CHAPTER 3

RESULTS & DISCUSSION

CHAPTER 3 RESULTS AND DISCUSSION

3.1 INTRODUCTION

The results and discussion of the study are presented in two sections, which is firstly, the site environmental audit and secondly, the management review exercise.

A) SITE ENVIRONMENTAL AUDIT RESULTS

The results of the site environmental audit are based on the topics outlined in the site environmental audit checklist which is appended in Appendix 1.

3.1 .1 SITE INFORMATION

The site that was audited is called "Putrajaya Wetlands" and is located along the trunk road connecting Kajang to Puchong. The site is located 10 km southwest of the Kajang town. The "Putrajaya Wetlands" is made up of a network of constructed wetlands. MHSB has been appointed to carry out the planting of wetland plants at the constructed wetlands.

The site (Figure 3.1) was originally an oil palm plantation with several tributaries of Sungai Chuau and Sungai Bisa (Figure 3.2) flowing through the plantation leading into the Sungai Langat river, have since been turned into 24 constructed wetland cells. The 24 wetland cells in the area are divided into several planting zones (Figure 3.3) as follows:

- Upper West (UW) Wetland Cells - 8 cells
- Upper North (UN) Wetland Cells - 7 cells
- Upper East (UE) Wetland Cells - 3 cells
- Lower East (LE) Wetland Cells - 2 cells
- Bisa Wetland Cell - 2 cells
- Central Wetland Cell
- Primary Lake

A cross section of a typical constructed wetland is shown in Figure 3.4.

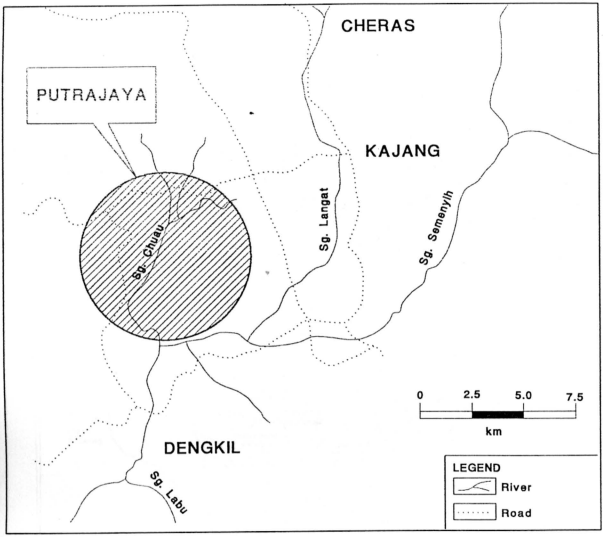


Figure 3.1 Location of the Putrajaya Wetlands site (MHSB, 1996)

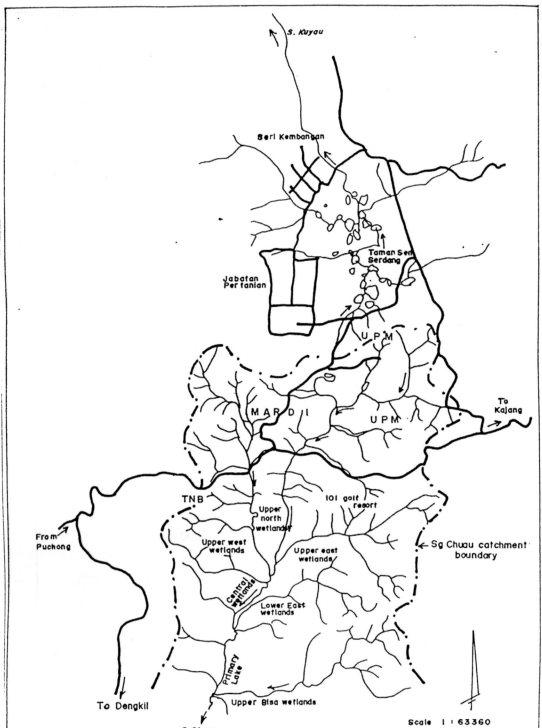


Figure 3.2 Catchment area of the constructed wetlands at Putrajaya

(MHSB, 1997b)

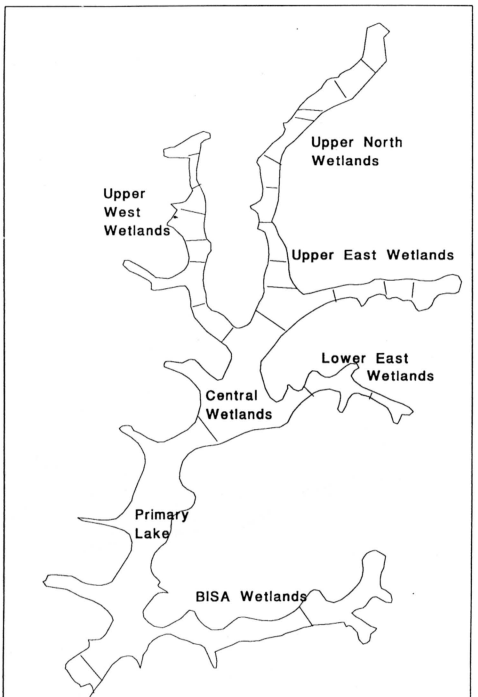


Figure 3.3 Planting Zones (MHSB, 1997c)

Eleven million plants of some 70 species such as *Phragmites* sp. are needed to be established in the 24 wetlands cell at Putrajaya. MHSB is involved in propagating the plants, setting up the nursery, planting the plants in the constructed wetland cells and maintaining them.

3.1.2 OPERATIONAL DETAILS

The main processes onsite are as follows:

- ***Plant sourcing and collection***

  This activity involves the sourcing of wetland plants from identified sources and the collection of these plants for propagation at the Putrajaya nursery (MHSB, 1997i). A team comprising of aquatic plant ecologists, botanists, assistant scientists and field workers are mobilised to conduct a survey of nearby natural wetlands and swamp areas. Potential sourcing areas are identified and mapped (MHSB, 1997d). Estimates on available quantities of planting materials, viz. seeds, plantlets, seedlings and cuttings per plant type are worked out. Groups of workers are then sent out to collect these plants on a need-to basis (MHSB, 1997e).

- ***Plant preparation***

  Considering the wide biological diversities and differences between species, different methods are used in their propagation and production. While for naturally abundant

species, direct transfer would suffice, others may require other methods such as seed germination, vegetative propagation and micropropagation.

The bulk of the planting materials for the Putrajaya Wetland Project are propagated by seeds or vegetatively using cuttings, tubers, and suckers. For seed-propagated marsh plants, the seeds are sown directly onto shallow trays filled with the recommended growing medium comprising of 75% sieved river washed sand and 25% compost.

Vegetative parts (cutting, tuber, sucker) are to be treated (where appropriate) with rooting hormones and fungicides before being planted in filled (with growing medium) trays. The treatment of the vegetative parts will improve the chances of successful rooting.

After germination, the plants are transplanted singly to individual pots or compartmentalized planting trays or peatpots (depending on plant types). The potted plants are kept in the nursery supplied with overhead mist irrigation. Plant types requiring constantly moist conditions will be placed in water troughs lined with durable polyethylene. The plants are given regular foliar sprays.

For swamp forest plants and large fringe plants, where plants exceeding 1.5m height are required, transplanting of 1.5m high seedlings or plantlets are sourced *in situ* and

transplanted to large polybags and nurtured in the nursery. Commercially available plants are sourced from associated nurseries.

- ***Plant propagation at nursery level***

  After sowing (seed)/planting of the vegetative parts, the planting trays are placed on raised benches made of treated tropical wood or galvanised steel inside a rain sheltered house for germination/rooting.

  The rain shelter house is constructed of galvanised steel frame covered with UV proofed plastic sheet. In addition, the house has an overhead shading net which will reduce heat and radiation by 50 to 75 percent.

  The rain shelter house is equipped with an automatic mist irrigation system. Misting is automatically controlled by humidity sensors placed inside the house.

The layout of the nursery is showed in Figure 3.5. The list of equipment used in the nursery for propagation of plants are as follows:

i) Planting containers

MHSB uses cylindrical (diameter of 10cm and height of 15 cm) peatpots as plant containers. Peatpots are made using specially compressed peat. These pots will biodegrade sufficiently within 3 to 4 months after filling with the growing medium to allow free passage of plant roots. Plate 1 shows the plants planted in the peatpots.

