

# The Case of Putrajaya Lake and Wetland

## Lessons on Preparing and Implementing a Lake and Wetlands Management Plan Within an Urban Development Framework

### Integrated Urban Development - Putrajaya Lake and Wetland

#### Introduction

Putrajaya is being developed as a Federal Government Administrative Centre and a first 'Intelligent City' in Malaysia. It is located at the heart of the planned Multimedia Super Corridor (MSC) as shown in **Figure 1**.

The development of this new city involved the opening of a large land area of up to 4500 hectares. The undulating hill land was formerly rubber and palm oil plantations. It is anticipated that the cutting off of the rubber and oil palm trees may increase the surface runoff velocity, which eventually flooding downstream areas. In addition, the development activities in the hilly and steep slope areas will inevitably cause soil erosion that will pollute the river.

Furthermore, the clearing activities will also expose the land to the daytime heat without enough shade for the first few years after the construction resulting in a higher temperature in the new urban areas before the full revegetation.

In view of the impacts on its surroundings and future situation, Putrajaya has adopted an innovative approach by allocating a comparatively large area within its boundary to be converted into water body in the form of wetland and lake.

#### The Development Concept for Putrajaya

The Master plan of Putrajaya covered the development of the core area, peripheral residential areas and parklands. It incorporates a comprehensive set of policies and guidelines for land use planning, transportation systems, utilities and infrastructure, residential areas, public amenities, information technology, parks, gardens and landscaped areas as shown in **Figure 2**. The area is divided into 20 precincts, with five main precincts for the government, mixed development, civic and cultural, sports and recreational, and commercial. The remaining area is designated for residential development.

The city is developed in two phases over a period of 15 years. Phase One, which is almost completed comprised of government offices, commercial offices, residential units, public amenities (parks, main transport terminals), wetlands, promenade and part of the Putrajaya Lake. Phase Two is scheduled for completion in 2010.

The Master plan emphasizes on creating, preserving and enhancing of its eco-culture while promoting an active, lively and caring society. The design also incorporates the infrastructure that will ease the pressure and stress of modern living. It reinforces the concept of a "City-in-a-Garden" by introducing "an integrated system of parks, water courses, wetlands, forest and open spaces". This concept will provide the green image control while maintaining its flexibility as an 'Intelligent City' that meets the administrative functions of the Federal Government.

#### Functionalism in Planning

A number of important functionalism considerations were given serious thought even before the acceptance of Putrajaya Master Plan. There are two tasks in defining functionalism in architecture and urban design. The first involves an understanding of human motivations and needs, and the second, is more on the aspects of the processes to fulfill those needs that might possibly be

**Figure 1: The location of Putrajaya within the Multimedia Super Corridor (MSC)**



met or affected by the structure and materials of the built environment.

The Putrajaya planning design goals include the making of a city which is more functional in meeting what are regarded as the positive motivations of its people vis-a-vis to make Putrajaya legible and to fulfill its population needs in a multidimensional way. Basically, it will have to serve both the sociogenic and biogenic function.

The biogenic environment consists of many interrelated components that constitute the edaphic environment - the topography, geology and climate of a place; and the bionic environment - its flora and fauna. The two are inextricably linked in an evolving system as changes in one component affect the other.

A number of intertwined changes brought about by human actions have to be considered in designing for human habitations while simultaneously designing a well-functioning biogenic environment. These changes include alterations to land forms; and thus changes in the hydrology of city; changes due to the effects of pollution through the production of garbage and other wastes; changes in the habitat for birds and animals; and the consumption of irreplaceable resources.

Putrajaya recognized these expected changes and it is poised to have a well-functioning biogenic environment, which is self-correcting, self-sustaining, unpolluted, and able to withstand stress. Therefore, it is designed to have a biogenic environment in which the natural forces within and from its surrounding will create a regenerative system while affording people the opportunities to meet their basic and cognitive needs. It is one that has considerable diversity - a mixture of ecological communities that foster healthy species of flora and fauna and inhibits undesirable species. (Hough 1990).

