar to the strategies proposed to the Taman, the long term planning of Urban Parks, Civic areas and City and Local Parks shall take into consideration that only shrubs will be irrigated continuously. Trees, palms and grass will not be irrigated upon their establishment and shall depend on rainfall.

Factor of drought tolerance of plant species shall be considered when designing the areas. This is for the purpose of saving water or dealing with water shortage and dry seasons if any of them occur.

The drought tolerant species that have been selected from the UDG plant list for residential areas are as follows:

i) *Cassia fistula*
ii) *Cinnamomum iners*
iii) *Samanea saman*
iv) *Delonix regia*
v) *Lagerstroemia speciosa*
vi) *Michelia alba*
vii) *Casuarina sumatrana*

The list of drought tolerant plant in Table S1 (Executive Summary) can be used as reference.

4.3.5 Public Utilities

The public utilities refer to reservoirs, sewage treatment plant, water treatment plant, electrical sub-station, electricity pylons, gas station, radio tower and public NGV. The landscape shall provide visual screens and additional security zones between the utilities and other land uses.

- Small spreading trees and palms shall be planted for the small utility facilities.
- Dense trees and shrubs shall be planted for the large utility facilities.
- Tall dense trees shall be planted for "mega-structures".

Strategies

The long term planning of Public Utilities shall take into consideration that only shrubs will be irrigated continuously. Tree, palms and grass will not be irrigated upon their establishment and shall depend on rainfall.

Any strategies that will be implemented shall be based on the characters of the public utilities. Drought tolerant species should be considered in designing public utilities. Its purpose is to provide less water for the plants and thus, reduce the cost for maintaining the landscape areas.

The drought tolerant species that have been selected from the UDG plant list for residential areas are as follow:

i) *Cinnamomum iners*

ii) *Erythrina variegata*

iii) *Lagerstroemia speciosa*

iv) *Michelia alba*

The list of drought tolerant plant in Table S1 (Executive Summary) can be used as reference.

The areas include:

i) Completed public utilities that fall within the no dig policy. Thus, no change shall be made on the landscape. JBA water are suggested to be used as irrigation water – Precinct 1, 8, 9, 10, 16. However, for water conservation and reduce maintenance cost, these areas should plant drought tolerant plants in future replanting exercise.

Public utilities that are still in preliminary stage or planning progress are recommended to be planted with drought tolerant species. Irrigation water will be tapped from nearby water sources. -- Precinct 4, 5 & 6, 11, 12, 14, 17, 18, 19, 20

4.3.6 Road Side and Buffer Zone

Roadside landscape and buffer zone are to contribute to a reduction in adverse environmental impacts created by roads, such as noise and air quality.

- The vegetation shall reflect a distinct character for each of the roads, which depends on the road hierarchy.
- Road corridor can be created as an ideal habitat for wildlife, especially along primary distributor road where human access is not actively promoted and reserves are wide enough to allow substantial belts of structure planting.
- Indigenous species shall be selected in associations that replicate natural habitats.
- Bio-diversity of indigenous species shall be promoted.

Strategies

Horticultural and landscape strategies for roadside and buffer zone shall be based on the above characters. These strategies shall be considered in relation with the irrigation strategies. Similar to the strategies for other public areas, only the watering needs of shrubs will be considered in the long run.

Basically, to reduce cost and time for transporting irrigation water, drought tolerant plants should be considered in the landscape design of roadside and buffer zone. After analyzing the plant list as indicated in the UDG, the following plants are recommended to be used as a guide when developing the planting plan:

i) *Cinnamomum iners*
ii) *Erythrina variegata*
iii) *Gardenia carinata*
iv) *Lagerstroemia speciosa*
v) *Michelia alba*
vi) *Tabebuia pallida*
vii) *Delonix regia*
viii) *Samanea saman*

However, this list is not exhaustive because to further assist the designers, the list of drought tolerant plant in Table S1 (Executive Summary) can be used as reference.