Plate 1 **Wetland plants planted in the peatpots**

ii) Automatic filling line

This project requires an average of 60,000 pots to be filled daily. It is not viable to resort to manual filling of the pots since a large number of workers would be required and could cause management and logistic problems.

An automatic filling machine specially developed for use with the planting pots is used. The filling machines is capable of filling up to 100,000 pots a day.

iii) Nursery shade house

An overhead shading net is used to protect the young seedlings from heavy rain drops during severe storm and shade off excessive heat. Plate 2 shows the shading net used at the nursery.

The shade house is equipped with an automatic micro (fine spray) overhead sprinkler irrigation system to provide watering facilities. Humidity sensors are strategically placed inside the shade house. These sensors will automatically trigger the irrigation system when the humidity inside the shade house drops below a predetermined level (MHSB, 1997f).

Plate 2 Shading Net used at the Nursery

vi) Open nursery

Once seedlings in the nursery shade house are firmly established they are transferred to the open nursery where they are hardened to withstand the elements after field planting.

Pest and disease control (if and when necessary) are controlled using motorized sprayers. Special equipment such as goggles, mask and a special apparel are used which cover the whole body.

The open nursery is equipped with an overhead irrigation sprinkler system to provide watering facilities. In addition, a shallow pond nursery (Plate 3) stores certain aquatic plants.

Plate 3 Aquatic pond located at the nursery grounds

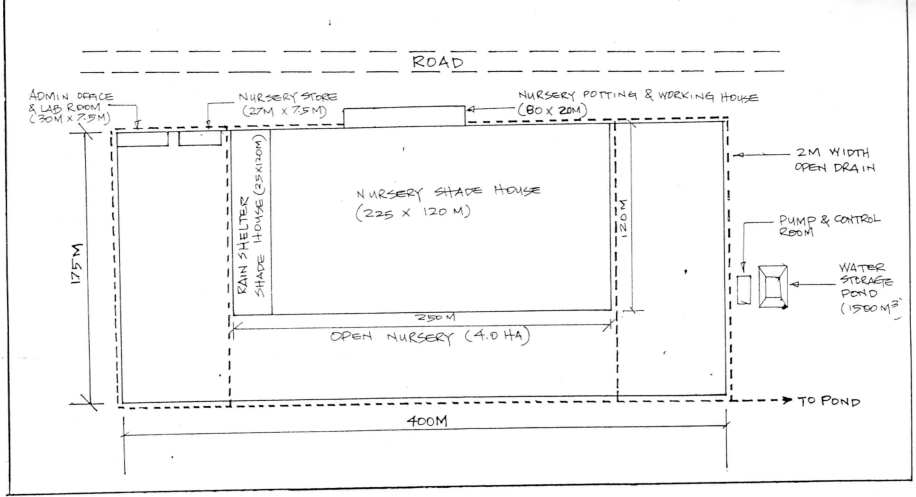


Figure 3.5 Layout of nursery (MHSB, 1997g)

- ***Planting at the constructed wetlands***

Planted containers from the open nursery will be transported to the general planting site. The potted plants are then planted directly into the subsoil surface at the prescribed planting density in accordance with the approved planting grid. Plate 4 shows a constructed wetland cell whereby planting activities has been fully completed.

The plants are categorize into two types of wetland plants for areas to be inundated and ornamental plants for areas called the "Zone of Intermediate and Inundation" (ZII) at the fringe of the wetlands (MHSB, 1997 l).

Planting in the ZII will only commence after germination tests have confirmed that the surface has less than 5 percent weed seedling cover.

After transplanting, the plants will be irrigated using a portable irrigation system. This will ensure successful transplanting.

Fishes and other aquatic fauna such as frogs, terrapins and eel are also introduced to provide for a continuity of the food chain in the planted wetland cell. Adequate aeration of water (aerators are used) and nutrients in water (to encourage phytoplankton production, an important food source for fish) is necessary to sustain a balanced ecosystem especially in the Primary Lake area (MHSB, 1997n).

Plate 4 Completed planting works at a constructed wetland cell

- *Plant maintenance*

For efficient control of pest and weed, situations may arise when pesticides and herbicides need to be used. MHSB will at all times practice a policy of integrated pest management (IPM). The use of biopesticides, such as BTs, will take precedence over chemical pesticides. Only herbicides approved for use on marshes and wetlands by BCPC (British Crop Protection Council), MAAF and US EPA (Environmental Protection Agency), will be used. Guidelines produced by these agencies on residue levels and buffer zones are strictly to be adhered (MHSB, 1996)

The following guidelines were found in place for the maintenance of the wetlands:

- weed and biomass control (submergent & emergent weeds)- chemical and mechanical, the biomass collected to be made into compost for own use;
- regular sediment removal from GPT (gross pollution traps), lakes and wetlands, and outlet structures;
- controlled and regulated fertilization of wetlands/lakes to maintain zooplankton and phytoplankton populations to ensure healthy and viable fish populations;
- replacement and gap-filling for damaged plants;
- monitor variation in hydraulic behaviour, and maintaining optimal water levels in wetland cells.

The appropriate resource persons in the relevant areas have been drawn upon to draft the "Wetlands Management Plan" (WMP) which will serve as a constant reference point for the maintenance of the wetlands. The experienced foreign consultants are invited to provide their inputs as well. The primary objective of the WMP is to ensure the sustainable management and development of the Putrajaya Wetlands. Emphasis is therefore placed on the following conditions when preparing the WMP:

- maintenance of ecological processes,
- maintenance of biodiversity,
- management of water levels to optimise competitive advantage of target species,

- sustainability of viable wetland plant populations through proper plant maintenance and management using IAPM (Integrated Aquatic Plant Management) systems. Biomass harvested will be composted for own use,
- zoning of areas to ensure minimum visitor impact to sensitive areas,
- sustainable and effective pest, animal, weed and plant disease management,
- management and removal of sediments in cells, lakes and "Gross Pollution Traps" (GPT),
- monitor variation in hydraulic behaviour of wetland cells,
- devise efficient monitoring system for determining water quality and ensuring effectiveness of the wetlands in cleansing the water, and
- incorporate environmental management planning.

- ***Plant growth monitoring***

After field planting, it is important that growth of the wetland plants be closely monitored so that any setbacks or anomalies to growth or normal plant health can be immediately identified and corrected. The main growth parameters are visual health, plant height, number of shoots or stems per unit area (MHSB, 1997j).

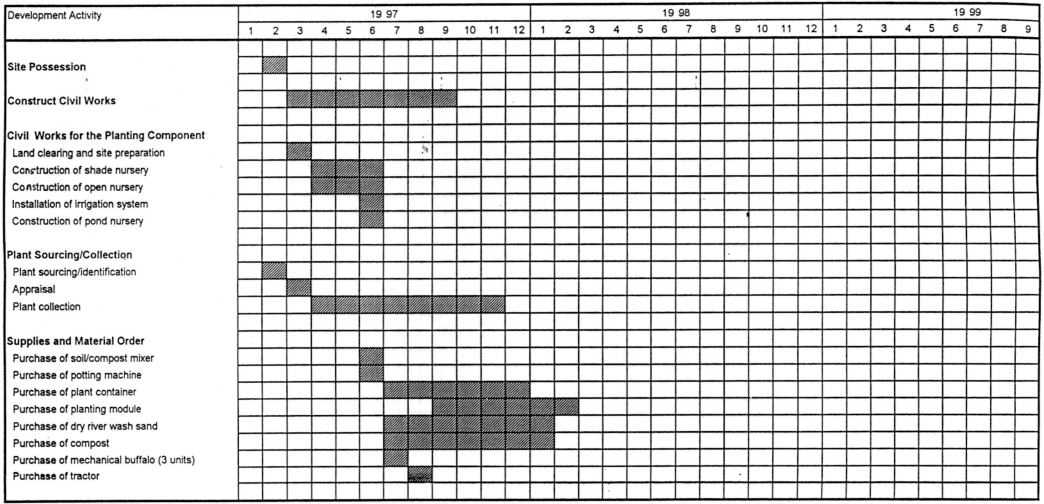
Workforce

The site has a work force of about 30 permanent staff and 100 contract workers.

Work Schedule

The work schedule is shown in Table 3.1. This planting project by MHSB commenced operation in February, 1997 and is due for completion in September, 1998. Monitoring activities are scheduled to commence in April 1998 until September 1999.

Table 3.1 Work Schedule of planting activities at Putrajaya Wetlands (MHSB, 1996).



