APPENDIX VIII

Comments and Discussions Concerning Wastewater Treatment System Environmental Factors and Performance Projections

PREPARED BY:

SOA, Inc., September 1993

TABLE OF CONTENTS

LIST OF TABLES

I. INTRODUCTION

Sentar Consultants, Ltd. has completed a master sewerage treatment and disposal program as part of the Kingston Harbor Environmental Project prepared for the National Water Commision, Jamaica, West Indies.

The flow West scheme is selected as the most appropriate wastewater management alternative for the Kingston metropolitan area including sections of the Portmore development. The ponding wastewater treatment technology is the system of choice because this method is a low cost, low maintenance, high reliability system with minimum mechanical equipment. The site for this technology is located south of the railway between Sandy Gully and the Rio Cobre River adjacent to Hunts Bay. This area is considered marginal for housing and other development and unsuitable for agricultural development.

II. TREATMENT SYSTEM

The objectives of wastewater treatment are to prepare collected wastewater for disposal under hygienic and aesthetic conditions with minimum adverse effect on public health and the environment.

Important in measurement of the ability of proposed wastewater treatment methods to attain these objectives, is the application of certain basic criteria. Among the most critical of these criteria are cost, effectiveness, reliability, flexibility, and environmental impact. The general criteria for wastewater systems is shown in Table I.

A. Costs

The costs of candidate systems for waste treatment are influenced by system size, the degree of treatment required to meet discharge requirements, the method used to attain the desired degree of treatment, the effectiveness of the method and the life span over which a system maintains its effectiveness.

Degrees of treatment required can range from simple screening and flotation to removing unsightly floatables, to primary treatment to remove settleable and floatable solids, secondary treatment to remove dissolved organics, tertiary treatment to remove plant nutrients, quaternary treatment to remove refractory organics, and finally, quintiary treatment to remove dissolved salts. Disinfection may be achieved during such treatment or, if needed, applied at some point in the process to meet bacteriological requirements.

If the cost of primary treatment is unitized, each subsequent degree of treatment can double costs. Thus, removal of salts may cost 16 times as much as primary treatment. Costs can generally be broken down into two major areas; plant or system cost, and the cost of operation and maintenance of the plant or system.

TABLE I

GENERAL CRITERIA FOR WASTEWATER TREATMENT SYSTEMS FOR KINGSTON, JAMAICA

FACTORS INFLUENCING COST	FACTORS INFLUENCING EFFECTIVENESS	FACTORS INFLUENCING RELIABILITY
System Size	Discharge Standards	Process Design
System Design - process - materials - equipment - controls	Waste Strength - organic loads - solids loads	Redundancy
Land Required	Waste Consistency	Fail-Safe
Sludge Production	Presence of - toxics - industrial wastes - bacteria - virus - frions - ova & cysts - inorganic salts - plant nutrients	Number of Mechanical Parts
Complexity		Equipment - complexity - life expectancy
Redundancy		Operator Skill
Useful Lifespan		
Energy Requirements		
Manpower		
Construction Time		

System cost is impacted by the type of system, i.e., degree of treatment, system size, the material from which the system is constructed, the complexity of the system, the redundancy provided in the system, and the useful life of the system. Also important are engineering costs and construction time, which are particularly influenced by the complexity of the system itself.

Contribution to operational costs include manpower and energy for transferring fluids (pumping and conveyance), for aeration, oxygenation and for sludge collection and handling. Laboratory facilities and sensing and control equipment may also be needed. Materials such as chlorine for disinfection and odor control, and lubricants for equipment contribute importantly for operational costs when used.

Manpower for maintenance of equipment is also a significant cost item. All mechanical units require frequent lubrication and replacement or repair when worn or broken. For example, it is rare that pumping equipment can extend for more than 5 years without repair or replacement. Sensing and control equipment must be maintained and tested frequently to assure that accurate measurements and read-outs are provided. Analytical laboratory equipment must also be operated and maintained. Administration, record maintenance and communications add further to costs.

B. Effectiveness

By definition, an effective system is one which satisfactorily performs all of the functions for which it was designed. The implication here is that all subsystems are performing up to specifications.

The competence and concern of operational and administrative staff impact importantly on this aspect of waste treatment, since a carelessly or improperly operated system is not likely to be effective.

C. Reliability

Reliability transcends effectiveness in that it implies not only specified performance, but also system dependability. A dependable system contains assurance against breakdown or failures throughout the life of the project. Generally speaking, the more complex a system, the more likely it is to be dependant on component reliability. Since all mechanical components have a relatively short and unpredictable life expectancy, a designer usually must resort to redundancy (parallel systems) to achieve reliability. Redundancy, however, adds to cost, and hence can be justified only in the most crucial applications - for example, multiple pumps and standby power in pumping stations to avoid destruction of equipment due to flooding of the station during heavy rains and/or malfunctions. Accordingly, the criterion of reliability is adversely effected by the number of mechanical elements in a system.

D. Flexibility

An important evaluation factor is maintaining the operational and expansion flexibility to respond to future conditions which could include substantial increases in hydraulic and biological loading rates. All the alternatives considered will produce an effluent that will meet existing standards. However, it is expected that an integrated pond system will consistency produce as high or higher effluent quality than the other alternatives considered. This results from a reliance on natural systems to perform the necessary biological functions without the need for mechanical means for maintenance of continued and sustained effective treatment. The system is extremely flexible and may be modified to accept a much larger loading without increasing the size of the system. All alternatives are natural systems, but others must supplement conditions by the use of a variety of mechanical equipment. This equipment is costly, energy-intensive, subject to periodic failures, relatively difficult to operate, unreliable and lacks fail-safe operational features. The greater the degree of complexity and intensiveness, the greater skill required to maintain continued, trouble-free operation.

Any Wastewater Management System that is adopted must include facilities which will ensure the present and future operation of the system. All the viable alternatives represent proven processes which have been demonstrated in many other installations.

E. Environmental Impact of No Wastewater Treatment

The factors in liquid organic waste that may have an adverse impact on the environment are odors, corrosive gases, unsightly floatable and settleable solids, oxygen-demanding suspended organic matter, disease causing microorganisms, plant nutrients, refractory organics and salts. Inspection of several areas within the Study Area indicate several materials clearly of sewage origin including; foam, floatables, rubber and plastic goods and darkened sand. Darkened sand indicates that, during low-flow periods, the river may be black from formation of metal sulfides due to lack of dissolved oxygen and/or from deposited sludges. This indicates that at low flow conditions, oxygen resources are overwhelmed and depleted. Although not easily observable, it is still likely that settleable solids and inert solids (grit) from the sewage settle into low places during low flows and undergo microbial decomposition, further diminishing the oxygen resources of the river. For this reason, the classical "Streeter-Phelps Oxygen Sag Curve Analyses" does not fully predict the extent of environmental decline. The presence of these settled solids also leads to air pollution from hydrogen sulfide and other gases.

The environmental impact then, during low flow conditions, includes air pollution, unsightly residues on rocks and sand, oxygen-demanding liquids and sludges, floatable items and foams of obvious sewage origin. Under these conditions, downstream use of this water by either humans, livestock or wildlife is extremely hazardous. It is no doubt lethal to stream organisms such as fish and bottom-dwelling invertebrates. Aquatic plants are also stressed under degraded conditions.

F. Discharge Requirements

Because major environmental impacts cited above are caused by floatable and settleable solids, BOD, foams, odors and unsightly black water, the process applied in waste treatment should be one that deals with these factors in economical and hygienic fashion - that is, the process should remove floatable and settleable solids, including parasite ova, foams, and destroy sufficient dissolved organic matter to prevent serious oxygen depletion in the surface waters. Because there always appears to be some flow, plant nutrients, soluble refractory compounds, microalgae and salts will be carried away. Proposed effluent standards are BOD_5, 40 mg/l; suspended solids, 50 mg/l and MPN 1,000/100 ml of fecal coliform bacteria; and variations from the mean as shown in Table II.

G. Degree of Treatment Desired

Treatment should be provided to remove all floatable and foam forming materials, all parasite ova and at least 80 percent of the BOD and suspended solids in order to meet the above requirements. Although disinfection is not currently required, there will be a significant disinfection in company with removal of settleable solids and BOD to meet requirements. Complete mixed primary systems such as oxidation ditches should be avoided, since they will transmit parasitic ova from influent to effluent. The system must be designed to prevent short circuiting and to avoid anoxic surface conditions.

H. Disposal

The disposal of treated wastewater to the Rio Cobre and/or Hunts Bay will provide sufficient water to carry diluted and fine suspended matter with insignificant environmental impact. There is a possibility that there will be some current downstream use of effluent or river water for irrigation purposes, so the treatment process selected should provide the necessary effluent downstream protection.

III. POND SYSTEM TREATMENT TECHNOLOGIES

A. Introduction

Communities must explore all possibilities to select the most efficient and cost effective wastewater treatment process for prevailing conditions and environment. Conventional mechanical treatment and disposal has become more costly due to increased effluent limitations and awareness of environmental consequences, and is not deemed feasible for emerging areas.

Physical, biological and chemical processes are combined to formulate wastewater treatment systems. Initial assessment of processes has concluded that a strictly physical-chemical treatment process is not appropriate for Kingston, Jamaica. Some form of biological

TABLE II

CONSIDERED WASTEWATER DISCHARGE REQUIREMENTS[2]

CONSTITUENT	UNIT	30-DAY Average	30-DAY Medium	7-DAY AVERAGE	DAILY MAXIMUM
BOD_5[1]	mg/l	40		60	80
Total Suspended Matter	mg/l	50		75	100
Total Fecal Coliform[2]	MPN/100ml		1000		5000

1 5 day Biochemical Oxygen Demand (BOD_5)

2 WHO European and USA standards

treatment process will be required to meet stated goals. A number of criteria are described for evaluation and comparison of the various biological treatment processes which could be applicable for the Study Area. These are included in Table II.

Primary sedimentation is most efficient in removing course solids, whereas biological processes are typically employed for removal of organic substances that are soluble or in the colloidal size range. Most biological waste treatment systems involve the application of either suspended or fixed microbial cultures for organic waste stabilization.

Conventional Bacterial processes were originally designed in the colder climates of Europe and the Northeastern United States,where ponding systems have been developed to take advantage of naturally-occurring pollutant removal. This is not really effective in these climate zones. Effective treatment is more natural in temperate and tropical climates.

The various types of ponds include anaerobic, facultative, advanced hybrid facultative, high rate, aeration or oxidation and maturation. Strictly anaerobic ponds are usually odorous, emit noxious gases, and are not recommended as an uncombined treatment method. Facultative high rate and maturation ponds, although extremely energy-saving, do require large areas of land. Thus, a decision to use such systems must involve a trade-off analysis of construction, maintenance and energy cost vs land cost.

