Economic Development with Environmental Management Strategies for Mauritius

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Infrastructure Operations Division
Eastern Africa Department

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CURRENCY EQUIVALENTS

Currency Unit = Mauritius Rupee (MRs)
US$ 1.0 = MRs 13.5
MRs 1 = US$ 0.

ABBREVIATIONS AND ACRONYMS

AHRIM - Hotel & Restaurant Association
CITES - Convention on International Trade in Endangered Species
CWA - Central Water Authority
DOE - Department of Environment
EEC - Commission of the European Communities
EPZ - Export Processing Zone
FAO - Food and Agriculture Organization
GOM - Government of Mauritius
ICBP - International Council for Bird Preservation
IPM - Integrated Pest Management
IUCN - International Union for Conservation of Nature and Natural Resources
JWPT - Jersey Wildlife Preservation Trust
MEDIA - Mauritius Export Development and Investment Authority
HEMP - Marine Environmental Management Plan
MHLE - Ministry of Housing, Lands and the Environment
MOA - Ministry of Agriculture
MOF - Ministry of Finance
MOH - Ministry of Health
MSIRI - Mauritius Sugar Industry Research Institute
NEC - National Environment Commission
NGO - Non-Governmental Organization
NPDP - National Physical Development Plan
PCB - Pesticides Control Board
WHO - World Health Organization
WWF - World Wildlife Fund

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ECONOMIC DEVELOPMENT WITH ENVIRONMENTAL MANAGEMENT

STRATEGIES FOR MAURITIUS

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This report was prepared and presented to the Government by a World Bank Mission which visited Mauritius from February 1 - 20, 1988. This report was subsequently updated to reflect the conclusions of a Technical Seminar on Mauritius Environmental Protection Program held in Mauritius from September 12 - 15, 1988. The September mission comprised Messrs. M. Rathnam (Mission Leader), R. Ackerman, B. Baratz, R. Beardmore, J. Brown, L. Christiansen, K. Kleiner, J. Post, Ms. A. Kiss and Messrs. I. Irvine, K. Johannessen and L. Talbot (Consultants).
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ECONOMIC DEVELOPMENT WITH ENVIRONMENTAL MANAGEMENT

STRATEGIES FOR MAURITIUS

I. OVERVIEW

A. INTRODUCTION

"....Mauritius was made first, and then heaven; heaven was copied after Mauritius."

Mark Twain.

Mauritius has reached a threshold at which the country finds it must take actions to ensure the sustainability of its rapid economic development, and the long-term well-being and quality of life of its citizens. Economic growth and sustainable management of the environment and natural resources are compatible and mutually reinforcing, provided appropriate steps are taken at this time to improve the efficiency and productivity of land and water management and to safeguard valuable elements of the country’s natural heritage. Sustainable development implies maximizing the net benefits from existing resources (human, natural and produced capital), subject to maintaining the services and quality of these resources over time.

This report lays out the major issues facing Mauritius, focuses on the priority concerns to ensure continued sustained development, and then presents a short- and medium-term plan of action to be pursued with the support of the donor community. The main conclusions and recommendations of the report are contained in Section II - Issues and Recommendations. The recommendations are again summarized as short-, medium- and long-term action program in Section III - Programme of Action and Priorities. Section IV discusses the various options available to the Government with respect to the Institutional and Legal Framework.

The report reflects the findings of the World Bank mission which visited Mauritius in February 1988 at the request of the Government of Mauritius to review environmental issues facing Mauritius and to recommend an action program. This report, approved in principle by the Cabinet in May 1988, was subsequently updated to reflect the conclusions of a Technical Seminar on Mauritius' Environmental Protection Programme held in Mauritius on September 12-15, 1988, under the sponsorship of the Government and chaired by the Minister of Housing, Lands and Environment (MHLE). The seminar was attended by members of the Government, national and international nongovernmental organizations, and bilateral and multilateral development institutions and donors. As such, the technical seminar served to underline the Government’s fundamental commitment to the issue. It provided a unique opportunity to develop a consensus on the problems of priority concern, and laid the basis for discussions with donors, currently scheduled to be held in Paris in January, 1989.
B. DEVELOPMENT CONSTRAINTS AND OPPORTUNITIES

Mauritius consists of a group of islands in the Indian Ocean, with a total area of about 2,045 km². The densely populated principal island (with a population 1.0 million in 1985) is located some 800 km east of Madagascar. Less developed outer islands are dispersed over a wide area of the Indian Ocean; the largest of them (Rodrigues with a population of 30,700 in 1985) is 650 km east of the main island of Mauritius.

The country has a narrow natural resource base. Sugar cane is grown on almost 90 percent of the island’s total cultivable land (45 percent of total land area), and the sugar industry employs about 20 percent of the labor force (1987). Despite significant expansion since the early 1970s of other sectors, notably manufacturing and tourism, sugar cane exports still represent the largest source of net foreign exchange earnings, and the export tax levied on sugar output contributes about 11 percent to the Government’s current revenues.

Mauritius is dependent on imports to provide most of its food supplies. Rice, dairy products and flour account for almost a quarter of import expenditure. Petroleum imports account for another 18 percent of the value of imports (1981). Mauritius is self-sufficient for about a quarter of its electricity needs, which it derives from hydroelectric sources and from the recycling of sugar by-products, particularly bagasse.

The absence of mineral resources and the distance of Mauritius from major markets affect the potential for economic development and condition its choice of economic activities. Mauritius does not lie on the main sea routes and maritime transport costs are higher than for countries competing in similar markets.

The country’s shortcomings in the way of location and natural resources are compensated by its well-educated population and rich cultural heritage. Standards of nutrition, health care, and general education greatly exceed those of neighboring countries. The adult literacy rate is 83 percent (many Mauritians speak three or more languages); life expectancy at birth is about 68 years; the population growth rate is 1.4 percent per year and the basic needs of the population are extensively covered. GNP per capita topped US$1,600 in 1987, placing Mauritius solidly in the group of middle-income countries. Unemployment in 1987 is estimated to have been around 5 percent, and the inflation rate was below 1 percent. About 66 percent of the population is of Indian origin; 29 percent consists of people of African or mixed descent, and Sino-Mauritians and Franco-Mauritians account for the remaining 5 percent.

Reflecting its history over the past 350 years, Mauritius has inherited a complex legal framework encompassing elements of both the French and English systems. Diluted authority and diffused legislation have important implications for rational, efficient, and sustainable natural resource management. To be successful, a concerted effort to tackle environmental problems will require a systematic review of institutional, legal and regulatory arrangements, and the establishment of a comprehensive national policy for environmental protection and management.
C. ECONOMIC POLICIES AND RECENT PERFORMANCE

After a decade of impressive growth following independence (1968), Mauritius faced serious economic difficulties following the sugar boom of 1973-74. The decline of sugar prices in 1976 and the second petroleum price increase in 1979 led to a sharp turnaround in the country's international terms of trade and a rapid deterioration in the balance of payments which was further aggravated by an expansionary fiscal policy. During 1976-79 the country's external debt more than tripled and the debt service ratio rose significantly. This period was also marked by a deceleration of output and export growth, while the domestic annual inflation rate accelerated.

In 1979 the Government embarked on a stabilization and structural adjustment program supported by the IMF and the World Bank. Central to these programs have been the adoption of appropriate exchange rate policies, restrictive credit and monetary policies, reductions in the overall fiscal deficit, maintenance of a liberal system of trade and payments, reductions in consumer subsidies, and wage restraint. Despite unfavorable exogenous factors, including adverse weather conditions in 1980 and 1983, a worldwide recession in 1980-82, and continued deterioration in the country's external terms of trade, progress under the stabilization programs was remarkable, with significant improvements in the overall budget deficit, the external current-account balance, and the domestic inflation rate.

The structural adjustment program aimed primarily at encouraging growth based on export-oriented manufacturing and tourism, and, to a lesser extent, on import substitution in food, energy and some manufactured products. After a period of low growth during 1979-83, the economy rebounded strongly in 1984 and continues to expand rapidly. In the last five years, output has grown annually by 7 percent in real terms and total exports have risen by 13 percent annually on average. The current account of the balance of payments showed a large surplus in 1986/87. The rapid growth has been led primarily by Export Processing Zone (EPZ) industries, the value-added of which has grown by over 29 percent per annum on average between 1983 and 1987 reflecting in part the success of government policies in attracting new investment and in restoring and improving the country's export competitiveness through appropriate exchange rate and wage policies. Significant policy measures have also been introduced to improve capital efficiency, reduce the incentives granted to import-substituting activities, and allocate a growing share of investment to export-oriented and labor-intensive lines of industrial production.

Other sectors contributing to rapid economic expansion have been the sugar industry and tourism. The sugar sector recovered in 1985 from a below-normal production level in 1984 and had a bumper crop in 1986. As most of Mauritius' sugar is exported to Europe the future economic success of the sugar sector depends critically on the continuation of the sugar quota arrangements with the European Economic Community (EEC). Since 1984, there has also been rapid, though less impressive, expansion in the production of tea and domestic food crops. In tourism, the country has
moved ahead effectively with measures to strengthen the promotion of Mauritius as a destination for tourists, to open up new air access points abroad and to expand existing room capacity. As a result, tourist arrivals have increased substantially and value added in tourism has grown by 15 percent in real terms in 1984 and by around 12 percent annually since then.

On the demand side, there was an upturn in capital formation in 1984 which continued in 1985 and 1986. Gross fixed investment is estimated to have increased in real terms by 6 percent in 1984, 10 percent in 1985, and nearly 11 percent in 1986. Most of the increase is attributable to substantial recovery of domestic income, which has been rising faster than consumption. Gross domestic savings increased to 28 percent of GDP in 1987 and consumption expenditure fell to 72 percent of GDP by 1987.

The significant progress achieved in stimulating export manufacturing has resulted in a notable change in the structure of the Mauritian economy. The share of the sugar sector, including sugar milling, in total GDP has declined from 20 percent in 1979 to about 11 percent in 1987, while the share of total manufacturing, excluding sugar milling, has increased from 11 to 18 percent over this period.

Rapid economic growth has also generated an unprecedented increase in employment. The rate of unemployment has been reduced to as little as 5 percent in 1988. Nearly all of the new jobs generated during 1983-87 were in the export processing industries. The manufacturing sector as a whole now provides more than one-third of total wage employment in Mauritius, significantly exceeding the shares of the sugar industry and the public sector as traditional employers. The overall government budget deficit has been reduced to 2.9 percent of GDP by 1987/88 and the inflation rate was less than 1 percent in 1987.

D. DEVELOPMENT PRIORITIES

The success of future economic growth in Mauritius will depend largely on four factors:

(a) the ability of the EPZ sector to diversify into new commodities away from textiles and garments;

(b) the success with which agricultural diversification away from sugar can be accomplished;

(c) improvement of the quality of life and of the environment as unemployment decreases and wages increase; and

(d) manpower development to address the growing shortage of skilled labor.

Concern with the environment is a central issue in three of these factors. Diversification of the export sector offers an excellent opportunity to scrutinize future activities for their environmental impact.
and to make suitable choices as to technology and location to avoid unnecessary future costs. In promoting agricultural diversification, increasing consideration will have to be given to competing land use options (such as for conservation, tourism, or settlement) and to the need to avoid creating an unnecessary burden on the government budget. Finally, environmental protection per se will encompass, in addition to the above mentioned preventive measures, significant actions to remedy existing problems affecting the health and well-being of Mauritians, and to safeguard the valuable natural heritage of the islands.

Moreover, if tourism is to remain a successful and generally accepted enterprise, the economic benefits of that sector will need to be felt throughout the population. Given tourism's relatively modest economic impact (3 percent of value added in GDP; 10 percent of foreign exchange earnings; 7 percent direct and 14 percent indirect share of employment) in contrast to its potentially major social and land use impact, it will be important to monitor growth in that sector carefully, and to ensure that it does not outpace social and economic development. A modest additional tourist tax levied on lodging expenses could, for instance, help defray some of the costs of public investments associated with the growth in the tourism sector.1

E. ENVIRONMENTAL MANAGEMENT AND ECONOMIC DEVELOPMENT

Mauritius' existing institutional and legislative arrangements for environmental management and protection have developed sector by sector, on an incremental basis over a long period, and Governmental recognition that environmental issues are basic to economic development and that they cut across all sectors is very recent. One result is that there is some duplication and overlapping in existing responsibilities and authorities concerning the environment, and there are major areas which are not covered. Consequently, Mauritius has no national environmental policy, no comprehensive institutional structure to provide for necessary coordination and implementation of environmental goals, and no overall and consistent legal framework for effective action.

Although Mauritius does not share the type of severity of environmental problems found in most poorer developing countries, it still has to give increasing emphasis to the protection of the environment to ensure that development activities do not outstrip the regenerative capacities of the island. Success in this endeavor will depend critically on actions in two areas: the ability to manage land use, and deal with the quality of water resources (water pollution) in an efficient and equitable manner. As conflicts between different uses of land (for industry, tourism, settlement, agriculture, conservation) grow and it becomes increasingly difficult to cope with industrial and domestic effluents and waste, the overriding policy issue for Mauritius will be to increase the allocative and technical efficiency with which the basic inputs to

1/For instance, a 2 percent tourist tax could have produced revenues of about Rs 20 million in 1987.
production -- land, water, and chemical inputs -- are used \(^2\), and hence to improve economic productivity. This approach ensures both environmental and economic benefits.

To increase the efficiency of natural resource use, and to tackle the major issues of uncontrolled land use, industrial pollution and domestic waste, a series of critical steps will need to be taken before any significant investments can be made for environmental purposes:

**Land Use.** Government has taken the decision to prepare a National Physical Development Plan (NPDP) \(^3\) whose objectives would be to:

(a) identify the capacity of land to support various activities;

(b) provide a framework for detailed local development planning and control;

(c) provide a basis for public sector investment planning;

(d) identify critical environmental areas and the means for their protection from degradation;

(e) assure efficient and equitable spatial distribution of infrastructure facilities in a manner which protects the physical environment; and

(f) provide for assessment of long-term needs for land and the consequent allocation of parcels for various uses.

The NPDP takes on particular importance with respect to industrial development, as the EPZ sector is a legal concept, rather than a geographical one. Thus, export industries can, in principle, locate anywhere in Mauritius, and are not confined to particular areas or industrial parks. Initially, there had been a planned approach to EPZ development. At the time, however, planning only encompassed industries involving dry wastes. With the rapid growth of the textile industry with its liquid effluents, unforeseen problems have arisen which are difficult to cope with because of the dispersed nature of the industry. To prevent a deterioration of the problem, land use planning must have a perspective reaching significantly into the future and taking population growth, technological and market changes into account. More generally, completion and implementation of the NPDP is a prerequisite for most development activities, as well as for protection of conservation areas which serve important functions such as wildlife habitat, aesthetic appeal, water catchment, flood prevention and erosion control. Government should seize the current momentum to move ahead rapidly.

\(^2\)This process may be assisted by greater mechanization and the reallocation of labor to jobs requiring greater skills.

\(^3\)Based on an earlier Plan prepared in 1977 that was not implemented.
At the same time, significant attention needs to be given to the factors that have prevented rational land use planning in the past. Thus, Government needs to make every possible effort to resolve (through legislation if not through legal steps) continued uncertainty with respect to land administration procedures, i.e., cadaster and titling. At present, there are no registered titles and many ownerships are potentially clouded, so much so that banks will not lend on a land deed as collateral. As a result, there are no accurate records of land ownership which could form the basis of a comprehensive program of land use planning and administration.

Management of Wastewater and Solid Wastes. Once spatial planning has been accomplished, industrial and domestic pollution can be more efficiently addressed. Aside from solid waste disposal (already a problem of serious proportions in the Port Louis areas), the major sources of industrial pollution are sugar factories and dye houses (textile manufacturers). Mauritius has laid the groundwork for master plans to be prepared for sewerage management and for solid waste management. Neither of these can be meaningfully implemented, however, until the NPDP has been completed, as it is not known where future industrial parks and other infrastructure developments, which would have a major impact on effluent levels, will be located. Even localized problems of priority concern, such as the cleanup of Tombeau Bay, cannot be satisfactorily tackled until the longer-term development plans of the region are known, allowing least-cost approaches to pollution abatement. Subject to the NPDP, Government should be encouraged, again, to forge ahead as fast as possible with well-designed plans for sewerage and waste management, prior to undertaking further ad hoc capital investments.

Effluent Charges and Cost Recovery. Any activity that involves natural resource degradation -- whether it be the improper use of land or the pollution of surface or groundwaters -- imposes a cost on society, both because of the immediate need for mitigatory measures, and because of the foregone benefits from the resource in the future. Typically, the cost is not borne by the user, but is shifted to society. Frequently, the poorest members of society bear the heaviest burden as they must live in areas most affected by pollution and not desired by those who are better off. In the case of Mauritius, those who benefit most from the free use of the environment are the hotels, the sugar factories, and industries. However, all users of water and sewerage systems benefit from environmental services for which they do not pay adequately.

In Mauritius, there is a charge for provision of water (about RS 150-180 per month per household), based on actual water usage. The fee is collected by the Central Water Authority (CWA). Much less progress has been made, however, in recovering the costs associated with effluents and solid waste, and in providing incentives for pollution control.

From an economic perspective, efficient investment in pollution control implies that the present worth of the benefits of the control program exceed the present worth of its costs, and that the excess of benefits over cost be maximized. This requires a systematic comparison of costs and benefits of alternative courses of action (variations in scale,
scope, timing, technology, and input/output prices) to determine investment priorities, and to ensure that the attainment of environmental standards is achieved at least cost to society. Among the technical options are in-plant process changes vs. end-of-the-pipe waste treatment, and joint vs. collective waste management facilities. As Mauritius ventures into new types of industries that could involve increasingly hazardous wastes, thorough analyses that include environmental costs and benefits should be carried out, to determine the merits of such investments.

Numerous approaches have been recommended to encourage industries and municipalities to reduce pollution loads (primarily into water courses). Evidence suggests that effluent charges coupled with a set of minimum standards, represent the least-cost means of achieving pollution control. Other mechanism, such as subsidies for investments in pollution control equipment, uniform standards, and special pollution-related licenses and permits are less efficient in this regard. Effluent charges for industries can be set at such a level that dischargers would find it worthwhile to reduce their discharge (or to pre-treat their effluents) to a level at which the remaining effluents can be processed in municipal waste management systems. At that level, the marginal cost to the firm of a further unit of waste reduction, just equals the effluent charge avoided on that unit. In industrial parks, industries could decide how much treatment they want to undertake individually and how much would be performed at jointly-owned treatment centers. (The role of economic considerations at a more general level is briefly discussed in Annex I.)

In addition to providing an incentive for pollution abatement by industries, effluent charges also allow part or all of the costs of additional (usually centrally managed) pollution control and land management to be recovered. Both liquid and solid waste management have generally not been successful in Mauritius because of lack of funds to carry out adequate operation and maintenance of waste management systems, even where funds were available for capital investments. Every effort will need to be made to gradually introduce effective cost recovery -- initially at least of recurrent costs, and eventually also of capital costs.

In particular, implementation of the Sewerage Master Plan depends critically on introduction of a rational tariff system based on the long-run marginal cost of providing sewerage services. For this purpose, the tariff study\(^4\) carried out in 1981 needs to be critically reviewed and brought up-to-date, as discussed in the Government’s next Three-Year Plan. The study had recommended a tariff system that included, for households, a charge per cubic meter of water received from the Central Water Authority, and for industries a higher charge per cubic meter of suitably pretreated effluent. The study was never implemented, and the current sewerage tax, which is a percentage of the property tax in urban areas, is very low (Rs 30-50 per year). Only about a third of the assessments have been collected.

Other Issues. Mauritius is fortunate in that it is not yet faced with environmental problems of overwhelming proportions. Action at this time will be effective in avoiding future costs. Moreover, the country is benefitting from outstanding economic growth and sound macro-economic management, which make a reallocation of resources to ensure sustainable development politically and socially possible and desirable.

This report addresses the whole range of environmental issues in Mauritius, including the priority problems mentioned above. Fortunately, many of the other problems -- though important -- do not represent serious bottlenecks to development. Thus, while water quality has been described as a serious problem, water quantity appears to be less of an issue. To the extent that there are shortages, these can be addressed through more efficient transmission in the short-term. Looking into the future, Mauritius also has the option of creating additional reservoirs for water storage. A National Water Resources Master Plan to address these issues is currently being completed.

In agriculture, cultivation practices up to now have not had a significant adverse effect on the environment. Unlike soil-erosion problems which have reached crisis situations in many mainland Sub-Saharan African countries, in Mauritius the problem is of a localized nature.

The major issue of concern is the high, and arguably excessive, level of application of fertilizers and pesticides. Fertilizer consumption in Mauritius is three times higher than average rates of application on permanently cropped land in Western Europe, and sixty times the average rate in Africa. Average pesticide use per hectare is probably the highest in the world. In addition to being economically wasteful, the effects of such application rates on public health could become substantial. As well, they may reduce soil fertility, and lead to the appearance of pesticide-resistant species which have had a devastating impact on agricultural productivity in other parts of the world.