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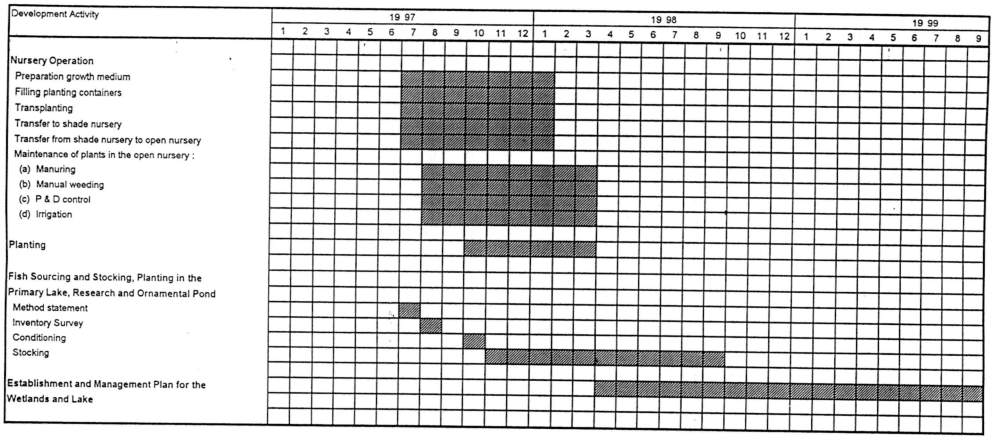

3.1.3 SITE HISTORY

The project site was originally an oil palm estate. The current owner, Putrajaya Holdings Sdn. Bhd. which is to develop the new Centralised Malaysian Government Administration, cleared the land in accordance to the EIA (Environmental Impact Assessment) Report that was approved by the Department of Environment.

3.2 ENVIRONMENTAL MANAGEMENT

3.2.1 MANAGEMENT STRUCTURE

The management structure at the nursery site is as shown in Figure 3.6. The group is headed by the planting operations manager. There are four supervisors, each responsible for the four activities at the nursery. Under them are four more assistant supervisors who help in supervising the contract workers.

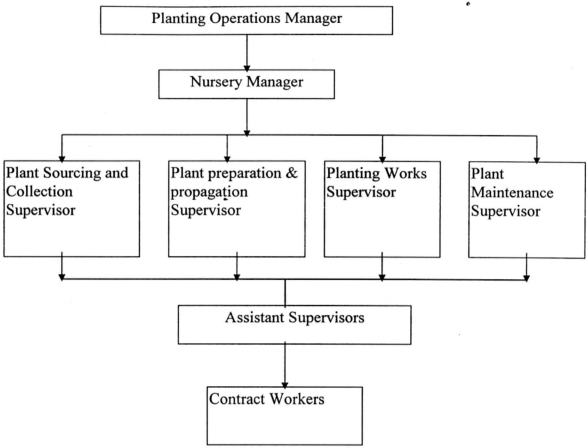

Figure 3.6 Management Structure of the Nursery Site

3.2.2 SITE ENVIRONMENTAL POLICY

The site at the moment does not have a site environmental policy.

3.2.3 ENVIRONMENTAL TRAINING PROGRAM

No environmental training program is provided for the site personnel.

3.2.4 INTERNAL ENVIRONMENTAL AUDITING PROGRAM

There is no Internal Environmental Auditing Program

3.2.5 INTERNAL ENVIRONMENTAL MONITORING PROGRAM

MHSB has an Internal Environmental Monitoring Program which monitors the water and soil qualities in relation to plant growth. Air and noise monitoring are not carried out.

a) Water Quality Monitoring

MHSB took baseline water quality data of the rivers before construction began. It has an on-going program to monitor the water quality in each of the wetland cells. The water samples are taken every fortnightly and sent to an accredited laboratory for the analyses.

The parameters analyzed are :

- Water level (height in meters)
- Rate of flow at the time of sampling (L/s)
- pH
- Conductivity
- Oxidized nitrogen (NO_x)
- Ammoniacal nitrogen
- Phosphorus
- Potassium
- Soluble Iron
- Magnesium
- Turbidity
- Suspended Solids
- BOD
- COD (MHSB, 1997c).

The proposed water sampling points before and after wetlands construction is shown in Figure 3.7 and 3.8. The data acceptance criteria used for water quality sampling are Class IIB of the Interim National Water Quality Standards. An example of the baseline data before construction of the wetlands (Plate 5) and after completion of the wetlands (Plate 6) at the same river, are shown in Table 3.2 below.

Table 3.2 Before and after water quality data for the Upper West river (MHSB, 1997b) and an Upper West constructed wetland cell (MHSB, 1998d)

Parameters	Unit	Before (March, 1997)	After (February, 1998)
Physical:			
pH		6.8	7.65
Temperature	°C	28.9	31.7
Turbidity	FTU	35.7	16
TSS	mg/L	24.0	5
Flowrate	m^3/s	0.44	0.45
Chemical:			
Conductivity	µmhos/cm	66.7	54
Ammoniacal Nitrogen	mg/L	0.6	0.33
Nitrate	mg/L	3.0	0.58
Phosphorus	mg/L	0.03	<0.01
Potassium	mg/L	1.3	1.63
Magnesium	mg/L	1.0	0.82
Soluble Fe	mg/L	0.9	0.17
DO	%	63.6	83.8
COD	mg/L	<1.0	3
Biological:			
Faecal coliform	MPN/100ml	5500	<100
BOD	mg/L	1.2	<0.63

Based on Table 3.2 and Plates 5 and 6, it is evidently clear that the constructed wetlands have managed to improve the water quality at the Upper West tributary river of Sungai Chuau.

Plate 5 **The condition of the Upper West River of Sungai Chuau in March, 1997. (MHSB, 1997b)**

Plate 6 **The water quality of the existing outlet sediment pond of the Upper West wetland cell in February, 1998**

The Water Quality Index (WQI) adopted by Department of Environment is used to determine the status of the water samples. The calculations are as follows:

WQI = 0.22 * SIDO + 0.19 * SIBOD + 0.16 * SICOD + 0.15 * SIAN + 0.16 * SISS + 0.12 * SIpH

Table 3.3 shows the calculations for the subindexes.

Table 3.3 Best-fit Equations for the Estimation of the Various Subindex Values

Subindex	Equation	Concentration
DO (in % saturation)	SIDO = 0 or 100	for $x \leq 8$ or $x \geq 92$
	$SIDO = -0.395 + 0.030x^2 - 0.00020x^3$	for $8 < x < 92$
BOD	SIBOD = 100.4 - 4.23x	for $x \leq 5$
	$SIBOD = 108 * e^{-0.055x} - 0.1x$	for $x > 5$
COD	SICOD = -1.33x + 99.1	for $x \leq 20$
	$SICOD = 103 * e^{-0.0157x} - 0.04x$	for $x > 20$
AN	SIAN = 100.5 - 105x	for $x \leq 0.3$
	$SIAN = 94 * e^{-0.573x} - 5 * \lvert x-2 \rvert$	for $0.3 < x < 4$
	SIAN = 0	for $x \geq 4$
SS	$SISS = 97.5 * e^{-0.00676x} + 0.05x$	for $x \leq 100$
	$SISS = 71 * e^{-0.0016x} - 0.015x$	for $100 < x < 1000$
	SISS = 0	for $x \geq 1000$
pH	$SIpH = 17.2 - 17.2x + 5.02x^2$	for $x < 5.5$
	$SIpH = -242 + 95.5x - 6.67x^2$	for $5.5 \leq x < 7$
	$SIpH = -181 + 82.4x - 6.05x^2$	for $7 \leq x < 8.75$
	$SIpH = 536 - 77.0x + 2.76x^2$	for $x \geq 8.75$

x = concentration in mg/l for all parameters except pH
* = multiply by
SI= subindex

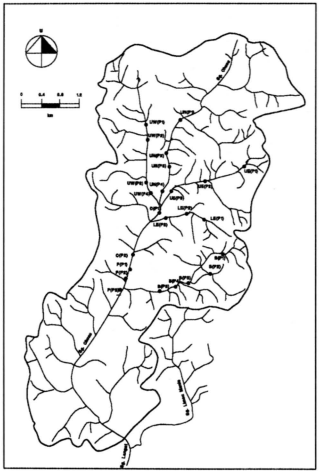

Figure 3.7 Water Sampling Points Before Wetlands Construction (MHSB(1997a)

Figure 3.8 Proposed Water Sampling Points After Wetlands Construction

b) Topsoil Monitoring

Soil samples are taken from undisturbed grounds (before the construction of the wetland cell) and from each planted wetland cell to test the quality of soil and the extent of previous oil palm contamination (MHSB, 1997h). The soil monitoring is carried out every month and the parameters are as follows:

- Total nitrogen (N)
- Available phosphorus
- Exchangable Potassium
- Exchangable Magnesium
- pH
- Conductivity
- Percentage of Organic Matter
- Phytotoxic metals
- Hydrocarbons
- Herbicides (paraquate, glyphosphate and 2,4-D) (MHSB, 1997 l)

Figure 3.9 shows the soil monitoring points at Putrajaya Wetlands.