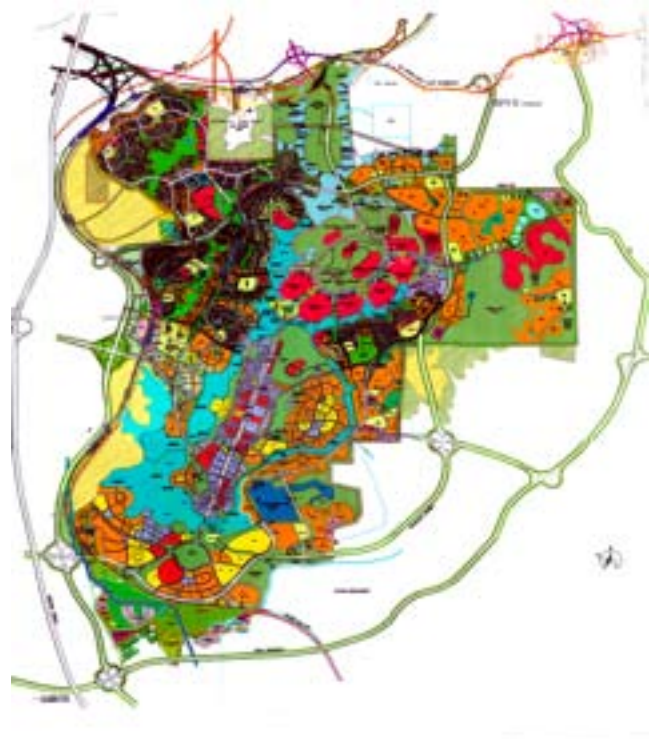
Thus, the critical component of the city project is the Putrajaya Lake, which is located in the heart of the city. The quality of the lake water is of paramount importance to the development of Putrajaya. To achieve a high standard of lake water quality, the master plan proposed the construction of The Putrajaya Wetlands to remove pollutants and cleanse catchments runoff before it enters the lake.

### **Sociogenic Environment Function**

The sociogenic environment functions of the wetland and lake in Putrajaya development will be achieved among others through:

- a systematic approach of implementing the environmental management target;

**Figure 2: Putrajaya Masterplan incorporates the creation of parks, garden and landscape areas including water body**



- will allow the people of Putrajaya and its visitors to spend their time in relaxing and enjoying recreational activities; and
- creating the opportunities for the execution of education and research activities.

### **Environmental management target**

The difficulty that urban designers face in making politically and economically astute proposals for projects is that, in designing to meet people's sociogenic needs as they are expressed today, they will be creating serious environmental problems.

Like all design decisions, there are tradeoffs involved between the attainment of one goal and another. The Putrajaya design obligation is, however, to progressively develop the built environment to ensure the future health of the biogenic environment. As all built environments alter the biogenic environment, guidelines and management manuals has been established that will shape environmental change so that not only is no further biogenic harm done but also that its future developments, piece by piece, have a restorative impact.

In order to achieve this, a sound environmental management target in Putrajaya must be set. This is where the existence of the wetland and lake become the focus of the environmental management function. The water quality of Putrajaya Lake needs to be suitable for a variety of

recreational pursuits, not least of which is the pleasure of viewing the lake from the shores, buildings and roadways. Since it is subject to significant variations in inflows and because the catchments will become increasingly urbanised, people should come to expect periods during which the water is more turbid. However, they should expect a lake that is largely free of floating algae and weeds, and is safe and healthy for humans and freshwater fauna.

### **Public Education and Research**

Putrajaya wetland and lake is a fertile ground for public education and research. As a recently built feature, it has the amenities to help facilitate public understanding of wetlands. Ensuring the functioning of the fragile ecosystems around the wetlands will need the support of the public at large. Greater understanding and awareness of its mechanisms by the public and residents will ensure the respective roles in conserving and preserving the 'nature reserve'. The public education programs are centered at The Nature Interpretation Centre. The centre provides information primarily on the development of Putrajaya Wetlands, whilst highlighting the related environmental issues. The general information about the wetlands around the world is also provided.

As a pioneer in a man-made constructed wetlands project, Putrajaya Wetlands offers innumerable research opportunities. Much research and study was undertaken during the project, from studies of catchments conditions to plant sourcing and propagation.

The construction of the wetland brings about a unique wildlife habitat. Yet, another branch of the sciences can undertake studies on the varieties of flora and fauna, their behavior and habits. Migratory birds, even mammals, can be tagged to study their movements. It would be interesting and useful to study the succession of wetlands plants species and the mosaic pattern of the flora.

The wetland and the lake water body are also a base for the biogenic environmental as well as the sociogenic study ground for the urban development planning. This will include the architectural base information, landscaping architectural study, urban social study and the urban planning. The success of this complementary theory in urban design can be assessed from the actual condition of the wetland, lake and the city itself and this area of research is very much an attraction to many professional in urban and infrastructures development field.