The road side and buffer zone includes:

i) Road reserves that are completed or almost completed in construction. Owing to no dig policy, landscape design is suggested to remain and irrigation will be done by trucking – Precinct 16. To reduce cost for trucking, drought tolerant plant should be considered in future replanting exercise or reduce planting as what currently practise for the oval road in Precinct 1.

ii) Road reserves that are partly completed and constrained by no dig policy. Since it is partly completed, landscape designers are recommended to utilise drought tolerant plants in their design. Irrigation will be sourced from the pipeline with pipe - jacking where necessary to cross paved roads. – Precinct 1, 7, 8, 9, 10 & 13

iii) Road reserves that are still in the progress of planning. Drought tolerant species are suggested to be planted in order to conserve water. Lake or rainwater harvesting will be the resources for irrigation purpose – Precinct 5 & 6, 11

iv) Road reserves that are adjacent to lake or supply main and where the CUT is still under design stage. Pipe for irrigation purpose will be proposed beside or in the CUT. Irrigation water will be tapped from the lake. To conserve irrigation water for new development area, drought tolerant plants are recommended for – Precinct 2, 3, 4, 18

v) Road reserves that are in the stage of preliminary planning. Since they are nearby to the irrigation main line, it is suggested that irrigation water will be tapped from supply main. Drought tolerant plants are recommended for – Precinct 12, 17, 14 & 15, 19, 20.

4.3.7 Nurseries

The land use plan has allocated a nursery in each precinct as requested by Perbadanan Putrajaya. It is however noted that in some of the precincts no dig policy is in place, and these precincts have inadequate water resources. For this reason, irrigation has to rely on JBA supply, which may not be reliable in time of drought. It is therefore proposed that nurseries in Precinct 3, 7, 9, 10, 11 and 16 be relocated to other precincts where sources of water is reliable such as near to the Sewage Treatment Plant, or near to retention ponds.

4.4 Private Realm

According to the Use Class Order, the open spaces belonging to the private realm are classified as Residential and Commercial areas. The following paragraphs shall explain the proposed strategies according to the use class order.

Residential Landscape

Residential landscape shall comprise of a variety of plant species that reflect and enhance the overall character of each neighbourhood. Each neighbourhood shall have its own distinct planting theme using different plant species, colour or particular maintenance regime.

- The use of variety of indigenous species is encouraged.
- All roads shall have indigenous tree planting which consists of appropriate species not prone to causing damage to the roads and paths.
- Neighbourhood entrance shall feature ornamental planting creating a colourful entry statement.
- Planting shall be located at the rear and side boundary of the individual lots.

Strategies

Drought tolerant species shall be considered in designing residential landscape especially in the situation that no irrigation facilities are provided. This is because all residential areas are considered as private area. The purpose of planting drought tolerant species is to reduce the demand for irrigation water to maintain the landscape areas.

To reduce the water demand further, upon establishment of the plant materials that has been planted, only shrubs will be irrigated continuously in line with the long term strategies for the public areas.

The drought tolerant species that have been selected from the UDG plant list for residential areas are as follow:

i) *Bauhinia pupurea*
ii) *Ficus benjamina*
iii) *Plumeria spp*
iv) *Tabebuia rosea*
v) *Delonix regia*
vi) *Erythrina variegata*
vii) *Samanea saman*

The list of drought tolerant plant in Table S1 (Executive Summary) can be used as reference.

The residential area includes:

i) Strata-titled property (All Precincts except 1, 2, 3, 4, 18)

ii) Landed-tilted property (All Precincts except 1, 2, 3, 4, 5 & 6, 20)

iii) Both of the above areas are private area and no irrigation facilities will be provided. Thus, rainfall harvesting and JBA water is suggested to be used for irrigation water.

iv) Commercial centres (All precincts)

All commercial centres are private areas and no irrigation system will be installed. Rainfall harvesting in conjunction with JBA water are suggested to be used for irrigation water.

Drought tolerant plants are recommended to be planted.

Neighbourhood Centre

The neighbourhood centre (Precinct 8) shall function as a central meeting space for the residents, and shall encourage interaction with nature on a local scale.

- The vegetation of neighbourhood centre shall be a combination of ornamental flowering plants with emphasis on fragrant flowers, mix forest tree and colourful shrubs.
- Ornamental colourful planting shall be provided at the entrance. Each entrance shall have a distinct different landscape approach or character design around a dominant species or colour.