B. Advanced Integrated Ponding System

Advanced Integrated Ponding Systems (AIPS) in their most effective, reliable and economical form consist of a series of at least four ponds, each designed to most effectively perform one or more of the basic treatment processes.

1. Facultative Pond

The Facultative Pond, with an aerobic surface and extremely anoxic internal cells for sedimentation and fermentation, is the first in the series. In this type of system, raw or screened wastewater is introduced directly to the bottom of a relatively deep internal cell or cells within a primary facultative-type pond, where settleable water is digested anaerobically. The overflow velocity in the cell is maintained at an extremely low rate such that suspended solids and BOD_5 removal efficiency approach 100 and 70 percent respectively. Upflow velocities of 3-7 feet per day are less than the settling velocities of helminth ova and parasite cysts. Consequently, most of these organisms remain in the cells and are permanently removed from the effluent. Due to the large cell volume and reducing environment, settled solids in the anoxic cells ferment to the extent that virtually only ash remains. Hence, sludge removal is seldom required. Since it isolates most odorous activity, the cell also tends to minimize odors sometimes emanating from the upwind side of conventional ponds, due to upswelling of anoxic bottom waters during storms.

Treatment of more soluble waste continues in the upper, aerobic zone of the primary pond, where oxygen is provided by algal growth or by supplemental mechanical aerators. Thus, two necessary but normally incompatible biological waste treatment processes can be designed to take place in the same earthwork reactor.

2. High Rate Pond

The second pond in the AIPS system, typically called a High Rate Pond, is designed as an endless shallow raceway. Wastewater is circulated in this raceway using a paddle wheel or pumps. A High Rate Pond is designed to generate oxygen by algae production. In this pond, abundant microalgal growth released oxygen from the water by photosynthesis; over 200 pounds of oxygen per acre per day may be released. This oxygen is immediately available to bacterial organisms (aerobic sludge) retained in the raceway. These organisms oxidize a major fraction of the soluble and biodegradable BOD_5 remaining in the effluent from the facultative pond.

Recirculation of the oxygenated water, from the secondary pond (High Rate Pond) to the surface of the Facultative Pond, provides an oxygen-rich overlay on the Facultative Pond. This is the first option to natural reaeration through surface layers. This oxygen quickly acts to oxidize reduced gases emerging from the fermentation cell, and thus to mitigate possible migrating odors. Algae in the recycled waste tend to absorb heavy metals that may be present in the incoming waste. These algae tend to settle in the facultative pond. A significant fraction of any influent heavy metals thus can be removed from the facultative pond effluent. The anoxic pits in the Facultative Pond also tend to retain metallic sulfides. Since most of the metals tend to be removed in the Primary Pond, algae in the second pond tend to be low in absorbed metals.

3. Settling Ponds

Dual settling ponds follow the High Rate Pond in the series. Settling ponds are designed to provide for sedimentation of algae present in the effluent of the High Rate Pond. The gentle natural flow in the High Rate Pond environment tends to preferentially select for algae that are settleable when not in a gentle mixing field. Algae which settle tend to hibernate, and thus do not immediately decompose and produce odors. Because parasite ova are retained in the fermentation pits, there is little risk of parasite transmission by this route. A primary digester in the front end of the secondary pond includes an anaerobic environment which tends to increase denitrification by reducing the nitrate present.

4. Maturation Pond

Effluent from the settling ponds are sufficiently low in BOD_5 and suspended solids to percolate readily into the ground or be used for irrigation purposes. However, this effluent will occasionally contain an MPN greater than 1,000 fecal per 100 ml, and hence will require additional storage prior to use. The final pond in the AIPS series, often referred to as a Maturation Pond, has the dual purpose of providing added disinfection and storage for irrigation or other reuse.

C. Advantages

Among the major advantages of pond systems are low construction costs resulting from minimization of the use of reinforced concrete structures by using formed earth, shorter design and construction time, and a significant reduction in the use of expensive mechanical equipment.

Low operation and maintenance costs result from the elimination of daily sludge handling and separate sludge digestion, decreased energy and manpower requirements, and minimal spare equipment and parts inventories. By virtue of the tremendous volume of dilution water available in the ponds and consequent buffer capacity, ponding systems are much less sensitive to biological and/or hydraulic upset from shock loading. A properly designed and operated pond system will produce no objectionable odors.

D. Disadvantages

Two of the disadvantages associated with ponding systems are relatively large areas of land required and the carry-over of algal suspended solids in the effluent. Modern pond system design minimizes these drawbacks by providing polishing (maturation) pond capacity for algae settling and permitting almost full salvage value for land reclaimed after the service life of the system has elapsed.

E. Design Considerations

Design of ponding systems have taken a number of forms over the years. Facultative, oxidation and completely mixed ponds are the more common forms encountered and described in numerous publications. In many instances ponding system have received poor publicity because of the unreliability of treatment, odor emissions, sludge accumulations and other nuisance factors.

Malfunctions occur as a result of temperature stratifications wave and/or turbulence factors, lack of complete mixing, overloading, incomplete oxidation, short circuiting etc. These malfunctions usually result in significant odor emissions and incomplete treatment.

Significant research and applied research has been completed over the years to evaluate system functions, performance and elements responsible for these problems encountered in the past. This effort has resulted in improved elements designed to optimize the microbiological activities to effectively complete the treatment of various waste streams. These improvements incorporate the two principle biological activities involved in all biological waste treatment systems in a single reactor. Normally they are maintained in separate systems because of total incompatibility. One is unable to survive in the atmosphere fostering the second microbiological group and vice-versa. In order to create a system to contain both biological group within the same reactor, the regime of each must be scrupulously maintained, without intrusions from the opposite group. This is accomplished by design.

Digesters or facultative fermentation pits are designed at the inlet end of the pond to depth. The design is such that this pit or jets are separated from the remainder of the pond by internal berms. Surface water is common to both regions of the pond. The geometry, size and location of these pits are carefully calculated to ensure isolation from the remainder of the pond and maintenance of the aerobic zone upward. Inlet velocities are maintained at a rate lower than settling velocities of parasitic eggs and other forms of introduced microorganisms. This ensures retention within a specific pit and ultimate destruction. Many particles that would normally float undergo sufficient compression, because of the depth of the pits, such that the density of these particles becomes greater than that of water, thus they tend to remain at the bottom.

A sludge blanket phenomena occurs in these sites as a consequence of the fermentation stage. Gas bubbles form and are attached to particles which accumulate and act to reduce densities. As these particles rise pressures decrease and the bubbles increase in size. Finally these bubbles detach and rise to the surface, the solids are released and resettle creating the blanket effect. All newly introduced flow wont pass through this blanket effectively entraining additional solids.

The inlet is at the bottom of each pit to allow settling of the suspended solids which then undergo anaerobic fermentation. The pit design allows for the accumulation of inorganic solids over a minimum 20 year period. This provides an almost infinite detention time for organic solids decomposition. Even the most difficult organics may undergo this decomposition over this prolonged time period. Thus daily sludge handling is eliminated.

This anaerobic zone effectively allows for the effective denitrification of all the organic nitrogen plus the volatization of a fraction of the ammonia present. Heavy metals are removed as a result of the reduced salts formed. These salts are insoluble and settle.

The flow progresses to the pond surface through the anaerobic section. The initial anaerobic zone effectively removes up to 60% of the total BOD entering the system. This greatly reduces the BOD surface loading on the remainder of the pond.

Oxidation takes place in the remainder of the pond. The oxidation of soluble organics are extracted by aerobic forms of microorganisms to create additional cell mass. This effectively creates additional solids. In some instances secondary digesters are placed at the effluent end of this initial pond to allow these solids to settle. Digestions of these settled solids take place in these secondary digesters.

Other designs include primary digesters in the influent end of the second pond. The advantage of this design is to provide a further settling area for digestions and added denitrification. The flow from pond one is introduced to the bottom of the digesters in the second pond in the same manner as introduced in pond one.

The initial pond may rely on surface reaeration alone for maintaining oxygenated conditions. Recirculation of flow from pond two to pond one will add to the oxygenation reliability of the surface of pond one. Surface aerators in pond one will assure complete oxygenation condition reliability. These aerators are normally of the aspirated type to provide surface mixing as well as oxygenated conditions. However, in the design for Kingston, Jamaica the use of mechanical equipment is minimized.

The complete system normally consists of four ponds in series to minimize short-circuiting and maintain the degree of coliform concentration required. The design of second and third ponds are maintained at a minimum depth of three meters and preferably to four meters. Some publications have suggested two meters or less.

The construction of shallow ponds in tropical climates are not recommended and this practice has been discontinued in recent designs. It is our experience that such ponds can become quickly hyperentrophic.

The deeper ponds reduce area requirements for similar detention times which tends to reduce costs and are more economical on cost per unit volume and process effecting basis. The deeper ponds are not subject to overturn by wind and wave action and prove more stable over the life of the system. The shallower pond criteria can still be found in some text books but these designs lack sophistication and should be abandoned in favor of the more efficient state of the art designs.

The system as proposed results in an extremely compact facility using all available biological means for treatment purposes. Daily sludge handling is eliminated while maintaining a high level of treatment. The effluent water quality discharge in a well operated system is generally somewhere between secondary and tertiary. Relatively high concentrations of nitrogen, phosphorus and heavy metals are removed in the process. There is evidence that many halogenated hydrocarbons and pesticides are rendered innocuous in the process.

F. Expected Removal of Nitrogen, Phosphorus and Coliform

1. Projected removal rates for various parameters

From past performances of existing AIPS, raw wastewater can be reduced to several important characteristics as follows:

*	Biological Oxygen Demand	90-97%
*	Chemical Oxygen Demand	90-95%
*	Total Nitrogens	80-90%
*	Total Phosphorus	55-60%
*	E. Coliform Bacteria	99.99%

2. Nitrogen

An eighty percent removal rate is expected through the AIPS treatment system. Removals are in the form of denitrification of organic nitrogen and volatization of ammonia, and extraction by algae to form additional algal mass (cells). Ammonium and nitrate are removed by incorporation into cells to the extent of 8-10% of the dry weight of the cells. The removal rates are as follows:

a.	Denitrification of organic nitrogen and volatization of a fraction of ammonia	35%
b.	Extraction by algae cells	45%
	Total	**80%**

It is expected that 7-10 mg/l of nitrogen will be discharged from the system; 1-2 mg/l in solution and the remainder in the form of algae assuming an average initial total nitrogen concentration.

3. Phosphorus

Approximately fifty percent of the phosphorus will be removed depending on the initial concentration. Although at higher pH's, calcium phosphate will precipitate in wastewater high in calcium. This percentage will be incorporated into algal mass, most of which will be retained within the treatment system. Orthophosphate is the only known form of phosphorous available to algae. Phosphorous comprises only 1-2% of the dry weight of an algal cell. It can be expected that no more than 50% of the original concentration will be discharged.