The island has a coastline, mostly very attractive, of some 150 km, but good sand beaches suitable for tourism only extend for about 50 km, making their protection and soundly planned exploitation an urgent priority. The tourism industry has been built consciously and correctly for the affluent long-haul market, with policy prohibiting highrises and environmental pollution. The immediate coastal areas and near shore lagoons and reefs appear to be in generally good condition. There are, however, localized water pollution problems in estuaries near urbanized or industrial areas and in lagoons adjacent to high intensity tourist developments. Some littoral erosion and inundation have also been reported during cyclone periods.

Nature Conservation and Biodiversity. Mauritius can offer some beautiful scenery, and has extensive areas suitable for diving tourism. Perhaps more importantly, the island also contains the vestiges of a unique biological heritage conditioned on Mauritius' remoteness and special type of development.

5/Currently, over 40 percent of the piped water is lost in transmission.
Mauritius is of volcanic origin, lifted up from the seabed millions of years ago. As the volcanic rock weathered, fertile soil was formed, creating a suitable substrate for the germination of seeds transported by air, by birds, or washed ashore. Gradually, most of the island was covered with ebony forest with most species of trees being endemic (found nowhere else) to Mauritius. Birds and bats, carried by errant winds, established themselves. Some land animals such as tortoises and lizards also started to inhabit the island, having survived the long sea voyage on rafts of branches or trees swept out into the ocean by cyclones. Over millions of years their progeny evolved into species unique to the island.

Except for five species of bats, no mammals ever reached Mauritius. There were only two small predators among the birds (an owl and a kestrel), and the fauna evolved virtually without pressure from predators. In fact some birds, no longer threatened by predators, lost their ability to fly. Examples are the famous Dodo (a fat flightless waddling bird), and a big black flightless parrot. The tortoises grew larger until they weighed over two thousand pounds. Lizards and snakes evolved into unique and brightly colored species.

The arrival of humans in the sixteenth and seventeenth century had a devastating impact on the flora and fauna of the island. The defenseless animal species were killed for food and sport and the ebony forests were cut down for their precious wood and to make place for sugar cane fields. Cats, dogs, pigs, rats, mongooses, and monkeys were introduced, found an easy prey in many of the Mauritian animals. Some twenty exotic bird species started competing with the indigenous birds. Imported plants and trees outcompeted and destroyed the native vegetation.

In a historically very short space of time, a number of unique species vanished -- the Dodo, the giant black flightless parrot, the giant Mauritius tortoise, the Rodrigues tortoise, the strange flightless bird of Rodrigues, the Solitaire, a flightless rail and tortoise from Round Island, and probably many more of which no records exist. Only small pockets of the indigenous forests survived. On the reefs, the dugong (a sea cow) has vanished, and indiscriminate spearfishing and dynamiting in the 1960s and 1970s resulted in the disappearance of most larger residential reef fish such as the groupers, snappers and parrot fish.

In many developing countries, particularly in Africa, alteration of the natural environment often results in degradation which directly threatens the livelihood of the local population and forecloses options for the future. Alteration of the environment in Mauritius, however, most of which occurred several hundred years ago, does not seem to have affected its productive capacity very greatly. Those functions, beneficial to humans, such as erosion prevention, wood production by forests, or mass consumption of insect pests by birds seem to have been taken over from the original flora and fauna by the introduced species.

From the point of view of the original biodiversity, the environment of Mauritius has been impoverished and it is important to preserve what remains to sustain the bio-diversity which is of interest to
the whole world. From the point of view of environmental quality essential to human well being (water quality, air quality, soil quality, erosion, scenic beauty, etc.), however, Mauritius is still in relatively good shape.

F. BENEFITS AND JUSTIFICATION

Investments in environmental management and cleanup must be justified in social and economic terms. In many instances, economic efficiency will be an important criterion; in other cases, concern with social equity, as well as ethical, aesthetic, cultural, and scientific values may predominate. Many of the costs of environmental problems are well-known, even if hard or impossible to quantify: reduced productivity of workers and increased expenses for medical care as a result of water (and air) pollution; reduced tourism revenues as Mauritius loses its attractive beaches and the aesthetic appeal of other landmarks is diminished; unnecessary transportation and infrastructure costs as a result of unplanned spatial development; reduced recreational benefits, etc.

As environmental quality improves, however, the marginal benefits of environmental investments may be expected to fall, while the marginal costs of improvements increase. The evaluation of the benefits of environmental investments therefore becomes increasingly important. To understand which are the issues of priority concern at any given time, information is needed about progress (or the lack thereof) in environmental quality.

This Programme of Action for environmental management in Mauritius is meant to lay the basis for an efficient long-term investment program. It does so by making recommendations along three lines:

(a) Specific policies and investments to deal with the grossest forms of water pollution and inappropriate land management. Such efforts are likely to yield high economic benefits.

(b) Institutional and legislative reform to ensure efficient and equitable natural resource management in the future. Though not quantifiable, such efforts can also be expected to yield high economic returns.

(c) Collection of relevant information to monitor environmental factors and to provide the basis for determining the viability and cost-effectiveness of future investments.

In addition, the Programme of Action addresses a number of broader concerns, particularly nature conservation, which cannot and should not be justified on narrow economic grounds. The benefits from such efforts accrue not only to Mauritius, but to humankind as a whole.
II. ISSUES AND RECOMMENDATIONS

As noted earlier, Environmental problems in Mauritius have not yet reached the stage where they hamper development and seriously threaten the quality of life as compared to other countries. Increasing emphasis, however, must still be given to the protection of environment, to ensure the rapid pace of economic development is maintained without compromising the health and welfare of the Mauritian people and the extraordinary quality of the natural environment. As resource pressures have not yet reached crisis proportions, there are opportunities to focus on preventive strategies and policies. The high level of political will, commitment of the Government of Mauritius, and growing public concern about environmental issues all present a unique opportunity for Mauritius to develop an overall strategy which fully integrates environmental management into its development process.

Environmental challenges faced by Mauritius can be accommodated without inhibiting economic growth; indeed, accommodating these challenges is in large measure a prerequisite for sustained economic growth. However, as environment and development are inexorably linked, environmental problems cannot be resolved separately by fragmented institutions and policies. Environmental policies must be guided by the concept of sustainable development. Consequently, a coordinated approach which integrates environmental concerns and the development process, supported by an institutional and legal framework which clearly defines levels of responsibility and accountability, is essential for promoting economic growth and environmental protection.

A prerequisite for sustained progress in the area of the environment is a holistic approach, in which problems are tackled in a comprehensive way that cuts across traditional divisions of responsibilities between government ministries and involves, as thoroughly as possible, the public and local communities in formulating and carrying out the required actions. As has been the experience in many other countries, many of the difficulties which Mauritius has encountered in dealing with environmental problems have arisen because of the multi-sectoral nature of those problems and hence the cross-cutting ministerial responsibilities in the implementation of policies.

There is a need for more forceful articulation of environmental concerns in planning and policy making, as well as improved coordination, institutional structures and legal instruments in the implementation of policies involving environment and development.

1. National Environmental Policy (NEP)

Mauritius lacks a comprehensive national environmental policy, i.e. no comprehensive policy for environmental protection and natural resource management which provides the goals, directions and guidance for government action, and which explicitly lays out the essential linkage between the government's environmental and economic development endeavors.
Recommendations:

Immediate

Develop a National Environmental Policy for Mauritius, for review and adoption by Government. The policy must be based explicitly on the essential interdependence of environment and sustainable economic development. Development of the policy should be carried out primarily by Mauritians and should involve public participation as well as contributions from the various sectors of Government.

Medium-long term

Monitor the national environmental conditions, including environmental quality, and the effectiveness of the government's implementation of the environmental policy and programmes to implement it. If changes in conditions indicate that there should be changes in the basic national policy, make the necessary amendments.

2. Institutional Framework

Virtually all aspects of a nation's governmental endeavors affect environmental factors, and in turn are affected by them. Environment is not a single, "vertical" sector, like energy or agriculture; it is "horizontal", cutting across all sectors. Therefore government cannot deal with environment in the same way that it does the other aspects of governmental business. New institutional structures are required, particularly to achieve the necessary cross-sectoral coordination.

Present institutional arrangements for environmental protection and natural resources management have developed on an incremental basis over a long period. New responsibilities and organizations were gradually introduced in response to changing needs and priorities, usually in addition to rather than in replacement of existing ones. The result today is a complex set of relationships with a considerable degree of shared responsibilities and functions which has undermined accountability.

In the field of water resources, for example, there are over seven different Ministries and government bodies with some authority to exercise a variety of functions under as many different pieces of legislation. Moreover, judging by problems which are emerging, there is an apparent lack of concerted action among the principal organizations. As noted earlier, although there are growing indications that both ground and surface water are becoming increasingly polluted, none of the organizations seems to have a clear picture of the overall situation; no water quality standards have been established; critical pollutants are not being measured; adequate equipment and trained staff are lacking.

These problems are not confined to the water sector alone. Similar situations in other sectors have resulted in an institutional structure that is overloaded and weak in certain key areas with significant gaps in others. For example, there are no ambient or emission standards for air pollution, no standards for noise, no organization has a mandate or
capacity to monitor compliance and enforce standards for noise, and no organization has a mandate or capacity to monitor compliance and enforce standards when they are established. Coastal marine pollution is a growing public concern and a potential threat to human health and to tourism, yet there is no clear authority or program for monitoring and controlling it.

Clearly, with growing concern over environmental issues, there is a need for establishment of an institutional framework which will be fully responsive. In developing such a framework, levels of authority, responsibility and accountability must be clearly defined.

Recommendation

Immediate

Establish a coordinating body at the highest governmental level with authority to coordinate all government activities which affect the environment.

The success of Mauritius’ environmental policy will be determined by how completely environmental considerations are internalized throughout all sectors of government. There are many ministries and government bodies with individual missions and authorities which involve the environment. Some have authority over some parts of environment, others have missions which impact the environment. There is duplication and overlapping, and there are significant gaps in coverage. Therefore, there is need for an institutional structure to provide oversight and coordination of governmental actions which affect environmental management and protection.

This coordination function requires that the proposed body be located at an administrative level above that of the other components of government which it is to coordinate. The National Environment Commission (NEC), chaired by the Prime Minister, would be the logical body to carry out this function if it was provided adequate staff assistance and facilities.

Establish an institutional framework that remedies the weaknesses and gaps in the various sectors and key issue areas and develops a capacity to perform other major functions which include:

- evaluating environmental implications of major economic and sectoral policies;
- identifying and evaluating options for pollution abatement and providing technical advice on pollution control practices;
- formulating priorities and coordinating a government-wide programme of research on critical environmental and natural resource management issues; and
- preparing and publishing an overall assessment of the current state and emerging trends of the environment.
In Mid-February, 1988, the Government considered the report of the National Environment Committee and agreed:

- to create a Department of the Environment (DOE) in the present Ministry of Housing, Lands and the Environment (MHLE):

- to establish a National Environment Commission to be chaired by the Prime Minister with the Minister of Housing, Lands and the Environment as Vice-President and other key Ministers as members.

More detailed decisions by the Government have yet to be taken regarding the precise role and responsibilities of the Department of the Environment (DOE) in relation to those of other Ministries. The Government has two basic options:

- to streamline and strengthen responsibilities and functions of existing institutions, with the new Department of the Environment exercising overall coordination, enforcement and operational functions not presently performed by other government agencies

OR

- to centralize and consolidate priority programs with their staff and financial resources in the Department of the Environment.

Both options are open to Government. If the first option is chosen but later proves ineffective in achieving the short-term goals and priorities of the Government, the second option can be exercised. At that point a third option may be considered: creation of a comprehensive Ministry of the Environment with executive, operational and enforcement functions on all matters concerning environmental protection and sustainable development.

The options selected would depend primarily on goals and priorities of the Government. These are considered in the next section of this report, following which the implications of the various institutional options are examined further.

3. Legislative Framework and Economic Incentives

3.1 Legislation

There are at present over 25 distinct Acts in force in Mauritius concerning various aspects of environmental protection and natural resources management. Considered together they still fall short of providing an overall and consistent legal framework for effective action.
The majority of the most relevant Acts were adopted after Independence in 1968. However, a few of the principal acts were adopted 30 to 50 years ago in response to very different needs and circumstances. For example, the Public Health Act was adopted in 1925. While it contains extensive provisions for dealing with leprosy (no longer a significant health hazard) there are other modern threats that were not anticipated and reflected in the Act, such as dangers to public health posed by increased levels of air or noise pollution. The Act should be reviewed and updated to take these and other emerging issues fully into account. In so doing, consideration should also be given to reviewing the drinking water and other standards in the light of the most recent recommendations of WHO and the laws of other relevant countries.

Specific provisions in other Acts adopted decades ago also need to be reconsidered in light of modern problems and needs. For example, under clause 7(2) of the Town and Country Planning Act adopted in 1954, municipal/district councils were given the sole authority to grant permits for the development of land. They can seek the advice of the Town and Country Planning Board but are not required to follow their recommendations. With their exclusive power, local authorities can undermine the implementation of any national physical development plan as well as national requirements for new enterprises to use appropriate environmental protection measures.

In addition to omissions or weaknesses in existing Acts, there are also issues of political and public concern that are not covered by any existing legislation. For example, no Government agency is endowed by any present legislation with the authority to monitor and take measures to prevent pollution of coastal waters. Under the 1925 Public Health Act and the 1971 Central Water Authority Act, responsibilities and functions of the Ministry of Health (MOH) and the CWA appear to stop at the shoreline.

The 1980 Fisheries Act does contain relevant but limited authority, but is confined under clause 9(1) only to "substances likely to injure any fish". This particular gap in the legal and institutional framework needs to be filled as a matter of priority.

It also appears from documents made available to the mission that earlier Acts or parts of earlier Acts were not repealed or consolidated when new acts on the same subject were adopted. This has inevitably led to overlap and duplication between them and between different organizations empowered to apply them. There have been over seven Acts adopted since 1906 which, in whole or in part, concern water resources use and quality. For example, under the 1963 Rivers and Canals Act the Permanent Secretary of the Ministry of Health can apply for an injunction to prevent anyone from polluting water of a river or canal. However, under Section 21 and 49(a) of the 1954 Central Water Authority Act, the CWA is also assigned the principal responsibility for abatement and prevention of water pollution and for initiating action against those contravening the Act.

The most serious weakness in virtually all of the legislation is that penalties are uniformly low. The maximum fine specified in most cases is either 500 or 1000 rupees. Penalties for non-compliance should be significantly increased in all existing legislation to a level that will
act as a deterrent to would-be polluters. They should include jail sentences for major and/or repeated violators and provisions for injunctions or "cease-and-desist" orders when there is a serious threat to human health or protected species.

In addition to penalties that are too lenient, existing legislation is often not enforced. Strict penalties and rigorous enforcement are necessary.

Effective enforcement requires the technical capital for compliance monitoring (e.g., equipment and trained personnel), the organizational and legal capacity to respond quickly to violations, and the political commitment to apply the law consistently and rigorously. Specific proposals for strengthening the crucial enforcement function are made in Section IV, which outlines options for institutional change.

Many countries have sought to deal with legislation on a sector-by-sector basis. In such cases, the vested interests often looked after their interests, and this approach has often resulted in a patchwork of individual laws with areas of duplication and gaps, rather than a consistent and cohesive legislative framework.

The most effective approach has been a comprehensive one, involving a review of the nation's whole body of law in relation to the country's needs in environmental protection and management, including natural resource management and land use. On the basis of the review, a comprehensive legislative framework can be designed.

**Recommendation**

**Immediate**

Conduct a comprehensive review of Mauritius' legislative needs related to environment, and its existing legislation which bears on the subject, i.e., not only the environmental legislation per se, but also legislation in other areas which may impact environmental considerations or lead to conflicts with environmental goals. On the basis of the review, create a complete and cohesive legislative framework for environmental protection and management. This endeavor should be accomplished as a comprehensive project rather than on a piecemeal basis. Details of more specific areas for legislative reform - amendment or repeal of existing laws and development of new ones -- are presented in Section IV below.

At the same time, the responsibilities and authorities of the NEC and DOE should be established, paying particular attention to the issues of overall governmental coordination.

**3.2 Incentives**

Frequently, legislation alone is inadequate or inappropriate to motivate industries to reduce the amount of pollutants they emit into the air and water, and the amount of solid waste they create. As noted earlier, effluent (waste) charges, combined with a relatively flexible set of minimum standards, have been found to represent the least-cost means of
achieving pollution control objectives. At this time, however, not much thought has been given to the desired standards for effluents leaving the industrial gate (i.e., how much they should be pre-treated), or the standards for effluents discharged from municipal treatment facilities. In the absence of such information, appropriate charges cannot be established, nor can the necessary legislative procedures to support their introduction. Moreover, depending on the desired objectives, additional economic and financial incentives are conceivable.

Recommendation

Immediate

It is recommended, therefore, that a study should be performed to examine economic and financial incentives for pollution reduction, and to provide legislative requirements for enforcement of norms and standards for the discharge of gases, liquids and solids. The study should include pre-treatment norms for disposal into municipal systems and the development of a classification scheme for receiving waters. The classification scheme is to be consistent with the NPDP and National Sewerage Master Plan.

4. Marine Resources

4.1 General

There is a general opinion in Mauritius that the quality and quantity of coastal marine resources have declined over the last fifteen years. Estuaries and lagoons have been polluted, corals destroyed, fish catch has declined, etc. However, a scientific database to substantiate these opinions is sorely lacking. There is no overall planning, legislative or administrative framework for protection of the marine environment.

Recommendation

Immediate:

Mapping of the marine environment from the high water line to the 40 metre contour line should be started as the basis for a coastal marine environmental management plan.

Start a monitoring programme for basic parameters of the estuary, lagoon and reef ecosystems. Transects should be laid out along the coast and parameters such as water quality, coral cover and health, fish fauna, invertebrates and plants should be measured at regular intervals. This is the only way changes can be detected. Even a simple monitoring system requiring careful observation and standard laboratory tests will prove immensely valuable.

Medium Term

Develop a Marine Environmental Management Plan (MEMP) to control the exploitation of the marine environment and preserve its resources. Develop a Marine Conservation Centre to administer the management plan. Prepare a Marine Environmental Protection Act.
4.2 Fishery Activities

Fisheries activities in Mauritius can be divided into three categories:

(a) Small scale artisanal fisheries with small boats in lagoons and close to reefs.

(b) Larger scale pelagic fisheries with bigger boats exploiting free roaming fish stocks in the high seas or on shallower banks far away.

(c) Aquarium fish collecting.

Pelagic fisheries are outside the scope of the present study and will not be considered. Artisanal fisheries however are directly influenced by adjacent land areas, by pollution, habitat degradation or destruction, intensive use etc.

The artisanal fishery exploits fishing grounds around Mauritius to a depth of about 200 meters, i.e. an area of some 1,000 km2. At present, there are about 2,600 registered artisanal fishermen on the island. Fishing gear consists of nets, lines, baskets, traps and harpoons. Fish catch has shown a decline over the past ten years but appears to have stabilized at about 1300 tonnes annually. Another 300 to 500 tonnes is believed to be caught by occasional and amateur fishermen.

Environmental Implications of Artisanal Fisheries:

Fish stocks can be exploited without unacceptable harm to the aquatic ecosystem. The difficulty, however, is to manage fisheries in such a way that a maximum yield is harvested each year without decline over time. Two factors are of crucial importance:

- avoidance of overfishing;
- keeping the productive ecosystem intact.

Avoidance of overfishing (determining the maximum sustainable yield) is the subject of a specialized study which will not be discussed here. Preserving the productive ecosystem to the greatest extent possible, however, directly concerns the present report.

There are several ways in which the artisanal fishery is detrimental:

- Through illegal fishing methods such as dynamiting and fishing with spearguns and nets with undersized meshes. The use of dynamite has been drastically reduced over the past years through enforcement of regulations. Although the use of spearguns is outlawed, a lot of spearfishing is still being done illegally.
As to nets with undersized meshes, the situation is not so clear. Indeed, many reports and informants mention the catch of juvenile fish using nets with undersized meshes. It is also believed that nets which are meant to catch sardines are used to catch large numbers of juvenile fish, while damaging coral in the lagoon.

Through anchoring and poling of boats over the reef and through the lagoon: these activities break coral, but are hard to avoid as in many places the reef is too shallow to get across by outboard motor and sailing boats have no other choice when there is no wind. Since the top of the reef is pounded by waves which smash the coral anyway, this is not considered to be a serious problem. However, in the lagoon poling and anchoring of boats is definitely a major damaging factor.

Poor implementation of the Fisheries Act of 1980 which regulates fisheries of Mauritius and provides for management measures related to number, types and sizes of nets as well as their period of utilization and allowable mesh size of basket traps. Besides, it provides minimum size limits for all commercial species and sets aside five fisheries reserves where no net fishing is allowed (Fisheries Act, 1980).