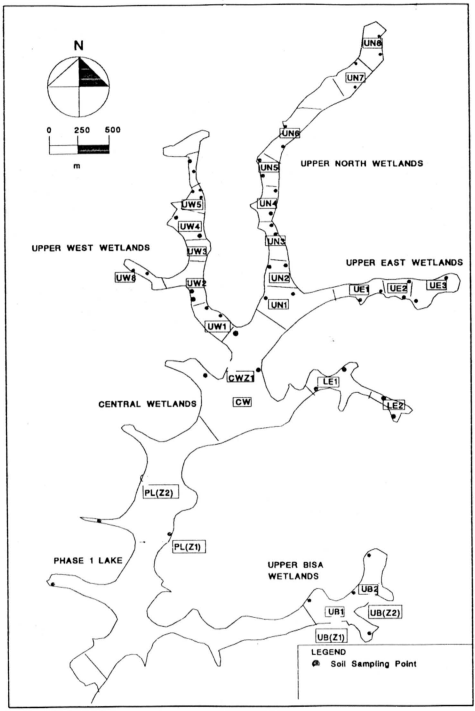

Figure 3.9 Soil Monitoring Points at Putrajaya Wetlands (MHSB, 1997o)

The results of the water and soil analyses from the laboratory are reported within 10 days of the date of sampling. The Water Quality Index is used to summarize the water quality analysis and to classify the samples as polluted, slightly polluted or clean. The water and soil results are tabulated and discussions regarding the results are documented in the monthly Water Quality Report and Topsoil Monitoring Report. These reports are distributed to the client (Putrajaya Holdings Sdn. Bhd.), joint-venture partners and Wetlands International.

3.2.6 INTERNAL INSPECTIONS

Some internal environmental inspections are carried out among the MHSB staff weekly to lookout for potential soil erosion, water and soil pollution.

3.2.7 PRODUCT LIFE CYCLE ANALYSES

Internal product lifecycle analyses have never been carried out.

3.2.8 EXTERNAL MONITORING PROGRAM

MHSB does not carry out any external monitoring program at the site.

3.3 PROCESS REVIEW

A process review flowchart of the activities at the site are shown in Figure 3.10.

The input materials required at the site are :

a) Water

The water used on the site is obtained from the nearby river using a water pump. The water is pumped into a nearby constructed pond and goes through a filter as well as natural process of oxidation by sunlight before being used to irrigate the plants at the nursery as well as for washing purposes. The nursery uses about 500 cubic metres of water daily.

b) Energy

Electricity at the site is generated using a 500KV generator. This generator operates between 8.00 a.m. to 12.00 p.m. and from 1.00 p.m. to 6.00 p.m. An air compressor is used and it is equipped with mufflers, air cleaner and an oil filter cathridge. The oil filter cathridge is cleaned every 100 hours of operation.

c) Peat

Peat is used to fill up the pots prior to planting at the nursery level.

d) Polybags

An estimated figure of 2500 kilograms of polybags (Plate 7) have been used for planting since February 1997 until February 1998. Most of these polybags were recycled to minimize the waste.

e) Plastic (planting) Trays

Since February 1997 until February 1998, about eighty thousand plastic trays have been bought. Plate 8 shows samples of some plastic planting trays.

Plate 7 Polybags used for planting some of the plants

Plate 8 **Plastic (planting) trays**

f) Peatpots

Since February 1997 until February 1998, about eight million peatpots have been used.

g) Chemicals and Pesticides

Only authorized personnels (a registered Occupational Safety and Health Officer) are allowed to handle these chemicals and all safety precautions are taken when releasing the chemical in the nursery such as goggles, face mask and special apparel. The chemicals are mostly bought on a "need to" basis and are only stored (if necessary) under lock and key at the MHSB Nursery Manager's site office.

h) Fuel

Two to three barrels of diesel oil are kept 50 metres away from the nursery office. The diesel oil is needed to fuel machines, nursery vehicles and the air compressor.

MHSB strictly prohibits smoking as there are flammable substances at the nursery. A fine is imposed on any person caught smoking or littering of cigarette butts.

i) Transport

MHSB owns 4 lorries, 2 vans and 3 four wheel drives. The lorries are used to transport plants during plant collection and during planting activities at the constructed wetlands.

The main output of the process review is the waste problem which can be classified as solid waste, liquid waste, sewage and sullage waste and hazardous waste.

a) Solid Waste Generated and its Treatment

The solid waste can be further divided into biodegradable and non-biodegradable waste.

I. Biodegradable waste

Biodegradable waste is mainly created by the agro-residues (Plate 9) that are leftover during the plant preparation activity. Some of the plants that are brought in have to be cut into appropriate sizes for planting in the peatpots. It is estimated that about one ton of agro-waste is produced each day. This includes the 40% rejected plants that are turned into waste due to stringent quality control checks.

MHSB manages this agro-residue (waste) problem by landfilling them in a nearby pond or by leaving it to biodegrade by themselves.

Apart from agro-waste, other biodegradable waste include spoilt peatpots, used newspapers, used gunny sacks, loose topsoil and peat waste (due to clumping of the peat). All these biodegradable solid wastes are used to fill up uneven areas within the nursery grounds.

Plate 9 **Agriculture residues (agro-residues) at the nursery**

II. Non-biodegradable waste

Materials which are non-biodegradable such as used plastics trays and used polybags pose a problem. For the meantime, these plastic trays and polybags are reused as many times as possible before taken to the landfill. So far, no plastic trays have been discarded. Nevertheless, most of the polybags are unable to be reused as the roots of some plants have penetrated the polybags.

b) Liquid Waste

The results of the audit showed that the liquid waste problem at the site is due to the washwater during the plant preparation and propagation stage. These waters are channeled through constructed earth-drains to the nearby Upper West river. As the earthdrains ultimately leads to the nearby Upper West Wetland Cells which will cleanse the waters, treatment of this liquid waste is naturally being taken care of.

About $500m^3$ of water is used daily and it is estimated that 90% of this water is turned into washings.

Based on the hydrogeological map of Peninsular Malaysia, the audited site has a groundwater potential of less than 2,500 gallons/hour/well. Therefore, groundwater pollution from the site is deemed insignificant.

c) Sewage and Sullage Waste

The nursery at the Putrajaya is equipped with a septic tank toilet and the contents are desludged by a Sewage Contractor every month. A mobile toilet is available at the MHSB site office and its content is desludged every two weeks.

d) Hazardous Waste

There are not many hazardous substances that are used by MHSB. The types of hazardous material that are used onsite are pesticides and herbicides.

The empty insecticide, pesticide and herbicide containers are separated from the other wastes and are properly marked and reused.

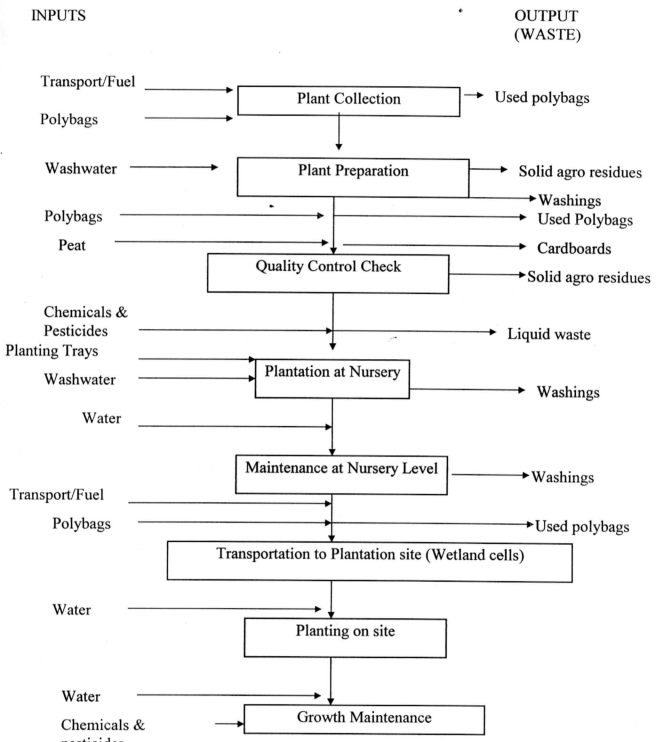

Figure 3.10 Process Flowchart at the Putrajaya Wetlands

3.3.1 ASSESSMENT OF INDIRECT ENVIRONMENTAL EFFECTS

Dust Pollution

Dust pollution is mainly due to movement of vehicles on untarred roads within the site. Vehicles with soiled tyres are not washed before leaving the site causing dust pollution to the environment outside the nursery , especially for vehicles traveling on the public road.