### **The Recreational Function and Ecotourism Destination**

The Putrajaya Lake will be an eco-friendly centre of recreational activities. Water-based activities permitted on the lake include kayaking, rowing, swimming, dinghy sailing and windsurfing. The lakeshore is ideal among other

things for bush-walking, bird watching, jogging, cycling and relaxing. The waterfront facilities include picnic and barbecue sites, lookout points and restaurants.

Much space has been dedicated to public parks, gardens and water bodies - oases of tranquility for those seeking refuge from the pressures of modern urban living in Putrajaya. The ecotourism appeal of Putrajaya lies in the development of a series of green areas and buffer zones complementing the water body that have merged to form a unique ecosystem, which is a vibrant corridor for local wildlife and vegetation.

The riparian parks which are the low-lying surface runoff buffer zones with a number of different (natural and constructed) level - some submerged with different water depth, in residential areas along the lake front will make them an ideal habitat for some flora and fauna. The attractive landscape feature of various garden designs will make it attractive to visitors and tourists alike.

### **Ecological Function**

One of the aspirations of the Putrajaya development programs is to meet the need of a well-functioning biogenic environment by creating the biologically self-correcting system of built and open areas. For this purpose, consideration is given to the ecological functions in the sense of how best to deal with the atmospheric pollution that the new settlement will generate and such as how to avoid hydrological imbalances.

### **Water body function in Putrajaya ecosystem**

Water bodies have been used in many ways in urban design, i.e. as a decorative element, a space-defining element, and as a temperature-modifying element. It has been reported that cities on natural waterways or on the sea have a special character that those cities without significant bodies of water lack (Lang, 1994).

In Putrajaya about 650 hectares or 14% of its land use is allocated for the formation of wetlands and lake system. By having the wetlands and the lake system in Putrajaya, a number of water elements related advantages can be achieved. The existence of the water body will influence the effort to:

- ensure that built forms are created that shape wind flow which will enable the air to be cleansed and will avoid the development of heat islands;
- avoid the transmission of pollutants into waterways within the city and downstream; and
- reduce the increasing storm-water runoff, which is a result of the increased proportion of hard surfaces (roads, footpath and surface parking lots).

The Putrajaya Wetlands concept was also designed as a device for treating the surface runoff that relies on the natural processes of the natural pond and aquatic plants as filters. The latter part of this paper will elaborate on the technical functions of the wetlands.

### **Hydrological Processes**

Most of the original area of Putrajaya was agricultural land utilized mainly for oil palm and rubber production. The area has a relatively flat topography interspersed with steep-sided hills. The valley floors are quite flat resulting in significant floodplain storage during flow events. The major rivers are the Sungai (Sg.---meaning river in Malaysian) Chuau, Sg. Bisa and Sg. Limau manis which flow southward to the Sg. Langat.

The annual rainfall for the project area is 2000 mm. 60% of the rainfall falls between 2pm and 8pm. (Malik Lip, 1994 cited by Minconsult, 1996). Rainfall is generated by both monsoonal and convective storm systems. Rainfall generated by convective storm activity usually occurs late afternoon and has duration less than 6 hours. Stormwater drainage are most affected these storms. The earlier runoff rainfall volumetric ratio is estimated to be 35%. At present, the ratio is estimated to be 50% and the ratio will be increased to 65% after fully developed (AGHD, 1996).

The mean monthly evaporation ranges from a minimum in December to a maximum in March. Open water evaporation averages at 4.7 mm/day. Design Average Recurrence Intervals (ARI) for residential is 5 years and for trunk drainage will have the sufficient capacity to safely convey stormwater runoff generated by the 1:100 year design storm event.

There are three identified major effects of urban development on hydrology (Leopold, 1968):

- Changes in total runoff;
- Changes in peak flow characteristics; and
- Changes in water quality (Chandler (1976); Hough (1984)).

As cities grow in size and more surfaces are paved, there is a growing concern for the water channeling effect of run-offs on watercourses and the lack of water penetration into the ground to replenish water tables. The speed of runoff causes problems of erosion in watercourses and oil from parking lots raises the pollution levels of water, and consequently, affects aquatic life.

The actual effects vary from city to city, but the overall impact of the high degree of hard surfaces in cities is to increase flood discharges by as much as 50 percent in areas with highly pervious surfaces, and up to 400 percent in

cities with 80 percent impervious surfaces and whose areas are 80 percent storm-sewered (Chandler, 1976).