Overfishing: There are clear signs that the lagoon and the reef are being overfished at present. In particular, seine nets designed for sardine and anchovy fishing contribute to overfishing as they can catch large numbers of fish from other species as well. Data are inadequate to accurately assess the maximum sustainable yield, but it has been estimated that this yield would be about 2000 tonnes/year, an amount which was landed in 1982.

Recommendation

Immediate

The total ban on spear fishing and dynamiting should be more effectively implemented. Use of seine nets with fine mesh should be strictly controlled, or, if this appears to be difficult, outlawed. Fishing Reserve areas should be strictly guarded. It might also be feasible to gradually reduce the number of licenses to prevent overfishing and increase the efficiency of fishing.

Aquarium Fish: There are at present five exporters of aquarium fish and marine invertebrates in Mauritius. In principle, catch and export of aquarium fish can be a sustainable form of reef exploitation if certain conditions are met. Artisanal fisheries mainly remove predators from the reef, while aquarium fish collectors mainly concentrate on prey species and invertebrates like anemones and shrimp. The balance between predators and prey species, disturbed by artisanal fisheries, is thus somewhat restored. However, aquarium fish collectors selectively remove certain species which are in high demand. This can result in local extinction of some species.
Furthermore, some of the most beautiful fish, such as some species of Butterfly and Angel-fishes, are impossible to keep alive in an aquarium. Some aquarium fish catchers use chemicals (essentially poisons) to chase the fish out of their hiding places and into the net. The poison eventually kills life in the coral reef. It may also kill the aquarium fish exposed to small doses after they had been exported. Apart from poison, mortality of aquarium fish at the exporters can be as high as 70 percent due to improper storage, rough handling, etc.

Regulating the aquarium fish trade has been the subject of lengthy debates. It is extremely difficult to set quotas for various species. In some areas cleaner shrimp, for instance, which perform an essential function in the reef ecosystem, are quite rare, while in other areas they are abundant and their population is largely determined by the number of suitable hiding places with or without large predators like moray eels to protect them. The sustainable yield of the latter area would be much greater than the former. A crucial factor in the regulatory process is an understanding of the reef ecosystem by the person controlling the trade. This person must regularly dive with fish collectors, do stock assessments and follow the trend in catch and population sizes.

**Recommendations**

**Immediate**

Strictly enforce the ban on the use of chemicals in fish capture.

**Medium-Long Term:**

Assess mortality after the catch and withdraw permits from exporters where mortality is excessive. Train someone at the Fisheries Department to accompany fish catchers on a regular basis and assess natural populations and exports. This person should eventually set quotas and standards if deemed necessary. Give fish catchers exclusive rights to catch fish in specific areas. This would force them to manage their resources.

4.3 **Coastal**

4.3.1 **Sand and Coral Removal**

*Sand:* At present, most of the sand which is used in Mauritius comes from terrestrial quarries (over 300,000 tonnes/year). These quarries, mainly situated in Wolmar and St. Felix, are being exploited in an ecologically sound way: they are covered with topsoil following sand extraction, after which the area is planted with sugar cane.

A considerable quantity of sand, however, is extracted on a smaller scale from lagoons by individuals using 6 to 8 metre boats along the east coast of the island. There are eight places where extraction of sand from the lagoon is authorized. The most affected areas are: Mahebourg, Grande Rivière du Sud-Est and Roches Noires/Rivière du Rempart.
The most detrimental effect of sand extraction from the lagoon is likely to be beach erosion. Resuspension of fine silt can also affect coral growth by reducing light penetration and by smothering. This will depend on the silt content of the sand. There is a widespread belief that removal of lagoon sand is harmful to coastal ecosystems because it increases the turbidity of the water. It is equally likely, however, that long term deterioration in ecosystems, including reduction in fisheries yield, is due to the progressive silting up of the lagoons with associated loss of habitat and increase in water quality fluctuations, particularly temperature. Temperature above about 32 degrees are lethal to corals. The data to determine the causes of ecosystem deterioration are lacking. It may be possible to improve the environment and enhance biodiversity by excavating certain parts of the lagoon to bedrock or deeper, where bedrock consists of usable (fossil) coral. Provided there is enough circulation, a deep area behind the reef with a solid substrate will soon become colonized by sessile organisms, including corals. It would also provide a more productive and varied environment than a sand bottom. A case in point is Blue Bay. Here, a deep area behind the barrier reef has developed into a beautiful coral garden now being proposed as a marine park.

The important point, however, is to first establish an objective for an area. Clearly, beach conservation (if there is any in the region of sand extraction) is incompatible with island extraction. But from the point of view of nature conservation, a system can probably be developed which suits both purposes. At least, it can be explored on a pilot basis.

**Recommendation**

**Medium-Term:**

Replacing coral sand with rock sand appears to be a distinct possibility. This would be advisable as in such a case no risks are taken with the environment. If, for economic reasons, this substitution is not feasible, a carefully planned sand extraction operation, possibly in combination with fossil coral mining, might be carried out in an environmentally acceptable way. If done with proper insight and creativity, there is a likelihood of even enhancing the environment. It is strongly recommended that no sand be removed from lagoons which border a sandy beach. There appear to be technical reasons as well, however, to phase out removal of sand from the lagoon. The quality of the lagoon sand for construction purposes seems to be poor and rock sand is preferred by builders and architects.

**Coral Removal (for Industrial Purposes):** There are seven lime kilns on the island employing about 150 people and some 50 to 70 people are employed in the provision of the raw material: coral from the lagoon or limestone from land quarries. About 5000 to 8000 tonnes of coral are used yearly by the kilns. Of this an estimated 2000 tonnes is live coral, the rest being dead coral from lagoons and fossil coral from terrestrial quarries. Coral collected from the lagoons consist mainly of Acropora colonies, either dead or alive. Even on the barrier reefs coral is extracted with crow bars. This damages the important wave breaking function of the reef.
It has been estimated (Quelennec 1987) that about 1 km² of lagoon coral is being destroyed in Mauritius each year. Of a total lagoon surface of 243 km², of which only a small percentage is suitable for coral growth, this represents an unacceptably high figure.

Extraction of live and dead coral should be prohibited, because both are essential parts of the reef and larval ecosystems. Dead coral provides shelter for reef fish, a substrata for food and live coral, and is cemented together by calcareous algae to form the "backbone" of the reef.

Live or dead coral may be substituted with fossil coral from land quarries. There appear to be sufficient fossil coral reserves for several decennia on Mauritius and even greater deposits on Rodrigues (Quelennec 1987). The economics for extraction of live and dead coral versus fossil coral have not yet been worked out.

**Recommendation**

**Immediate:**

Phase out extraction of live and dead coral from the lagoon and replace it with fossil coral from land quarries. If for economic or technical reasons this is not feasible, quarrying in an authorized sand extraction site in the lagoon might be considered if the bottom consists of fossil coral. It is recommended that in this case fossil coral extraction should be concentrated in one location and done according to an ecologically-based plan as previously indicated for sand removal.

### 4.3.2 Marine Parks

Marine parks are being created all over the world as counterparts to terrestrial parks for the preservation of the beauty, genetic diversity, and productivity of the underwater world. Most marine parks cater to the needs of diving and snorkeling tourism, one of the fastest growing sectors of activity-oriented tourism in the world. Marine parks are amongst the economically most successful nature reserves. On islands with little other resources, diving tourism has become a major source of income (Bonaire, Cozumel and the Cayman Islands in the Caribbean, Heron Island in Australia, the Maldives in the Indian Ocean).

Reserves themselves have usually required little investment. Nature had already provided these areas with sufficient attractions. What was necessary, however, was to ensure that no harmful influences would destroy these attractions. This meant a total ban on: spear fishing, destruction of coral, and collection of shells or other biota. When the marine park comprises the complete fringing coral reef of the island, as is the case in Bonaire, artisanal fisheries are allowed.

In Mauritius, several proposals for marine parks have been made. These proposals call for creation of relatively small areas of marine park along the coast of Mauritius and offshore islands. Although the idea of preserving the underwater flora and fauna is fully supported, criteria for
the selection of areas are rather vague and the objectives not clearly defined. This has resulted in proposals which are considered to be too elaborate and unnecessarily heavy in terms of organization, staffing and budget. The questions to be answered are:

-- which biota need protection against which influences and why?

-- Are these biota endangered elsewhere on the reef?

-- If none of these biota is endangered, does the attractiveness of an intact ecosystem compared to a damaged ecosystem outside the park justify investment? In that case the economic feasibility of the park has to be demonstrated.

-- Are series of parks necessary for replenishment of depleted fish stocks in areas between the parks, or is this function already (more cheaply) fulfilled by fishing reserves?

-- Is a marine park (with a staff of 27, as has been proposed) the best way to protect Mauritius' marine environment, or would some regulations concerning the whole coastal area (i.e. a comprehensive marine environmental management plan) in combination with patrolling by 27 people be more effective (the entire underwater park in Bonaire was effectively patrolled by 2 people).

-- At present, diving tourism is managed by about seventeen diving operators, mainly associated with big hotels. Their action radius is limited to a certain area in the vicinity of their diving base. Diving in the marine park has to be much better for most of them to justify a trip all the way to the park. Therefore, their view on priority areas should be solicited.

Recommendation

Medium-Term:

Implement a feasibility study for a marine park or series of parks against the background of its function as a diving tourism attraction. Establish a "Pilot Park" with limited staffing and budget to gain experience. A suitable area would probably be Baie de l'Arsenal. It is of good quality and reasonably close to the main tourist hotels.

4.3.3 Mangroves

It is a well known fact that mangroves are of great importance as nursery grounds for juvenile shrimp and fish. The original mangrove areas have been largely destroyed by clearing for development or by logging. The few small areas of mangroves, remaining in Mauritius, which lie mainly on the east coast should be strictly protected.
4.3.4 Beaches

A major part of the natural resources of Mauritius are its beaches. All the land, stretching inland from the high water line 81 metres and 21 centimeters wide, is unalienable Crown Land which can be leased to third parties. This stretch of land is known as the "Pas Geometriques". All beaches are thus Crown Land and publicly accessible. The Government, in the Pas Geometriques Act, has a unique opportunity to create a buffer zone between the land and marine environment. It can specify conditions in the lease. At present, there are many complaints about the fact that the area of beach accessible to the public is rapidly diminishing because of large scale development along the coast.

Creation of beaches by several big hotels is a special issue that merits further discussion. Beaches are created by pushing large quantities of soil into the sea. This soil appears to be very silty and as a result, coral in front of that beach will be smothered.

Recommendation

Immediate:

Careful planning of beach development is the best instrument to avoid loss of public access to the beach. Beach creation should be subject to regulations as to location and types of sand to be used. Preferably, coarse sand with as little silt as possible should be used. Unfortunately, this type of sand is only available in beaches or lagoons. Such sand should only be taken from lagoons that do not have adjacent beaches.

4.4 Pollution

There is a widespread public perception and clear visual evidence that the bays, estuaries and lagoons of Mauritius which are intensively used are becoming seriously polluted by runoff, seepage and waste disposal. No marine pollution data are available.

Recommendation

Immediate

Begin a marine pollution monitoring programme, concentrated on all areas, especially bays and estuaries, with known or suspected pollution problems. The programme would collect regular monitoring data on key water quality parameters and would aim to define the nature and extent of the pollution problem and predict its impacts.

4.4.1 Land Based

The seas and lagoons around Mauritius are the ultimate sink for most pollution created on the island. Pollution originating from the land finds its way into the lagoon in the following manner:
by pipelines, which discharge largely untreated sewage into the sea. There are three outfalls (400 m, 700 m and 1006 m long) in the Port Louis area, discharging sewage into the sea. Discharge from these outfalls are one of the main sources of coastal water pollution around Port Louis. The pipeline at Pointe Moyenne does not extend into the sea over any length. This results in coastal waters being polluted in the vicinity of the outfall. Much floating sewage was seen to travel along the coast with the tidal currents and part of its ends up from time to time in the lagoon of the holiday resort at Flic en Flac. Ear infections incurred by swimmers and inflammation of minor cuts and bruises have been reported in this area. No data are available on the extent and severity of water or sediment pollution of the lagoons.

**Recommendation**

**Immediate:**

Treat sewage before it is pumped into the sea via outfalls. The pipeline at Pointe Moyenne should be extended further into the sea so that sewage does not reach the lagoons or public beaches.

by surface run off. Surface run off collects in rivers, streams and drains which discharge into the sea. These water bodies are used by the population to dump garbage and by industries to dump their industrial waste. The sugar industry and dyeing industries, in particular, are polluting rivers and streams. There is even a river known locally as the "Riviere Sirope" because of the discharge from a sugar mill. The worst pollution, however, was observed in a stream in Port Louis which conveys oily waste from holding tanks directly into the harbour.

**Recommendation**

**Immediate:**

No industry should be allowed to discharge untreated sewage into surface water bodies. Garbage collection should be improved.

**Medium-Long Term:**

The population should be educated against throwing their garbage into streams and rivers.

by seepage from septic and infiltration tanks: Fortunately, most sewage which is not collected in a sewerage system goes into septic and infiltration tanks in the coastal zone. In principle, this is a satisfactory situation. However, it has been observed that some of these tanks are close enough to the sea to permit seepage of insufficiently decomposed
sewage. In fact, sand along the waterline on one of the most popular tourist beaches on the island has been observed to be badly contaminated with seepage from an infiltration tank. The sand was grey, anaerobic and stinking of hydrogen sulfide over a length of about 100 metres.

The Government of Mauritius, in the *Pas Geometriques Act*, has a splendid opportunity to prevent buildings and their septic tanks from being constructed too close to shore. If a buffer zone of sufficient width is kept between water and the habitation, it will effectively act as a filtration and purification area for sewage.

The big hotels seem to have satisfactory sewage treatment systems. They either treat sewage themselves or store it in holding tanks which are emptied regularly by trucks which transport the sewage to one of the for treatment plants on the island. However, seepage from septic tanks, even if it has been satisfactorily degraded, enriches the receiving sea water with nutrients (e.g. phosphorus, nitrogen, etc.). These nutrients will cause growth of plankton which turns water green and less clear, and which, when excessive, will lead to water quality problems. In the open sea or in lagoons with a reasonable circulation such problems are unlikely to occur. However, in semi-enclosed water bodies like Grande Baie, the first stages of this eutrophication process are already visible.

**Recommendation**

**Immediate:**

No direct discharge of sewage from individual houses, restaurants, hotels etc., should be allowed into lagoons. Septic tanks and infiltration tanks should be located as far as possible from the beaches to allow maximum treatment and filtration of sewage before it reaches the lagoons. A minimum standard distance should be set. No building should be allowed right at the waterfront as sewage discharge from such buildings is virtually impossible to control. In the case where a (semi) enclosed waterbody is surrounded by dense habitation (such as Grande Baie), it is advisable to install a sewage collection and treatment system.

4.4.2 **Sea Based Pollution**

**Accidental Oil Spills:** The biggest threat to the coastal environment of Mauritius from sea based pollution probably comes from calamities such as wreckage of ships with cargoes such as oil or hazardous chemicals. It is impossible to deal with all possible hazardous substances which might eventually end up in the coastal waters. However, for oil a national oil spill contingency plan has been prepared.

**Visiting Yachts:** A problem with discharge of raw sewage by visiting yachts has been observed only in Grande Baie. These yachts, usually anchor in this area if they wish to stay for any length of time on the island. They have to register in Port Louis first, however. At present, many yachts discharge their sewage directly into Grande Baie, although there are facilities to dispose of it at the yacht club.
As Grande Baie already receives a fairly heavy pollution load from the land (drains which discharge in it, seepage from septic tanks and some garbage thrown directly into it), poor circulation in the bay is most probably unable to flush the water sufficiently to avoid steady eutrophication. Therefore the extra pollution load caused by yachts has to be avoided, the more so because this sewage contains faecal material which poses a health hazard. A study for a masterplan for Grande Baie, covering the aspects described, has already been commissioned.

Recommendation

Immediate:

The present sewage disposal system from ships in Grande Baie should be improved. Strict sewage disposal regulations should be drafted. A pamphlet should be issued to each yacht registering in Port Louis explaining how to comply with these regulations. The coast guard should inspect ships to ensure they are equipped to comply with the regulations and actually do so. Failure to comply should result in withdrawal of the permit to stay.

5. Water Resources

5.1 Quantity

On the average, surface waters contribute 60 percent of the islands' total water supply or about 80,000 M3/day. However, this year the drought has reduced replenishment so that about 50,000 M3/day is available from surface waters. Underground waters provide the difference, or about 50,000 M3/day under normal conditions and 80,000 M3/day this year. Most underground water demand is placed upon the Curepipe aquifier, and it is estimated that most future demands for underground water will also be supplied by this aquifier. Modelling has indicated that the total potential of the Curepipe aquifier is about 120 to 125,000 M3/day.

5.2 Quality

Current patterns of agricultural practice (pesticides and fertilizer use), industrial discharges, (fabric dyeing plants and sugar mills) and commercial/residential sewage disposal are providing strong indications that both surface and ground waters are becoming severely polluted. Unfortunately, no definitive statements can be made due to lack of conclusive testing. However, the evidence is accumulating. For example, excessive nitrate levels in agricultural areas indicate fertilizer inputs are contaminating water supplies and further suggest that pesticides, more dangerous pollutants, may also be contaminating water supplies. Unfortunately, much of this pollution is occurring in the Curepipe aquifer, the one already most heavily exploited.

Additional indications of pollution include: fish kills in surface waters near dyeing plants and sugar mill discharges during the harvest season, and complaints of unnatural taste, smell and coloration of waters being received by household consumers located near dyeing plants. Also,
many restaurants, smaller hotels and individual households do not have access to sewage lines. Their waste effluents are being released into the soil and in several locations are percolating to and contaminating beaches, lagoons and both ground and surface waters which form part of the public drinking water supply.

5.3 **Supply**

All drinking water supplied to the island is treated by the standard methods (sand filters, sedimentation, pH control, chlorination). Indeed, all drinking water supply is tested for standard parameters (coliforms, taste, color, odor, pH, simple anions and cations).

Water has not been tested for major suspected pollutants like pesticides and dyes to any great extent. For dyes, appropriate analytical equipment is not available and the exact chemical nature of dyes is unknown. Indeed, the chief concern expressed to the mission was contamination from chrome dyes. Yet the mission learned that chromium detection equipment at the CWA laboratory is still out of order.

In the case of pesticides, some surface water measurements do not indicate a problem. However, neither river sediment samples (where pesticides accumulate) or groundwater samples have been tested. It is also strongly suspected that the full range of pesticide materials used on the island have not been investigated. Additionally, the chlorination provided for treatment of all drinking water is designed to destroy virus and bacteria contamination. However, if complex synthetic organic chemicals such as dyes and pesticides are chlorinated, they could become a greater health hazard than the original pollutants.

To remedy this situation, the following measures are proposed:

**Recommendations**

**Immediate**

The chromium analyzer at CWA should be repaired and all further testing of water supplies should include this parameter. A complete inventory of dyes and pesticides should be established. Trade names are inappropriate. Chemical names are necessary for analysis. A drinking water standard should be established which is based upon tolerable levels of pesticide and dye residues or any other chemicals being imported. Although WHO standards may serve as a guide, clearly the extensive use of exotic chemicals and their close communication with water supplies in Mauritius requires a specialized approach to the setting of these standards. Terms of reference for this program are attached (see Annex 2).

**Medium-Term**

An analytical chemical laboratory should be established with a full range of capabilities for detecting the complete spectrum of parameters necessary to fully characterize potable waters as safe to drink over the short term. This laboratory should be adequately staffed with properly trained personnel.
A study should be undertaken to determine the adequacy of existing water treatment facilities for protecting the drinking water supply and the increased costs associated with improvement of water treatment plants in order to meet the drinking water standard.

Medium-Term

Standards should be established for irrigation water and livestock watering.

All surface waters and aquifers should be classified as to their intended use: e.g. drinking, fishing, recreational, irrigation, industrial/municipal discharges. Having so classified these waters, norms of water quality should be established within each of the designated classifications.

6. Forestry, Flora and Fauna, and Nature Reserves

6.1 Indigenous Forests

Indigenous vegetation has disappeared from most of Mauritius and even where not destroyed it is threatened by more vigorous, invasive exotic species. Original lowland forests have been virtually destroyed, but some upland communities remain including swamp forest, Sideroxylon thicket, upland forest, mossy forest on Mount Cocotte, and Philippia thicket.

The GOM (Department of Forestry), is making remarkable efforts to protect the few remaining areas of indigenous forest. Most of these forests are contained in Nature Reserves. The largest and most important reserve in Mauritius is the Macchabee - Bel Ombre Reserve (3,611 ha). It comprises much of the lower part of the Black River valley. Some patches of representative indigenous forest are small, such as the Perrier Nature Reserve (1.50 ha).

Maintenance of the indigenous forests faces major problems:

-- Invasion by exotic species which outcompete indigenous species is perhaps the most serious problem. Guava and privet are the most troublesome species, guava in particular forming completely impenetrable thickets throughout much of the Black River area. Continuous weeding of exotics is therefore imperative. This task requires sustainable manpower, and sufficient knowledge to distinguish between indigenous and exotic species.