Noise Pollution

Noise pollution is mainly caused by movement of machineries and the generator. The noise level when all machineries are in operation was at about 72 dBA which exceed the WHO Noise level of 55 dBA in the daytime and 45 dBA in the nighttime. .

Soil Erosion

Soil erosion may be a problem during heavy rainfall days. This is due to the fact that the nursery is located at a lower ground than some of the other areas within the Putrajaya site. In addition, almost all of the constructed wetland sites are located on much lower ground than the other portions of the land. If not properly controlled, during a heavy rainfall, the whole wetland site could be highly prone to soil erosion and sedimentation problems, leading to more pollution along the waterways.

Silt/sedimentation ponds and weirs (Plate 10) are built to trap silt/sediments from reaching the waterways. The pond design was adopted from the EPA manual and are located at the lowest point just downstream of each wetland cell.

Plate 10 Silt/sedimentation pond and weir at the outlet of a constructed wetland

Construction of each wetland cell was staggered so that land disturbance at any one time was at a minimum. This limited the time the exposed areas were at risk from erosion. Erosion control and slope stabilising measures are applied to areas which have been opened up for construction of the wetland cell. Where possible, land disturbing operations

were done in the dry season when erosion is less severe. Other work practices adopted by MHSB were:

- setting up silt fences for silt/sediment
- hydroseeding
- using biodegradable blankets
- construction of catch drains

3.4 GASEOUS EMISSIONS

3.4.1 IDENTIFICATION OF SOURCES OF GASEOUS EMISSIONS

The possible gaseous emissions are carbon monoxide which are emitted from the machinery, generator and transporting vehicles. Nevertheless, these emissions are not significant due to the small amount of vehicles and machinery involved.

3.4.2 MONITORING PROGRAMS FOR THE GASEOUS EMISSIONS

No monitoring programs are in place for the gaseous emissions

3.4.3 COMPLIANCE STATUS FOR THE GASEOUS EMISSIONS

MHSB does not need a permit for its gaseous emission as the amount is insignificant.

3.4.4 GASEOUS EMISSIONS CONTROL

The air compressor has its own air cleaning filter and it is maintained every 100 hours of operation. No other gaseous emissions control was found to be in place.

3.4.5 FORTHCOMING DEVELOPMENTS

As the gaseous emissions factor is insignificant, no forthcoming developments are foreseen.

3.5 WASTEWATER

3.5.1 IDENTIFICATION OF SOURCES OF LIQUID EFFLUENT

Washwater from the site and stormwater are the only sources of liquid effluent flowing out of the site. The sullage water are collected in septic tanks and mobile toilets and therefore do not pose a problem.

3.5.2 DRAINAGE NETWORK DETAILS

There is a pump at the nursery site which pumps the water from upstream of the upper west tributary of Sungai Chuau.

The drains around the audit site is made out of earthdrains. The earthdrains are channeled back to the Upper West series of constructed wetlands. At the constructed wetland, the water is treated as they flow pass the wetland plants and are put through weirs at the outlet of the wetlands.

3.5.3 TREATMENT ON-SITE

The water is recycled back into the constructed wetlands for treatment. No other on-site treatment of the liquid effluent is carried out. Flooding is not a problem as the wetlands are designed to mitigate flooding problems. During the dry season, water is pumped to these wetlands to ensure the growth of these wetland plants and their efficiency to cleanse the river water.

3.5.4 TREATMENT OFF-SITE

No treatment off- site is carried out on the liquid effluent.

3.5.5 INTERNAL MONITORING PROGRAMS

An internal water quality monitoring program has been formulated and is implemented fortnightly. The parameters involved are reported in section 3.2.5 of this chapter. The receiving watercourse is Sungai Langat.

3.5.6 EXTERNAL MONITORING PROGRAMS

No external monitoring program was formulated.

3.5.7 COMPLIANCE STATUS

As the water gets recycled back to the river and is cleansed by the wetlands, no permits are required for the liquid effluent from the site.

3.5.8 FORTHCOMING DEVELOPMENTS

The liquid effluent does not pose a serious problem as the constructed wetlands are able to cleanse the waters. Therefore no forthcoming development is foreseen.

3.6 SOLID WASTE MANAGEMENT

3.6.1 ITINERARY OF GENERAL WASTE

The general waste itinerary generated at the site with its disposal routes are shown in Table 3.4 below:

Table 3.4 Itinerary of general waste and disposal routes

Waste	Quantity	Quality	Disposal routes
Domestic waste	2 garbage bags (500 grams) per day	Food packaging, refuse, etc.	Municipal garbage centres
Commercial waste	1 ton per day	Wood planks, agro-residues	Landfilled
Inert waste	<10 grams per day	Plastic bags	Municipal garbage centres
Hazardous/solid waste	All cans and bottles are recycled and labelled.	Chemicals and pesticide bottles and cans	Recycled

3.6.2 SPECIFIC WASTE TYPES GENERATED

The site does not produce solvents, PCB's, paints, oils, asbestos, CFCs, halons and other waste.

3.6.3 TREATMENT ON-SITE

No treatment on solid waste is carried out.

3.6.4 STORAGE OF WASTE

All wastes are removed from the site at the end of the day's activities or in the early working hours of the next morning. No special storage area is provided for these waste.

3.6.5 TRANSPORTATION OF WASTE

Internal lorries are used to transport the agro-residues. No other transportation is used to carry off the waste.

3.6.5 ON-SITE DISPOSAL

No on-site disposal is carried out.

3.6.6 OFF-SITE DISPOSAL

A license is not needed for the private landfill used to landfill the agro-residues.

3.6.7 REUSE AND RECYCLING

Plastic trays and some polybags are reused on-site. The pesticide and chemical containers are also recycled.

3.6.8 FORTHCOMING DEVELOPMENTS

MHSB is looking into the possibility of composting its agro-residues for commercial purposes. A more environmentally friendly way of disposing its plastic materials are also being looked into to solve the inert waste problem.

3.7 ACCIDENT AND EMERGENCY

3.7.1 EMERGENCY PLANNING

Given the relatively minor use of machinery and equipment, no emergency plan is in place at the nursery. However four first aid-kits, six fire extinguishers and several sand pails were sighted on the site. The place is maintained within the reasonable safe expectation for such a site.

3.7.2 INCIDENT REPORT

No accidents and negligent spills have occurred since its operation

3.8 PACKAGING

The raw materials and their respective packaging materials are shown in Table 3.5.

Table 3.5 Packaging Materials

Raw Material	Packaging
Topsoil	Transported by lorries
Peat	Paper Packages
Peatpots	Cardboard Boxes
Chemicals	Glass bottles
Diesel /Petrol	Steel drums

The packaging material for peat and peatpots are collected and sent to recycling paper plants. The bottles and the drums used for the chemicals and the diesel/petrol are recycled and used to refill when repurchased. They are also regularly checked for leakages.

3.9 COMPLIANCE STATUS

Among the statutory regulations and guidelines undertaken by MHSB are :

- Environmental Quality Act, 1974 - MHSB comes under this act in terms of pollution to the environment namely, air, water and noise.
- Environment Quality Regulations (Sewage & Industrial Effluents) 1979 - The water quality that would be leaving the Putrajaya site would eventually have to meet Standards A of the Environment Quality Regulations (Sewage & Industrial Effluents) 1979 as what a normal wastewater treatment plant would have to comply.