4. Coliforms

Natural bacterial die-off in the wastewater ponds during hold-over for treatment will greatly reduce concentrations to acceptable levels for disposal to Hunts Bay without disinfection. Effluent from the wastewater treatment plant can be applied on land, where available, and any remaining treated water may be discharged to local wetlands and/or to the Bay. Effluent quality will meet acceptable standards for land application, wetland use and marine water discharge. In addition, helminth ova and parasitic nematodes do not survive the reductive environment of the deep digester or the upward filtering through the heavy sludge blanket.

It is doubtful that eggs and larvae from schistosome can survive the harsh environment of the pit digesters and sludge blankets or the prolonged detentions in the pond system. The transitional stages of schistosome are time dependant to maintain infective potential. Long hydraulic retention times in AIPS reduce schistosome viability. Moreover, the environment of wastewater ponds is not hospitable to the carrier snails. These snails are confined to unique ecological enclaves found mainly in the shade of vegetation along the banks of fresh water bodies and flowing streams. Ponds of wastewater that are cleared of vegetation on banks are not conducive to snail habitation.

AIPS is designed to a standard of 1,000 fecal coliforms/100 ml which is the WHO-European standard for water contact sports. The four pond series is designed to prevent short-circuiting. A detention period of 20 days coupled with short-circuiting prevention is expected to ensure the fecal limit.

5. Heavy Metals

Studies have also shown that AIPS can reduce heavy metal concentrations in the deep anaerobic digesters. Heavy metals form reduced salts in this anaerobic atmosphere and thus precipitate to form part of the inorganic deposits. Subsequently in the aerobic ponds, adsorption/absorption by algal cells and their removal by settling can further reduce heavy metal concentrations in the effluent.

IV. DESIGN CONSIDERATIONS - KINGSTON, JAMAICA

Local climate, environmental factors and the general economy of any specific area all may have significant impact on the design of infrastructure, in this case as it specifically relates to wastewater treatment and disposal facilities.

Climate factors have an effect on loading rates, detention times, removal rates, coliform residual and ultimate size of the system. The temperature in the vicinity of Kingston and Hunts Bay ranges from a January average of 24°C to a July average of 27°C with an annual average of 25°C. This moderately high average annual temperature coupled with abundant sunlight and relatively low rainfall are elements conducive to a more effective and efficient design. System size is reduced and reliability enhanced because of the reduced fluctuation in these climatic factors and maintenance of steady state conditions.

This is an area subject to periodic high winds and occasionally of hurricane force to 100 mph or greater. Thus consideration for wave generation within the ponding system is important. Freeboards of 1.3-1.5 meters should be included in the design of the larger facultative ponds. This freeboard allowance serves to reduce the potential for over-topping of the levees during major storms.

It is the intent that mechanical equipment will be reduced to a minimum. Mechanical aeration and pond recirculation is not included as part of the initial design. Winds are generally from the South Southeast at a constant rate of 10-20 miles per hour every afternoon. The reliability and steady state wind factor can be utilized as a component in pond surface reaeration and mixing. Efforts will be made to utilize this wind power for surface mechanical aeration where practical.

The facultative ponds will include primary digesters designed for the total volume of the influent flow including suspended solids. All suspended solids will be deposited within the digesters on entering the system. Two additional septage digesters are included for the treatment of all collected septage discharged at the site by septage haulers.

Primary digesters will be included in pond two to add to the efficiency of total nitrogen removal. The system is planned as four ponds in series with a total 20 days detention to ensure the prevention of short circuiting and to meet the low coliform concentration (1,000 fecal E/100ml) requirement in the effluent. Each module will be designed using this four pond concept.

The ponds within the system will be designed with a minimum 10-foot water depth. This will tend to ensure higher treatment efficiency while maintaining minimum area requirements resulting in a more efficient and effective system.

V. ENVIRONMENTAL OBJECTIVE AND NEED FOR ACTION

The primary objective of the Master Plan for the study area, defined as the Kingston Metropolitan and Port More area, is the preparation of a wastewater management scheme. The Master Plan identifies specific sewerage facilities, including collection, treatment and disposal structures. Environmental assessment is an integral part of this Master Plan and provides an evaluation of the environmental consequences in the implementation of related projects.

The purposes of the Master Plan and identified needs for action are derived from national goals for the protection of public health, the improvement of the well being of people, the conservation of natural resources and sustaining the framework for socio-economic development of the country. The specific action program is focused on the need for installation of water pollution control facilities.

The purpose of the EA is to provide an environmental overview of the Master Plan and related projects, to ensure that their objectives can be attained and environmental consequences are identified, evaluated and understood.

VI. ENVIRONMENTAL FACTORS

The human and natural resources of Jamaica form the foundation of the cultural and socio-economic fabric of the inhabitants and the environment. The protection and conservation of these resources to enable sustainable long term development remain basic goals of Government.

There are many stresses on the present environment of the island, and both the public well-being and natural resources are at risk. The many studies, plans and projects over the past 50 years have highlighted these environmental features. These studies range from individual reports on degradation of specific elements of the ecology to the broad comprehensive reports on water quality management needs. The salient feature of these many environmental studies is the urgent call for action. Today many of these recommendations have not been concluded. In most cases, implementation plans have been hindered mainly by the lack of adequate funding support. However, with the growing emphasis on the protection of the global and national environment, there appears to be encouraging changes over recent years.

VII. ENVIRONMENTAL CRITERIA

In environmental assessments, the goals and objectives of an action plan must be evaluated in relation to established or acceptable criteria for the protection and preservation of resources. Environmental criteria have been developed extensively worldwide from specific scientific research and/or epidemiological studies, relative to substances or elements of concern. From these scientifically derived criteria, regulatory authorities can establish standards to guide operating agencies on action plans, specific to any site for the protection of surrounding environmental resources.

For many developing countries, the formulation of national or local standards are guided frequently by criteria compiled from other countries or international agencies because indigenous research and/or epidemiological studies are costly and require extensive scientific capabilities and resources. Therefore, environmental guidelines by international agencies frequently provide the criteria base for national standards development.

Public health regulations and guidelines have been established by the Ministry of Health. The basic requirements for wastewater discharges include limit levels of 30 mg/l BOD and 30 mg/l suspended solids. There are no specific requirements for discharges from industrial, agricultural, marine or commercial facilities. Monitoring of discharge and receiving water is not required and reports for compliance are not submitted routinely. Enforcement is not aggressively pursued, if at all.

In the absence of a legal and regulatory action plan, it is pertinent to review existing environmental criteria available from abroad as references for the environmental assessment of the Master Plan. It should be emphasized that the review of these external references does not imply acceptance of foreign criteria. Formal regulatory procedures leading to establishment of environmental standards must follow established legal processes.

With the availability of new scientific research and epidemiological studies, major assessments of surface water criteria for environmental protection have been prepared over the last decade. Recent studies have focused on toxic substances in addition to the traditional parameters of bacterial, biological, chemical and physical substances. These parameters have been evaluated in inland fresh waters (rivers, lakes), tidal waters (estuaries, inlets and embayments) and open marine waters. A large interest exists in establishing criteria for the use of reclaimed wastewater. For the purpose of the Environmental Assessment, principle water criteria will be reviewed for application in the action plan, which is focused on the treatment and disposal of wastewater.

Criteria for the maintenance of environmental resources are discussed at this stage to provide background. Under the preferred plan, treated effluent will be disposed onto the marine environment, wetlands and into adjacent rivers and/or gullies. Trace residuals from treated wastewater will likely reach aquatic systems downstream. Accordingly, criteria for the maintenance of these ecosystems will be presented in the following paragraphs.

Reuse of wastewater effluent for irrigation can be guided by criteria compiled by the UN Food and Agricultural Organization (1976) for irrigated crops (Table III). These criteria cover minerals and other parameters (pH and salinity) which limit wastewater reuse, since these factors can influence crops and soil conditions. Salinity is a significant factor since some crops have low tolerances for the accumulation of salts in the soil following prolonged applications. Also ionic composition (especially pH) of water can affect soil conditions. Adequate drainage must be maintained for salt balance and crop vitality.

For the reuse of wastewater on edible vegetables and other edible crops, the World Health Organization (1989) provides guidelines for microbiological factors (Table IV) and containment of health risks. Wastewater treatment to attain these standards is recommended.

Criteria for fresh water and marine aquatic ecosystems have been developed in many countries with limits for bacterial, biological, chemical and physical parameters. For example, the US Environmental Protection Agency under the Clean Water Act (Amended 1982) established numeric criteria for 129 chemical pollutants for the protection of human health and aquatic resources after extensive review of research and epidemiological reports. Under this listing, 14 heavy metals (Table V) are identified as potentially toxic. The remainder of this extensive list is composed of volatile hydrocarbons (mainly industrial and household solvents), synthetic organics (pesticides, herbicides and fungicides), and many other compounds that have been identified as carcinogenics. Although this exhaustive list has significance in most industrialized countries, the complete list of compounds are not listed herein because they are not all particularly relevant. However, limits for pesticides, herbicides and fungicide compounds as well as commercial and household solvents should be noted since some may be used locally.

In fresh waters of the Rio Cobre, Sandy Gully and in the marine aquatic environment, water quality objectives can be identified by narrative (non-numeric) factors to guide planners and regulators. Typically these can include the following factors that are relevant to aquatic ecosystems:

- Waste discharge should not degrade or over-fertilize surface water communities and populations, including vertebrates, invertebrates and plant species (aquatic or shoreline).
- Natural taste and odor of fish, shellfish and other aquatic resources used for human consumption should not be impaired.
- Toxic pollution should not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health.

Criteria for the maintenance of environmental resources are discussed at this stage to provide background. Under the preferred plan, treated effluent will be disposed onto the marine environment, wetlands and into adjacent rivers and/or gullies. Trace residuals from treated wastewater will likely reach aquatic systems downstream. Accordingly, criteria for the maintenance of these ecosystems will be presented in the following paragraphs.

Reuse of wastewater effluent for irrigation can be guided by criteria compiled by the UN Food and Agricultural Organization (1976) for irrigated crops (Table III). These criteria cover minerals and other parameters (pH and salinity) which limit wastewater reuse, since these factors can influence crops and soil conditions. Salinity is a significant factor since some crops have low tolerances for the accumulation of salts in the soil following prolonged applications. Also ionic composition (especially pH) of water can affect soil conditions. Adequate drainage must be maintained for salt balance and crop vitality.

For the reuse of wastewater on edible vegetables and other edible crops, the World Health Organization (1989) provides guidelines for microbiological factors (Table IV) and containment of health risks. Wastewater treatment to attain these standards is recommended.