Not only does the total discharge increase, but also does the speed of runoff, leading to erosion and the scouring of riverbeds. The changes to patterns of vegetation and aquatic life diminish the ability of rivers to cleanse themselves naturally over time, causing the loss of aquatic and riverbank habitats, native plants and wildlife populations.

### **The Hydrological Control**

The Putrajaya Wetland and Lake has taken into consideration of this hydrological impact. The Lower Sungai Langat River Basin will not be able to absorb the increase in runoff volume, velocity and the pollutant resulting from the massive development in Putrajaya area without an integrated management and engineering approach to tackle the problem.

The Putrajaya Wetland and Lake Management Plan include the preparation of:

- The Putrajaya Drainage Master plan
- The Putrajaya Urban Stormwater Management Guidelines; and
- The Putrajaya Lake Catchment Management Guidelines

### **The Drainage Master Plan**

The overall goals for the Putrajaya Drainage Master plan are to:

- preserve the urban ecological values within the wetlands and the lake areas;
- mitigate the runoff and pollutant exports to external catchments;
- provide for public convenience and safety from flooding
- provide a cost effective maintainable drainage system

Apart from the conventional approach of surface runoff drainage design calculations, the Putrajaya Drainage Master plan has been using the Hydraulics Loading Rates (HLR) and the Pollutant Loading Rates in its design calculations and hydrological models. The pollutant loading rates is necessary in the design of the Putrajaya Lake and Wetlands created in the middle of the city.

This is an advantage and important improvement from the conventional drainage designs which normally considers only the HLR. The water quality model uses pollutant

retention curves (based on the hydraulic residence time) to estimate daily pollutant removal rates. Eutrophication potential is assessed using Vollenweider analysis - assuming phosphorus is the limiting nutrient.

In the hydrological study in the Putrajaya Lake Catchments Guidelines another engineering model software package is used for the simulation of flows which was also based on water quality and sediment transport. It is a dynamic, one-dimensional modeling tool for the design, management and operation of river and channel systems.

The use of pollutant rates is an advantage for the Putrajaya Wetland and Lake design since the limitation as well as the carrying capacity of the water body system will be able to be estimated.

### The Putrajaya Urban Stormwater Management Guidelines

Awareness of environmental issues in recent times has highlighted the importance of environmental management of urban stormwater. It is well documented that urban stormwater runoff is generally of poorer overall quality than runoff from a rural catchments. The impact of poor stormwater quality is becoming an increasing issue of concern amongst catchment’s managers. The impacts can include the deposition of suspended material, which can smother aquatic habitats, increased concentrations of nutrients, oxygen-demanding material, micro-organisms and toxic materials and the deposition of litter. Increase catchment runoff can lead to significant changes to the morphology of creeks and rivers leading to degradation of aquatic habitats. Stormwater contaminants cause dissolve oxygen depletion and increased toxicity levels with the consequential degradation of ecological health of the receiving waters.

There have been a number of initiatives to change the conventional means by which urban stormwater is managed. In Putrajaya, the Putrajaya Integrated Stormwater Management Guidelines were developed. For that reason the review on the earlier ‘The Drainage Master Plan’ was done. The guidelines set strategies that include stormwater drainage, managing stormwater as a resource, protection of receiving water quality and protection of downstream ecological health.

The wetlands and lake within Putrajaya will be an aid to the ailing health of the Sungai Langat River system. The stormwater Management Guidelines outlined the different design considerations needed in relation to the specific stormwater management objectives for the city such as structural measures to prevent urban litter in the stormwater drainage and flow detention and in-stream retardation to prevent

excessive physical disturbance of aquatic habitat by stormwater runoff in the effort of protection of downstream aquatic habitats.

The guidelines also list out the different type of control that can be applied in the city drainage design according to the location of the drainage system. For example the land use planning and regulation as the source control mechanism and the detention basins and gross pollutant traps are some of the applicable solutions that can be established in the drainage transit area.

### Technical Interventions in Lake Basin Management

#### Lake Catchment’s Management Guidelines

Apart from the Putrajaya Integrated Stormwater Management Guidelines, the Integrated Catchment’s Management Guidelines within the catchment area of the Putrajaya Lake and wetlands will ensure the stress on the river downstream not be overburdened by the upstream development progress (within the catchments) outside Putrajaya.

The overall wetland water quality management involves various elements that are related to the actual wetland ecosystems. Proper planning, operation and control measures are essential for the effective implementation of the management elements. The management phases are illustrated in the diagram in **Figure 3** below. However, the implementation of the phases is not in relation to time, rather to the mechanisms involved in exercising it.