Strategies

Since it is a private area, irrigation water will not be provided from the main irrigation pipe. However, water demand for the area has been calculated and JBA water will be used for plant irrigation purpose. Drought tolerant species are recommended to be used to reduce the irrigation demand from JBA. Again, only shrubs will be irrigated upon establishment of the soft landscape for purpose of long term water conservation measures. The list of plant species listed is extracted from UDG, which was categorised as drought tolerant species. However, the list of drought tolerant species in Table S1 (Executive Summary) can be used as reference.

i) *Bauhinia pupurea*

ii) *Ficus benjamina*

iii) *Plumeria spp*

iv) *Tabebuia rosea*

v) *Delonix regia*

vi) *Erythrina variegata*

vii) *Michelia alba*

viii) *Michelia chempaka*

ix) *Samanea saman*

x) *Peltophorum pterocarpum*

4.5 Water Conservation In Horticultural Practice

Mulching Mat From Oil Palm Empty Fruit Bunches*

Introduction

Mulching with oil palm empty fruit bunches (EFB) in newly established plantations (mainly oil palm trees) is a common practice in Malaysia. It serves as a cost saving waste disposing method that benefits the plantations. EFB has good nutrient content and is able to improve the properties of the soil and is biodegradable.

The common practice in the fields is to lay or stack the EFB around the young plants. However, the main problem with this practice is in the physical characteristics of the material. It is the thorny, heavy, bulky and slippery and requires intensive labour for this activity. If it is not laid properly, weeds will be able to grow and thus compete for fertiliser with the young oil palms. Parts of the soil not totally covered will dry up during the dry season, hence watering needs to be carried out.

In order to overcome these drawbacks and to promote the utilisation of this waste universally in all types of plantations, estates and gardens, the Forest Research Institute of Malaysia in collaboration with a local company has successfully produced a mat from EFB, which proves to be very practical for use as mulching material.

Material and Methods

The production of this mulching mat involves various stages of mechanical processing of EFB either whole or dewatered by screw press in the mill. The EFB are shredded into semifibrous form with a fractionator. The material is then air dried to a moisture content of about 10 -15%. Then it is sprayed with a biodegradable binder in a mould that is set between two metal caul plates. The fibres are pre-pressed and released from the mould. The semi-finished mat is then cold pressed under high pressure between 2cm space bars on each side of the mat for four minutes after which the pressure is released and the metal plates are clamped together in order to reduce bounce –back of fibre. It is then left overnight for the binder to set. The clamps are then released and the mat is left to dry. The mat is then baled and packed out for transportation to or application in the fields. The mat produced is of dimensions 100cm x 50cm x 4cm. A semi circular hole is made in the middle of one side so as to slot in the stem of the tree. Two mats are applied to each tree.

Application And Functions

The mulching mat from oil palms empty fruit bunches (EFB) generally functions as:

- Water absorption material, one of the most important element for plant growth.
- Protection for the soil surface from being eroded by water or wind and gives the space for important soil growth micro - organism to live and multiply.
- To reduce labour for maintenance works in the form of weeding and fertilising and avoiding the tree stem from being injured by blade from grass-cutter.
- Reduce the application of fertilisers because fertilisers applied around the tree stem are not wash away by watering or evaporation.

* *Extracted from text prepared by Wan Asma Ibrahim, Wan Rasidah Kadir*

5 IRRIGATION WATER DEMAND

5.1 Objectives

The horticultural and landscaping objectives of this study are identified as the assessment of total irrigation demand for plants in Putrajaya and the recommendation on landscape strategy and how these issues will affect the outcome of this study.

5.2 Scope of Work

The scope of work for the study of horticultural aspects of the irrigation master plan is concentrated mainly on the calculation of total irrigation water demand. To achieve that, it is pertinent that the water demand of plant group is established first. This study shall explain the basis for the plant water demand and factors such as the soil series, plant root depth zone and most importantly, the evapotranspiration rate of plants will be studied and explained.

Once the plant water demand has been established, the calculation of total irrigation water demand can be obtained by multiplying the plant water demand against the quantity of plant materials derived from plans and drawings submitted to Perbadanan Putrajaya.

5.3 Issues and Constraints

To assess the total water demand, it is pertinent that the plants in these areas are to be divided into four major plant groups. They are divided into groups of trees, palms, shrubs and ground covers and lawn.

The irrigation demand of each group is determined by considering factors such soil and its available water, evapotranspiration rate of plants, the root zone depth and plant quantity. These factors will be examined to enable us to establish the water demand of each plant group. It is pertinent to note that the calculation was based on FAO (Food and Agriculture Organization, United Nation) method.