Criteria for fresh water and marine aquatic ecosystems have been developed in many countries with limits for bacterial, biological, chemical and physical parameters. For example, the US Environmental Protection Agency under the Clean Water Act (Amended 1982) established numeric criteria for 129 chemical pollutants for the protection of human health and aquatic resources after extensive review of research and epidemiological reports. Under this listing, 14 heavy metals (Table V) are identified as potentially toxic. The remainder of this extensive list is composed of volatile hydrocarbons (mainly industrial and household solvents), synthetic organics (pesticides, herbicides and fungicides), and many other compounds that have been identified as carcinogenics. Although this exhaustive list has significance in most industrialized countries, the complete list of compounds are not listed herein because they are not all particularly relevant. However, limits for pesticides, herbicides and fungicide compounds as well as commercial and household solvents should be noted since some may be used locally.

In fresh waters of the Rio Cobre, Sandy Gully and in the marine aquatic environment, water quality objectives can be identified by narrative (non-numeric) factors to guide planners and regulators. Typically these can include the following factors that are relevant to aquatic ecosystems:

- Waste discharge should not degrade or over-fertilize surface water communities and populations, including vertebrates, invertebrates and plant species (aquatic or shoreline).
- Natural taste and odor of fish, shellfish and other aquatic resources used for human consumption should not be impaired.
- Toxic pollution should not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health.

TABLE III

RECOMMENDED MAXIMUM CONCENTRATIONS OF ELEMENTS IN IRRIGATION WATER[1]

Element		Recom Max Con (mg/l)	Remarks
Al	(aluminum)	5.0	Can cause non-productivity in acid soils (pH < 5.5), but more alkaline soils at pH > 7.0 will precipitate the ion and eliminate any toxicity.
As	(arsenic)	0.10	Toxicity to plants varies widely, ranging from 12 mg/l for Sudan grass to less than 0.05 mg/l for rice.
Be	(beryllium)	0.10	Toxicity to plants varies widely, ranging from 5 mg/l for kale to 0.5 mg/l for bush beans.
Cd	(cadmium)	0.01	Toxic to beans, beets and turnips at concentrations as low as 0.1 mg/l in nutrient solutions. Conservative limits recommended due to its potential for accumulation in plants and soils to concentrations that may be harmful to humans.
Co	(cobalt)	0.05	Toxic to tomato plants at 0.1 mg/l in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Cr	(chromium)	0.10	Not generally recognized as an essential growth element. Conservative limits recommended due to lack of knowledge on its toxicity to plants.
Cu	(copper)	0.20	Toxic to a number of plants at 0.1 to 1.0 mg/l in nutrient solutions.
F	(fluoride)	1.0	Inactivated by neutral and alkaline soils.
Fe	(iron)	5.0	Not toxic to plants in aerated soils, but can contribute to soil acidification and loss of availability of essential phosphorus and molybdenum. Overhead sprinkling may result in unsightly deposits on plants, equipment and buildings.
Li	(lithium)	2.5	Tolerated by most crops up to 5 mg/l; mobile in soil. Toxic to citrus at low concentrations (,0.075 mg/l). Acts similarly to boron.
Mn	(manganese)	0.20	Toxic to a number of crops at a few-tenths to a few mg/l, but usually only in acid soils.
Mo	(molybdenum)	0.01	Not toxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high concentrations of available molybdenum.
Ni	(nickel)	0.20	Toxic to a number of plants at 0.5 mg/l to 1.0 mg/l; reduced toxicity at neutral or alkaline pH.
Pd	(lead)	5.0	Can inhibit plant cell growth at very high concentrations.
Se	(selenium)	0.02	Toxic to plants at concentrations as low as 0.025 mg/l and toxic to livestock if forage is grown in soils with relatively high levels of added selenium. An essential element to animals but in very low concentrations.

TABLE III

RECOMMENDED MAXIMUM CONCENTRATIONS OF ELEMENTS IN IRRIGATION WATER[1] (continued)

Sn	(tin)	---	Effectively excluded by plants; specific tolerance unknown.
Ti	(titanium)	---	Effectively excluded by plants; specific tolerance unknown.
W	(tungsten)	---	Effectively excluded by plants; specific tolerance unknown.
V	(vanadium)	0.10	Toxic to manu plants at relatively low concentrations.
Zn	(zinc)	2.0	Toxic to many plants at widely varying concentrations; reduced toxicity at pH > 6.0 and in fine textured or organic soils.

1. UN Food and Agricultural Organization (1976).

Note: The maximum concentration is based on a water application rate which is consistent with good irrigation practices (10,000m^3 per hectare per year). If the water application rate greatly exceeds this, the maximum concentrations should be adjusted downward accordingly. No adjustment should be made for application rates less than 10,000m^3 per hectare per year. The values given are for water used on a continuous basis at one site.

TABLE IV

RECOMMENDED MICROBIOLOGICAL QUALITY GUIDELINES FOR WASTEWATER USE IN AGRICULTURE[1]

Cate gory	Reuse Conditions	Exposed Group	Intestinal nematodes[2] (arithmetic mean no. of eggs per 100 ml[3]/liter[3])	Fecal coliform (geometric mean no.)	Wastewater treatment expected to achieve microbiological quality
A	Irrigation of crops likely to be eaten uncooked, sports fields, public parks[4]	Workers, consumers, public	≤ 1	≤ 1,000	A series of stabilization ponds designed to achieve the microbiological quality indicated, or equivalent treatment
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture and trees[5]	Workers	≤ 1	not applicable	Retention in stabilization ponds for 8 to 10 days or equivalent helminth and fecal E. coliform removal
C	Localized irrigation of crops in category B if exposure of workers and the public does not occur	None	not applicable	not applicable	Pre-treatment as required by the irrigation technology, but no less than primary sedimentation

1. In specific cases, local epidemiological, socio-cultural and environmental factors should be taken into account, and these Guidelines modified accordingly.

2. Ascaris, Trichuris and hookworms.

3. During the irrigation period.

4. A more stringent guideline (≤ 200 fecal E. coliform/100 ml) is appropriate for public lawns, such as hotel laws, with which the public may have direct contact.

5. In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.

Source: World Health Organization (1989)

TABLE V

HEAVY METAL WATER QUALITY CRITERIA[1]

(#) COMPOUND	FRESHWATER (ug/l)	SALTWATER (ug/l)	HUMAN HEALTH For Consumption of:	
			Water & Organisms (ug/l)	Organisms Only (ug/l)
Antimony	n	n	14	4,300
Arsenic	360	69	0.018	0.14
Beryllium	n	n	n	n
Cadmium	3.9	43	n	n
Chromium (III)	1,700	n	n	n
Chromium (VI)	16	1,100	n	n
Copper	18	2.9	n	n
Lead	82	220	n	n
Mercury	2.4	2.1	0.14	0.15
Nickel	1,400	75	610	6,600
Selenium	20	300	n	n
Silver	4.1	2.3	n	n
Chatlium	n	n	1.7	6.3
Zinc	120	95	n	n
Cyanide	22	n	700	220,000

1. US Environmental Protection Agency (1992)

n = none

- Concentration of toxic pollutants in water, sediments or biota should not adversely affect beneficial uses.

- Rate of deposition of inert solids and their specific characteristics should not change bottom sediments such that benthic communities are degraded.

Physical characteristics which are relevant in the aquatic ecosystem and aesthetic values are suggested as follows:

- Floating particles, grease, and oil should not be visible.

- Discharge should not cause aesthetically undesirable discoloration of the water surface.

- Natural light should not be significantly reduced to impact photosynthetic plankton in the water column or attached benthic plants.

Bacteriological criteria for recreation (wading, swimming, boating) and shellfish have been developed and may be applicable to the action plan. The World Health Organization and the UN Environment Program (1978) proposed interim bacteriological criteria for recreation and shellfish areas. These were proposed under the Mediterranean Sea program to guide national pollution control programs along the extensive shorelines. After much discussions through several meetings, an interim recreational water criteria of 1,000 fecal E. coliform (90% of the time) per 100 ml was adopted in 1985. This fecal E. coliform limit is similar to the European Economic Commission (1976) for bathing and swimming waters. The World Health Organization and the UN Environment Program also proposed an additional bacterial indicator for fecal streptococci (1000/100ml for 90% of time) but agreement could not be reached among national representatives for acceptance.

The US Environmental Protection Agency in 1986 established bacterial standards for recreational waters (full body contact) in fresh and marine environments. The geometric means of indicated bacterial densities should not exceed one or the other of the following:

E. coliform	126 per 100 or
enterococci	33 per 100 ml

The US EPA recommended either the E. coliform or enterococci indicators for fresh water but only the enterococci for marine water.

Studies for developing the US EPA criteria were made in large urban environments and they indicated limitations in extrapolating these criteria to small populations or when epidemic conditions are present in the community. In view of these expressed limitations on the US EPA criteria, the international criteria is suggested for the specific locations in Jamaica.

Natural wetlands occupy zones between the receiving waters and land. These zones can border fresh water as well as marine environments. Recently wetlands have gained great interest and many uses of wetlands have been identified. Wetlands can take the form of natural wetlands, constructed wetlands and aquatic plant systems. Wetlands can be alternately dry and wet or continuously wet. Wetland water quality criteria have not been established but the US EPA has scheduled a compilation of wetland criteria to be completed by the end of 1993. It can be expected that the criteria will reflect the limitations already established for applications of wastewater to land and aquatic systems. Limitations would depend on the site specifics of each wetland system and on ecological objectives.

Washington State (1991) in the USA has drafted criteria for the maintenance of wetlands. These criteria are non-numeric and establish a qualitative state for the protection of wetlands.

In the absence of any quantitative wetland criteria, it is useful to review these narrative standards for water quality guidelines, which are as follows:

Water Quality Criteria

Fecal E. coliform organisms - no measurable change from natural conditions. Human-influenced activities should not be allowed to raise fecal E. coliform concentrations above natural conditions.

pH - no measurable change from natural conditions.

Settleable solids should not be introduced or allowed to accumulate in a wetland such that they directly or indirectly degrade the wetland or interfere with the existing or characteristic uses.

Toxic, radioactive, or deleterious material concentrations should be below those which may adversely affect characteristic water uses, cause acute or chronic conditions to aquatic and terrestrial biota, or adversely affect public health or welfare.

Aesthetic values should not be reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use, or form nuisances or taint tissue of edible species.

Nutrients should not be introduced to or allowed to accumulate in a wetland such that they directly or indirectly degrade the wetland or interfere with the existing or characteristic uses of the wetland.

Natural physical and biological characteristics should be maintained and protected so that there is no significant degradation of characteristic uses.

Hydrological conditions should be maintained, including hydroperiod, hydrodynamics and natural water temperature variations necessary to support vegetation which would be present naturally.

Necessary substrate characteristics should be maintained to support vegetation which would be present naturally.

These wetland guidelines for water quality are useful for disposal of treated wastewater. Wetlands can be effective biological filters for removal of residual pollutants remaining in treated effluent. Wetlands are not a substitute for treatment but are a polishing system for residuals and are an added refinement to conventional pollution reduction. Under these guidelines, wetlands can be maintained and even enhanced by the application of treated wastewater.