For the purpose of enhancing the wetland efficiency in stripping the extremely high phosphorus loading in Putrajaya Wetland, the catchment management mechanisms are formulated to monitor and ensure the discharge pollutant loading in the upstream region is limited to the desired level. Another measure that has been considered in the design is the formation of primary sedimentation basins or fore bays prior to entry to the wetlands.

**Figure 3: The three phases of wetland management elements**



## Catchment Management and Control

The urban stormwater management involves the control of pollutant loading and the control of runoff hydrological aspects (water volume, speed and flow rate). Naturally, the pollutants coming into the Putrajaya Lake system will continuously come not only from within its boundaries but also from the whole catchment, parts of which lie outside its boundary and jurisdiction. For that reason the management approach of the lake system should be seen from the overall management system within the catchment area.

The catchment's area of the Putrajaya Lake lies within the administrative jurisdiction of three different municipalities, i.e. the Majlis Daerah Sepang, Majlis Perbandaran Subang Jaya and Pebadanan Putrajaya. There are nine areas with stakeholders of different entities, i.e. government, private corporation and individuals as shown in **Figure 4**, including areas within the Pebadanan Putrajaya jurisdiction. The other stakeholders are UPM, MARDI, IOI, West Country, TNB, UNITEN, Cyberjaya and a small Sungai Merab area, which is under individual ownership.

The management focus on areas of concern such as the stormwater quantity and quality including the groundwater, the emergency preparedness and public awareness and participation are the basis for management decisions and actions that will have to be undertaken to fulfill the water

quality requirements of the Putrajaya Lake and Wetlands system.

The reality of the situation requires us to observe at the response and interactions between the Lake and the wetlands and the wetlands with the catchments. The implementation mechanisms used is within a comprehensive legislative framework of the catchments management and will involve the control of hydrological factors including its pollutant as well as the human activities and the landuse control. There is also generally the need to upgrade the sewage treatment facilities, developing the riparian buffer strips along streams and common usage of the best management practices applicable in the area for related human activities.

Within the Putrajaya Catchments, the wetland and the lake is designed in the manner that it is the most sensitive and is most protected from development. The planning will carry through the concept of fringing intermediate buffer zone of low intensity use with increasing intensity use located in the outer fringe.

It is also practical to impose the population density of an area and the allowable land usage of certain areas in order to limit the source of pollutants discharged into the water body system.

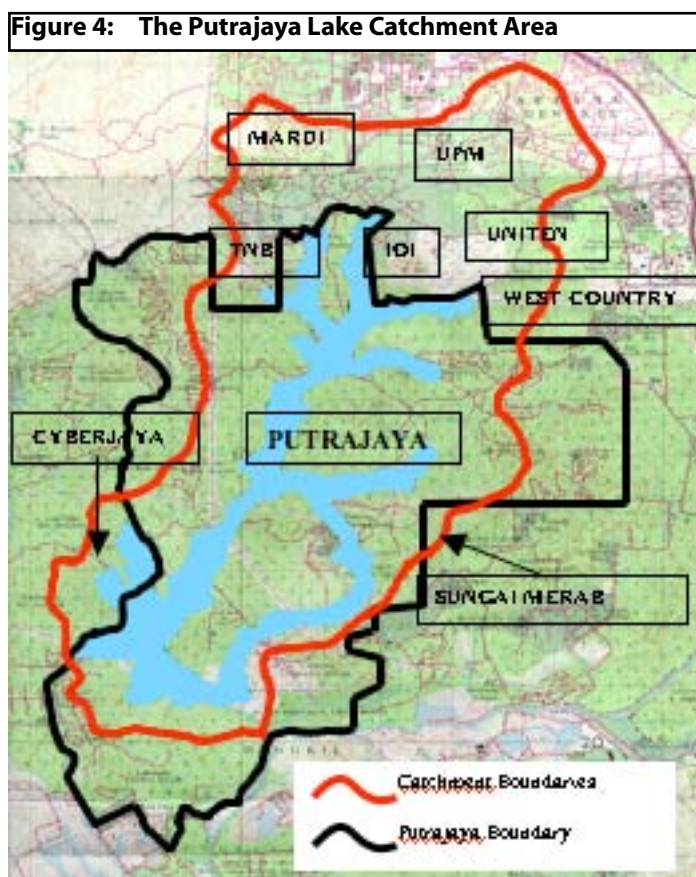
In addition to land use planning and zoning, there must also be the monitoring and control of construction and development activities in the area. All construction sites within the catchment will have to apply the best construction site management practice which will ensure the acceptable level of pollution discharge from within any work areas.