- Environment Quality (EIA) Order 1987 - MHSB has shown to be abiding to all the approved EIA regulations. This would include mitigation measures stated in the EIA report to curb any negative impacts that would arise due to MHSB's activities.
- Occupational Safety & Health Act 1985 - This Act is applicable to MHSB under the generality of working conditions suitable at the workplace. All preventive precautions and safety procedures are adhered to.
- Ministry of Health - Regulations concerning health matters at the site would include standing waters which would breed mosquitoes and other disease causing microorganism.
- Ministry of Transport - Transportation of plants and movement of vehicles owned by MHSB and those used by its contractors are to abide with all regulations stated by the Works Department.
- Custom and Excise Department - Importing of goods such as machinery and peat pots are required to comply to all regulations stipulated by the Custom and Excise Department.
- Immigration Department- Foreign workers who are directly employed by MHSB satisfied all rules as per the Immigration Department. MHSB has made due diligence checks to ensure that their foreign workers have satisfied these rulings including funds to repatriate them when their terms of contract expire. As for foreign workers not directly employed by MHSB, the latter has keep up dialogue session with both their contractors to ensure that treatment of these workers are in line with international labour standards where practicable.

B) DISCUSSION AND MITIGATION MEASURES BASED ON THE SITE ENVIRONMENTAL AUDIT

3.10 INTRODUCTION

From the site environmental audit, it can be perceived that MHSB's activities are in line with their company's stated intention of promoting and enhancing the environment for the betterment of mankind. MHSB being the pioneer in developing wetlands, has shown willingness to experiment with new improved technology and where economically feasible, have adopt them in line with their interest. Nevertheless, this system can be further improve with additional mitigation measures which will be discussed in the following sections, as per our suggestion.

3.10.1 DISCUSSION ON OUR RECOMMENDATION FOR MHSB'S MAIN PROCESSES

1) Plant sourcing and collection

The selection criteria for plants should take into consideration factors such as indigenous species, ease of propagation, availability, aesthetic value, ability to transfer oxygen to roots and biodiversity.

The collection team should ensure that in situ removal will not have any significant impact on the environment and ecology. As a general rule, no more than 20% of plants in any collection site will be removed. Only topcuttings will be carried out for certain plants

and sometimes the seeds are obtained. Ecological balance must always be maintained at the source.

An inventory of the potential sourcing areas is carried out detailing the information on the abundance of wetland species present, the ecological environment, soil type, soil nutrient status and water quality data. (MHSB, 1997i). This database should be updated and inspected within a framed period of time.

Safety measures that should be taken during the plant collection exercise includes

- wearing rubber gloves and boots during field sampling
- use of rubber dingy, life jacket and inflated tyres for deeper areas
- carry first aid kit

2) Plant preparation

On arrival of plants at the nursery, all batches of plants should be examined by the botanist and/or nursery manager to ensure their correct identification. Steps should be taken to ensure that serious pests and diseases are not introduced into the site. These are :-

- training of collectors to identify serious pests/diseases
- collect only from areas free from serious pests/diseases
- plants entering the nursery are constantly checked for pests/diseases
- there must be no direct planting of plants collected from outside into the wetlands

- all plants will be nurtured at least 2 months in the nursery (away from the wetlands) during which the plants will be observed for the presence of any potentially serious pests.

3) Plant propagation at nursery level

At the nursery level planting is carried out using :

a) Peatpots - These peatpots are made out of compressed peat and are manufactured in Denmark. These pots are biodegradable and will biodegrade in about 4 months after filling with pot mixture and planting. They will integrate into and blend with the planting substrate, thus becoming part of the planting substrate.

The reasons for using peatpots as plant containers are:

- They are made to comply to the biodegradeable characteristic required,
- The pots are readily available in large numbers and can be produced to size specification in a short period of time,
- The pots have been successfully used as plant containers in large scale horticultural and reforestation projects for more than 15 years.

b) Polybags

For the propagation of the large plants, which require a longer period of nursery time (6-10 months), perforated plastic bags are used.

c) Planting Trays

Geminating plastic trays are used for some wetland plants.

4) Planting at the wetlands

After the wetland is constructed, the top ground soil testing is carried out to assess the quality of the soil. (MHSB, 1997d). The plants are transported from the nursery to the field to be planted. Planting is also carried out at the Zone of Intermediate and Inundation areas to add aesthetic to the area. Flooding of the wetland cells will take place on the completion of planting activities at the wetlands.

5) Plant Growth Monitoring

Plant performance is assessed using visual health (presence of deficiency symptoms and disease) and several indicators of growth such as plant height, number of side shoots and number of stems per m^2 (MHSB, 1997k).

Weekly site inspections will be carried out for every cell. Other methods of monitoring include;

- Percentage of survival
- Weed control (because of the ecological sensivity of the wetland system, manual weeding have precedence over chemical weeding but where spraying of pesticides is necessary, only chemicals approved by the Pesticide Board is used).
- Spread of planted species
- Pests and Diseases

Abnormal or diseased plants would be replaced with healthy plants. All supply and replacement plants are checked to ensure that they are healthy and free from pest and disease.

Table 3.6 outlines the possible environmental impacts arising from MHSB's activities.

Table 3.6 Environmental Impacts of Activities at the Wetland site

Activity	Aspect	Impact
Plant Collection	Loss of endangered plants Possible loss of ground cover	Ecological Soil erosion
Plant Selection	Cutting of plants for planting in nursery Washwater from washing of residues	Solid waste disposal Contaminate the river
Plant Propagation	Plastic Trays and used polybags Washwater Fertilisers Pesticides & Insecticides	Solid waste Contaminate the river Contaminate the soil &river Contaminate the river
Field Planting	Used polybags Fertilisers Pesticides & Insecticides	Solid waste Liquid waste Contaminate the river

con't Table 3.6

Activity	Aspect	Impact
Field Maintenance	Washwater	Liquid waste
	Fertilisers	Contaminate the soil & river
	Pesticides & Insecticides	Contaminate the river
Transport	Unwashed tyres	Road accidents and dirty roads
	Storage of diesel onsite	Spillage - contaminate the soil and rivers, fire accidents

3.10.2 MITIGATION MEASURES FOR SOLID WASTE MANAGEMENT

Agro-residues

The main issue here is the agro-residues that are produced which can be turned into a by-product for composting (MHSB, 1998b). A process of grinding these residues into a homogeneous form could be carried out. By adjusting the moisture content, temperature and the nitrogen, phosphorus and calcium content of these agro-residues, a composting system could be set up. Furthermore this process can be easily accomplished with no additional capital investment and will save the need for long term fertilisers.

Plastics

Plastic containers, trays and polybags should be recycled as many times as possible. If they are to be thrown, separation should be carried out and sold to recycling companies which eventually will earn some income for MHSB. They should not be mixed together with the rest of the solid waste and be taken to the landfill as they are classified as non-biodegradables (Hajjah, 1996). A stricter plan based on usage analysis should be considered and adopted. Possibilities of replacing these plastic with more environmentally friendly products should also be looked into.

3.10.3 MITIGATION MEASURES FOR TRAFFIC DUST POLLUTION

A ski jet water pump should be placed at the exit of the nursery to wash the tyres of vehicles leaving the site. The water should be diverted to a properly constructed sediment weirs which would be able to trap the silt and suspended solids. (DOE, 1997). This sediment weirs should be maintained with a suspended solid load of about 50 mg/L. (EQA, 1974b).

If financing permits, roads around the nursery should be tarred wherever possible to reduce the dust formation in the site. These roads should be wetted at a suitable interval especially during the dry season.

3.10.4 MITIGATION MEASURES FOR HAZARDOUS MATERIAL MANAGEMENT

Two to three barrels of diesel oil are kept within the premises of the nursery office. These drums are located too near the working area (only about 50 metres) and would pose a danger to the workers. A good diesel management system have to be organized whereby the barrels are placed in a sand bunded area which has a capacity of 110% of that of the total maximum capacities of the barrels (ENSEARCH, 1997). This sand bunded area should be in an open spaced area and far away from possible auto-ignition sources. Signboards should be erected to warn workers of the content of these drums and a no-smoking sign should be put up. Fire-fighting equipment should be located on-site to put out any fire at the nursery.

Chemical and pesticide aerosol cans should be separated from the normal solid waste and be properly labeled as a hazardous material.

An emergency response plan should be in place to handle emergency situations involving fire and any threat to the public safety. An emergency response plan has since been discussed and a draft copy is appended in Appendix 5.