M180.1	M190	463	457	0	0.470	119.260	0.272	0.300	2.955	13160.9	107.860	0.329	0.300	2.373	13160.9
M185.1	M180	20	300	0	0.044	119.300	0.240	0.016	0.269	403.8	119.260	0.275	0.016	0.239	403.8
M190.1	M200	157	457	0	0.372	107.860	0.321	0.303	2.462	13283.9	105.440	0.321	0.303	2.462	13283.9
M200.1	M210	253	457	0	0.420	104.490	0.296	0.305	2.718	13366.1	99.520	0.313	0.305	2.545	13366.1
M210.1	M220	272	457	0	0.401	99.520	0.306	0.307	2.627	13436.0	94.630	0.310	0.307	2.590	13436.0
M220.1	M230	215	457	0	0.415	94.630	0.303	0.312	2.710	13691.7	90.490	0.309	0.312	2.646	13691.7
M230.1	M240	277	457	0	0.424	90.490	0.302	0.318	2.764	13920.8	84.930	0.311	0.318	2.673	13920.8
M245.1	M240	50	250	0	0.086	86.000	0.072	0.014	1.178	292.8	85.000	0.240	0.014	0.411	292.8
M240.1	M250	84	457	0	0.426	84.930	0.303	0.321	2.780	14309.3	83.230	0.303	0.321	2.780	14309.3
M250.1	M260	243	457	0	0.423	82.320	0.307	0.324	2.772	14452.6	77.460	0.315	0.324	2.689	14452.6
M260.1	M270	322	457	0	0.425	77.460	0.307	0.326	2.781	14508.7	70.980	0.307	0.326	2.781	14508.7
M270.1	M275	88	457	0	0.425	69.990	0.309	0.328	2.786	14636.0	68.220	0.309	0.328	2.786	14636.0
M275.1	M280	222	533	0	0.635	68.220	0.280	0.330	2.785	14711.5	63.790	0.515	0.330	1.493	14711.5
M280.1	M290	411	686	0	0.971	63.790	0.501	0.832	2.875	36149.3	58.720	0.501	0.832	2.875	36149.3
M290.1	M300	358	686	0	1.073	58.720	0.465	0.834	3.123	36236.3	53.330	0.464	0.837	3.203	36236.3
M300.1	M310	154	762	0	1.400	53.330	0.453	0.894	3.168	38393.6	51.060	0.453	0.894	3.163	38393.6
M303.1	M300	467	533	0	0.486	58.970	0.132	0.055	1.292	1693.1	53.500	0.287	0.055	1.174	1693.4

Link Reference	D/S Node	Pipe Len (m)	Pipe Hgt (mm)	Sed Dpth (mm)	P.Full Flow (m3/s)	< Upstream Invert Level (m AD)	Upstream Max Depth (m)	Upstream Max Flow (m3/s)	Upstream Max Vel (m/s)	Upstream Total Flow (m3) >	< Downstream Invert Level (m AD)	Downstream Max Depth (m)	Downstream Max Flow (m3/s)	Downstream Max Vel (m/s)	Downstream Total Flow (m3) >
M307.1	M303	460	457	0	0.366	66.010	0.128	0.056	1.477	1693.1	59.110	0.128	0.055	1.475	1693.1
M310.1	M320	180	762	0	1.306	49.640	0.476	0.900	3.004	38749.1	47.330	0.476	0.900	3.004	38749.1
M320.1	M330	211	762	0	1.345	45.810	0.469	0.905	3.076	39001.8	42.940	0.470	0.905	3.063	39001.8
M330.1	M340	180	762	0	1.361	42.940	0.465	0.905	3.106	39033.0	40.430	0.465	0.905	3.106	39033.0
M340.1	M350	182	762	0	1.445	40.430	0.449	0.909	3.254	39229.9	37.570	0.465	0.909	3.122	39229.9
M350.1	M360	496	762	0	1.396	37.570	0.460	0.911	3.171	39355.8	30.300	0.460	0.911	3.171	39355.8
M360.1	M370	35	762	0	4.065	30.300	0.256	0.913	6.776	39457.2	25.960	0.486	0.913	2.976	39457.2
M370.1	M380	419	838	0	1.603	25.960	0.483	0.973	2.957	41677.0	21.050	0.483	0.973	2.957	41677.1
M375.1	M370	50	300	0	0.264	30.000	0.104	0.063	2.888	2198.6	26.400	0.104	0.063	2.888	2198.6
M380.1	DH230	457	838	0	1.744	21.050	0.459	0.976	3.154	41852.0	14.709	0.459	0.976	3.154	41852.1
M385.1	M380	20	300	0	0.069	21.400	0.112	0.002	0.213	44.2	21.300	0.211	0.002	0.377	44.2
SBTW.1	SBTWO	100	1500	0	13.506	4.000	0.626	4.650	6.654	200144.9	0.100	0.626	4.650	6.654	200145.5

+ after total flow indicates a pipe/channel surcharged by flow and depth at that end.
x after total flow indicates a pipe/channel surcharged by depth only at that end.

NOTE :
(i) maximum elevations, depths, volumes, velocities and discharges are selected from the values at each time increment and will be in general more extreme than the maximum values in the hydrograph files.
(ii) maximum elevations, velocities and discharges are not necessarily calculated at the same time.
(iii) max. velocity is not calculated for a pipe if either the water level does not exceed 5% of the pipe depth or the discharge is less than 0.001 m3/s.

End of run 1 mins (elapsed) Produced on 17/07/2003 Last page

THE PLANNING INSTITUTE OF JAMAICA

16 Oxford Road, Kingston 5, Jamaica, W.I.
P.O. Box 634, E-mail: info@pioj.gov.jm
Telephone: (876)-906-4463/4, (876)-960-9339, Facsimile: (876)-906-5011

July 14, 2009

Amb. Paul Harker
Director
Bilateral Relations Department
Ministry of Foreign Affairs & Foreign Trade
21 Dominica Drive
Kingston 5

Dear Amb. Harker:

Re: JICA Mission for Kingston Sewerage Development Project

The Planning Institute is pleased to accept JICA's consultant team in connection with the captioned project. Members of the team will be dispatched to Jamaica over the period July 20, 2009 to January 9, 2010. Below are the names of the seven team members:

1. Kevin Tynes – Team Leader
2. Hideo Tsuta – Sub-Team Leader
3. Thomas Wilshusen
4. Masaaki Ueda
5. Naoki Hosotani
6. Hideyo Shimazu
7. Yusaku Makita

We look forward to the support from the team, and would appreciate your assistance in the communication of this endorsement to the Embassy of Japan.

Yours sincerely,

Saskia Frater Smith
for Director General

copy: Mr. Toshimasa Takashima, Resident Representative, JICA/JOCV Jamaica Office

APPENDIX IX

Economic Assessment of Privatization Option

APPENDIX IX

PRIVATIZATION OPTIONS FOR WASTEWATER TREATMENT AND DISPOSAL; KINGSTON, JAMAICA

Prepared by:

Dr. Ernest Addison, Ph. D. Econ.

IX.I INTRODUCTION

Privatisation refers to the sale of a Public enterprise to a private party under which the private party buys or builds and operates the newly acquired facility. It may take different forms including complete divestiture, where publicly held assets are transferred by sale to private individuals or firms, after which the government no longer bears any responsibility for the operation of the assets. Alternatively, the government may engage in partial divestiture by selling only a portion of assets to private entities.

The financial problems of developing country governments have led to an increasing demand for privatisation and this has been spurred on by ideological changes that have taken place in many countries regarding the role of the state in economic activity.

The rationale for the privatisation process then lies in the positive effects on the government's budget, the need to make enterprises more efficient and, more recently, the desire of less developed country (LDC) governments to democratise the ownership of productive assets in the economy.

IX.2 ADVANTAGES

Privatisation has been shown to produce positive results by strengthening the productive capacities of industry and agriculture, and helping develop the banking and financial system in many less developed countries. Since inefficient public enterprises are often subsidised and maintained with public funds, privatisation also benefits tax payers, and may expand the profit base by turning unprofitable ventures into profitable ones. This has implications for the economy as a whole.

Critiques of privatisation dwell on its ineffectiveness in capital constrained economies and its aggravation of income inequality; however, recent experience has shown an increased number of first time shareholders and the oversubscription of shares in many privatization attempts (e.g Jamaica & Nigeria). This serves to show that the absorptive capacity of the domestic capital market need not necessarily be strained by privatization.

Nevertheless, it is important not to generalise, as the elements of privatization tend to vary not only across industries but also across countries and there is the need to assess each privatization attempt on its own merit.

IX.5 MACROECONOMIC EFFECTS OF PRIVATISATION

This section attempts to show the economywide effects of privatising the Water system in Jamaica using some economic criteria[1]. Traditionally, project evaluation is based on cost benefit analyses which indicate whether the economic and social benefits of the project are greater than the costs and projects are selected by ranking the possible projects in terms of the returns from each project.

In the case of privatisation, the comparison is between current level of production and expected stream of economic magnitudes after the establishment is privatised. This implies that the criteria of using internal rates of return, net present values and cost benefit ratios need to be modified to take into consideration factors that may change after privatisation.

While privatisation is usually fueled by social, political and even ideological changes, this technocratic approach provides a framework that enables policymakers to make important decisions fully informed of the economic consequences of policy options chosen.

Privatisation may lead to the improvement of machines and equipment, which would lead to increased production, increased quality and a reduction in costs of production. It may even include management changes that increases efficiency and profits. When enterprises that are previously owned and operated by government are privatised, then subsidies that were previously paid by the government to ensure viability, may be freed and used more productively. This reduction in subsidies, generates employment in other sectors, reduces the budget deficit, leading to positive effects on capital markets in the economy.

Indirect effects could take place through interindustry linkages.

Two important criteria that must be met are, (a) comparing net value added before and after privatisation, and ensuring that net value added after privatisation is greater, (b) efficiency criteria of ensuring that internal rates of return after privatisation is greater than it was before privatisation. Below these are discusssed in further detail.

---

1 The macroeconomic approach used is based on Andic Fuat M. "Privatisation: Some Theoretical and Practical considerations". Occasional Paper #100, April 1988, Latin American and Carribean Centre, Florida International University.

supplements private sector equity, and if there is a default, the government succeeds to the rights of the lender. The private participant loses its equity. Given the apparent desire of the Jamaican government to rid itself of the burden of being actively involved in the provision of wastewater treatment, such a partnership would not be an appropriate solution for Jamaica.

IX.3.2 Leased Transactions

These refer to arrangements under which the public authority leases assets, and equipment of the public utility to a private party.
Major capital improvements to the assets remain with the owner (i.e. the public authority). Such an arrangement limits the capital formation and the overall condition of assets would determine payments on the lease. Rental payments on the lease would come from fees charged to users of the facility.