-- Spread of exotic species is accelerated through previous introduction of monkeys and birds which spread their seeds. Monkeys, wild pigs and rodents eat fruits and seeds of the indigenous trees which are not adapted to germinating after being eaten. Deer have a negative impact because of their appetite for seedlings of indigenous plants.
--- **Illegal logging:** Wood is still extensively used in Mauritius for cooking purposes. According to a Housing and Population census conducted in July 1983, one out of two households used wood for cooking purposes. Therefore, pressure on the few remaining forest areas is considerable.

--- **Clearance of forest for deer ranching:** Forest, even indigenous forest, is still being cleared to provide grazing for deer.

**Recommendations**

**Immediate:**

Crown lands with indigenous forest should be declared as nature reserves and managed as such. *Ile aux Aigrettes* should be cleared of exotics. No indigenous forest should be cleared for deer ranching. The Forestry Department should be encouraged to focus even more on indigenous forests. More effort should be made to reforest with indigenous species. Work of local and foreign organizations in the conservation of indigenous flora should be supported.

6.2 **Plantation Forests**

The Forest Department has made a major effort to establish forest plantations. These plantations, however, consist exclusively of exotic species such as pine and eucalyptus. They serve their purpose to provide timber and fuelwood and prevent erosion, but little life is found in these monotonous plantations. Local fauna and even the introduced exotics are not adapted to these trees or the monoculture environment.

6.3 **Indigenous Fauna**

Of the nine endemic Mauritian bird species, six species are listed as endangered in the International Union for the Conservation of Nature (IUCN) red data book. Furthermore, the two snake species on Round Island are highly endangered with one perhaps already extinct. One species of gecko from Round Island is quite rare. Some large butterfly species are also threatened. A captive breeding programme is being successfully carried out at Black River for the Echo Parakeet, the Pink Pigeon, the Mauritius Kestrel and the Rodrigues Fruit Bat. This project, a joint effort between the government and international conservation organisations, is aimed at preventing these species from extinction and releasing them gradually back into the wild. At the same time, scientific data are acquired.

**Recommendation**

**Immediate**

The captive breeding, release and management programme at Black River should be fully supported.
6.4 Exotic Fauna

Originally there were only 5 species of mammals in Mauritius: two fruit bats and three insectivorous bats. All other wild mammals on the island have been introduced (e.g. deer, wild pigs, monkeys, rats, cats, dogs, mice, mongoose and the tenrec). All these introductions have occurred at the expense of indigenous flora and fauna. Consequently, some species of flora and fauna have been exterminated. Monkeys, deer and wild pigs are particularly harmful to indigenous forests while monkeys also prey upon birds, their eggs and their young.

Recommendation

Medium-Term:

From a nature conservation point of view, it would be advisable to eradicate monkeys and wild pigs. However, this is practically impossible. In fenced-in areas of indigenous forest, however, deer and wild pigs should be eradicated and the monkey population in nature reserves should be reduced as much as possible.

6.5 Indigenous Flora

Indigenous flora of Mauritius is of great interest to scientists, amateur naturalists and tourists. It is also vital to some bird species predominantly confined to undisturbed indigenous forest. Many plant species are endemic to Mauritius.

Recommendation

Immediate:

Indigenous flora of Mauritius should be preserved in situ as much as possible. Weeding and fencing are the main management tools. Apart from mainland reserves, offshore islands (in particular Ile aux Aigrettes and Round Island) offer good opportunities for preservation of indigenous vegetation. Ile aux Aigrettes could be weeded of exotics, would need no fencing and would not so easily be invaded as other reserves in Mauritius. The nursery facilities at the Forestry Department dedicated to propagating indigenous plants should be strengthened.

6.6 Exotic Flora

Most plants and trees presently seen in Mauritius are exotics. Trees, in particular, contribute greatly to the beauty of the island and serve a purpose in spontaneously colonizing denuded mountain slopes, thus preventing erosion. They also provide firewood and timber. However, where they invade indigenous forests, these plants and trees should be removed to the greatest extent possible.
6.7 **Nature Reserves**

At present there are eighteen Nature Reserves in Mauritius, including nine on the island itself and nine on offshore islands. Of the reserves on Mauritius, the Macchabee – Bel Ombre reserve is the most important. Here, most of the remaining endemic birds of Mauritius can still be seen. The smallest reserve, Perrier, is of great botanical interest as it harbours a large number of endemic species and shows an intermediate stage between upland and lowland forest. Dry land forest, however, is underrepresented in Nature Reserves.

**Recommendation**

**Long-Term:**

The Macchabee-Bel Ombre Nature Reserve should be included in a national park in the Black River Gorges. Additional Nature Reserves, especially in dry areas such as Magenta and Chamarel, should be created.

6.8 **Round Island**

One reserve which merits special attention because of its scientific interest and its great potential for improvement is Round Island. Round Island lies 22 km to the north east of Mauritius. It is of volcanic origin and rises, coneshaped, from the sea to some 300 metres above sea level. Its surface is 156 hectares. The original flora and fauna of the island was very rich and very high in endemism, a typical example of an island ecosystem of the Indian Ocean and of the Mascarenes in particular. Near the summit there was a small forest of hardwood trees which has disappeared over the last century. Several species of palm, at least one variety only known to Round Island, formed a forest at lower altitudes.

Even more interesting was the animal life. There were two species of snakes, at least three species of lizard, a giant land tortoise and a flightless rail unique to the island. One *Phelsuma* (a Gecko), found on Round Island is also found in Mauritius. One bird species, a petrel, is found only on Round Island and in Trinidad. There are also the spectacularly beautiful white tropic bird and the red tailed tropic bird, both breeding on the island.

Unfortunately, in the 18th century, goats and rabbits were released on the island. Both species destroyed the vegetation while rabbits dug holes in the shallow topsoil. Today there is nothing left of the small hardwood forest which once was found near the summit, and the island is badly eroded. The giant tortoise, the flightless rail and possibly the burrowing boa (one of the two snake species) have vanished. One endemic variety of palm is down to two specimens, and other species are greatly reduced in numbers. Fortunately, a recent campaign to eradicate the goats and rabbits on Round Island has met with success. It is widely believed that goats and rabbits have been completely exterminated. During the mission visit to Round Island no signs of either goats or rabbits were evident.
The Future of Round Island

There is practically universal consensus that Round Island should remain a nature reserve, and not be subjected to any kind of development. There are basically two options for the management of the island:

(a) do nothing but protect the island from poaching, vandalism, etc.

(b) Attempt active restoration of flora and some fauna components to what is thought to be as close as possible to the original state of the ecosystem.

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If nothing is done, the original flora may reestablish itself, but this will take centuries. It is highly unlikely that even within this time, original hardwood forests will come back spontaneously. Already some invasion by exotic plants, formerly kept under control by rabbits and goats, is evident. Occasionally, tropic birds are slaughtered for Chinese Restaurants in Mauritius. This practice should be prevented and stopped immediately. Access to the island should only be granted to occasional scientists, film crews, etc. who can be accompanied and supervised on an ad hoc basis by the Forestry Department.

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Under a more active management regime, efforts can be made to try and restore the island to its original state more quickly. This involves eradication of exotic plant species, (which is recommended under both management regimes), erosion control, soil consolidation and eventual soil formation from local tuft, propagation and replanting of indigenous species, possible introduction of the Aldabra giant land tortoise, and the Aldabra flightless rail etc. Such a scheme requires funding and public support and would be difficult to justify without granting special interest groups limited access to the island. At present, access is very difficult. Virtually the entire coast rises from the sea as a sheer cliff with only one possible landing site. This site can only be used when there is very little swell.

Extreme caution has to be taken, however, both in restoration of the island and in access so that no exotic plants or animals are accidentally introduced.

The whole operation, if initiated, should be subject to a carefully laid out management plan. Expertise should be solicited from organizations who, in the past have been involved in Mauritius and Round Island. These organizations should include but not be limited to:
- The Forestry Department (Ministry of Agriculture, Fisheries and Natural Resources)

- The Captive Breeding Programme in Black River

- The I.U.C.N. - World Wildlife Fund (WWF) botanical expert

- The Jersey Wildlife Preservation Trust (JWPT)

- The International Council for Bird Preservation (IUCN)

- The Wildlife Clubs of Mauritius

Recommendation

Medium-Term:

The ten-year plan for the management and restoration of Round Island already developed should be implemented.

7. Land Resource Planning and Administration

7.1 National Physical Development Plan

The need for a national physical plan to guide the spatial development of the island of Mauritius has been recognized for nearly thirty years. Prior to 1970 the lack of socio-economic data and skilled physical planners prevented progress on the meeting of this need. During the 1970's a major attempt to prepare a comprehensive land use plan for the country (MATIM) resulted in the compilation of useful data, the definition of medium and long-term physical development proposals and suggestions for ways to exercise development control. The fact that the plan did not contain an assessment of development priorities with associated economic and financial costs, coupled with the lack of an appropriate institutional framework for the implementation of the proposals, meant that there was still no effective guidance mechanism for spatial development.

Further attempts to revise the MATIM plan and to generate alternative growth scenarios in the context of rapid industrialization of the economy of the island in the early 1980's ran into a fundamental policy snag, namely economic growth versus environmental conservation. This problem was exacerbated by a deadlock on the issue of institutional control of the planning process. Ad hoc attempts by the then Ministry of Housing and Lands and Town and Country Planning to prepare "outline schemes" or zoning plans for various local areas was largely ineffective owing to the lack of an appropriate plan approval process involving an out-dated Town and Country Planning Board (TCPB). It was also the victim of cumbersome and poorly understood development control regulations administered by a plethora of public agencies both at the central and local level. Thus the problems of uncontrolled spatial development continue unabated.

The chief manifestations of this uncontrolled process include the juxtaposition of mutually antagonistic land uses, continued unapproved encroachment on agricultural land, lack of co-ordination of planning and
installing urban and industrial infrastructure, and speculation in undeveloped land. One of the major consequences of this situation has been the creation of environmental stress which threatens the long-term prospects for a high quality of life in Mauritius.

There is clearly a need to complete the task of preparing a NPDP and to reform the governmental institutional framework needed for effective land development control. Briefly, the objectives of this exercise would be as follows:

(a) identify the capacity of land to support various uses;
(b) provide a framework for detailed local development planning;
(c) provide a basis for public sector investment planning;
(d) identify critical environmental areas and the means for their protection from degradation;
(e) assure efficient and equitable spatial distribution of infrastructure facilities in a manner which protects the natural physical environment;
(f) provide for assessment of the long-term needs for land and the consequent allocation of parcels for various uses;
(g) provide for adequate public participation, including forms of public inquiry, in the planning process;
(h) regularize the development permitting process.

Recommendations

Immediate

Preparation of a NPDP should be resumed under the aegis of the MHLE. The plan should reflect industrial, agricultural, commercial, urban and tourism development policies and, as such, it should contain realistic infrastructure investment priorities.

The control of physical development should be centralized under a reorganized MHLE. The entire body of relevant law, including the Town and Country Planning Act 1954, should be reviewed and revised. The TCPB should be reconstituted under the amended legislation. MHLE should be provided with adequate resources in the form of trained manpower, equipment and funds to carry out its duties under the revised law.

7.2 Land Administration

To the extent that development control, and, by implication, environmental protection, are functions of effective land administration, there is a need to strengthen the process by which parcels of land are defined, identified, allocated, transferred, subdivided (morcellement), registered as to titles including encumbrances, valued, and taxed. The basis for rational land administration is the cadaster based on large-scale mapping.
Recommendation

Immediate

The MHLE should be strengthened in matters of land administration through the promulgation of amended legislation; the upgrading of the survey division and related land administration cadres, and the provision of technical assistance, training and equipment. Similar strengthening of the Ministry of Finance (MOF) should be undertaken with respect to land valuation. More specifically, the following actions should be taken:

(a) initiate cadastral surveys and mapping;
(b) introduce a simple, efficient, low-cost and reliable system of land registration;
(c) introduce legislation to provide for the adjudication of land and the registration of titles.

8. Energy

Current power generating capacity in Mauritius is about 250MW of which fuel oil (45 percent) and coal (10 to 20 percent) constitute the major fuel sources. Hydro-electric power supplies about 20 percent and the difference is met with bagasse.

Presently there is no excess of bagasse available for meeting future energy demand with indigenous fuel. An additional 70MW will be needed by the year 2000.

A recent World Bank loan (Sugar Industry, Ln. 2728) to the Government of Mauritius is aimed at, among other things, promoting energy efficiency in sugar mills. If the objective of this loan is met, excess bagasse would be available to meet all or part of any future power demands. The remainder of this demand would be met by diesel units.

Major environmental issues facing the energy sector would be dust emissions from bagasse burning. Although some sugar mills have dust scrubbing equipment, this is not universally true. Even those with scrubbers still have some emissions. In all cases with scrubbing, the scrubber waters are discharged into the nearest convenient water body. Additionally, some mills are far from population centers while others are quite close.

Leaded gasoline and diesel represent the main transportation fuels. Pedestrians and people living close to main roads may experience adverse health effects. A particular problem is the excessive emissions from many improperly adjusted diesel engines in trucks and buses.
Recommendations

Immediate:

Adopt a dust emission standard for the sugar industry. Perform a health study of blood lead levels and incidence of pulmonary disease among high exposure population sectors. Establish incentives for the use of low leaded gasoline. Regulate emissions from diesel engines in accordance with international standards.

Long-term

Initiate a dust emission monitoring program for the sugar industry and enforce emission standards on a priority basis; those mills closest to population centers should receive top priority.

9. Agriculture

Agriculture has been the backbone of the economy of Mauritius for nearly 150 years. It remains the second most important foreign exchange earner (now surpassed by the EPZ sector), occupies approximately 100,000 hectares of land and employs over 25 percent of the population.

9.1 Agrochemicals

There are three principal environmental concerns relating to the agricultural sector: (1) the condition and sustainable management of the agro-ecosystem itself, (2) the impact of agricultural practices on the "external" physical and biological environment, and (3) the impact of agricultural practices on human health and the quality of life.

The major threat in all three cases is the high, and arguably excessive, level of application of agrochemicals, both fertilizers and pesticides (including herbicides, insecticides, fungicides and rodenticides). Recent estimates reported by the GOM Subcommittee on Pesticides and Fertilizers (July, 1988) are that fertilizer consumption in Mauritius averages 600 kg per hectare: that is three times higher than average rates of application in permanently cropped land in Western Europe, and sixty times the average rate in Africa. Pesticide use is also extremely high, with application rates (per cropping cycle) averaging 44 kg per hectare, probably the highest in the world. The problem is particularly acute in the sugar sector, as herbicides for sugar cane account for over 50 percent of total annual pesticide imports. No insecticides are used in sugarcane, thanks to the existence of a very effective biological control program. However, insecticides are heavily used in the production of green vegetables. Overall application rates of insecticides in recent years have been as much as five times those of the next highest user, Japan, and the trend has been toward increase rather than decrease.

The potential economic, environmental and public health impacts of such high levels of agrochemical use are well known. Soil fertility may be reduced through the adverse effects of pesticide residues on soil microorganisms as well as by excessive leaching of nutrients. Ground and surface water may be contaminated through leaching, percolation or surface
run-off. Such contamination may be directly toxic to humans or to aquatic or terrestrial wildlife (e.g. nitrates, pesticide residues), or may damage important aquatic ecosystems through nutrient imbalances. Excessive and improper use of pesticides may leave harmful residues on foods, endangering the health of the general public. Over-use of pesticides can also destroy non-target organisms, including beneficial insects such as honeybees and the natural enemies of pest species, and can lead to the development of pesticide-resistance in target pest populations. Together these factors can bring about an increase in pest problems, as may be occurring now in the horticultural sector.

Despite the potential importance of these problems, there is a severe shortage of data on the environmental impacts of agrochemical usage in Mauritius. Sampling of soil nutrient levels is carried out by the Ministry of Agriculture on a regional basis and upon request of individual planters, but the sampling is not systematic or comprehensive as it addresses only key nutrient levels. Evaluation of the overall impact of current agricultural practices would require development and regular updating of a comprehensive soil profile, including soil structure, organic matter, microbial communities, etc. The CWA carries out sampling and analyses of ground water for nitrate levels, but not for other nutrients and ions which may be environmentally significant, and surface water is not analyzed systematically. Recent CWA results indicate that nitrate levels are approaching internationally recommended tolerance levels in some agricultural areas of the island at certain periods of the year, but the water monitoring program is inadequate to track these developments in adequate detail. Occasional market basket surveys by the Ministry of Agriculture so far have indicated no problem of excessive residue levels, but here again the existing capacity is inadequate to collect and process an adequate number of samples to ensure the safeguarding of public health. Similarly, monitoring of pesticide exposure among high-risk agricultural and industrial workers is currently limited to blood cholinesterase levels, which is not an appropriate indicator for all types of pesticides.

In addition to the overall application levels, there are environmental and health hazards associated with public access to pesticides, the only poisons regularly available over the counter. The Pesticides Control Act of 1970 was strengthened in 1986 (with regard to eliminating imports of some of the most hazardous pesticides), and a further Amendment currently under consideration by the Government would significantly improve the existing legal framework, particularly with respect to the responsibilities of formulators, importers and sellers and the authority of the MOH to seize or sample pesticides for analysis. A further amendment to adopt the FAO Code of Conduct on Distribution and Sale of Pesticides as national policy is also under discussion.

Despite this relatively strong and comprehensive legal framework, there remains a significant gap on the enforcement side, which has led to continuing criticism from consumer groups and other NGOs. The Pesticide Control Board has no implementation or enforcement arm, and the MOH has only general health officers who are meant to combine pesticide related control activities with many other duties. There is no pesticide assay laboratory to carry out independent evaluation of imported pesticides or of samples collected from the marketplace, and there have been reports of
mislabelling and inferior quality of products. Finally, there is an overall lack of information on the actual status of pesticide control in the field and of public perceptions of pesticide use and hazard; such information is necessary for developing appropriate regulatory and educational measures.

Recommendations

An action program for environmental aspects of agriculture and agrochemicals use in Mauritius should comprise three key elements: (1) an improved system for evaluating and monitoring the movement and impact of chemicals in the environment, (2) specific activities to promote reduction of levels of agrochemical usage, and (3) improved regulation and control of pesticide distribution, handling and disposal.

Development of an effective monitoring system includes both technical and institutional aspects. Technical requirements are for the establishment of systematic, scientific sampling and the development and maintenance of adequate laboratory facilities and trained staff to analyse a statistically relevant volume of samples. The institutional side involves a reporting system where technical data are systematically brought to the attention of relevant authorities, responsibilities for regulation and enforcement are clearly defined, and the agencies responsible for inspection, monitoring and enforcement are supported by adequate human and financial resources and by clear and appropriate legislation.

Agrochemicals are costly to purchase and to apply. Consequently, farmers are rarely averse to reducing use of these inputs if they can be persuaded that this can be done without reduction in yields or, more importantly, in profits. While the types of agrochemicals used may be regulated by law, economic arguments are generally more effective than regulation in influencing application rates. Thus, an appropriate program should include: (1) orientation of research programs toward reduced-input technologies and achieving maximum profit through balancing the costs and benefits of inputs (optimum thresholds); (2) extension of these research results to farmers, along with education regarding the negative aspects of excessive chemical use; and (3) policies which affect the economics of crop production (eg. subsidization or taxation of inputs, pricing policies, penalties for polluting or other abuses).

### 9.1.1 Environmental Monitoring and Analysis

**Immediate:**

The legislative and institutional framework for monitoring agricultural pollution in water and soil should be reviewed, consolidated and strengthened and new legislation drafted to fill any gaps (eg. to establish standards for ground water for biofertilizers).

A systematic soil profile should be developed and then updated regularly to monitor the impacts of agrochemical use and other agricultural practices (such as pre-harvest burning of sugarcane fields) on soil fertility, structure and quality.
A more systematic monitoring of ground and surface water in agricultural areas should be instituted under the auspices of CWA and expanded to include non-nitrate fertilizer residues and ions as well as all commonly used pesticides.

Existing laboratory facilities should be strengthened to increase the breadth and quality of analyses undertaken. This strengthening will include provision, update and repair of equipment, training of additional staff and review of existing procedures for data collection and analysis. Analysis of pesticide residues in environmental samples (soil, water, air, fish and wildlife) should be centralized within a single general chemical analytical laboratory which is also responsible for monitoring industrial and municipal pollution. The laboratory of the Ministry of Agriculture’s Agricultural Chemicals Division, which is responsible for examining pesticide residues in foods, should be strengthened as it currently lacks several important instruments. The Government Chemical Analytical Laboratory within the MOH, whose responsibilities include monitoring of pesticide exposure in agricultural workers, should be similarly strengthened as needed. In addition, a new pesticide assay laboratory should be established to facilitate regulation of the quality of both imported and domestically - formulated pesticides and to assist in enforcement of regulations on pesticide sale and distribution (i.e., for identification and analysis of obsolete or unlabeled, confiscated materials).