3.10.5 MITIGATION MEASURES FOR SURFACE RUNOFF MANAGEMENT

The drainage system at the site mainly consist of earthdrains. Another suggestion would be to use a unique patented drainage construction system for erosion and sediment control called "tyredrain". Tyredrain is manufactured from half segments of recycled tyres, with the side walls stapled together to form 1 meter lengths of channel shaped section. Provision is made to peg each length of Tyredrain into the ground and weep holes are inserted in each tyre segment. The 1 metre lengths are joined on site to form a drain of any length. Tyredrains have been used in Australia to reduce drainage erosion at roadside table drains and catchment drains, dispersion of water from culverts, Local council and Water Authority applications, railways, pipe line applications, forestry areas and National Parks, etc. (Nicholson, 1998).

Among the advantages of tyredrain over conventional methods are as follows:

- A fraction of the price of conventional methods, quicker and easier to install
- Flexible construction, allowing for ground movement
- Doubles as a rubble drain
- Reduces siltation, the silt is trapped in tyre cavities
- Self cleaning, turbulence created by the tyre walls creates a self cleaning effect within the drain
- Virtually invisible when vegetation is established and silt and gravel builds up within tyre cavities
- Reduces the velocity of the water by absorbing peak downpours

Tyredrain provides another major environmental benefit, the recycling of used tyres which is currently creating a major problem that creates enormous environmental damage and fills scarce landfill sites.(Nicholson, 1998).

3.10.6 MITIGATION MEASURES FOR NOISE POLLUTION

Noise is not a major health problem on the site but prolonged exposure might cause other work related accidents or even possible deafness. Nevertheless, workers should be provided with ear plugs to reduce undue exposure of their ear drums to long duration of loud noises which would be damaging in the long run. Muffing of noisy machinery is highly recommended. (Trieff, 1980).

3.10.7 MITIGATION MEASURES FOR OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT

Fire

There will always be risks of fire at a site. Therefore, it is recommended that proper fire prevention and fire fighting facilities be installed and all rules or regulations of the Fire Department be strictly complied with.

A central fire detection system with sirens should be installed in order to alert or signal personnel during an emergency. Since the detection devices/alarms are only used on an intermittent basis, a testing program should be implemented to ensure the system is functioning properly. Regular maintenance and inspection are necessary to ensure its reliability during an emergency.

An emergency telephone line should be set up to cope with any emergency cases. MHSB should also employ a consultant to do a six months inspection to ensure the emergency response systems (*e.g.* fire fighting system) are always in full operation condition.

Additional items that should be provided on-site are fire extinguishers and first aid kits.

Safety

Clear sign boards indicating and highlighting dangerous areas should be put up. Adequate first aid facilities should be made available on site. The main purpose of these practices is to avoid and minimize occupational as well as accidental hazards to workers.

Health and safety Unit

The company should designate a Health and Safety Unit to draw up and enforce a safety and health memorandum which is under the preview of the Board of Directors.

The memorandum should be made available to the company's staff. A tangible audit should be formulated to assess the safety level of the site.

Various activities and programs such Health and Safety Talks should be carried out to create awareness among the employees in the aspects of health and safety. (Trieff, 1980).

C) RESULTS OF THE MANAGEMENT REVIEW EXERCISE

3.11 ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)

Currently, there is no any formal Environmental Management System in place at MHSB. However, the company, being a pioneer in constructed wetlands, is concentrating on its commitment towards ensuring that the Wetland project be successfully completed and on time. In doing so, being an environment conscious company, it has introduced, considered and integrated environmentally sound principles into its decision-making and operational processes.

As a result of this study, some of the short-falls identified during the review on February 1998 are listed below:-

- No environmental policy, recorded in writing or endorsed by the management
- No communication of its environmental commitment at all levels within the organization
- Insufficient resources and personnel for the implementation of an environmental management system
- There is no environmental training provided to the employees
- There are no awareness programs carried out for the benefit of the employees
- There is no procedures for dealing with direct and indirect environmental effects of its activities

- No environmental audit is being carried out

Nevertheless, MHSB has published documentation on its general operational processes. As at February 1998, MHSB has published the following reports and distributed to interested parties such as Wetlands International and its joint venture partners:

- 15th March, 1997 - Method Statement - Water Quality Monitoring in relation to Plant Growth.
- 16th June, 1997 - Water Quality Monitoring in relation to Plant Growth, March 1997.
- 15th March, 1997 - Method Statement - Initial Topsoil Testing.
- 25th March, 1997 - Method Statement - Plant Sourcing, Selection and Collection.
- 3rd April, 1997 - Report on Plant Sourcing, Selection and Collection.
- 3rd May, 1997 - Method Statement - Propagation, Transplanting, Growing-on, Acclimatization and Irrigation during Plant Production and Storage.
- 3rd May, 1997 - Method Statement - Plant Propagation and Production Facilities.
- 12th May, 1997 - Report on Initial Topsoil Testing for the Upper-West Wetland Cells.
- Report on Water Quality and Soil Nutrient Analysis of Potential Sampling Sites for Wetland Plants.
- 16th June, 1997 - Planting Plan and Establishment of the Wetland Cells.
- 8th July, 1997 - Method Statement - Plant Growth Monitoring.
- 12th August, 1997 - Report on Initial Topsoil Testing for the UW8, UN1-8, UE1 - 3, LE1 - 2, UB1 - UB2, CW Wetland Cells and the Primary Lake.

- 15th August, 1997 - Method Statement - Final Ground Preparation Testing and Soil Monitoring.
- 30th August, 1997 - Method Statement - Fish Stocking & Culture.
- 15th January, 1998 - Challenges in the Construction Of The Putrajaya Wetlands.
- 15th February, 1998 - Compost Prōduction.
- 27th February, 1998 - Plant Growth Monitoring - UW5 cell
- 18th March, 1998 - Water Quality Monitoring in relation to Plant Growth, February 1998

D) MITIGATION MEASURES FOR THE MANAGEMENT OF MHSB (FROM THE ENVIRONMENT POINT OF VIEW)

3.12 ENVIRONMENTAL MANAGEMENT SYSTEM

There should be an EMS in place which would uphold the environmental policy of the company. This EMS should be functioning and documented.

3.12.1 ENVIRONMENTAL POLICY AND OBJECTIVES

There should be an environmental policy which can indicate the type of business MHSB is involved in and the associated environmental impacts. The environmental policy should be made available to all employees and the public. The policy would reflect the management's commitment to continual improvement of environmental performance and taking into consideration the most economically viable application of the best available technology. Environmental objectives should also be set up to achieve and perform the environmental policy

3.12.2 PERSONNEL

There should be sufficient personnel trusted with responsibilities, competencies and mutual relationships in the organization structure to :

- provide sufficient resources and personnel for the implementation of the environmental management system
- ensure that the environmental policy is implemented
- identify and record environmental problems
- initiate, recommend or provide solutions for these problems through designated channels
- verify whether the solutions have been implemented
- co-ordinate activities until a deficiency or unwanted situation in the environmental field has been corrected
- act in emergency situations

Adequate resources must be provided for the implementation of the internal work quality control. A competent personnel should be designated to perform internal control.

Procedures should be established for communication to personnel of :

1. the importance of complying with the environmental policy, the environmental objectives and the requirements of the standard
2. the significant environmental effects (actual or potential) of their activities and the benefits for the environment

3. their roles and responsibilities in complying with the environmental policy, the environmental objectives and the requirements of this standard
4. the possible consequences of deviations from the established procedures and working instructions

Procedures have to be formulated to determine training requirements and to provide appropriate training, for personnel who perform activities with significant environmental effects.

Supplementary education updates, training and/or experience requirements must be established for special environmental tasks such as what is required by legislation and regulations.

Relevant personnel must also satisfy the educational requirements. Education and training must be provided and registered.

3.12.3 CONTRACTORS

Procedures must be formulated to inform contractors about relevant requirements and provisions of the environmental management system.

3.12.4 ENVIRONMENTAL EFFECTS

Procedures must also be formulated for dealing with (receipt, filing and answering) communications from both internal and external interested parties about the environmental effects and organization's management.

Procedures must be formulated and implemented for identifying, examining and evaluating the direct and indirect environmental effects of the organization's activities. A register of environmental effects which are considered significant should be recorded

Procedures relating to controlling the following should be established:

1. controlled and uncontrolled (occasional) emissions to air
2. controlled and uncontrolled discharges to water
3. solid waste and other waste products
4. pollution of ground and groundwater
5. use of land, water , fuels and energy and other natural resources
6. noise, smell, dust , vibration and landscape pollution (visual)
7. impacts on specific parts of the environment, including ecosystems

Activity procedures should take into account environmental impacts as a result of

1. normal operating conditions
2. unusual (abnormal) operating conditions inc. start-up and shut-down
3. incidents, accidents and potential emergency situations
4. activities in the past, the present and the future

Procedures have to be formulated to identify and record all environmental legislation, rules and regulations and government and corporate policy which relate to the environmental impacts of the business activities. These procedures should be maintained and implemented.