5.4 The Soil and Its Water

Referring to the soil map of Putrajaya, it was discovered that the area has 17 types of soil series. However, it is interesting to note that approximately 80 % of the soil series in Putrajaya are made up of the Bungor series as evident from the soil map. (Please refer Figure 5.1). Being the most predominant soil series in Putrajaya, it is therefore, quite relevant to use the characteristics of the Bungor soil series as the basis for the calculation of water demand. Figure 5.2 shows the section of Bungor soil series.

From *Panduan Mengenali Siri-Siri Tanah Utama di Semenanjung Malaysia* by *Jabatan Pertanian Semenanjung Malaysia,* the Bungor soil series is described as having a fine sandy loam texture. Structurally, it is weak to moderate medium and fine subangular blocky. It is also a well-drained soil with a moderately low water retention capacity. The field capacity of Bungor soil series is 216.7 mm/m with a wilting point of 66.7 mm/m. The difference between the field capacity and the wilting point will give the available water of 150 mm/m for this soil series. Please refer Figure 5.3.

Field capacity is the capacity of the soil to retain water against the downward pull of the force of gravity. In atmosphere of tension this is 1/3. Subsequently, w*ilting point* is the moisture content of soil at which a plant wilts and is unable to recover. In the atmosphere, this is 15. *(*Please refer Figure 5.4*). Available water* is the range of soil moisture between the wilting point and the field capacity. For plant growing purposes, that is the most important range of soil moisture. Table 5.1 describes the characteristics of Bungor soil series. In addition to that and for reference purposes, Table 5.2 also shows the different characteristics of other types of soil textures.

Table 5.1 The Characteristics Of Bungor Series

Characteristic	Description
Colour	Brownish yellow to yellowish brown
Texture	Fine sandy loam.
Structure	Weak to moderate medium and fine sub-angular blocky and consistence friable to firm with depth
Drainage	Well drained
Water Retention	Moderate low
Depth	Deep

(Source: Panduan mengenai siri-siri tanah utama di Semenanjung Malaysia. 1993. Jabatan Pertanian Semenanjung Malaysia.)

Table 5.2 Wilting Point, Field Capacity and Available Water Based On Soil Texture

Soil Texture	Wilting Point (mm/m)	Field Capacity (mm/m)	Available Water (mm/m)
Medium Sand	25	100	75
Fine Sand	33	125	92
Sandy Loam	50	166.7	116.7
Fine Sandy Loam *	66.7	216.7	150
Loam	100	266.7	166.7
Silt Loam	116.7	291.7	175
Clay Loam	150	316.7	166.7
Clay	216.7	333.3	116.6

(Source: Soi', their chemistry and fertility in trop:cal Asia. 1966. Prentice Hall)
** -- Texture of Bungor Series*

5.5 Root Depth Zone

This is also one of the most important factor to determine the plant water demand. However, it has to be noted that due to economic reasons, research materials available to determine the root depth zone are generally concentrated for harvest crops instead of ornamental crops. Nevertheless, the information available from the research papers on harvest crops can be adopted to determine the root depth zone of ornamental crops. For example, from the research paper entitled *Irrigation Practice and Water Management by Food and Agriculture Organization (FAO)* of United Nation, the rooting depth of mature irrigated crops grown in a deep permeable well-drained soil are divided into 3 categories. The categories are described as the shallow rooted, moderately deep rooted and deep rooted. The shallow rooted crops have a range of rooting depth of between 0 to 0.6m while the moderately deep-rooted crops have a range of rooting depth of between 0.5 to 1.2m. Meanwhile, the deep-rooted crops are categorised as having a rooting depth of between 1.0 to 2.0m.

For this study, the root depth zone for plant groups shall be based on the average of the rooting depth of harvest crops mentioned earlier. For example, the rooting depth of shallow rooted harvest crops such as groundnut, onion and turf grasses is between 0.3m to 0.6m. The average root depth of these shallow rooted crops is adopted for the groundcovers and lawn plant grouping. The average rooting depth of bananas (0.5-0.9m), sunflower (0.7-1.2m) and tobacco (0.5-1.0m) which comes under the moderately deep-rooted crops is then adopted as the average for root depth zone for shrubs. Deep rooted harvest crops such as rubber trees, avocado and citrus with their range of rooting depth between 1.0 to 2.0m is used as the basis to get the average root depth zone for trees and palms. The average root zone depth is tabulated in the following Table 5.3.