Monitoring and control of chemical use in the catchments is also a new approach that should be seriously considered within the catchment areas. This will also be applicable in the use and application of fertilizers.

## Preparing and Implementing a Management Plan

A lake management planning is a way of thinking which involves recording, planning and evaluating. It is a process subject to constant review and revision. Lake management plans should, therefore, be regarded as dynamic documents, which should be updated from time to time.

A summary of the developing process of the Putrajaya Lake and Wetlands Management Plan is described in the following topics.



## **Policy**

Putrajaya Development Master Plan has developed the concept of how the Putrajaya Lake and Wetlands should be managed. Having a clear management policy is essential for the formulation of a proper Lake Management Plans. It is the policy of the Perbadanan Putrajaya to manage the Putrajaya Lake in a manner to ensure its aesthetic viability, sustain good and healthy water quality and allow for different recreational uses, including body contact activities.

## **The description**

The description of the lake catchment features will enable a proper assessment of the water body system to be done. Thus the inventory, sampling and surveys activities should be conducted to collect and compile the existing information for the areas. It covers various aspects of information on abiotic and biotic features such as physical, ecological and socio-economics details. The description is fundamentally a collation and synthesis exercise of existing data and information.

The management structure of the lake management should also be included in this report. There is also a section where information about the most important phenomena and inter-relations of ecological relationships and its implications for management will need to be described.

## **The Lake and wetlands evaluation**

Evaluation is the process of identifying or confirming the important features or foci for planning. It means the assessment of the major features of the site and is applied to the lake and wetland description. Important specific aspects are determined. Evaluation criteria must be developed for each area of interest.

What are the most important features and main threats will be listed out in the evaluation. The important features on a site (habitats, populations and processes) provide a focus for the planning process. The main purpose of this section of the management plan is to provide a list of the features and to confirm their status. Choices made in this part will have great impact on the formulation of objectives.

## **Objectives**

Once data collation and the preparation of the descriptive sections of the plan are complete, the process of developing the management plan will have to prepare management objectives. The long-term objectives of lake and wetland management plan are actually the determination of 'what' are the things we want to achieve in the catchments areas: for instance, increase efficiency of wetland cells, increase the number of wetland fish species, etc.

## **Identification of Operational Objectives - derive management measures**

This section of the plan is concerned with identifying and describing the management outline considered necessary to maintain the site features in (or restore to) favourable status. This time, the focus is on seeking management solutions to bring the factors under control. Control can mean the removal, maintenance or application of factors

This is the stage where the operational objectives will be developed and translated into relevant management measures to be derived. A management measure is derived by defining a certain action that is implemental within the limit or capability of the lake management structure. This should include of various method statements of how to implement it.

Operational objectives are also prepared to ensure compliance with legal and other obligations. These are not strictly objectives as defined for the features. They are, in fact, prescriptions, or the operations that must be carried out in a protected area or pre-determined restrictive areas to ensure that the prime feature objectives are met.

In relation to this, deriving management measures is to understand things to be implemented. This is necessary because most of management measures or technical intervention will most likely to have its impact or confrontational with the long term objectives, policy and/or legislation.

For example in Putrajaya Lake and Wetland context is the desilting work of a wetland cell. Desilting of a wetland cell will involve the removal of silts including the wetland vegetation in the cell. It is physically clearing off the cell from the present ecological condition and to be converted into a refurbished new cell. The habitat and species within the cell will be greatly affected by this measure. In the overall management context this is necessary because the final product will be a newly refurbished wetland cell which will maintain its water cleansing efficiency.

## **Operational limits**

Operational limits define the range of values within which the impact of a factor is considered as being acceptable. Limits for nature conservation features were developed in recognition of the natural dynamics and cyclic change in populations and communities. A sufficient safety margin must always be allowed to account for the possibility of unexpected changes or unforeseen impacts.

## **Performance indicators and monitoring**

Objectives must be quantified and measurable. This stage in the planning process identifies the performance indicators that will be used to provide evidence about the condition of an area or environmental status. Because it is not

possible to measure the totality of a feature, there is a need to focus on a limited range of performance indicators.

Performance indicators are characteristics, qualities or properties of a feature that are inherent and inseparable from that feature and it should be quantifiable and measurable. Indicators should be of a general condition of a feature, and should be informative about something other than them.