The advantage of this type of arrangement is that it does not raise the debt of the lessor, i.e. the public utility, and it is favoured over those arrangements where the public utiltiy issues bonds or guarantees debt. It is also useful where authorities lack sufficient bond authorization. The leases can be set to cover the lessee's operations, maintenance and repair costs and public authorities cost of capital investments.

Such leased transactions may not be suitable for Jamaica because of the need for capital improvements to upgrade wastewater services and increase efficiency. But it has also been argued that if leased arrangements improve financial efficiency, then the entity may attract more investment capital which would lead to improved services.

IX.3.3 Public /Private Partnership With Direct Public Financing

This arrangement involves the private partner contracting to manage all construction and operation of the facility. Commercial risks associated with construction and operation are borne by the private partner, and they share consumption and user default risks with the public partner.

The public authority is responsible for all financing, and assumes the costs of capital risk, the risk of changes in environmental laws and part of the consumption and user default risk. The Public authority can borrow directly from the revolving fund of the World Bank to finance new investments. The major disadvantage of this system is that it raises the indebtedness of the government.

concession. The annual capital component of the concession fee is that amount which provides for repayment of debt and an agreed return on equity.

The capital component of the concession fee is given preferential clauses, such that a default or termination by the concessionaire does not terminate the capital component, but gives the public authority the right to transfer the concession including the capital component to another party. Also, should the capital component turn out to be insufficient because of lower consumption of services, default by users of the facility, or excess costs due to environmental change of laws then the public authority must permit an increase in rates or make a payment to the concessionaire to ensure economic viability. In sum, these provisions insulate the investors from (i) operating risks (ii) consumption risks (iii) consumer defaults (iv) changes in regulatory policy.

Clearly this form of arrangement necessitates a long period of concession or higher user fees for the recovery of capital investments of tens of millions of dollars.

IX.3.7 Conclusions

The concessionary form of arrangement seems to offer advantages for Jamaica, because it involves capital inflow into the economy and the concessionaire could be required to create a local company with part ownership by Jamaicans. This arrangement would allow the government to reallocate some of its domestic expenditures in other sectors of the economy, and play only a regulatory function in the privatised sector. Examples of this abound and include the Turkish government's deal with a private consortium, led by Philipp Holzmann AG, on a hydro electric project in that country, a 1.1$bn water deal between the Malaysian government and Lyonnaise des Eaux/ Dumez of Paris, and the $4.0bn water concession arrangement between the Argentine government and the consortium Aguas Argentinas.

The concessions include:

(1) Exclusive rights and complete responsibility for a period of time usually 25 years.

(2) They are typically BOOT arrangements; i.e. investors build, own, operate, and transfer the system back to the relevant authorities at the end of the concession.

(3) Tariffs and provisions for adjustments are provided in the contracts.

The Leases include operation and maintenace roles for the private party, whereas ownership rests with local authorities. Tariffs are arranged to be adjusted and provisions are made for contributions to a capital fund.

IX.4.4 Developing Country Experiences

A large number of developing countries, including Argentina, Mexico, Chile, and Cote D'Ivoire, are turning to privatisation of their water and wastewater treatment plants. This privatisation impetus, is also very much present in post communist Europe, where massive privatisation of entire economies are taking place.

For example the city of Brno, in Czech, recently approved a plan under which it will own the infrastructure of the water and sewer utility, but the operations and maintenance management will be undertaken by a private firm. This firm has as shareholders, both the City and private investors.

Perhaps the most striking case of privatised water entity in a less developed country, is that of the Societe de Distribution D'eau de la Cote d'Ivoire (SODECI), which was established in 1959. The government entrusted management of urban water supplies to a French company, Societe d'Amenagement Urban et Rural (SAUR) which held the majority shares in SODECI.

In 1980, paid in capital of SODECI was increased as SAUR slipped from being a majority shareholder to a 46.5% level, whilst Ivorian nationals took over 47.8% of the shares. By 1983, Ivorian nationals had 52% of total shares.

SODECI has been criticised on distributional grounds, in terms of their failure to provide water connections to house owners in poorer areas of the city at a cheaper rate, creating a need for government to subsidise these water connections. Despite these distributional issues, the World Bank evaluates it as the most efficient, offering one of the highest standards in all of West Africa, in water quality, with uniform pressure.

$$\sigma NVA_d = NVA_p - NVA_g$$

where the net value added is obtained as the value of total output minus material inputs used up in the production process defined as follows:

NVA_i	$= O_i - (MI+D)_i$
where, O_i	= Indirect Output
MI	= Material inputs
D	= Depreciation

Estimates of value added by the water sector could not be derived accurately from the 1980 input output tables, due to the aggregation of the sector with electricity. Also, even though the gross value added for both water and electricity stood at $J75.8m in the 1980 input-output tables, estimates of gross value added by the water sector alone in 1991 from Statin was $J187.9M[2] This is probably due to the high levels of inflation, but could also reflect substantial errors in the statistical exercise, calling for cautious interpretation of any estimations based on these numbers. Given a gross output value of $J506.0m, material inputs worth $J318.1m were derived, leaving the gross value added by the sector under government operation to stand at $J187.9m and net value added of $J169.16m after depreciation.

In order to estimate the net value added under privatisation, the cash flow analysis submitted by Future Water Inc. was used to obtain an idea of what the expected levels of value added would be. The cash flow analysis starts off on a different premise and items are classified to suit that purpose; e.g. operating revenues from all sources are categorised from domestic users, commercial users, revenue from fertiliser and irrigation etc. Operating surplus was then obtained by subtracting operating costs which include labour, materials, administrative costs, land lease etc.

To preserve the economist's definition of value added, these accounting cost items were reclassified, including payments to all factors of production in the value added estimate. Value added was derived as the total revenue from all sources minus the value of material inputs used up in the production process.

[2] See annex B, item 2 of data submitted by Francis A.

method of payback was from a monthly surcharge on consumers. Another case is that of the City of Auburn, Alabama, which went into partnership with a private firm, to provide a $36m wastewater treatment system, for the use of the community.

These American examples are minor compared to trends in other European and Latin American countries. Recently, a concession was granted to a private firm (Aguas Argentina) for thirty years, to provide a water plant, upgrade existing systems and wastewater facilities for eight million people in Buenos Aires, Argentina. The total value of this project is $4b U.S.

Another example is that of Mexico City, where the public authorities (Comision del Aguas) have contracted out water distribution and collection services to a private firm. The value of this project was estimated at $120 million over two years, and includes metering and mapping of the city, billings and collections as well as customer service facilities.

Another major privatization attempt is in Malaysia, where a twenty year concession has been awarded to a private firm to provide water and sewerage services. The value of the project is estimated at $1.1 billion and is to be financed through a combination of debt and equity. Izmit, Turkey is yet another example with a 15 year concession, and a project worth $700 million. The bulk of the project is being financed with a loan from a Japanese bank.

Table 2 shows a listing of privatization in water and sewerage and techniques used in each case. With the exception of Liberia, which is still in process, all of the above countries have completed these projects. The concessionary arrangement seems to be the most common method adopted, and is probably the best method for the water and sewerage sector in a country without much domestic savings. However, as shown in the case of the United Kingdom, the water and sewerage sector can also be privatized in a public offering of shares.

The concession method has been fully tried in France with good results, and has led to its application in many countries e.g. United Kingdom, Spain, Casablanca, and Macao. Its variant, the "affermage" differs only by length of contract and the fact that the government maintains certain rights of control. The private operator is legally responsible for the utility service, collects all water fees and under takes the operational risk. It may be required to build into rates an amount to be remitted to the owner to cover all aspects of financing costs of the asset as well.

TABLE 3 PRIVATIZATION OF WATER AND ELECTRICITY

Country	Method
Austria	Public Offering
Canada	Private Sale
Chile	Private Sale/public Offering/ Employee Buy Out
France	Management Contract / Lease
Grenada	Private Sale
Guinea	Lease
Japan	Private Sale
Korea	Public Offering
Malaysia	Management Contract
Phillipines	Private Sale
Spain	Public Offering/ Management Contract

Source: "Techniques of Privatization" World Bank Technical Paper #90

This table shows that privatization in either water or electricity, has taken place in developed countries such as Canada and Japan, and in poorer ones such as Grenada and Chile. Three French companies are involved in the water sector in Cote D'Ivoire and also in Argentina and Malaysia. This suggests that investment in these sectors by foreign companies are possible, provided the correct incentives are put into place. The next section, discusses the conclusions and the necessary steps that may be taken to ensure a successful privatization attempt.

CONCLUSIONS

This review has shown that though privatization in the water and sewerage sectors are still in their formative stages, trends in the industry suggest that this method will become a permanent feature in many countries.

Private capital can be attracted to the privatization of water and sewerage utilities, provided incentives to do so exist. Since water and sewer utilities are generally capital intensive operations, investment in the sector is not attractive, unless the tax systems, tarriff regulations and

These different objectives mean that the government must be clear and sure of the types of incentives and assurances that they are prepared to offer. The success of any privatization attempt depends on tactful negotiation and the political will to do so.

Benefits

The Kingston Harbour Environmental project forecasts a $300 million cost for a sewerage system to accomplish significant Harbour improvements such as would affect the welfare of private individuals, government profits in the economy. The benefits of this investment would be an aggregate of the effects on each of these factors. The effect on these factors depends on how this investment is financed. If the project is publicly financed (e.g. through a tax mechanism), then there would also be effects on the expenditures of private individuals who would otherwise have had more discretionary income. If the "sale" is to domestic consumers, e.g. through pension funds, the effect would depend on the effect on capital markets and the changes in interest rates that might occur as a result. These changes in interest rate would determine whether investments in other sectors of the economy would be affected. For example, if workers are compelled to purchase shares, this would reduce their opportunity to place savings elsewhere, and some investment would be crowded out. If workers were saving nothing before, then we expect the capital market repercussions would be minimal. Foreign funding can be seen as an addition to domestic resources, and may enhance gains from privatization. However the gains may be limited by the constraints that may arise from the eventual need to repatriate capital or service debt.

In the macroeconomic approach described earlier in this report, the effects of privatization were assessed from the increase in net value added as a result of privatization. This was described as having subsequent effects on employment, the government's budget, and the balance of payments.

Employment Effects

In order to assess the effects of different levels of investment, we proceed in a similar manner by assuming that all of the investment is an exogenous infusion of capital, and has no effect on investment in other sectors of the economy.

Employment effects for different levels of investment are shown in Table 1 following. Employment effects are subject to wide variation, as labour markets do not operate on a single logic, especially in a developing country with many market imperfections. It is important to note that the Kingston Harbour Environmental Project is capital intensive, and hence employment impacts may not be the overwhelming effect. Estimates from Sentar's cost analyses suggest operating and maintenance costs ranging between 3% to 7% of total costs, with the bulk of long term

TABLE 1 : EMPLOYMENT EFFECTS

Direct Effects		Indirect Effects[2]	
E_p	= 6100	E_p	= 6100
$-E_g$	= 6000	$-E_g$	= 6000
$+E_c$	= 0	* m	= 10
σE_d	= 100	$+ E_c m$	= 0
		σ Ei	= 1000

NOTES: The following are the meaning of the letters used.