Table 5.3 The Range and Average Of The Root Zone Depth

Plant Category	Range of Root Zone Depth (m)	Average Root Zone Depth (m)
Tree	1.00 - 2.00	1.50
Shrub	0.50 - 1.20	0.85
Palm	0.70 - 1.30	1.00
Ground Cover and Lawn	0 - 0.60	0.30

(Source: Irrigation practice and water management, 1984, FAO)

Unlike harvest crops where irrigation is a continuous process, it has been established that the initial 3 years period is the most critical period of plant growth especially for ornamental trees and palms. Therefore, in the calculation of water demand, this is an important factor whereby, upon establishment of the trees and palms, the water required for irrigation purposes can be greatly reduced.

5.6 Evapotranspiration Rate

Evapotranspiration is defined as the loss of water by evaporation from soil and vegetative surface and transpiration by plant. It is essentially the water demand of plants. To estimate evapotranspiration rate of tree, shrub, palm and ground cover, several examples of each plant group were selected to obtain an average. It has to be noted that, similar to the root depth zone, the evapotranspiration rate is also based on harvest crops since there are numerous research that has been done on them. Assumption is also made that plants in the same family should have a similar Etcrop. Table 5.4 below shows the average evapotranspiration rate of each category of plants.

Table 5. 4 Average Evapotranspiration Rate For Plant Groups

Plants	Etcrop	Average Etcrop
Trees		
Hevea brasiliensis (Rubber tree)	6.32	4.33
Coffea spp (Coffee)	2.74	
Cocoa	2.74	
Persia americana (Avocado)	2.26	
Citrus spp (Citrus)	2.88	
Shrubs		
Musa spp (Banana)	4.66	4.53
Ananas cosmosus (Pinapple)	2.33	
Helianthus annus (Sunflower)	6.15	
Lycopersicon esculentum (Tomato)	4.76	
Nicotiana tabacum (Tobacco)	4.76	
Palms		
Cyrtostachis renda (Red Palm)	3.56	3.57
Licuala grandis (Fan Plam)	3.58	
Groundcover and Lawn		
Arachis hypogea (Ground nut)	5.85	4.87
Allium cepa (Onion)	3.75	
Various turf grasses	5.00	

(Source : Irrigation practice and water management. 1984.FAO)

5.7 Water Requirement

Using the FAO calculation method and all relevant information that has been gathered, the water requirement for tree, palm, shrub and ground cover can be determined. Among the factors that has been described and was used to obtain the water demand are the soil available water, allowable water deficit, rooting depth, assumed application efficiency, evapotranspiration rate and coverage area. Table 5.5 below shows the average evapotranspiration rate and calculated water requirement for each category of plant.

Table 5.5 Average Evapotranspiration Rate And Calculated Water Requirement For Each Category Of Plant

Plant Type	Average Evapotranspiration Rate	Calculated Water Requirement, L
Tree	4.33 mm / No / day	24 L / No / day
Palm	3.57 mm / No / day	7.1 L / No / day
Shrub	22.65 mm / sq. m. / day	6.3 L / sq. m. / day
Ground Cover and Lawn	121.75 mm / sq. m. / day	3.1 L / sq. m. / day

(Source: Crop water requirement. 1977. FAO)

With the information provided on the basis of plant water demand calculation, it is believed that the total water demand calculation can be obtained.

5.8 Plant Quantity

Plant quantity was obtained by looking into approved landscape plans from PPJ. Plant quantity of unapproved areas will be determined by comparing the approved areas together with information obtained from the land use plan and its use class order.

The irrigation demand of each precinct is determined by considering water demand and quantity of each plant category of all areas inside the precinct. Total irrigation demand is obtain by adding the irrigation of whole 20 precincts in Putrajaya as shown in Appendix SC (in Executive Summary).

5.9 Water Demand Strategy

Based on the water requirement and plant quantity, the total water demand in each precinct is as follows:

	Water Demand (MLD)
Irrigation of shrubs & grass	35.5
Irrigation of shrubs only	16.8

Owing to the tremendous demand it is agreed with PPJ that irrigation of plants should be limited to shrubs only. For trees and palms, water is requires generally during the growing stage only and during this period water will be supplied through trucking. As for grass the water demand is high particularly owing to the large area of underground cover. During period of drought grass may become brown and this has to be accepted in order that irrigation water demand and system cost can be reduced. In fact, it was highlight during a recent meeting with the maintenance team of Taman Wetlands that only the shrubs were watered during the watering rounds.