### **Formulation of measurable objectives**

The requirements or need that is necessary to maintain or to improve the condition within the lake and wetlands catchments area is to be detailed down in this subject. The focus will be for the requirements and/or need which are more realistic.

There are three key steps in the process of preparing measurable objectives:

- Describe the condition that we require for a feature.
- Identify the factors that influence the feature and consider how the feature may change as a consequence.
- Identify and quantify a number of performance indicators.

Each of the performance indicators that are established must be monitored. That is their entire purpose. The measurement of the performance indicators provides the evidence that is used, in part, to determine the condition of the features.

### **Implementation of Management Plans - Action Plan**

Setting up the action plans is the start of implementation process of the lake and management plan. The program which include information of when and how to carry out the management measures will be carried out.

Once the obligations are known, the management requirements can then be identified. At this stage, negotiation with stakeholders becomes essential and needs to be re-confirmed. While objectives are not negotiable, it is often possible to identify a range of alternative management approaches that would meet the objectives.

It is important that the following areas are given attention:

- When will the work be carried out and for how long?
- Where on the site will activities take place?
- Who will do the work and how much time will be required?

- What priority is given to the project?
- How much expenditure will the work cost?

### **Management Review**

The management review of the Putrajaya Lake and Wetlands Management Plan is to be done by the top management levels of the organizations. Details of the catchments status in terms of its physical as well as its ecological conditions will be presented. Management measures with its monitoring data which will show its status=.

Having this information in place will enable the management team to decide on the next course of actions to be implemented. It is necessary to present the recommendation of which direction should be done in the catchments within its ecological and physical components.

A management review will complete one whole cycle of the lake and wetland management plan exercise. It can be done once in 3 to 5 years or even at shorter intervals required by specific operational objectives requirements.

### **Role of Information/Monitoring**

#### **Monitoring Programs**

Monitoring programs will be part of the management activities. It is implemented for important different purposes:

- To established the base data information of the wetland and lake system;
- To be able to make a fair assessment of the wetland functions in relation to its ecological requirements;
- Whenever performance indicators are established they must be monitored. That is their entire purpose.
- To measure the effectiveness of various technical and/or management interventions within the catchments areas for management decisions and for future development program.

Briefly there are many types of monitoring programs that is related to the wetland and lake system functionality components such as the lake and wetland ecology monitoring that covers the flora and fauna in the area including the bird counts. In case of the Putrajaya Lake and Wetlands monitoring exercise, the water quality sampling data is of paramount important and it is being compiled in different frequency for a number of fixed and mobile station for specific pre-determined parameters.



## The Wetland Maintenance

The wetland and lake maintenance activities cover a wide portion of the overall management requirements. Although it seems to be enough coverage of the maintenance exercise in fulfilling every aspects of the management demand there is always a clear divisional area that differentiates the two. One good example is while the maintenance activities for monitoring and collecting data and the necessary inventories for certain aspects, the overall management duties is to analyse and managing the massive collection of data and use it for controlling purpose or other future improvement and development programs.

Basically the maintenance of the wetland involves a number of main components such as:

- the management of the wetland cells and lake
- the condition of the wetland and lake at any one time
- water quality monitoring and investigation
- plant management
- hydrological structural and access maintenance

The operation of maintenance activities consists of various aspects in different scopes but that are very closely related:

- House keeping - rubbish, weed, security;
- Desalting - v-drain and GPT, wetland cells when required;
- The Civil and M&E - GPT, drains, weir and dams, culverts, pumps, main switch;
- Biological - weed management, fish monitoring;
- Plant management - wetland vegetation, the ZII plants
- The hydrological - water level control
- Control of pests - including that of birds, insects, reptiles, amphibians
- Control of aquatic pests - a number of fish species, snails

The management or technical measures are also part of maintenance activities in the Putrajaya Lake and Wetland management context. The implementations of various management measures as part of action plans are being done as part of daily maintenance programs. This integrated management approach will be able to optimize the use of manpower and cost of implementation.

## Lesson Learned

### i. The Putrajaya Lake and Wetland Status

At present it is anticipated that the wetland and other water body within the catchments will experience massive inflow of sediment in the form of suspended solids. The sediment inflow from construction sites is expected to pose a serious problem both from outside and within Putrajaya areas. This is expected from any large urbanisation. This problem is to be handled by applying the best site management practice at all construction sites and also by executing stern enforcement. A prudent environmental management approach at all construction sites is expected to be carried out in this area. This will include the enforcement routine inspection and sound legislation which is expected to be carried along with it.