E	=	employment
Ec	=	indirect public sector employment
Ed	=	direct employment
Ei	=	indirect employment
p	=	privatized
g	=	non privatized
m	=	employment multiplier

Total effects, as given by the sum of direct and indirect effects, therefore add up to 1100 new jobs. Two other levels of investment from the total of $300 million were also considered - $85 million and $150 million. These levels roughly represent a possible first stage, and a minimum "ultimate" system respectively, whereas $300 million is the approximate cost for sewering the entire city. The levels of employment for $85 million of investment and for $150 million, are extrapolated as lying between 400 and 600 new jobs respectively.

[2] Assuming that the employment multiplier was 10, then we expect an increase in indirect jobs of 1000. This multiplier is fairly arbitrary given no information on its actual value for Jamaica, but is believed to be fairly conservative since it measures employment responses throughout the economy. The direct employment response is, however, the more important estimate here.

Table 2 shows the summary of the fiscal effects. Assuming that 10% of investment accrues to the government as sale proceeds, and using the values obtained for subsidies and debt incurred for the sector, we obtain the immediate effect of such a sale.

TABLE 2: FISCAL EFFECTS OF INVESTMENT

Investment :	**($300M)**	**($150M)**	**($85M)**
10% Of Sale Proceeds	$30M	$15M	$8.5M
In Jamaican $ Terms	$J660M	$330M	$187M
Less Subs. And Debt.	$J527.8M	$J527.8M	$J527.8M
Impact Effect	$J133.0M	$J-197.8M	$J-340.0M

The results show that the investment level of $300M would have the effect of reversing the deficit, while the $150M and $85M investment would reduce, but not reverse the budget stance.

In the next subsection we focus our analysis on welfare considerations of these levels of investment, moving away from the quantitative "best guesses" to a more qualitative assessment of welfare effects. The three main effects considered are the effect on consumption, profits, and government. A project aimed at providing sewerage services may have a great impact on improving living conditions of consumers, whether this would translate into increased consumption is another issue. Profits in the economy may also be affected and finally the government is affected financially by the project. We accorded government funds a pivotal role in the effect on the economy as a whole, and hence, gave it the greatest weight in the ranking. It is also shown that whereas these rankings may not differ much by way of the level of investment, consumption effects are ranked higher than profits when the highest level of investment is pursued. The major justification for this ranking is the ultimate objective of economic growth, and the importance of government funds in achieving this end.

NOTES:

Freeman, A Myrick (1990) " Water Pollution Policy" in Public Policies for Environmental Protection, (ed) Portney Paul R., Resources for the future, Washington D.C.

Mansoor Ali (1991) "Fiscal impact of privatization" In Privatization in less developed countries (ed) Cook P. and KirkPatrick C.

Stren Richard E. (1991) "Urban Services in Africa" in Privatization in less developed countries (ed) Cook P. KirkPatrick C.

Tietenberg Tom (1992) Environmental and Natural Resource Economics, 3rd edition, Harper Collins Publishers.

APPENDIX IX

ANNEX B

ECONOMIC DATA ON WATER SECTOR

Prepared by: Dr. Alfred Francis Ph.D. Econ.

THE UNIVERSITY OF THE WEST INDIES
DEPARTMENT OF ECONOMICS
MONA CAMPUS

Cable: Univers Telex: 2123 Mona
Kingston 7, Jamaica

10th March 1993

Mr. Horace L. Beckford
Sentar Consultants Ltd.
13 West Kings House Road
Kingston 10

Dear Mr. Beckford,

Re: Data Requirements on the Water Sector: Interim Submission

Figures on the Water Sector are reflected by the 'Water and Sanitation Sector' in the National Accounts of the Jamaican Economy prepared by the Statistical Institute of Jamaica (STATIN). The primary source of the raw data for Water and Sanitation in the National Accounts is the National Water Commission (NWC).

Item 2. Estimate of Value Added by Water Sector

187,961 (J$ '000) 1991

Source: STATIN

Item 4. Employment of Water Sector

Average No. of Persons Employed

1990	3542
1991 Q1	3276
1991 QII	3147
1991 QIII	3390

Source: STATIN

../2

Telephone: 809-927-1660-9 • Direct Line: 809-927-4557 • Telefax: 809-977-1483

ITEM 6. MARGINAL PROPENSITY TO CONSUME IN JAMAICA

Year	GDP at constant (1974) Prices J$ million	Private Final Consumption Expenditure Constant (1974)prices J$ million	Mean Population ('000)
1974	2159.2	1606.1	1979.9
1975	2152.5	1596.9	2012.8
1976	2013.5	1562.5	2040.5
1977	1965.5	1543.4	2063.1
1978	1976.0	1468.7	2087.8
1979	1940.0	1347.4	2112.1
1980	1828.8	1280.2	2133.2
1981	1875.5	1317.5	2162.3
1982	1898.7	1362.6	2200.1
1983	1942.2	1505.8	2240.8
1984	1925.6	1629.9	2279.8
1985	1836.1	1637.5	2311.1
1986	1867.2	1642.2	2335.8
1987	1983.4	1793.1	2350.6
1988	2012.6	1842.7	2356.4

Sources: National Income and Product Preliminary Report 1990, National Income and Product 1989, 1988; Statistical Yearbook 1989. STATIN.

IX.I INTRODUCTION

Privatisation refers to the sale of a Public enterprise to a private party under which the private party buys or builds and operates the newly acquired facility. It may take different forms including complete divestiture, where publicly held assets are transferred by sale to private individuals or firms, after which the government no longer bears any responsibility for the operation of the assets. Alternatively, the government may engage in partial divestiture by selling only a portion of assets to private entities.

The financial problems of developing country governments have led to an increasing demand for privatisation and this has been spurred on by ideological changes that have taken place in many countries regarding the role of the state in economic activity.

The rationale for the privatisation process then lies in the positive effects on the government's budget, the need to make enterprises more efficient and, more recently, the desire of less developed country (LDC) governments to democratise the ownership of productive assets in the economy.

IX.2 ADVANTAGES

Privatisation has been shown to produce positive results by strengthening the productive capacities of industry and agriculture, and helping develop the banking and financial system in many less developed countries. Since inefficient public enterprises are often subsidised and maintained with public funds, privatisation also benefits tax payers, and may expand the profit base by turning unprofitable ventures into profitable ones. This has implications for the economy as a whole.

Critiques of privatisation dwell on its ineffectiveness in capital constrained economies and its aggravation of income inequality; however, recent experience has shown an increased number of first time shareholders and the oversubscription of shares in many privatization attempts (e.g Jamaica & Nigeria). This serves to show that the absorptive capacity of the domestic capital market need not necessarily be strained by privatization.

Nevertheless, it is important not to generalise, as the elements of privatization tend to vary not only across industries but also across countries and there is the need to assess each privatization attempt on its own merit.

The rest of this report is organised as follows. Section IX.3 reviews the various privatization options that are available and identifies the feasible options for the National Water Commission and the Government of Jamaica. Section IX.4 reviews international examples of privatisation and assesses their relevance to the Jamaican case. Section IX.5 then analyses the viability of a privatised sewage system in Jamaica, using estimates from the 1991 proposal by Future Water Inc. and develops a model to analyse possible economywide effects of privatization showing in particular the benefits and costs to the government's budget and payments account. Section IX.5 discusses regulatory issues and pricing consideration under privatisation. Section IX.6 presents the conclusion of the report and policy recommendations. Annex "A" develops a benefit analysis of privatization considering the Kingston Harbour Environmental Proejct, and presents some international examples of privatized water and sewerage systems.

IX.3 PRIVATISATION OPTIONS FOR JAMAICA

IX.3.1 Public/Private Partnership

Under this arrangement, the private partner designs, constructs, owns and operates new or existing wastewater treatment plants and guarantees the performance of the new treatment plants in meeting all the environmental and health standards. The Government is responsible for leasing of land to be used for wastewater treatment and the establishment and collection of user fees. Service fees are then paid by the Government on a periodic basis to the private partner.

An example of this form of privatisation attempt is that of the city of Auburn/ Metcalf & Eddy Inc. partnership on wastewater treatment in Alabama. The source of funding for this project was the issue of bonds by the Government, backed by plant revenues. Here, the Government issued 25 year floating /fixed rate tax exempt industrial development bonds to the value of $36 million. The city pays the fixed rate on the bonds and if the floating rate goes below the City's fixed rate the private company pays the difference. These bonds were rated AAA and insured. Another example of this arrangement is that of the City of Chandler and Parsons municipal services.

Whilst this arrangement seems to pacify concerns about losing autonomy or control over water and wastewater management, by retaining some degree of control, it does not meet the objective of reducing the role of the government in the economy and freeing up government resources for other purposes. Another variant of this arrangement is that of the New German Lander, where a subsidised loan programme for water projects is guaranteed by the host government. This loan

IX.5 MACROECONOMIC EFFECTS OF PRIVATISATION

This section attempts to show the economywide effects of privatising the Water system in Jamaica using some economic criteria[1]. Traditionally, project evaluation is based on cost benefit analyses which indicate whether the economic and social benefits of the project are greater than the costs and projects are selected by ranking the possible projects in terms of the returns from each project.

In the case of privatisation, the comparison is between current level of production and expected stream of economic magnitudes after the establishment is privatised. This implies that the criteria of using internal rates of return, net present values and cost benefit ratios need to be modified to take into consideration factors that may change after privatisation.

While privatisation is usually fueled by social, political and even ideological changes, this technocratic approach provides a framework that enables policymakers to make important decisions fully informed of the economic consequences of policy options chosen.

Privatisation may lead to the improvement of machines and equipment, which would lead to increased production, increased quality and a reduction in costs of production. It may even include management changes that increases efficiency and profits. When enterprises that are previously owned and operated by government are privatised, then subsidies that were previously paid by the government to ensure viability, may be freed and used more productively. This reduction in subsidies, generates employment in other sectors, reduces the budget deficit, leading to positive effects on capital markets in the economy.

Indirect effects could take place through interindustry linkages.

Two important criteria that must be met are, (a) comparing net value added before and after privatisation, and ensuring that net value added after privatisation is greater, (b) efficiency criteria of ensuring that internal rates of return after privatisation is greater than it was before privatisation. Below these are discussed in further detail.

---

1 The macroeconomic approach used is based on Andic Fuat M. "Privatisation: Some Theoretical and Practical considerations". Occasional Paper #100, April 1988, Latin American and Carribean Centre, Florida International University.