Adopting the strategy of irrigation shrubs only the water demand in each precinct are as follows:

Precinct	Demand (MLD)
1	0.87
2	1.35
3	0.22
4	0.39
5&6	0.96
7	0.31
8	0.58
9	0.43
10	0.44
11	1.04
12	0.40
13	1.08
14,15&DE	1.06

16	0.43
17	0.37
18	0.59
19	1.11
20	5.16
Total	**16.79**

5.10 Water Demand By Phases

The delivery of irrigation water is greatly influenced by the development phases, namely,

1. Phase 1A from 1/1999 to 12/2000
2. Phase 1B from 1/2001 to 12/2005 (Fully developed)
3. Phase 2 from 1/2006 onward (Assume full development by 2010)

Another important factor to consider is water requirement in relation to plant growth i.e. tree and palm in fact do not need watering after three (3) years as they have reached their establishment stage.

Taking into account the plant growth requirement, development phasing and source of water supply/ irrigation scenarios (detailed in Chapter 6), the total water demand is calculated and is presented in the form of bar charts (Figure 5.5 - 5.7). The water demand (from Putrajaya Lake and rain harvesting ponds) for the following scenarios have been computed:-

Option 1 : All Irrigation needs supplied from the lake.

Option 1a - Irrigation demand for public and private realms (Table 5.6 and Figure 5.5)

Option 1b - Irrigation demand for public realm only (Table 5.6 and Figure 5.6)

Option 2 : Combination of Various Water Sources i.e. Proposed Option

Irrigation demand for public realm using Lake Water (Table 5.7 and Figure 5.7)

The water demand for all these options is illustrated in Figure 5.8 and summarised in Table 5.8.

Table 5.8 Various Irrigation Water Demand By Year

	Irrigation Water Demand (Mld)				
Year End	2000	2003	2010	2013	2020
Option 1a	7.11	18.12	23.923	16.849	16.849
Option 1b	5.366	13.74	18.894	13.779	13.779
Option 2 i.e. Proposed Option Using					
Lake Water	5.203	10.627	8.088	5.622	5.622
STP Water	0.000	1.651	8.478	6.983	6.983
Trucking	1.009	2.344	0.192	0.192	0.192
JBA Water*	0.163	1.210	2.082	1.240	1.240

** for Public and Private Realms*

Chapter 6 of this report addresses the Putrajaya Lake drawdown owing to water abstraction from the lake under various irrigation scenarios.

6. WATER RESOURCES

6.1 Introduction

The estimated surface area of Putrajaya Lake 4 km^2. It is a huge water body and would be the obvious source of water except that the recreational and aesthetic function of the lake does not allow excessive and prolonged drawdown of water below its targeted +21m LSD. Besides the lake there are other potential sources. Our study examines the potential of following sources of water supply.

- Rainwater harvesting/ponds
- Ground water
- Treated sewage water
- Augmentation from Sungai Langat
- Putrajaya Lake
- JBA water supply
- Augmentation from Sungai Gajah
- Mining pond (in Precinct 20)

In matching irrigated areas with designated water sources, the problems with delivery and distribution of water would have to be looked into. A practical irrigation system would probably abstract from various water sources depending on the proximity of the area to be irrigated to the source of water, the reliability of the water source and the irrigation priority accorded to various areas.

6.2 Rainwater Harvesting

Rainwater harvesting can be accomplished in two ways: (1) via open ponds and (2) via underground storages. Open ponds could be developed in parks and garden to catch stormwater. The amount that could be irrigated from ponds would depend on the size of ponds and the acceptable drawdown of pond storage. Initial computations indicate that for a pond covering 5 % of the irrigated area and an acceptable drawdown of 1.5m, the area that could be irrigated is 30% assuming a 2 year drought event. For built up areas, tanks could be installed to store rainwater for irrigation and other uses.

Besides irrigation, ponds and tanks also have a flood mitigation function. Currently, JPS is encouraging the use of such methods as a means to reduce the stormwater runoff at source and the cumulative effect of many such installations is that stormwater runoff downstream could be substantially reduced.