The accumulation of pollutants within the wetland cells can be estimated by proper monitoring of the sediment volume and its contents. The data is used to estimate the appropriate time required for the desilting activities of the cells sediment. The optimum amount of sediment allowable within each cell is thus an important parameter that is being used to arrest this problem.

### ii. Pollutants of concern and its alarm criteria or indicator

The major pollutants of concern to the lake water quality are nutrients, bacteria and organic chemicals and trace metals which may accumulate in the sediments. The main nutrient of concern is phosphorus. Other pollutant will have to be established from time to time.

The pollution alarm criteria or indicator for the identified pollutant will be a tool for the management for making decisions on certain important policy matters such as the appropriate time for the control of water level in the cells, desilting operations of the cells or the appropriate time for plant harvesting. The criteria will need to be established using the available water quality and plants maintenance data. Thus the continuous monitoring and assessment must be undertaken to ensure that:

- management and maintenance objectives are being met
- further improvement in relation to maintenance and management measures are introduced from time to time.

### iii. The creation and maintenance of habitat

The Putrajaya Wetland was not designed only for the purpose of controlling the pollution and quality in the surface runoff passing the area, although it remains one of the main reasons for its construction. Consideration of the

overall ecosystem advantages from its setting has also been anticipated and taken into account. Understanding this will allow us to be more knowledgeable in managing and assessing the capacity and capabilities of the constructed Putrajaya Wetland.

The assessment of the wetland functions will reflect the characteristics of the wetland ecosystem and landscape under consideration. The overall benefit and other interrelated functions of the wetland is also being assessed accordingly to establish the actual overall capacity and value of the Putrajaya Lake and Wetland catchment system.

#### **iv. Proper Maintenance**

Proper maintenance and implementation of the management measures is the key to the success of achieving the lake and wetlands management and operational objectives.

Operation and maintenance must be well planned in order to prolong the life of constructed wetlands and the activities will change during the lifetime of constructed wetlands.

#### **v. Legislation and control**

There must be mechanisms to control direct discharge of fertilizer, detergent and sewage to the system from within the catchments areas.

Active participation from all stakeholders within the catchments is crucial to ensure proper implementation of the catchments management recommended programs and control.

#### **vi. Integrated Management System**

The integration of the hydrological data with that of biological and water quality will somehow determine the ecological benefit. This integrated management exercise and its product will then be used to quantitatively assess the true value of the Putrajaya wetland and lake ecosystem.

The three management phases highlighted in this paper covers broad area of activities. The application of recommendations from various studies, monitoring and survey done and guidelines prepared for the purpose of designing, controlling and managing the wetland and lake are very important as management tools in tackling the delicate control of the overall ecosystem of Putrajaya City.

Through detail observations, research activities and strong commitment from Perbadanan Putrajaya, an integrated management approach for the water quality and ecology management database for the Putrajaya Lake and Wetland is necessary and being fully applicable in the near future.

#### **vii. Ecosystem model**

Many planning and urban design decisions have had predictable but undesirable effects on the quality of the biogenic environment. Suburban developments led by highway construction and the neglect of urban mass transit systems have created serious air pollution problems in valleys in which polluted air can easily be trapped by temperature inversions and water pollution of its surface runoff streams. There has been little consideration given to the conditions of the natural systems that operate in a city. The time has come to take designing with nature rather than against it seriously (McHarg, 1969).

Although our ability to develop ecosystem models that include the essential response loop between changes in settlement forms and changes in the condition of the biogenic environment is still limited (Goldsmith, 1990), Putrajaya has taken a bold step in pursuing the new and proper environmental management approach and change.

The major change required in the thinking of many people will be to reorganize our attitudes to the symbolic meaning of the natural elements of the city - the occasional meanings of its topography, water, flora, and fauna. Without such attitudes, it will be difficult to create a more salubrious environment for people and for its own sake - for its own aesthetic logic (Hough, 1984; Spirn, 1989).

The future challenge of the Putrajaya Wetland and Lake Management is to be able to achieve desired beneficial uses of the water body within the limits of time, finances and natural capacity of the aquatic system. Such a task is often not easily accomplished without some compromise. Most of all, management of a resource requires an adaptive approach. Conditions will change, so is the flexibility in management which will lead to long-term success although there will be no compromise in terms of the water quality as emphasized in the city plan.