9.1.2. Fertilizer and Pesticide/Pest Management Research

Immediate

The feasibility and cost-effectiveness of increased use of organic and biofertilizers should be investigated, both with respect to small-scale use by small farmers and the potential for development of a biofertilizer industry on a larger scale. The latter approach should consider the use of agriculture, industrial and municipal solid wastes and waste water, but with appropriate standards and controls to safeguard the crops, the environment and public health.

Existing research programs in Entomology and Plant Pathology at the MSIRI, Ministry of Agriculture and the University of Mauritius should be reviewed, with a view toward strengthening research relating to reduced-chemical and integrated pest management (IPM) methods. Primary emphasis should be put on research on weed control in sugarcane, and on insect and disease control in vegetables, fruits, livestock and stored products, as these represent the major users of pesticides.

A pilot program should be established with the MOA Pesticide Spray Unit to evaluate the cost-effectiveness of ULV hand-held and/or electrostatic sprayers to replace the more wasteful hydraulic back-pack sprayers currently in use.
Medium-term

A feasibility study should be carried out on the development of biofertilizers as a substitute, or partial substitute for synthetic chemical fertilizers. This study should consider both small-scale, individual-based approaches for use primarily by small farmers and the potential for development of a biofertilizer industry. The study should encompass both the recycling of local organic materials to improve soil quality and fertility and the potential for recycling of industrial and municipal (particularly non-sewage) waste for fertilizer.

9.1.3 Pesticide Regulation and Education

Immediate

The proposed Amendment Bill to the Pesticides Control Act should be enacted into law as soon as possible.

A small "Pesticide Survey Team" should be established to investigate the current situation of pesticide sale, handling, use and disposal and levels of public perceptions and knowledge. This information should be reported to the MOA and PCB to form the basis for improvements in regulatory and educational measures and programs. The team can also evaluate whether an action program is required for collection and disposal of hazardous pesticides made obsolete by the new legislation.

The team should be multi-sectoral (Entomology, Plant Pathology, Chemistry, Health, Extension all represented) and trained in pesticide use and safety as well as in public survey/educational methods. Once assembled and trained, this team will prove a valuable and lasting resource which can provide effective public education both directly and through collaboration with the extension service, and help the PCB keep track of its effectiveness and refine its approach on an on-going basis.

Interested local NGOs should be invited to participate on the PCB and contribute to its information collection and public education efforts.

Medium-term

Educational programs relating to pesticide hazards and use should be strengthened and expanded (based on the needs identified by the Pesticide Survey Team), making use of all possible media such as local publication (eg. Farmers’ News), Farmers Service Centres, Radio and Television, etc.

9.2 Irrigation

At present, all irrigation schemes utilize waters received directly from surface or ground water sources. There is no use of recycled waters. Presently, there are no gross imbalances between water supplies and demands, but local imbalances are occurring and as industrial development and population growth continue the problem will become more severe and widespread in the foreseeable future. The potential for recycling water is substantial. One site visit to a sewage treatment plant
(San Martin) included a visit to its ocean outfall. The brief drive from the treatment plant to the outfall traversed land entirely dedicated to sugar cane. Clearly, there is an opportunity to utilize the treated sewage effluent as a source of nutrients and irrigation water. This would reduce demands on the water supply system, reduce fertilizer requirements and eliminate a source of coastal pollution (the outfall would not be required). The possibility is under study at the University of Mauritius and should certainly be encouraged and supported.

In addition to municipal wastewaters, certain industrial wastes, if they are or can be made non-toxic and are biodegradable, might also be considered for use as irrigation waters. Indeed, wastewaters from sugar mills themselves are rich in organic content and should provide substantially greatly benefits than the waters currently in use. The obvious problem here is that sugar mill wastewaters are produced during harvest season and irrigation waters are required during the growing season. Nevertheless, it is possible to stagger the growing season and thereby allow some overlap of milling and growing phases. The extent to which this could be accomplished would benefit growers (less fertilizer use and reduced water costs), preserve the precious water resource, and reduce a substantial pollution problem of both surface and coastal waters.

Recommendation

Medium-Term

An active research program should be initiated and/or expanded in the use of municipal and certain industrial wastewaters for irrigation.

10. Municipal Waste Management

10.1 Sewage

About twenty percent of the overall population has access to sewage hookup. The remainder depend upon some form of underground disposal. For these systems, raw sewage percolates through the soil or sand, and in many cases sewage is not fully decomposed by the time it reaches a river, aquifer or lagoon. The end result is pollution of these waters and potential health hazard to any users (bathing, drinking, contaminated shell fish, etc.) The extent of this pollution is unknown: few measurements have been made.

In addition to residential sources, pleasure craft, hotels and restaurants also discharge substantial quantities of untreated sewage directly into coastal lagoons. Some larger hotels are installing secondary sewage treatment plants and the government is requiring other large hotels to do so as well. Nonetheless, problems of raw sewage discharge are evident in Grande Baie.

Three of the four treatment plants maintained by the Ministry of Works were visited. None of these plants was believed to be operating properly, because they lacked equipment, spare parts and had difficulty in obtaining adequate and timely maintenance repairs. Unfortunately, none of the installations had any facilities to monitor plant performance,
especially solids removal and BOD reduction. Indeed, no plant had a flowmeter, so the loading could not even be determined. Furthermore, a visit to the shortest outfall at Pt. Moyenne revealed that local fisherman had dumped rocks into the overflow bypass and sewage was thus being diverted from ocean discharge to spill directly on the beach below.

The longer outfalls discharge wastewaters which have received primary treatment (removal of sand and grit). All organic material is separated, macerated and reinjected into the outfall. The resultant ocean discharge is polluting the coastal region to an unknown degree.

The Ministry of Works has prepared Terms of Reference entitled "Master Plan for Sewage". These terms of reference appear adequate for future planning, but they fail to emphasize analysis and recommendations for improvements to be made in the existing collection and treatment facilities. As soon as the water quality laboratory (see Section 5.3) is established, the Ministry of Works is planning to perform an environmental monitoring program in the vicinity of the outfalls to determine the extent to which they are polluting.

**Recommendation**

**Immediate**

A survey of equipment, monitoring and repair requirements for existing sewage treatment plants and collector systems should be made. Recommended improvements for rehabilitation and emergency extensions should be rapidly implemented. A water quality laboratory should receive high priority. Dependent upon future organizational arrangements, this laboratory could either be separate from the laboratory recommended under Section 5.3 or both could be combined. This satellite laboratory should be capable of routine effluent monitoring for industrial pollutants.

A National Sewage Master Plan should be prepared.

**Medium-Term**

The recommendations which result from the master plan for sewage should be implemented.

10.2 **Solid Waste**

Solid wastes from households, commercial and industrial establishments are seen everywhere on the island ... even under signs proclaiming "No Dumping Allowed". Garbage is tossed into lagoons and drainage canals and in smoldering heaps at roadsides. Statistics of municipal garbage collection were obtained for seven of the eight districts. The data were recast into daily tonnage collected per 100,000 population served. Results are shown below for each district along with the percent of vehicles in service.
<table>
<thead>
<tr>
<th>Municipal/District</th>
<th>Percent Vehicles in Service</th>
<th>Tonnes collected/100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rose Hill</td>
<td>82</td>
<td>42.1</td>
</tr>
<tr>
<td>Curepipe</td>
<td>73</td>
<td>62</td>
</tr>
<tr>
<td>Quatre Bornes</td>
<td>57</td>
<td>138</td>
</tr>
<tr>
<td>Vacoas/Phoenix</td>
<td>70</td>
<td>91</td>
</tr>
<tr>
<td>Port Louis</td>
<td>73</td>
<td>84</td>
</tr>
<tr>
<td>District-North</td>
<td>100</td>
<td>81</td>
</tr>
<tr>
<td>Moka Flacq</td>
<td>65</td>
<td>42</td>
</tr>
</tbody>
</table>

Clearly the data are inconsistent since the municipality with the smallest fraction of available vehicles (Quatre Bornes) is indicated to be far and above the most efficient. On the assumption that a figure of about 85 tonnes/100,000 population is a reasonable figure for efficient collection, then using actual population values for each of the districts it is estimated that 121 tons of garbage are going uncollected daily. However, one does not need such analysis, one can almost judge the results on the basis of personal observation. Garbage disposal at industrial estates is also a random, disorganized affair. Indeed at one site, the mission witnessed wastes being burned in reasonably close proximity to an oil storage tank.

The municipal dump for Port Louis is an unmanaged, unsightly and unhealthy blight. Burning of garbage there further contributes to air pollution. By contrast the disposal site for the municipality of Beau Bassin seemed reasonably well managed.

Collectively, the mission made many independent site visits on the island. In the three week period only on three occasions did anyone see a garbage truck, and only on one occasion did anyone actually witness garbage being removed. This situation is reaching a deplorable state and could start affecting tourism. People simply do not wish to vacation in the middle of garbage.

A number of proposals have been presented to the Government for utilizing refuse to generate compost, electricity, etc. These schemes are appealing, yet the critical issue for all is waste collection. Unless collection can be implemented successfully, none of these proposals can succeed.

**Recommendation**

**Immediate**

A study should be initiated as soon as possible to determine the status of solid waste collection and disposal services (industrial, commercial, agricultural and municipal). The study should include an assessment of the adequacy of existing institutional arrangements and laws, as well as the capacity of existing disposal sites, and if necessary, identify additional sites consistent with future development and land use. At least one site for disposal of hazardous waste should be identified. A national solid waste inventory should be compiled (operation, collection
and disposal statistics by sector and location). Recommendations, including changes in institutional arrangements (such as privatization) should be considered. If any aspects of a study of this nature have already been done, the recommendations should be implemented. A National Solid Waste Management Plan should be developed. It should use the inventory as a basis for future projections and systems to be considered in the medium and long terms, for proper waste management throughout the country.

Medium-Term

Industrial estates and other collective commercial units should study combining their refuse for mutual incineration, and, if attractive, a joint refuse-fired boiler to generate process steam might be studied.

Long-Term:

As collection and disposal of refuse is demonstrated to be more effective, implementation of schemes identified in the National Solid Waste Management Plan for utilizing the waste (compost, electricity, etc.) should be considered.

11. Industry

11.1 Textiles

Liquid waste from dye houses is one of the most serious environmental problems which has accompanied the nations' economic success. Presently, virtually no effluent from any dyeing operation is treated properly, or treated at all. Raw effluents are discharged on land creating a public nuisance and possibly contaminating aquifers; they are also discharged in deep wells (eventually reaching drinking water aquifers) or directly into rivers, killing fish and affecting both the water quality and aesthetic appearance.

Clearly, the situation is becoming uncontrollable and government must act quickly. The Chief problem areas are: lack of information about the chemical nature of the dyes, lack of knowledge regarding appropriate norms for dyehouse effluents and lack of equipment for enforcement and environmental monitoring. These issues are discussed below:

-- At present, no government authority has any detailed data about the chemical nature of the dyes being imported. All that is provided are trade names which in themselves are virtually meaningless. Many dyes are believed to contain chromium or other heavy metals which are both toxic to aquatic life and can inhibit proper operation of biologic sewage treatment plants (they poison the activated sludge). Other dyes are carcinogenic and may be affecting the health of dye-house workers.
The Government would like to establish effluent standards for dye houses but has been at a loss to determine which norms are appropriate.

Lastly, there is no capability on the island to analyze dye-stuffs being imported to ensure they are safe to human health and environment. There is no capability to analyze dye house waste effluents for conformance to any realistic norms which may be selected.

Recommendation

Immediate

A dyestuff chemical control board should be established with authority similar to the pesticide control board in terms of authorizing import permits. Permit approvals would be based upon: whether or not the given material is banned in other countries (and why); costs for recommended processes for treating effluents and whether their effluents interfere with treatment of any other wastewaters (e.g., chromium) or can be treated jointly; human health risk (carcinogenicity, mutagenicity and teratogenicity); equipment and precautions for handling and use, and toxicity to aquatic species and plants. Much of this information is readily available in international registers of toxic chemicals.

An assay laboratory should be established for the dyestuff control board and it should be equipped with analytic capabilities to monitor all dyes being imported (see Annex 1 for TOR). The laboratory should be staffed by well trained personnel.

The control board should perform a complete inventory and evaluation of dyestuff materials currently in use and ban and/or confiscate those which it deems a health or environmental hazard.

The dyestuff control board could be combined with the pesticide control board (Section 9.1) to form a Hazardous Substance Control Board. This Board should have training and consultancy services, and make study tours to learn how other countries effectively manage this problem.

Norms for effluent discharges from individual dyehouses should be established both for pretreatment (if several dyehouses will treat their wastes jointly, or if the individual discharge will be to a public sewer system) and fully treated discharge (if an individual dye house wishes to completely treat its own waste). Pretreatment standards only apply to effluents destined for some additional treatment; effluent standards apply to discharge to the environment.

As an initial estimate, it is recommended that World Bank Guidelines for the textile industry be adopted as effluent standards. With these norms officially accepted, an industry has three options:
pretreating its waste (if necessary)* and combining its effluent with neighbor dye house waste for mutual treatment;

pretreating its waste (if necessary)* and discharging the effluent into municipal sewage treatment system; or

fully treating its own wastes and discharging to the environment.

If norms are vigorously enforced, it is believed that the isolated dye houses will find it uneconomic to fully treat their own wastes and will then move to areas where they can benefit from sharing in the costs of joint treatment.

With established norms, an effluent monitoring capability must be established for enforcement. This capability must include facilities to monitor dye house pollutants which might potentially be in the effluent.

Immediate

An emergency program to eliminate indiscriminate proliferation of dye houses and resolve the current dye house untreated effluent discharge problem should be implemented.

A high priority program of testing surface and groundwaters for contamination from dyeing chemicals should be initiated.

Medium

Government should undertake a policy of congregating all potentially polluting industries on industrial estates and require, as a condition of estate development, mutual facilities be provided to satisfactorily treat and dispose of all liquid and solid waste.

A project to provide the complete infrastructure at an industrial park, to be dedicated wholly to polluting industries, should be implemented.

11.2 Sugar

Air pollution problems of the sugar industry are associated with bagasse burning. This issue was discussed in Section 8 (Energy). At that point, it was noted that many mills scrub their exit gases to remove fly ash from the stack exhaust and that scrubber waters (laden with trapped dust) are discharged untreated into any convenient water body.

There are additional wastewater discharges associated with sugar production. In most parts of the world these waters are treated to acceptable levels prior to any discharge. Unfortunately, not a single sugar mill in Mauritius treats its effluent wastewaters. These effluents

(*Not all dyes require pretreatment to be accepted by a mutual treatment plant.*)
during the harvest season contain substantial quantities of organic materials (BOD). When the BOD is discharged into rivers or coastal zones it literally robs them of any oxygen, killing any fish in the waters and generating noxious odors. The organic wastes also deposit on the edges of the water leaving sticky black slime.

Currently there are no effluent norms for the sugar industry.

Recommendation

Immediate

Effluent norms for the sugar industry should be established. World Bank guidelines are recommended. The effluent monitoring capability previously discussed for dyehouses should also include instrumentation for monitoring sugar mill effluents.

11.3 Other Industries currently in Operation

There are several other industries currently in operation which are viewed as significant sources of pollution. Of particular concern are fertilizer, limestone and rock crushing plants as well as some food processing facilities. The former mainly generate air pollution, while the latter are usually sources of water pollution and nuisance smell.

Rock crushing facilities provide an interesting case of improperly formulated environmental norms. Here the regulations require water sprays be installed to suppress dust emissions. One of the facilities visited had installed a cheap inadequate system which satisfied the norm, but did not control dust. A more suitable approach would be to establish norms on ambient dust levels. This was not done because suitable dust monitoring equipment is not available in Mauritius.

Recommendation

Immediate

World Bank guidelines for dust emissions, fertilizer plants, fish and shellfish processing, meat processing and rendering, poultry processing and fruit and vegetable processing be adopted as initial norms.

Ambient dust monitoring equipment would be obtained and included in the compliance monitoring laboratory.

11.4 Future Industrial Growth

A number of new industries are projected to locate in Mauritius, notably leather tanning and plastic forming. Prior to allowing any new industry to be set up it is imperative that the government establish appropriate norms for any air and water pollution they might produce, and obtain monitoring equipment which may be necessary to enforce these norms.
Recommendation

Immediate

Adopt World Bank guidelines for leather tanning industry as a preliminary norm.

A major control laboratory should be established with a full range of analytical capabilities for assay work (possibly including the pesticide and dyestuff laboratories recommended earlier in Sections 9.1 and 11.1) air and water emissions and effluent sampling and analysis for both routine and complex parameters. Routine analyses would normally be compliance type monitoring. Complex analyses would include specific chemical or biological substances. Capabilities would also be used for air and water quality (surface, ground and coastal) as well as leachate tests on solid wastes to establish their classification as hazardous or non hazardous, and vehicular emissions testing.

It is also recommended that this laboratory should test pilot wastewater samples from new industries, so that industrialists can be advised of pretreatment requirements on their wastewater before discharge into the municipal sewerage system.

The laboratory would assist other satellite laboratories in their compliance role as well as engage in longer term research projects.

Immediate

In view of the fact that potentially hazardous industrial chemicals are currently in the Mauritian workplace, and more are likely in the future, a satellite laboratory should be established for the Factory Inspectorate (Ministry of Labour). The Laboratory would ensure that industrial facilities are operated in a manner that insures the health and safety of workers by enforcing appropriate Mauritian Standards and/or international (WHO/ILO) norms.

To effectively execute the environmental assessment role, the proposed DOE would require a satellite laboratory to conduct ambient noise and air quality measurements. This laboratory would also be equipped to evaluate the ease and practicality of monitoring any new or proposed standards and/or alternative monitoring equipment for existing standards. A modest capability for terrestial and aquatic flora and fauna sampling for preliminary assessment purposes is to be included. Air and noise monitoring equipment should be contained in a mobile unit.

Health studies should be performed on major industrial sectors to assess the impact of industrial practices on workers and high exposure population sectors. Impact of dust, hazardous materials and accidents for workers and nearby residents to dye houses, stone crushers, chemicals industries etc should be determined.
12.0 **Tourism**

Mauritius has enjoyed a steady increase in the volume of tourist traffic in recent years, growing from 123,820 tourist arrivals in 1983 to 207,560 in 1987. Tourist earnings have increased from Rs 503 million to Rs 1,786 million over the same period. The Government estimates an upper limit to this growth at about 400,000 visitors by the year 2000. The desire to maximize the earnings in this sector, coupled with the fixed upper limit on the number of tourists, has led the Government to target a selective (high-income) tourist market which demands a very high standard of service and facilities with a human dimension. To this end it has been decided that no hotel should have more than 200 rooms under the same management. While at present the major focus of international tourism is on the beach environment, there is a recognition that the potential for inland tourism has yet to be developed.

Associated with the growth of this sector is, of course, the threat to the natural environment posed by the uncoordinated and inappropriate expansion of tourist facilities and related activities, both on land and on the sea. There is a growing concern about the following environmental problems generated by increased tourism:

(a) physical pollution generated by the tourism industry, especially the disposal of sewage and other forms of waste;

(b) the encroachment of tourist facilities on adjacent non-tourist space;

(c) the growing lack of public access to beach areas because of physical barriers posed by tourist facilities;

(d) the lack of facilities to cater for the local tourist/leisure industry;

(e) the loss of beach front owing to natural erosion, mining activity, and the inappropriate erection of sea-side structures;

(f) the potential health hazards posed by international tourism;

(g) the lack of public information on the planning of future tourist developments and the resultant concern that the local public interest is being downplayed; and

(h) the uncontrolled "backyard" and ribbon development in tourist zones.

**Recommendations**

The national physical planning capacity of Mauritius should be strengthened and development control should be introduced in a meaningful way (See Section 7.0)
Infrastructure services of the necessary standards should be provided before additional hotel and tourist facilities development takes place (See section 7.0).

The remaining prime coastal tourist zones should be the subject of detailed planning studies.

The social and environmental impact of international tourism on Mauritius should be studied.

Legal issues of environmental protection in tourist zones should be identified and appropriate legislation prepared.

12. **Historic and Architectural Conservation**

The awareness of the disappearance of historic and architectural structures is a recent phenomenon in Mauritius. It has been prompted in part by a desire to foster increased cultural tourism.

The majority of places listed as historic are tombs and not buildings. By law no religious building may be added to the register of listed buildings. There are few listed buildings which are privately owned. There is no incentive system to promote the preservation of privately owned structures of historic interest. The current concept of preservation does not extend to the area or district in which the structure is located nor does it pay attention to conservation of the surrounding landscape or vegetation. There is a lack of criteria to determine whether or not a structure should be preserved. There is a growing concern about the loss of antiques.

The responsibility for historic preservation belongs to the Ministry of Works. It is assisted on occasion by a consultative committee made up of amateurs. There is a lack of funding and expertise to undertake preservation work.