3.12.5 ENVIRONMENTAL OBJECTIVES

Procedures must be formulated to establish quantitative and qualitative environmental objectives and consequent targets at all relevant levels in the organization. These procedures should be maintained and implemented.

The environmental objectives must involve:

a) compliance with environmental legislation and permit requirements

b) other objectives and terms of reference, including

- the register of environmental impacts (this is not a requirement under ISO 14001. Nevertheless, it is recommended to be included in the Appendix).

- the financial, operational and business requirements of the organization and
- the views of important interested parties

The environmental objectives and targets must be consistent with the environmental policy and must quantify the commitment to continual improvement, if possible.

3.12.6 ENVIRONMENTAL MANAGEMENT PROGRAM

A program must be formulated which establishes the way in which qualitative and quantitative environmental objectives can be achieved.

In addition, the program should also include:

a) the designation of responsibilities for achieving targets at each relevant level within the organization
b) the methods and the available resources

Separate programs should be formulated for the environmental management of

a) projects within the scope of new developments
b) new or modified products, services or processes (if that leads to significantly different environmental effects).

The environmental management program should include the following:

a) the environmental objectives

b) the way in which these objectives will be realized (mechanisms)

c) procedures for dealing with changes and modifications during the course of the project

d) measures of internal control (corrective mechanisms) and feedback

3.12.7 ENVIRONMENTAL MANAGEMENT MANUAL AND DOCUMENTATION

A manual or manuals must be produced which describe the environmental management system. After further discussion with the management, a preliminary draft of this EMS with its relevant principles is presented in Chapter 4.

This manual is inclusive of :

a) the environmental policy, the environmental objectives and the program

b) a description of the key roles and responsibilities

c) the relationship between the system elements

d) references to related documentation and to other management aspects, where appropriate.

In addition, the manual should take into account the state of affairs under :

a) normal operating circumstances

b) abnormal operating conditions

c) incidents, accidents and potential emergency situations

d) activities from the past, the present and planned activities.

An emergency response plan should be formulated with relevant environmental information and instructions.

This emergency plan must be tested (practiced) to check its effectiveness and specific defects.

Procedures should also be formulated for:

a) designation of the relevant organization, division, function or activity?

b) the regular evaluation, possible review and approval by authorized personnel before the reviewed procedures at all locations where activities take place and where environmental care is important.

c) the immediate removal of outdated documents.

d) determining the availability of the procedures inside and outside the organization

The documentation must be:

a) legible

b) dated (with revision dates)

c) identifiable

d) kept in an orderly fashion

e) kept for a specified period of time

3.12.8 OPERATIONAL CONTROL

Responsibilities are defined so that control, verification, measuring and testing within organizational units is adequately coordinated and performed effectively.

Within the scope of process control attention should be paid to :

a) documented procedures and working instructions (in accordance with and with reference to the manual) for the situations in which the lack of procedures and working instructions can result in operations which are not in accordance with the environmental policy.

b) documented procedures for purchasing and for the contracting out of activities to third parties

c) the measurement, registration and control of relevant process parameters

d) the approval of intended (planned) processes and capital equipment

e) the written standards which the performance must satisfy

Procedures must also be formulated for the testing of (or where applicable, the internal control of) compliance with the applicable regulations (from the program, the environmental objectives, the manual and the working instructions) and for the recording of the results of this supervision.

For each relevant activity or each relevant area there should be :

a) the necessary information for verification activities identified and recorded

b) the accuracy required specified

c) verification procedures to be followed described

d) the places and times of required measurements recorded

e) procedures established to control the quality of the measurements, including calibration and quality control charts

f) registrations maintained of the quality of the measurements

g) procedures established for data processing and interpretation

h) acceptance criteria which must be satisfied, established and described

i) the validity of data determined in the case of malfunctioning of the verification system

j) measurement and testing facilities safeguarded from unauthorized modifications or damage

In the event of non-compliance to the requirements of the environmental management system, its implementation and results, the environmentalist should be responsible to initiate an investigation, report to the management and take the necessary corrective measures established.

Investigations should include :

a) determination of the cause

b) drawing up a plan of action

c) starting corrective and preventive measures which are in line with the nature of the non-compliance

d) checking the effectiveness of the preventive measures

e) recording changes in the procedures as a result of corrective measures

3.12.9 ENVIRONMENTAL MANAGEMENT RECORDS

A recording system should be set up in order to demonstrate whether the organization fulfills the requirements of the environmental management system.

A recording system should be able to note the extent to which the environmental objectives and targets have been achieved.

Procedures should be established for the identification, collection, indexing, filing and maintenance and the deletion of environmental management records (including registrations of purchase and contracting out, audit and review results and education and training). These environmental records should be legible and categorized by activity, product or service. They should also be stored in such a way that they are easily accessible and protected against damage or loss, with retention times recorded.

The environmental records should be made available both internally and externally.

3.12.10 ENVIRONMENTAL MANAGEMENT AUDITS

An environmental management audit program should be established, implemented and maintained.

The audit should review whether

a) environmental management activities are implemented in compliance with the environmental manual, the program, the procedures and the working instructions and whether they have been implemented effectively;
b) the environmental management system fulfills the environmental policy effectively.

The following items should also be included in the audit program:

a) the activities / areas which are to be audited (organization structure, administrative and operational procedures , areas of work, operations and processes)

b) the frequency and planning of the audit on the basis of environmental relevance and/or the results of previous audits

c) the persons responsible for the audit in the various areas/activities.

Audit protocols and procedures refer to :

a) documentation, reports and records

b) environmental performance

c) the personnel requirements (independence, expertise required, support from internal and external specialists where necessary)

d) the audit approach and methodology

e) the procedures for reporting the audit results (meeting the requirements of system elements, the effectiveness of the environmental care system in achieving the environmental objectives, implementation and effectiveness of corrective measures from previous audits, conclusions and recommendations)

3.12.11 ENVIRONMENTAL MANAGEMENT REVIEWS

The management should periodically review the environmental management system to ensure its continuing suitability and effectiveness. All results should be recorded.

Periodically, there should be an assessment of the need to change the policy and objectives, in view of changed circumstances and/or the commitment to continual improvement.

E) COST BENEFIT SUMMARY

A summary of the estimated cost to implement an Environmental Management System is shown in Table 3.7 below.

Table 3.7 Estimated cost to implement the EMS

Requirements	Estimated Cost (US)
Set up database for plant collection site and incorporating a Geographical Information System (GIS).	US 6,000
Rubber Gloves / boots rubber dingy, life jacket, first aid kits	US 2,000
Plant Growth Monitoring - weekly site inspection	No cost
Agro-residues for composting	No cost
Recycling of plastic trays and separation effort	No cost
Water pump to wash vehicle tyres	US 200
Sand bunded area and extra fire-fighting equipment including central fire detection system and fire extinguishers	US 1,800

con't. Table 3.7

Requirements	Estimated Cost (US)
Using tyredrains instead of earthdrains	US 20 per meter (Cheaper if can get used tyres for free)
Muffling of noisy machinery/ or ear plugs	US 5/worker for ear plugs
Warning signboards & talks on safety, etc.	US 1,000 / yr
Environmental Policy	No cost. Already provided in this report (Chapter 4 - section 4.2.1).
Personnel (minimum two graduates trained in respective fields - Health, environmental compliance and auditing) to carry out training and awareness functions and auditing.	US 24,000 / yr.
Procedures / guidelines for controlling negative impacts of activities.	No cost. Provided in this study and will be maintained by the two personnel mentioned above.
Manual	No cost. Produced in this study.

Among the benefits and savings obtained by implementing an Environmental Management System are shown in Table 3.8 .

Table 3.8 Savings Summary of Implementing an EMS

Item	Savings (US)
Reduction in fertilizer cost by using agro-residue compost	10% / yr
Savings from Workers' medical insurance premium	Depends on the accident rates and medical claims.
Tax deduction available under the Income Tax Act 1967	Application pending
Better creditability with other contractors with ISO 14000 certification.	Unquantifiable
Compliance with Government regulations	No fines to be paid. No stop work order. Reduction in legal costs.