**Recommendation**

**Immediate**

Create an effective institution for the preservation of historic and architectural structures in Mauritius and establish a National Historic (Heritage) Trust.
III. PROGRAM OF ACTION AND PRIORITIES

This section of the report summarizes the specific recommendations (other than Institutional Issues and Options which are covered in Section IV) from the previous section in a short-, medium- and long-term recommended Action Programme.

1. IMMEDIATE

Marine Resources

General

Start a monitoring program for basic parameters of estuary, lagoon and reef ecosystems. Transects should be laid out along the coast where parameters such as water quality, coral cover and health invertebrates and plants should be measured. This is the only way changes can be detected. Even a simple monitoring system requiring careful observation and standard laboratory tests will prove immensely valuable.

Fisheries

The total ban on spear fishing and dynamiting is fully endorsed and should be more vigorously enforced (particularly spearfishing). Use of seine nets with fine mesh should be strictly controlled, or, if this appears to be difficult, should be outlawed. Fishing reserve areas should be strictly guarded. It might also be feasible to gradually reduce the number of licenses to prevent overfishing and increase the efficiency of fishing.

Strictly enforce the ban on use of chemicals in fish capture.

Coastal

Phase out extraction of live and dead coral from the lagoons and replace it with fossil coral from land quarries. If for economic or technical reasons this is not viable, quarrying in authorized sand extraction sites in the lagoons might be a feasible alternative, in particular, where the bedrock consists of fossil coral and sand extraction can be combined with fossil coral extraction in the same region. It is recommended that in this case fossil coral and sand extraction should be concentrated and carried out according to an ecologically sound plan in one location.

Careful planning of beach development is the best instrument to avoid loss of public access to the beach. Beach creation should be subject to regulations as to specific locations and types of sand to be used.
Coastal Pollution

Begin a marine pollution monitoring programme specifically tailored to investigate all areas, but especially bays and estuaries, with known or suspected pollution problems. The programme would collect regular monitoring data on key water quality parameters and would aim to define the nature and extent of the pollution problem and to predict its impacts.

Treat sewage before it is pumped into the sea via outfalls. The pipeline at Pointe Moyenne should be extended further into the sea so that sewage does not reach lagoons or public beaches.

No industry should be allowed to discharge untreated sewage into surface water bodies. Garbage collection should be improved.

No direct discharge of sewage from individual houses, restaurants, hotels, etc., should be allowed into lagoons. Grand Baie should be classified as top priority for improved sewage collection and treatment. Septic tanks and/or infiltration tanks should be located as far from the beach as possible to allow maximum treatment and filtration of sewage before it reaches the lagoons. A minimum standard distance should be set. No building should be allowed at the water front unless sewage treatment facilities are installed as sewage discharge from such buildings are virtually impossible to control. In cases where a (semi) enclosed waterbody is surrounded by dense habitation (such as Grande Baie), it is advisable to install a sewage collection and treatment system.

The present sewage disposal system from ships in Grande Baie should be improved. Strict sewage disposal regulations should be drafted. A pamphlet should be issued to each yacht registering in Port Louis explaining how to comply with these regulations. The Coast Guard should inspect ships to ensure that they are equipped to comply with the regulations and actually do so. Failure to comply should result in withdrawal of the permit to stay.

Water Resources

The chromium analyzer at CWA should be repaired and all further testing of water supplies should include measurements for chromium. A complete inventory of dyes and pesticides should be established. Trade names are inappropriate; chemical names are necessary for analysis. A drinking water standard should be established which is based upon tolerable levels of pesticides, dye residues and other chemicals in use. Although WHO standards may serve as a guide, clearly the extensive use of exotic chemicals and their close communication with water supplies in Mauritius requires a specialized approach to setting of these standards.
Land Resource Planning

Establish a multidisciplinary team to formulate and implement the NPDP.

Prepare the Land Resource Management document.

Centralize the Land Development Control and Monitoring Function (i.e. issuance of development permits.)

Forestry and Wildlife

The Forestry Department should be encouraged to focus even more on indigenous species. Reafforestation in areas previously cleared of native vegetation should be supported and expanded, but should place greater emphasis on established stands of mixed species and using native species where possible. The Forestry Department's facilities for propagating native species should be strengthened and expanded for this purpose.

A National Park should be established in the Black River Gorges Area, encompassing the existing Maccabee - Bel Ombre Nature Reserve. A management plan should be developed for multiple use (conservation, education, recreation, research) of this area.

Crown Lands with indigenous Forest should be declared as nature reserves and managed as such. No indigenous forest should be cleared for deer ranging.

The Captive breeding, release and management program at Black River should be fully supported and expanded. It should be used as a nucleus for a conservation centre which will include a public information centre, nursery and gardens for endangered species and facilities for local scientists.

The indigenous flora or fauna of Mauritius should be preserved in site as much as possible. Weeding, fencing, eradication of exotic species and patrolling are the main management tools. The work of local and foreign organizations for conservation of indigenous flora should be supported.

The ten-year management plan for Round Island should be implemented and broadened to include other offshore islands. The practice of conservation leasing of specific areas to NGO's, successfully pioneered at Ile aux Aigrettes, should be extended to selected other islets.

The nursery facilities at the Forestry Department dedicated to propagating indigenous plants should be strengthened.

Energy

Perform a health impact study on population sectors which experience high exposure to vehicle exhausts.
Agriculture

The impact of agrochemical use and other agricultural practice on soil structure and fertility should be investigated.

More systematic and comprehensive monitoring of chemical contaminants in ground and surface water should be instituted, and the institutional and legal framework for water quality control clarified and strengthened.

Analytical laboratories for environmental pollution (agricultural, industrial and municipal wastes in water, soil and air), pesticide residue analysis and analysis of human exposure to hazardous chemicals should be strengthened, and a separated pesticide assay laboratory (for identification and quality control of pesticide products) should be established.

Fertilizer research should be re-oriented to identify optimum thresholds and practices for fertilizer use, taking into account both economic and environmental factors. Fertilizer recommendations should be modified accordingly, and farmers educated regarding the problems associated with overuse.

The feasibility of further development of bio-fertilizers (including recycling of municipal and industrial wastes) should be investigated, with pilot trials of composting, green manuring, etc.

Research programs for non-chemical, reduced chemical and integrated pest management should be strengthened, particularly in relation to weed control in sugar cane and insect and disease control in vegetables, fruit, livestock and stored products. Researchers should be assisted in exploring existing work overseas with a view to transferring and adapting it to local conditions. Ultra-low-volume and electrostatic sprayers should be introduced on a pilot basis.

Pending legislation to strengthen pesticide regulation and control should be enacted as soon as possible. A Pesticide Survey Team, comprised of representatives from MOA Divisions of Entomology, Plant Pathology, Agricultural Chemicals and Extension and MOH should be formed to investigate and report on the effectiveness of existing regulatory and public education measures and programs. The Pesticides Control Board (PCB) should act on the team's information to develop and strengthen these programs and improve pesticide control.

Interested local NGO's should be given representation on the PCB and encouraged to assist in development and implementation of pesticide-related public education.

Analytic capability for trace levels of pesticides in human body fluids should be strengthened so that workers can be more thoroughly tested on a regular basis for their level of exposure.

A laboratory should be established to ensure standards for worker health and safety are maintained in packaging and formulation plants.
As a matter of urgency, all WHO Ia and Ib materials, and any materials containing mercury, lead, thallium, cadmium, selenium or arsenic should be immediately removed from public sale. The PCB should establish a meaningful packaging and labelling requirement for all pesticides if they have already not done so, and make this a requirement for all materials sold. Any pesticides not conforming to these requirements should not be sold. Regular surveillance of all retail sales should be maintained.

**Municipal Waste Management**

A survey of equipment, monitoring and repair requirements for existing sewage treatment plants and collector systems should be made. Recommended improvements for rehabilitation and emergency extension of the existing system should be rapidly implemented. A satellite Water Quality Laboratory should receive highest priority. Dependent upon future organizational arrangements, this laboratory could either be separate from the previously mentioned laboratory (see Water Resources: Medium-Term) or both could be combined.

The overall National Sewage Master Plan should be prepared. It should address all effluents (industrial, commercial and municipal) and consider treatment requirements, recycling and reuse possibilities, extension of existing outfalls or replacement, as well as the collection system.

A study should be initiated as soon as possible to determine the status of solid waste collection and disposal services. The study should include an assessment of the adequacy of existing institutional arrangements and laws as well as the capacity of existing disposal sites. If necessary, the study should identify additional sites consistent with future development and land use. At least one site for disposal of hazardous waste should be identified. Recommendations, including changes in institutional arrangements (including privatization) should be considered. An inventory of solid wastes for all sectors should be made, disaggregated as far as possible by geographic region. A National Solid Waste Management Plan should be developed.

**Industry**

A dyestuff chemical control board should be established with responsibilities similar to the pesticide control board in terms of authorizing import permits. Permit approvals would be based upon: whether or not the given material is banned in other countries (and why); costs for recommended processes of treating effluents and whether their effluents interfere with treatment of any other wastewaters (e.g. chromium) or can be treated jointly; human health risk, (carcinogenicity, mutagenicity and teratogenicity); equipment and precautions for handling and use; and toxicity to aquatic species and plants.

An assay laboratory should be established for the dyestuff control board and should be equipped with analytic capabilities to monitor all dyes being imported. The laboratory should be staffed by personnel who have received appropriate training.
The dyestuff control board should perform a complete inventory and evaluation of dyestuff materials currently in use and ban and/or confiscate those which it deems a health or environmental hazard.

The dyestuff control board could be combined with the pesticide control board to form a Hazardous Substance Control Board. Training, consultancy services and study tours should be prepared for board members. Norms for effluent discharges from dyehouses should be established for pretreatment (if several dyehouses will treat their wastes jointly, or if the individual discharge will be to a public sewer system), and fully treated discharge (if any individual dye house wishes or is required to completely treat its own waste). World Bank guidelines are recommended for adoption as initial effluent standards.

With the established dye house norms, effluent monitoring capability must be established for enforcement. This capability must include facilities to monitor dye house pollutants which might potentially be in the effluent.

A high priority program of testing surface and groundwaters for contamination, especially from dyeing chemicals, should be initiated.

An emergency program to eliminate indiscriminate proliferation of dye houses and their untreated discharges in the Baie du Tombeau area should be implemented. The program should start with an immediate study and construction of emergency works. A long range infrastructure needs study should also be developed for this area, consistent with the National Physical Development Plan.

Effluent norms for the following industries should be established:

- Sugar
- Rock crushing (dust)
- Fertilizer manufacture
- Fish and shellfish processing
- Poultry processing
- Fruit and vegetable processing
- Leather tanneries

World Bank guidelines could be adopted as initial official norms for the above industries.

Monitoring equipment should be obtained to measure compliance with the adopted norms.

A major central laboratory should be established with a full range of capability for assay of hazardous chemical, emission and effluent testing, solid waste characterization and vehicular emission testing.

Tourism

Provide necessary infrastructure for tourism development. Distribute tourism more evenly over the island. Set strict standards for sewage treatment and disposal from hotels.
2. **MEDIUM-TERM**

**Marine Resources**

Develop a Marine Environmental Management Plan to zone the marine environment, to control the exploitation of marine resources and protect the biological and physical characteristics of the environment. Develop a Marine Conservation Centre to research, prepare and administer the management plan. Prepare a Marine Environmental Protection Act.

**Coastal**

Replacing coral sand with rock sand is a distinct possibility. This procedure would be preferable, as no risks are taken with the environment. If, for economic or technical reasons, this substitution is not feasible, a carefully planned sand extraction operation, possibly in combination with fossil coral mining, might be carried out.

Establish one or more Marine Parks with limited staffing and budget. One suitable area for such a park is Baie de L'Arsenal, because of it proximity to the main tourist hotels.

**Ground Water Resources**

An analytical chemical laboratory should be established with a full range of capabilities for detecting the complete spectrum of agricultural/industrial chemicals currently, or likely to be, in use in the near future. It is understood that such a laboratory is being requested by the Minister of Works. Terms of reference have been prepared and should be reviewed to see if they include analysis of dyes, pesticides and heavy metals. This laboratory should be staffed with properly trained personnel.

A study should be undertaken to determine the adequacy of existing water treatment facilities for protecting the drinking water supply and the increased costs associated with improvement of water treatment plants in order to meet the drinking water standards.

Analogous to drinking water, standards should be established for irrigation water and livestock watering.

All surface waters and aquifers should be classified as to their intended use: e.g drinking, fishing, recreational, irrigation, industrial/municipal discharges. Having so classified these water bodies, norms of water quality should be established within each of the designated classifications.

**Forestry and Wildlife**

From a nature conservation point of view, it would be advisable to eradicate monkey and wild pigs. However, this is practically impossible. Consequently, in fenced-in-areas of indigenous forest, deer and wild pigs should be eradicated, and the monkey population should be reduced as much as possible in nature reserves.
Agriculture

The pesticide residue laboratory MOH should be updated and expanded so that a greater number of samples can be accommodated and analyzed.

An active research program should be initiated and/or expanded in the use of municipal and certain industrial wastewaters for irrigation purposes.

Municipal Waste Management

Industrial estates and other collective commercial units should study the possibility of combining their refuse for mutual incineration, and if attractive, a joint-refuse-fired boiler to generate process steam might be studied.

Detailed design of the National Sewage Master Plan should be prepared.

Industrial

Government should institute a policy of congregating all potentially polluting industries on industrial estate and require, as a condition of estate development, that mutual facilities to treat and dispose satisfactorily of all liquid and solid wastes be provided.

A project to supply complete infrastructure for an industrial site, to be dedicated strictly for polluting industries, should be implemented. Equipment to eliminate all industrial solids pollution problems is to be included. The project is to include a feasibility study, design and provision of equipment, and works.

Satellite laboratories for the Factory Inspectorate, and the proposed Department of Environment, should be established. The Factory Inspectorate Laboratory would ensure workplace standards are maintained, and the DOE Laboratory would support its responsibility in environmental assessments and standards review functions.

3. LONG-TERM

Marine Resources

Fisheries

Assess mortality after catches of aquarium fish and withdraw permits from exporters where mortality is excessive. Train Fisheries Department staff to accompany fish catchers on a regular basis, assess natural population and exports and set quotas and standards. Give the fish catchers exclusive rights to catch fish in certain areas. In this way, they will be encouraged to manage their resources.
Pollution

The population should be educated against throwing garbage into streams and rivers.

Explore the option of building a marina with proper sewage disposal facilities.

Energy

Initiate a dust emission monitoring program for the sugar industry and enforce emission standards on a priority basis, those mills closest to population centers receiving top priority.

Municipal Waste Management

As collection and disposal of refuse is demonstrated to be more effective, schemes for utilizing the waste (compost, electricity, process steam) should be considered.
IV. INSTITUTIONAL ISSUES:
OPTIONS FOR POLICY, INSTITUTIONAL AND LEGAL FRAMEWORK

1. Policy

Governments have generally followed two quite different approaches to the development of national environmental policy:

- Seeking to assemble a central policy by drawing together many separate pieces of sectoral legislation, statements of sector objectives and policies, etc. This is essentially an "after-the-fact", patchwork approach, and usually does not result in a comprehensive national policy.

- Developing an integrated policy as a single, comprehensive endeavor.

By far the more satisfactory approach for Mauritius will be that of developing a national policy as a comprehensive effort. The result can then provide the overall goals and guidance for development of institutional structures, legal framework, and implementing actions.

Among the principles which might be embodied in a national environmental policy and which might serve as guiding legal principles are the following:

- To assure all people living in the country the fundamental right to an environment adequate for their health and well-being.

- To achieve a balance between population and resource use which will permit economic development and improved standards of living throughout the country.

- To conserve and use the environment and natural resources of Mauritius for the benefit of both present and future generations.

- To maintain ecosystems and ecological processes essential for the functioning of the biosphere; to preserve biological diversity; and to observe the principle of optimum sustainable yield in the use of living natural resources and ecosystems.

- To reclaim damaged ecosystems where possible and reverse the degradation of natural resources.

- To establish adequate environmental protection standards and to monitor changes in and publish relevant data on environmental quality and resource use.

- To require prior environmental assessments of proposed activities which may significantly affect the environment or use of a natural resource.
To ensure that conservation is treated as an integral part of the planning and implementation of development activities.

2. Institutional Framework for Coordination

As indicated previously, there is no institutional structure to provide the needed oversight and coordination of government actions which affect environmental management and protection, and to assure that environmental concerns are integrated into the nation's economic development.

Therefore there is a need to establish such a structure at the highest level, with authority to (1) monitor and maintain oversight on the status of the government's efforts to manage Mauritius' environment, and (2) to coordinate government activities which affect the environment. This authority can be conferred by explicit legislation, and it might be reinforced through some degree of budgetary authority (as in the Environmental Action Plan for Madagascar).

The coordination function for the proposed body requires that it be located at an administrative level above that of the other components of government which it is to coordinate. Experience in other countries has shown that environmental ministries or departments cannot effectively exercise coordination or oversight over ministries or departments of an equal level. The same principle holds for policy development and oversight functions.

There are at least three options which government might select to establish this coordination function:

Option 1:

Have the NEC serve this function, with the proposed DOE serving as its secretariat.

Option 2:

Have the NEC serve this function, but provide it with separate secretariat staff and facilities.

Option 3:

Establish a new body, located in the Office of the Prime Minister, with adequate staff and authority to carry out the necessary functions. It might have several Members appointed by the Prime Minister, with executive staff. It should be complementary to the NEC which probably would be the body to whom the new organization reports and submits recommendations for policy, etc.

Government has established a ministerial level NEC chaired by the Prime Minister. While this body at present has advisory functions, it would appear to be an appropriate body to take on the coordination function
if it was provided with an adequate staff (or secretariat). Options 1 and 2 above would provide this. However, in terms of daily operations, Option 1 would place the DOE in the position of seeking to coordinate and maintain oversight over co-equal line departments, and this arrangement has not proven satisfactory in most other countries. Consequently, Option 2, using the NEC but providing it with a separate secretariat staff and facilities, would appear the more workable solution for the coordination function.

A variation on Option 1, suggested at the Technical Seminar, would be to raise the DOE to the administrative level of the Prime Minister’s Office, i.e., above the administrative level of the line departments which it is to coordinate.

3. Institutional Framework for Environmental Protection and Management

The immediately previous section dealt with the difficult institutional issue of coordination. The other major issue relating to institutional structure involves streamlining and strengthening the responsibilities and functions for environmental management and protection which presently exist in the line ministries and departments of government, and establishing new functions and responsibilities where there are gaps in the present system.

While a coordinated approach fully integrating environmental concerns and the development process is essential in promoting economic growth and environmental protection, the economic and financial concerns must not be overlooked. Consequently, the Government should ensure that these concerns are fully incorporated in an overall strategy. In this respect the Government may wish to undertake special studies to compare the costs and benefits of various options of an environmental protection policy.

Two options for institutional change were proposed in the earlier section on institutional arrangements (see Section II: Issues and Recommendations) namely: (i) streamline and strengthen in key issue areas the functions of existing institutions, with the new Department of Environment (DOE) responsible for overall coordination, review, and enforcement including those essential activities not being carried out by any institution; and (ii) consolidate priority programmes, staff and financial resources in the DOE.

The main institutional changes and functions under Option (1) are briefly described below:

**Option 1 - DOE functions**

The first major step in strengthening the institutional framework has already been taken with establishment of the NEC, with the new DOE serving as its Secretariat. As principal policy and decision making body for environment protection and natural resources management, NEC would set national goals and review and approve the following:
- A National Action Plan;
- Major changes in existing policies or proposed new policies;
- Major amendments to existing laws or proposed new laws; and
- Environmental standards.

Based on the above, the functions of DOE would be as follows:

- Formulate government goals and strategies for environmental protection and natural resources management;
- Coordinate and monitor implementation of the National Action Plan;
- Provide advice and assistance to other Ministries in modifying existing policies or developing new policies;
- Provide support in amending existing legislation and defining needs for new legislation;
- Review and/or formulate all environmental standards for NEC consideration.

In Section II (Issues and Recommendations), a series of functions not being carried out by other Ministries were identified. It is recommended that the DOE should be assigned the responsibilities for these four functions, namely:

- Evaluate environmental implications of major economic and sectoral policies;
- Identity and evaluate options for pollution abatement and provide technical advice on pollution control practices;
- Formulate priorities and coordinate a government-wide programme of research on critical environmental and natural resource management issues;
- Prepare and publish an overall assessment of the current state of the environment and emerging trends.

Air and noise pollution are not currently being addressed by the Government. It is recommended that the DOE be assigned overall responsibility and functions for both. For practical reasons, however, compliance monitoring may be undertaken by the Factory Inspectorate in the Ministry of Labour.
Centralizing Enforcement Functions

As noted in previous sections, lack of enforcement has been a major and chronic weakness throughout the legal and institutional framework in virtually all key issue areas. To remedy the situation, it is recommended that this responsibility be assigned exclusively to the DOE. This will provide an opportunity to build up a small concentrated staff who will gradually accumulate greater experience in initiating and expediting legal proceedings against violators. Their effectiveness would in itself become a further deterrent to potential violators.

The enforcement group in DOE would be informed by the compliance monitoring offices in various ministries whenever a violation is detected. The enforcement unit would then compile all necessary evidence and initiate legal action.

In addition to these enforcement functions, the expertise in this unit could also be used to provide advice and assistance within and outside the Department of the Environment in assessing the adequacy of existing laws and in formulating amendments or new laws.

Initial DOE Structure

All of the above functions could be organized and carried out with five main units:

- Environmental assessment
- Standards formulation and review
- Enforcement
- Policy and planning
- Public information and external relations.

The main functions of each unit are briefly described below (see Annex 3 for proposed organization chart for Option 1):

Environmental Assessment

Main functions:

1. Evaluate the environmental implications of proposed projects;
2. formulate priorities and coordinate a government-wide programme of research on critical environmental and natural resource management issues;
3. Conduct ambient noise and air quality monitoring and assess environmental data from other ministries;

6/Present Government proposal calls for including all of these functions in three rather than five units.
Carrying out these functions will require close cooperation with the following Ministries: Agriculture, Fisheries (Fisheries Protection Unit) and Natural Resources (Conservator of Forests); Economic Planning and Development; Education; Energy (Central Water Authority); Finance (Development Bank of Mauritius); Health (Environmental Health Unit & Pesticides Control Board); Industry (MEDIA); Labour (Factory Inspectorate); Local Government; Tourism; Trade and Shipping; Works (National Transportation Authority and Sewerage Division); and the University of Mauritius with respect to research activities.

Standards Formulation and Review

Main functions:

1. Formulate or review all environmental standards for NEC consideration;

2. Identify and evaluate options for pollution abatement and coordinate other research and development activities;

3. Provide technical advice on pollution control practices; and

4. Prepare codes of practice.

Carrying out these functions will require close cooperation with the Ministries of Agriculture, Fisheries (Fisheries Inspection Unit) and Natural Resources (Conservator of Forests); Energy (Central Water Authority); Finance (Development Bank of Mauritius); Health Inspectorate, Environmental Health Unit); Industry; Justice; Labour (Factory Inspectorate); Local Government; Trade and Shipping; Works (Sewerage Division and National Transportation Authority).

Enforcement

Main functions:

1. Issue notification of violations;

2. Review and provide necessary evidence to appropriate authorities to initiate legal action; and

3. Provide support in amending existing legislation and preparing new legislation.

Carrying out these functions will require close cooperation with those doing the compliance monitoring in key issue areas, principally the Ministries of: Agriculture, Fisheries (Fisheries Protection Unit) and Natural Resources (Conservator of Forests); Energy (Central Water Authority); Health Inspectorate, Environmental Health Unit); Labour (Factory Inspectorate); and Works (Sewerage Division). It will also require a close working relationship with the Ministry of Justice in initiating legal proceedings against violators.
Policy and Planning

Main functions:

1. Formulate government goals and strategies for environmental protection and natural resources management;

2. Coordinate and monitor implementation of the National Action Plan; and

3. Evaluate environmental implications of other major economic and sectoral policies;

Performing these functions will require consultation and cooperation with the following Ministries; Agriculture, Fisheries and Natural Resources; Economic Planning and Development; Education; Energy (Central Water Authority); Finance (Development Bank of Mauritius); Health; Industry (MEDIA); Labour; Local Government; Tourism; Trade and Shipping and Works.

Public Information and External Relations

Main functions:

1. Develop, in cooperation with the Ministry of Information and the Ministry of Education, information material for increasing public sensitivity to environmental issues, and special environmental education and training programmes;

2. Liaise with nongovernmental, international organizations and other governments with relevant expertise and information knowledgeable in addressing problems similar to those of Mauritius; and

3. Establish and develop a reference library.

Performing these functions will require close cooperation with the Ministries of Education, External Relations, Information, Youth and Sports, as well as with the information units in the other key environmental-related ministries and the University of Mauritius.

Technical Advisers

To advise and assist in establishing the Department of the Environment, formulation of a National Environmental Policy and to conduct a comprehensive review of Mauritius legislative needs related to environment, Technical Advisers to the Minister should be appointed. Proposed terms of reference are presented in Annex 2.

National Nongovernmental Advisory Group

As environmental concerns have escalated, so have the number of complaints, principally directed to the Ministry of Housing, Lands and the Environment. With growing public awareness and concern, these complaints
could overwhelm the limited resources of the new Department. A failure to respond could lead to public frustration and dissatisfaction at the crucial formative state of the Department.

As private citizens have already participated in advisory bodies for other government policy areas, it is recommended that a National Environment Consultative Council be established with representatives from industry, universities and nongovernmental organizations. Functions of the Council would be to provide advice to the Minister of Housing, Lands and the Environment on key environmental and natural resource management issues and to carry out enquiries and report to the Minister on specific matters referred to it by the Minister.

**Strengths and Weaknesses of Option 1**

The principal advantages of Option 1 are that it minimizes institutional disruption in other Ministries. It places in the new Department of the Environment necessary functions not being performed by other Ministries and leaves existing functions within current Ministries. At the same time it increases prospects for better performance in all critical functional areas through: regular assessment monitoring, standards setting, compliance monitoring and enforcement, and extended research and development and planning activities. Success will depend on effective functioning of the NEC, the quality of staff recruited for the DOE, and close coordination with all Ministries.

The chief disadvantages of Option 1 are the complexity in achieving inter-Ministerial Coordination. If this becomes a problem then consideration may be given to further institutional changes as indicated in Option 2 below.

**Option 2**

A special problem might arise as standards are established, and regular compliance monitoring and vigorous enforcement exercised: the Minister of Housing, Lands and the Environment, under whom most of the enforcement responsibility and capacity should be centralized will inevitably be subjected to a great deal of pressure to moderate enforcement.

One way to moderate such pressure is to have the NEC as the sole body empowered to deliberate on any exception.

**Streamlining Functions in Priority Issue Areas**

The initial effort under Option 2 should concentrate on streamlining government to be responsive to issue areas identified in the Action Plan as requiring immediate attention, namely:

- Water resources management, especially water pollution;
- Coastal zone management, especially marine pollution;
Solid wastes management;
- Chemicals management, especially pesticides and dyestuffs;

Proposals for addressing these priority issues will focus on the following main functions:
- Ambient monitoring;
- Standard setting;
- Compliance monitoring;
- Enforcement of laws;
- Research and development;
- Planning.

Water Resources Management

The CWA is, under clause 20(1) of the 1971 Act, the "sole undertaker for the supply of water for domestic, commercial and industrial purposes throughout Mauritius." It is therefore recommended that CWA's functions should be expanded to make it fully accountable for all aspects of water supply, use and quality.

Consequently, CWA should have responsibility for compliance and ambient monitoring, reporting water quality for surface and underground waters, for classifying all surface waters in accordance with their designated use, and formulating water quality standards within each of the designated classifications for consideration and approval by the DOE/NEC. In the case of non-compliance, DOE's Enforcement Unit should be provided with evidence for initiating legal action by CWA.

The CWA should have full authority to conduct research in order to develop technologies to reduce or avoid water pollution (e.g. wastewater treatment and/or reuse). CWA should also provide technical advisory services to major users, particularly industry and agriculture.

CWA has authority under clause 20(d) of the Central Water Authority Act to prepare plans for the conservation, utilization, control and development of water resources; such plans should now be developed in consultation with the Policy and Planning Unit of the DOE and become an integral part of the overall Action Plan for environmental protection and natural resources management.

Coastal and Marine Environmental Management (Marine Pollution)

As noted earlier, details on the present level of coastal marine pollution are lacking. However, there are indications of actual or imminent danger to public health, and damage to lagoon and reef ecosystems, especially along the north-west coast. If remedial action is not taken, tourism may be seriously threatened.
Presently, no Ministry appears to have direct responsibility for measuring or controlling coastal pollution: The Ministry of Health has responsibility under the 1925 Public Health Act for the mainland, but no apparent powers beyond the shoreline. Under clause 9(3) of the 1980 Fisheries Act the Minister of Agriculture, Fisheries and Forestry has the right to stop or charge anyone putting "any substance likely to injure any fish" into waters within the fishing limits of Mauritius. The Minister of Housing, Lands and the Environment under, the 1895 Pas Geometriques Act and the 1954 Town and Country Planning Act, has some powers to control activities on coastal land which might cause pollution. Although discharge of wastes into lagoons from pleasure craft is apparently a major source of pollution, there is no law prohibiting this.

In addition to an earlier recommendation for improving existing sewage treatment plants whose discharge is directed into coastal waters, consideration needs to be given to more effective management and control of all activities which contribute to coastal zone water pollution and environmental degradation (e.g. diffuse sources of water pollution from septic tanks, direct discharges from restaurants and hotels, seepage from coastal dumping sites and random dumping in the coastal area).

At present, the powers and responsibilities for coastal pollution and land-based sources contributing to coast pollution are scattered throughout several Ministries and local authorities.

As this area has such a special role in the quality of life and livelihood of many Mauritians, special measures are required:

- Prepare a special Coastal Zone Management Act which at least clarifies and establishes different responsibilities of key Ministries (Agriculture, Fisheries and Natural Resources/Housing, Lands and the Environment/Works/Tourism/Local Government/Industry and local authorities);

- Prepare a Coastal Zone Action Plan and establish a special Board or possibly a Central Authority to assume responsibility for managing or coordinating implementation of the action plan;

OR

- Assign this responsibility to an existing Ministry such as the Ministry of Housing, Lands and the Environment as it already has extensive and relevant powers under the 1895 Pas Geometriques Act and the 1954 Town and Country Planning Act.

- Prepare a Marine Environmental Protection Act which sets out the framework for overall management of the marine environment, from the high water mark to 40m depth.

- Assign the responsibility for preparation of a Marine Environmental Management Plan under the above act to a newly created Marine Conservation Centre within the DOE.
In addition, immediate steps must be taken to assess the present situation and prospects regarding the extent and sources of coastal water pollution.

The proposed Marine Conservation Centre should have the responsibility for baseline and pollution monitoring of water and sediment quality in estuaries, bays and lagoons, under the proposed Marine Environmental Protection Act.

**Solid Wastes Management**

The inadequate level of domestic and industrial waste collection and disposal services on the island is visible to both native Mauritians and tourists.

Solid waste collection and disposal is at present the responsibility of local authorities. However, when citizens are confronted by a decline in any public service they rarely care about jurisdictional distinctions between Government branches and usually blame Government generally. Even when they do understand the different responsibilities, they usually expect or insist that central government respond. This appears to be the current situation.

There are three choices:

- leave primary responsibility for solid waste collection and disposal to local authorities but prepare and secure agreement on an overall plan for coordinated national system for a collection and disposal of domestic and industrial solid wastes, or

- establish a new department or authority under an appropriate Ministry with full management and operational functions for the collection and disposal of solid wastes on the entire island, or

- privatize collection and disposal services entirely or in part (for example, privatize industrial waste collection and disposal).

**Chemicals Management**

Under present institutional arrangements, pesticides are controlled by the Ministry of Health under the 1972 Pesticides Control Act, and fertilizers by the Ministry of Agriculture under the 1980 Fertilizers Control Act. Control of industrial chemicals and pharmaceuticals would apparently be carried out by the Ministry of Health under the general powers and provisions of the 1925 Public Health Act.

In addition to establishing a pesticides assay laboratory and upgrading and expanding the pesticide residue laboratory, the 1980 Fertilizers Control Act contains provisions for designating sampling officers included in the 1972 Pesticides Control Act. Therefore, the latter should be amended accordingly or merged with the Fertilizer Control Act. Responsibilities under both acts should be discharged by the Ministry of Health.
The Government should consider expanding authority and capacity in the Ministry of Health to embrace not only agricultural chemicals but all potentially harmful industrial chemicals (notably dyes) and pharmaceuticals.

National Physical Development Plan and Permits

A National Physical Development Plan will provide a basis for guiding development and effective environmental protection and natural resources management. The plan should be developed and implemented by the MHLE. However, it could not be implemented effectively under present legal and institutional arrangements because the local authorities are solely empowered to grant permits for land development under the 1954 Town and Country Act. This should be changed to empower the Government to issue permits through the Ministry of Housing, Lands and the Environment.

Procedures for reviewing and issuing permits should be streamlined. These should require applicants to complete a single questionnaire encompassing all aspects of their proposed development. It should include protection of public health, environment and natural resources, and be submitted to a single office. A National Physical Planning and Development Control Unit within the MHLE should be responsible for assessing all requests in close cooperation with other Ministries, and for submitting the requests with their recommendations to the Minister. This unit should also have responsibility to monitor compliance against all conditions specified in the permit, including those regarding protection of the environment.

Option 3

As noted earlier, there is a third but later option which could also be considered: creation of a Ministry of the Environment with full executive, operational and enforcement functions on all matters concerning environmental protection, natural resource management and physical planning and control. This would include transfer of relevant responsibilities and functions, as well as corresponding staff units, equipment and financial resources from other Ministries.

The advantage of this option is that one Minister and Ministry would have full responsibility, accountability, necessary staff and financial resources for securing environmental protection and the management of natural resources.

One of the major disadvantages under Option 3, and possibly under Option 2 as well, is that by concentrating all major responsibilities and functions in a single Ministry, other economic and sectoral Ministries may feel and act as if the protection of the environment and of natural resources is no longer their concern. As it is, policies in, for example, energy, agriculture, and industry which have the greatest positive or negative impact on the environment, need the continued cooperation and willingness of corresponding Ministries to integrate environmental considerations into planning and decision-making in their sectors. This is essential for securing effective overall environmental protection and natural resources management.
4. **Legal Framework**

Priorities set out in the proposed Action Plan and institutional changes proposed under Option 1 require amendments to existing laws and new legislation to fill significant gaps in the present legal framework.

As discussed in the earlier section on Legislative Framework, the initial step in legislative reform should be a comprehensive review of:

(1) Mauritius' needs for environment legislation; and

(2) Mauritius' existing laws which affect the environment, directly or indirectly.

Based on the results of this review the full range of legislative reforms can be identified. However, on the basis of present information, a certain number of areas for reform can be specified now, and the immediate actions and options which Government should consider are briefly set out below:

**National Environment Commission and Department of Environment**

As a first priority, establish the responsibilities and authorities of the NEC and the DOE, giving particular attention to the authority required to implement the necessary coordination functions.

**Penalties and Provisions for Non-Compliance**

Increase the penalties in nearly all legislation to a scale that would effectively deter would-be offenders, including provisions for injunctions or "cease and desist" orders, especially when there is a serious immediate or persistent threat to human life or health, or protected species. This can be done either (i) on an act by act basis, or (ii) in an omnibus "environmental penalties" act.

**Water Resources Management**

- To reflect the new role and responsibilities of the CWA as described in the previous section of this report, amend sections 20 and 21 of the 1971 Central Water Authority Act.

- In the light of the above changes, review legislated responsibilities related to water resources management of other agencies and revise or delete unnecessary overlapping or duplicating provisions in, for example, the 1925 Public Health Act, the 1946 Prevention of Malaria Act, the 1963 Rivers and Canals Act.

- Transfer to the CWA responsibility for the 1963 Rivers and Canals Act, or repeal it and amend the 1971 Central Water Authority Act as necessary.
Develop guiding principles and objectives for water resources management and incorporate them in the 1971 Central Water Authority Act or in a separate Water Act to be applied by the CWA.

Amend clause 50(1) (b) of the 1971 Central Water Authority Act concerning the Water Advisory Council to read "The Council shall consider such matters affecting the distribution and quality of water ..."

**Marine Environmental Management**

Pass a new law for Marine Environmental Management, include provisions for giving overall responsibility for management and/or coordination to a special board or authority to be called the Marine Conservation Centre within the DOE and/or to an existing Ministry such as the Ministry of Housing, Lands and the Environment. The act would provide for the development of a Marine Environmental Management Plan, and within the plan for the zoning of the marine environment for specified uses, including fishing, recreation, establishment of marine parks.

Pass a new regulation prohibiting all pleasure craft from dumping their wastes into lagoons, including appropriate penalties for violations.

**Solid Waste Management**

Pass a Solid Waste Management Act or legislation establishing, under the Minister of Local Government, a new department or authority for national collection and disposal of solid wastes, OR privatize the collection and disposal function for all, or some sectors (e.g. industrial wastes).

**Chemicals Control**

Amend the Pesticides Act of 1972 to: (i) include provisions for examining products on sale in a manner similar to Section 5-8 of the 1980 Chemical Fertilizers Control Act OR merge the two acts into a single Agricultural Chemicals Control Act under the authority of the Minister of Health; and (ii) bring the schedules into conformity with recommendations of the World Health Organization.

**National Physical Planning**

To ensure nation-wide and consistent application of approved physical planning norms, building codes and environmental standards, amend clause 7(2) of the 1954 Town and Country Planning Act to give a representative national board or authority the exclusive right to grant development permits.

**Industry Guidelines**

Adopt relevant guidelines for the textile, leather, sugar, fertilizer, poultry processing, meat processing and rendering, fish and shellfish processing, and fruit and vegetable processing industries, and also guidelines regarding dust emissions.
Perform a study to examine economic and financial incentives for industrial pollution control and establish legislation needs for enforcement of industrial discharge norms, including pretreatment requirements. The study should also include development of classification schemes for receiving waters.

The medium to long term actions for consideration by the Government are:

Water Resources Management

Adopt a surface water and aquifer classification system and specific water quality standards according to designated uses. Add as schedules to the 1971 Central Water Authority Act OR to the proposed Water Act.

Air Pollution

Establish standards and norms for air pollution emissions from stationary and mobile sources either in an amendment to the 1925 Public Health Act OR in a new Clean Air Act.

Noise Control

Establish standards and norms for noise pollution by amending the 1938 Noise Prevention Act OR by amending the 1925 Public Health Act OR in a new Noise Control Act.

Chemicals Control

As a third option to the two proposals above regarding chemicals control, Government could adopt a comprehensive Chemical Control Act covering the import, labelling, production, storage, handling, sale, and use of pesticides, fertilizers, industrial chemicals and pharmaceuticals.

International Agreements

Amend and/or extend existing legislation to conform to international agreements to which Mauritius is a signatory. For example:

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): Amend appropriate legislation regarding import to Mauritius. Establish an awareness for the implementation of CITES.

5. Nongovernmental Organizations

Nongovernmental groups with interest in environmental issues are only just emerging in Mauritius. This development and expansion should be welcomed by Government, as broad private support for environmental concerns can supplement government monitoring, planning, funding, implementation and enforcement efforts. Moreover, heightened environmental awareness among the population will, over time, reduce environmental stress through sounder individual actions. For example, it is clearly better to educate individuals not to dredge sand from lagoons than to rely on police to detect such actions and then prosecute. Broader awareness through nongovernmental groups can help strengthen this type of knowledge.
Nongovernmental groups of relevance to the environment in Mauritius are of three types: (i) overseas ecological groups working in Mauritius; (ii) local economic interest groups, such as the Hotel and Restaurant Association (AHRIM); and (iii) local environmental/wildlife groups. Overseas groups (WWF, ICBP and JWPT) have had a modest but technically effective role in Mauritius. These groups can be encouraged further to provide technical expertise to solve specific problems. They should continue to be encouraged to work in Mauritius, but greater efforts should be made to ensure that this work is more broadly integrated into ongoing programs of Mauritian organizations (both governmental and nongovernmental).

Concerning local economic interest groups, there is scope to expand their roles, recognizing of course, that their particular interest will inevitably have a specific focus. The Hotel Association, for instance, will have an interest in reduced environmental damage in areas of interest to tourists. Industrial groups will have an interest in developing laws and regulations which are environmentally sound but not financially debilitating. Local environmental/wildlife groups can be a useful vehicle to begin education of future generations of Mauritians to care for their natural heritage.

The central conclusion for government is to work collaboratively with nongovernmental organizations for environmental preservation. An antagonistic, or even passive relationship between the public and private sectors would virtually doom government’s effort to improve the environment. Nongovernmental organizations must be not just tolerated but encouraged as they will make government’s task easier.

Recommendations

(i) Actively solicit the views of economic interest groups regarding environmental pollution issues;

(ii) Include private sector individuals in the NEC;

(iii) Support environmental education, environmental wildlife clubs and youth clubs in the schools; and

(iv) Involve the private sector in defining standards and norms.
ANNEX 1

MAURITIUS

Economic Development with Environmental Management
Strategies for Mauritius

Environmental Improvements

The regulation of pollution may be achieved by direct or indirect controls. Direct controls involve legal requirements that pollution not be produced or that pollution control be implemented by the polluters. For example, industrial plants could be required to clean the pollutants before discharging their wastes. To clean up the pollution involves costs since the goods and services used for this purpose could have been employed elsewhere in the economy. The determination of the optimal level of pollution rests on a comparison of the extra benefit to society of eliminating another unit of pollution with the extra cost to society of doing so. At some point, when it costs society more than the resulting benefit, it no longer makes economic sense to eliminate the remaining pollution. Thus it is seldom in the common interest to eliminate pollution altogether and direct controls should aim to set less idealistic standards than a completely pollution-free environment, by establishing tolerance limits for pollution from industrial plants, hotels, automobiles and so on.

There are a number of practical problems with direct controls. They presuppose that the Government can determine what the economically justifiable levels of pollution are; they raise the question of what is the efficient allocation of permissible pollution among polluters; and they require some mechanism for enforcing the standards of pollution since attempts at evasion can be expected.

Indirect controls of pollution means taxing the polluting activity, either on the basis of the quantities of pollution created or when an industrial plant does not have a treatment plant. The use of taxes provides an incentive to polluters to find improved ways and means of cleaning up and it also prevents the polluters from shifting the cost to others. The disadvantages are that it is difficult to determine the benefits, enforcement is not easy and politics may get in the way.

Whether direct or indirect controls are used, the cost of legislation and enforcement of pollution standards have to be included as part of the total cost to society of reducing or eliminating pollution. An attempt has been made to summarize main parameters relating to investments, cost recovery and benefits. The qualitative presentation is shown in Annex 1A.
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</table>
TERMS OF REFERENCE

Technical Advisor - Environmental Policy and Institution

The Technical Advisor will report directly to the Minister of Housing, Lands and the Environment. His/her duties and responsibilities will include the following:

- To assist with the development of a National Environmental Policy for Mauritius;
- To advise in the setting up and staffing of the Department of Environment within the Ministry of Housing, Lands and the Environment;
- To prepare an overall ministerial strategy to implement the national policy and the environmental action plan;
- To assess training needs and to develop/recommend appropriate training programs;
- To assist the Technical Advisor on Environmental Legislation with the development of an national legislative framework for environmental protection and management; and
- To advise the Minister and the Director, Department of Environment, on environmental matters.

Qualifications

Undergraduate and some graduate work in an appropriate field or fields of environmental management and protection and natural resource management, desirably including studies in biology, ecology and chemistry.

Minimum 10 years experience in administration of large complex environmental programs, preferably in either a public sector agency or an international agency;

Demonstrated track record in environmental management and policy;

Relevant practical experience in dealing with environmental issues in development countries and preferably in tropical island ecosystems;

Fluency in French desirable but not essential;

Ability to express ideas clearly and concisely to high level government officials;

Excellent writing ability.
TERMS OF REFERENCE

Technical Advisor - Environmental Legislation

The Technical Advisor will report directly to the Minister of Housing, Lands and the Environment, and will work closely with the Technical Advisor - Environmental Policy and Institutions. His/her duties and responsibilities will include the following:

- To assist with carrying out a comprehensive review of Mauritius’ needs in environmental legislation, in the light of the new institutional arrangements adopted by the Government with respect to environmental management and protection;

- To assist with carrying out a comprehensive review of the country’s existing legislation including both legislation which explicitly concerns environmental protection and resource management, and legislation which affects environmental considerations or which leads to conflicts with environmental goals and policies;

- On the basis of the above reviews, to assist in the design of a comprehensive and cohesive national framework for environmental legislation, including preparation of proposals for combining, amending, or repealing existing laws and for the development of new legislation;

- To assist, where appropriate, with the development of the resulting pieces of legislation; and

- To assist the Minister and Director, Department of Environment, on other matters of environmental law as needed.

Qualifications

A graduate degree in law with some undergraduate and/or graduate work in environmental law.

Minimum 10 years experience in the legal profession, preferably in either a public sector agency or an international agency;

Demonstrated track record in the field of environmental law;

Relevant practical experience in drafting legislation;
Good knowledge of and preferably experience with English law;

Reading knowledge of French is essential, and fluency in French is desirable;

Ability to express ideas clearly and concisely to high level government officials.
TERMS OF REFERENCE

Technical Advisor - Environmental Scientist

The Technical Advisor will report to the Minister of Housing, Lands and the Environment. His/her primarily responsibility will be to serve as Scientific Advisor to the Director of the Department of Environment. His/her specific duties and responsibilities will include the following:

- To advise the Minister and the Director, Department of Environment, on scientific matters arising in connection with the Department and with the National Environment Commission;

- To assess the scientific needs of the Department of Environment and recommend appropriate means of obtaining the necessary expertise; and

- To cooperate with the other Technical Advisors in the provision of appropriate scientific advise.

Qualifications

A doctorate in environmental science or a directly related field of science (e.g., ecology, biology);

Minimum 8 years experience, preferably with some science advisory experience in a public sector agency or international institution;

Reading knowledge of French is essential and fluency in French is desirable;

Experience in developing countries is desirable but not essential;

Ability to express ideas clearly and concisely to government officials;

Good writing ability.
TERMS OF REFERENCE: DRINKING WATER STANDARD

Consultant

The objective of this study will be to identify drinking water standards which are appropriate within the Mauritian context. Extensive use of pesticides and dyestuff materials, both likely to contain heavy metals, threatens contamination of surface waters, and the casual industrial and agricultural practices of many enterprises in managing water resources have given rise to widespread concern over the wholesomeness of the islands' drinking water supply.

In order to establish appropriate standards under these circumstances, the consultant would be required to perform the following tasks:

- perform an extensive survey to determine as completely as possible the detailed chemical nature of all pesticides and dyestuff materials that are being used in Mauritius;

- the survey should include chemicals that are currently in use, as well as a history of chemicals used over the last ten years, since many chemicals currently excluded may be stockpiled and are actively being used until stockpiles are depleted;

- the survey should also include any solvents or carriers (e.g., organic solvents) since these, too, may influence the safety of drinking water.

- contact all manufacturers of pesticides and dyestuffs and any manufacturers associations to determine information they might have regarding acceptable levels of their products in drinking water. Information regarding likely contaminants of these materials (e.g., dioxin in 2,4 D) and levels at which they are considered harmful should also be determined.

- to the extent possible, information regarding acceptable treatment processes for removal of these contaminants from drinking water should be secured. Processes which might further enhance contaminant toxicity (e.g., chlorination) should also be considered;

- drinking water standards recommended by various other countries where heavy use of these materials is made should be reviewed to determine any pertinent information they might possess. Officials from these countries who establish these standards should be contacted to obtain any views or recommendations they might provide.
- contacts should also be made with various international organizations (WHO, ILO, FAO, etc.) involved with health, drinking water supply, and hazardous materials, to establish any guidelines, norms or recommendations they might have established or are considering.

Finally, discussions with the Ministry of Industry and any other industrial development interests in Mauritius should be conducted to learn if any new industries are being considered. The implications of these industries, in terms of the chemicals they are likely to use (e.g., leather tanneries), and possible contaminants they might add to the water supply should be assessed.

Based upon the information collected above, a comprehensive drinking water standard for Mauritius should be prepared. A detailed enumeration should be provided for those chemicals where there is a lack of data or information and a potential health threat.
 TERMS OF REFERENCE: PESTICIDE ASSAY LABORATORY

Consultant

The candidate will be required to define resources necessary for establishment of a completely functional pesticide assay laboratory. Tasks required by the consultant are to include, as a minimum, the following:

- review the list of pesticide materials historically and currently in use as prepared by the consultant study for the Mauritius drinking water standards (see separate Terms of Reference).

- meet and discuss with the Pesticide Control Board (PCB) the likely number of shipments of pesticides imported annually (types, quantities, any seasonal variations).

- determine the likely sampling schedules (number of samples, types of tests, frequency of testing).

- review the data requirements of PCB for pesticide registration;

- confer with major pesticide manufacturers and any international organizations (e.g., FAO) regarding recommended analytical procedures;

- prepare a schedule of instrumentation required to analyze the above materials for the estimated sampling schedules.

- include types of instruments and the number of each required;

- recommend manufacturers of instrumentation considering ease of operation, ease of maintenance and repair, availability of spare parts; as a minimum, include facilities for organic analysis (chromatography - HPLC, GC, GLC), heavy metal analysis and simple efficacy/potency tests.

- include, in detail, all peripheral needs: reagents, glassware and supplies.

- estimate manpower necessary to operate and maintain the facility.

- number of people and associated skills.

- review manpower and skills currently available in the government;
- **recommend appropriate training requirements and identify institutions which can or do offer these services;**

- **prepare a detailed physical design (layout) and cost estimate for all the above elements.**
ORGANIZATIONAL CHART
FOR THE
MINISTRY OF HOUSING, LANDS AND THE ENVIRONMENT
(As proposed by the Ministry, 9/88)

MINISTER

PERMANENT SECRETARY

TECHNICAL ADVISERS ON
ENVIRONMENT

DIRECTOR, ENVIRONMENT
PROTECTION DEPARTMENT
AND DEPUTY DIRECTOR

HOUSING

SURVEY DIVISION

NATIONAL PLANNING AND
DEVELOPMENT DIV.

POLICY, PLANNING AND
ASSESSMENT UNIT

STANDARD FORMULATION
AND ENFORCEMENT UNIT

ENVIRONMENTAL EDUCATION
PUBLIC INFORMATION AND
EXTERNAL RELATIONS

DEPARTMENT

Policies and planning activities.

Housing projects.

Land surveying.

Land acquisition.

Pavement improvement.

Crown land.

Land quarries.

Building sites.

Hotel projects.

Development and implementation of a national physical development plan.

Exercise development control and issuance of development permits.

Prepare detailed and outline schemes.

Planning.

Building and architectural norms.

Development monitoring.

Enforcement.

Prepare and publish an overall assessment of current state of the environment and emerging trends.

Formulate government goals and strategies for environment protection and natural resources management.

Coordinate and monitor implications of national action plan.

Evaluate environmental implications of other major economic and sectoral policies.

Evaluate environmental implications of proposed projects.

Formulate priorities and coordinate government research programmes on key issues.

Provide advice and assistance in modifying existing policies and in developing new policies.

Formulate and review all environmental standards.

Identify and evaluate options for pollution abatement and coordinate other R & D activities.

Provide technical advice on pollution control practices.

Prepare codes of practice.

Conduct ambient noise and air quality monitoring and assess environmental data from other Ministries.

Issues notifications of violations wherever applicable.

Monitor and coordinate action by other Ministries/Depts. on violations.

Review and provide when necessary evidence to appropriate authorities to initiate legal action.

Arbitrate disputes between other Ministries and alleged offenders.

Provide support in amending existing legislation and preparing new legislation.

Establish and develop a reference library.
ORGANIZATIONAL CHART
FOR THE
DEPARTMENT OF ENVIRONMENT
(As proposed by the
Ministry of Housing, Lands and the Environment
9/88)

MINISTER

PERMANENT SECRETARY

DIRECTOR ENVIRONMENT PROTECTION
DEPARTMENT AND NEC SECRETARY

DEPUTY DIRECTOR

POLICY, PLANNING
AND ASSESSMENT
UNIT
1. Divisional Environment Officer
3. Environment Officers (Scientific)
3. Technical Officers (Environment)
1. Policy and Planning Officer

STANDARD FORMULATION AND ENFORCEMENT UNIT
1. Divisional Environment Officer
1. Environment Officer (Standard)
2. Environment Officer (Enforcement)
3. Technical Officers

ENVIRONMENTAL EDUCATION, PUBLIC INFORMATION AND EXTERNAL RELATIONS
Administrative Officer and Administrative Staff

2 Higher Executive Officers
3 Executive Officers
3 Clerical Officers
3 Typists
2 Confidential Assistants
3 Office Attendants

ADMINISTRATIVE STAFF
PROPOSED ORGANIZATIONAL CHART
FOR THE
NATIONAL ENVIRONMENT COMMISSION
AND THE
DEPARTMENT OF ENVIRONMENT

LEADERSHIP

PRIME MINISTER

NATIONAL ENVIRONMENT COMMISSION

SECRETARY

OTHER MINISTERS

MINISTER OF HOUSING, LANDS & THE ENVIRONMENT

DEPARTMENT OF ENVIRONMENT

DIRECTOR
# MAURITIUS

**TECHNICAL SEMINAR ON ENVIRONMENTAL DEVELOPMENT PROGRAM**  
(SEPTEMBER 12 - 15, 1988)

## LIST OF PARTICIPANTS

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<thead>
<tr>
<th>NAME</th>
<th>OCCUPATION</th>
<th>ORGANIZATION</th>
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<tbody>
<tr>
<td>Mr. Antoine, R.</td>
<td>Chairman</td>
<td>Mauritius Food &amp; Agricultural Research Council</td>
</tr>
<tr>
<td>Mr. Abdool, I.</td>
<td>Chief, Health Inspector</td>
<td>Ministry of Health</td>
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<tr>
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<td>Economist</td>
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<td>Mr. Allybokus, M.</td>
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<tr>
<td>Mr. Appadu, T.</td>
<td>Administrative Officer</td>
<td>Prime Minister's Office</td>
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<tr>
<td>Mr. Awotar, R.</td>
<td>Chairman</td>
<td>Mauritius Council for Development Environmental Studies Conservation (MAUDESCO)</td>
</tr>
<tr>
<td>Mr. Aubeeluck, K.V.</td>
<td>Officer-in-Charge</td>
<td>Development Works Corporation</td>
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<tr>
<td>Mr. Aubeeluck, P.</td>
<td>Principal Industrial Dev.</td>
<td>Ministry of Industry</td>
</tr>
<tr>
<td>Mrs. Bertilsson, I.</td>
<td>Environmental Coordinator</td>
<td>African Development Bank</td>
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<tr>
<td>Mr. Boodhun, M.</td>
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<tr>
<td>Mr. Bott, A.N.W.</td>
<td>Consulting Engr.</td>
<td>U.K. Private Consultant</td>
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<tr>
<td>Mr. Beardmore, R.</td>
<td>Urban Planner</td>
<td>World Bank</td>
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<tr>
<td>Dr. Bissoonauth, H.</td>
<td>Principal Medical Officer</td>
<td>Ministry of Health</td>
</tr>
<tr>
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<tr>
<td>Dr. Beye, I.</td>
<td>Programme Coordinator</td>
<td>International Environment Liaison Centre</td>
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<tr>
<td>Dr. Boodhoo, I.</td>
<td>Medical Practitioner</td>
<td>Ministry of Health</td>
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<tr>
<td>Mr. Balgobin, I.</td>
<td>Ag. Secretary/Manager</td>
<td>National Federation of Young Farmers Club</td>
</tr>
<tr>
<td>Ms. Banymandhub, K.</td>
<td>Treasurer</td>
<td>Mauritius Alliance of Women</td>
</tr>
<tr>
<td>Mr. Bhoojedur, S.</td>
<td>Professor</td>
<td>University of Mauritius</td>
</tr>
<tr>
<td>Mr. Bhuckory, K.C.</td>
<td>Chairman/Deputy General Manager</td>
<td>Fleurir Maurice Committee/ Mauritius Government Tourist Office</td>
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<tr>
<td>Mr. Brown, J. C.</td>
<td>Chief, Infrastructure Division</td>
<td>World Bank</td>
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<tr>
<td>Mr. Baratz, B.</td>
<td>Chemical Engr.</td>
<td>World Bank</td>
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<tr>
<td>Mrs. Boolell, H.</td>
<td>Sr. Economist</td>
<td>Ministry of Local Government</td>
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<tr>
<td>Mr. Burn, R.</td>
<td>Statistician</td>
<td>Mauritius Sugar Authority</td>
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<tr>
<td>Mr. Bholah, S.</td>
<td>Social Worker</td>
<td>SPACE</td>
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<tr>
<td>Mr. Boyramboli, B.</td>
<td>Administrative Officer</td>
<td>Ministry of Agriculture, Fisheries &amp; Natural Resources</td>
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<tr>
<td>Mrs. Burn, N.</td>
<td>Lecturer</td>
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<tr>
<td>Dr. Bissoonaath, O.</td>
<td>Agronomist</td>
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<tr>
<td>Mr. Beeharry, T.</td>
<td>Biochemist</td>
<td>Central Water Authority</td>
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<tr>
<td>Mr. Bundhoo, J.</td>
<td>Information Scientist</td>
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<tr>
<td>Dr. Dalal-Clayton</td>
<td>Environmental</td>
<td>U.K. (representing ODA)</td>
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<tr>
<td>Mr. Christoffersen, L.E.</td>
<td>Chief, Environment Div.</td>
<td>World Bank</td>
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<tr>
<td>Brother Carosin, R.</td>
<td>Chairman</td>
<td>Comite pour la Protection de l'Environment</td>
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<tr>
<td>Mr. Casse, B.</td>
<td>Engineer</td>
<td>Lions Clubs of Curepipe</td>
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<tr>
<td>Mr. Cowreea, O.</td>
<td>Attorney’s Clerk</td>
<td>CEDREFI</td>
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<tr>
<td>Mr. Chatoory, M.</td>
<td>Sr. Housing Officer</td>
<td>Central Housing Authority</td>
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<tr>
<td>Mr. Choolun, R.</td>
<td>Biochemist</td>
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<tr>
<td>Mr. Cattin, G.</td>
<td>Engineer</td>
<td>Caisse Centrale de Cooperation Economique</td>
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<tr>
<td>Mr. Chellum, J.</td>
<td>Secretary</td>
<td>L’Association des Consommateurs de l’Ile Maurice (ACIM)</td>
</tr>
<tr>
<td>Mr. Dabee, B.</td>
<td>Journalist/Animateur</td>
<td>Indian Ocean Islands Friendship Society-Amicale des Iles</td>
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<tr>
<td>Mr. Dhoorundhur, M.</td>
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<tr>
<td>Mr. Dulloo, M.E.</td>
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<tr>
<td>Mr. Dossa, M.I.</td>
<td>Second Secretary</td>
<td>Ministry of External Affairs &amp; Emigration</td>
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<tr>
<td>Mr. Domun, R.</td>
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<td>Ministry of Industry</td>
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<tr>
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<td>Mr. De Rham, P.</td>
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<tr>
<td>Mr. Dabholkar, U.</td>
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<tr>
<td>Mr. Doorga, D.</td>
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<tr>
<td>Mr. Eigen, J.</td>
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<td>Mr. Facknath, S.</td>
<td>Lecturer (Joint Coordinator for Env. Studies)</td>
<td>Mauritius</td>
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<tr>
<td>Ms. Forget, A.</td>
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<tr>
<td>Mr. Fagoonee, I.</td>
<td>Adviser</td>
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<tr>
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<tr>
<td>Mr. Gopaul, A.K.</td>
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<td>Mr. Gangapersad, D.</td>
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<td>Mr. Hare, C.</td>
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<tr>
<td>Mr. Hartley, J.</td>
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<td>Mr. Hemoo, R.</td>
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<td>Mr. James, I.</td>
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<td>Mr. Jhamna, B.</td>
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<td>N.E.C.</td>
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<td>Mr. Jogoo, V.</td>
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<tr>
<td>Mr. Khemraz, G.</td>
<td>Sr. Economist</td>
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<td>Mr. Kawol, B.</td>
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<tr>
<td>Ms. Koo Lam Tseung, K.</td>
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<td>Ministry of Housing, Lands &amp; the Environment</td>
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<tr>
<td>Mr. Kleiner, K.</td>
<td>Sr. Municipal Engineer</td>
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<td>Ms. Kiss, A.</td>
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<tr>
<td>Mr. Kallee, F.</td>
<td>Tech. Officer</td>
<td>Ministry of Agriculture, Fisheries &amp; Natural Resources</td>
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<tr>
<td>Mr. Loudiere, D.</td>
<td>Engineer</td>
<td>France</td>
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<tr>
<td>Mr. Lam Thion Mine L.C.</td>
<td>Div. Scientific Officer</td>
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<tr>
<td>Dr. Luthmeah, R.J.</td>
<td>Lecturer</td>
<td>University of Mauritius</td>
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<tr>
<td>Ms. Lan Hing Ting, D.</td>
<td>Scientific Officer</td>
<td>Ministry of Housing, Lands &amp; the Environment</td>
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<tr>
<td>Mr. La Hausse de la Louviere, P.</td>
<td>Aquatic Ecologist</td>
<td>Mauritius Marine Conservation Society</td>
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<tr>
<td>Mr. Leger, F.</td>
<td>Conseiller aux Investissements</td>
<td>Ministere de la Cooperation et du Developpement (France)</td>
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<tr>
<td>Mr. L'Heureux, P.R.</td>
<td>Ingenieur</td>
<td>Ministere de l'Environnement (Quebec)</td>
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<tr>
<td>Mr. Lutchmun, V.</td>
<td>Draughtsmen</td>
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<tr>
<td>Mr. Laulloo, R.</td>
<td>Prin. Engineer</td>
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<tr>
<td>Ms. Larcher, N.</td>
<td>Teacher</td>
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<tr>
<td>Mr. Leong Son, G.R.</td>
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<td>Pamplemousses/Riviere du Rempart District Council</td>
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<td>Secretary</td>
<td>Town &amp; Country Planning Board</td>
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<tr>
<td>Mr. Lan Pin Wing, M.</td>
<td>Industrial Dev. Officer</td>
<td>Ministry of Industry</td>
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