IX.5.1 Value Added

One of the criteria used to assess whether the net value added after privatisation is larger, or at least equal to net value added before privatisation, is "net value added". The net value added is the value of output less the value of material inputs consumed in production and services purchased from outside the entity, minus investment outlays. This criteria implies that the present value of net value added after privatisation is greater than the present value of net value added under government operation.

$$P(NVA)_p / P(NVA)_g > 1$$

where NVA = Net Value Added
P = Present value
p = privatised
g = government

The second criteria is to ensure that the internal rate of return after privatisation is greater than cost of capital and greater than the internal rate of return under government operation. This implies that:

$$IRR_p / IRR_g > 1$$

where, IRR = internal rate of return

If value added is distributed between capital and labour, then we want to ensure that returns to capital after wage payments are made are greater under privatisation than under government operation. This implies that:

$$P(NVA)_p - P(W)_p / P(NVA)_g - P(W)g > 1$$

where, NVA = Net Value Added
W = Wages
p = Privatised
g = government

The internal rate of return of the project must therefore exceed a minimum acceptable level; typically the interest rate used for foreign loans.

Using the concept of net value added after the entity is privatised, we can assess macroeconomic effects of privatisation in direct and indirect terms. The direct effect of privatisation is the increase in NVA after privatisation, e.g supplements private sector equity, and if there is a default, the government succeeds to the rights of the lender. The private participant loses its equity. Given the apparent desire of the Jamaican government to rid itself of the burden of being actively involved in the provision of wastewater treatment, such a partnership would not be an appropriate solution for Jamaica.

IX.3.2 Leased Transactions

These refer to arrangements under which the public authority leases assets, and equipment of the public utility to a private party.

Major capital improvements to the assets remain with the owner (i.e. the public authority). Such an arrangement limits the capital formation and the overall condition of assets would determine payments on the lease. Rental payments on the lease would come from fees charged to users of the facility.

The advantage of this type of arrangement is that it does not raise the debt of the lessor, i.e. the public utility, and it is favoured over those arrangements where the public utiltiy issues bonds or guarantees debt. It is also useful where authorities lack sufficient bond authorization. The leases can be set to cover the lessee's operations, maintenance and repair costs and public authorities cost of capital investments.

Such leased transactions may not be suitable for Jamaica because of the need for capital improvements to upgrade wastewater services and increase efficiency. But it has also been argued that if leased arrangements improve financial efficiency, then the entity may attract more investment capital which would lead to improved services.

IX.3.3 Public /Private Partnership With Direct Public Financing

This arrangement involves the private partner contracting to manage all construction and operation of the facility. Commercial risks associated with construction and operation are borne by the private partner, and they share consumption and user default risks with the public partner.

The public authority is responsible for all financing, and assumes the costs of capital risk, the risk of changes in environmental laws and part of the consumption and user default risk. The Public authority can borrow directly from the revolving fund of the World Bank to finance new investments. The major disadvantage of this system is that it raises the indebtedness of the government.

IX.3.4 Majority Public Ownership

This refers to arrangements where private partners act as financial investors, while ownership rests with the public authority and they operate the facility. This assumes that the public entity is efficient in the provision of the service and private partner participation is the sole objective. Such an arrangement is useful where there is a desire to involve the private sector in the service as the ultimate objective of the government.

IX.3.5 Private Financial Equity Ownership

This arrangement refers to the sale of equity ownership to members of the Jamaican public or private corporate purchasers. The government sells the utility in a share flotation and companies are later allowed to charge user fees sufficient to make an appropriate return on capital and have exclusive franchises.

This kind of arrangement satisfies the objective of democratising the ownership of assets, but the successful sale of shares depends on public perceptions about the viability of the company and the price at which shares are sold. In order to raise a substantial amount of capital the price per share has to be sufficiently high, or the volume of shares high enough to generate the capital required. Clearly this conflicts with making shares available and accessible to the general public.

IX.3.6 Concessions

Concessions are arrangements under which the private partner is allowed to build, expand, own and operate water and wastewater treatment facilities over a period of time, at the end of which assets are transferred back to the public authority. This is normally referred to as the BOOT in the privatisation literature and is increasingly becoming the most popular of all privatisation attempts. These arrangements ensure that capital expended during the tenure of private ownership would be recovered during the time that the concession lasts. Typically under this form of arrangement, the concessionaire is entitled to a concession fee which is ultimately provided by charging user rates which provide this concession fee on an annual basis. The concession fee may be in two parts, with the first part being an indexed operating component such that, if operating costs exceed this component the concessionaire loses money and, if operating costs are lower, it makes profit. The second component, is the fixed capital component and is based on the capital cost of the concession. The annual capital component of the concession fee is that amount which provides for repayment of debt and an agreed return on equity.

The capital component of the concession fee is given preferential clauses, such that a default or termination by the concessionaire does not terminate the capital component, but gives the public authority the right to transfer the concession including the capital component to another party. Also, should the capital component turn out to be insufficient because of lower consumption of services, default by users of the facility, or excess costs due to environmental change of laws then the public authority must permit an increase in rates or make a payment to the concessionaire to ensure economic viability. In sum, these provisions insulate the investors from (i) operating risks (ii) consumption risks (iii) consumer defaults (iv) changes in regulatory policy.

Clearly this form of arrangement necessitates a long period of concession or higher user fees for the recovery of capital investments of tens of millions of dollars.

IX.3.7 Conclusions

The concessionary form of arrangement seems to offer advantages for Jamaica, because it involves capital inflow into the economy and the concessionaire could be required to create a local company with part ownership by Jamaicans. This arrangement would allow the government to reallocate some of its domestic expenditures in other sectors of the economy, and play only a regulatory function in the privatised sector. Examples of this abound and include the Turkish government's deal with a private consortium, led by Philipp Holzmann AG, on a hydro electric project in that country, a 1.1$bn water deal between the Malaysian government and Lyonnaise des Eaux/ Dumez of Paris, and the $4.0bn water concession arrangement between the Argentine government and the consortium Aguas Argentinas.

IX.4 INTERNATIONAL EXAMPLES AND LESSONS FOR JAMAICA

IX.4.1 United States

In this country, water supply and wastewater treatment is typically organised and owned by municipal governments. Problems facing these municipal governments are similar to those in Jamaica. There are serious problems with deterioration of capital, maintenance is very often deferred, water supply is frequently unreliable and services are underpriced. These problems are the result of serious budgetary constraints at the local government level. The problem in Jamaica is of the same nature perhaps varying only by severity. If privatisation is seen as a solution in the U.S.A then it is worth considering in Jamaica as well.

In the U.S.A, the response has taken the form of infusing private sector activity into the sector, ranging from wastewater treatment facilities to entire water systems. Currently there are over 300 operations and maintenance contracts between local governments and private investors, in small cities, as well as in large ones such as New Orleans and Houston.

The U.S.A privatisation attempt is characterised by competitive franchising, restricted length of contracts, and operation and maintenace contracts. Current policy is moving in the direction of full scale privatisation away fom the current transitory privatisation in order to increase efficiency gains and capture part of the growing world market in water systems.

IX.4.2 Britain

This country privatised its 10 major public water authorities in 1989 implementing a full scale privatisation. This $8.3bn sale was financed entirely by the private sector.

Striking characteristics of the British model include a price control regulation that preserves the incentive to reduce costs, through a price cap regulation. Despite this, the cost of water services in this country has risen since privatisation.

IX.4.3 France

Perhaps this is the country with the longest history of private sector participation in the water and sewerage sector. Almost 65% of water supply customers are served by private water companies with two main approaches being concessions and lease contracts.

The concessions include:

(1) Exclusive rights and complete responsibility for a period of time usually 25 years.

(2) They are typically BOOT arrangements; i.e. investors build, own, operate, and transfer the system back to the relevant authorities at the end of the concession.

(3) Tariffs and provisions for adjustments are provided in the contracts.

The Leases include operation and maintenace roles for the private party, whereas ownership rests with local authorities. Tariffs are arranged to be adjusted and provisions are made for contributions to a capital fund.

IX.4.4 Developing Country Experiences

A large number of developing countries, including Argentina, Mexico, Chile, and Cote D'Ivoire, are turning to privatisation of their water and wastewater treatment plants. This privatisation impetus, is also very much present in post communist Europe, where massive privatisation of entire economies are taking place.

For example the city of Brno, in Czech, recently approved a plan under which it will own the infrastructure of the water and sewer utility, but the operations and maintenance management will be undertaken by a private firm. This firm has as shareholders, both the City and private investors.

Perhaps the most striking case of privatised water entity in a less developed country, is that of the Societe de Distribution D'eau de la Cote d'Ivoire (SODECI), which was established in 1959. The government entrusted management of urban water supplies to a French company, Societe d'Amenagement Urban et Rural (SAUR) which held the majority shares in SODECI.

In 1980, paid in capital of SODECI was increased as SAUR slipped from being a majority shareholder to a 46.5% level, whilst Ivorian nationals took over 47.8% of the shares. By 1983, Ivorian nationals had 52% of total shares.

SODECI has been criticised on distributional grounds, in terms of their failure to provide water connections to house owners in poorer areas of the city at a cheaper rate, creating a need for government to subsidise these water connections. Despite these distributional issues, the World Bank evaluates it as the most efficient, offering one of the highest standards in all of West Africa, in water quality, with uniform pressure.

The major factors identified for this success are,

(1) The setting of water tariffs to reflect costs fully

(2) The fact that consumers pay for service rather than taxpayer.

The experience in Cote d'Ivoire is not restricted to water connections alone but also to street cleaning and wastewater disposal. In the second largest city Bouake, this is entrusted to a private company, the Societe industrielle de transports automobiles africaines (SITAF). SITAF has collection points every 30 meters in medium and high cost housing areas, and a 100 meters interval in poorer areas. The company is paid by contract by the city. Based on data from the city, Stren R.E. (1990), argues that low income densely populated areas with 20.6% of total population, were allocated 10.1% of SITAF's total resources, whereas high income low populated areas were allocated 14.5% of resources.

XI.4.5 <u>Conclusion</u>

Our review has shown that privatisation of whole water systems and wastewater treatment systems is on the increase worldwide. Developed countries have seen the importance of this scheme in increasing efficiency. Perhaps the most instructive example, is from a developing country, Cote d'Ivoire. The major weakness of the scheme is its distributional consequences,in terms of increases in tarrifs for low income earners, which has been shown can be overwhelming, not only in developing countries, but in the developed ones as well.

$$\sigma NVA_d = NVA_p - NVA_g$$

where the net value added is obtained as the value of total output minus material inputs used up in the production process defined as follows:

$$NVA_i = O_i - (MI + D)_i$$

where, O;	= Indirect Output
MI	= Material inputs
D	= Depreciation

Estimates of value added by the water sector could not be derived accurately from the 1980 input output tables, due to the aggregation of the sector with electricity. Also, even though the gross value added for both water and electricity stood at $J75.8m in the 1980 input-output tables, estimates of gross value added by the water sector alone in 1991 from Statin was $J187.9M[2] This is probably due to the high levels of inflation, but could also reflect substantial errors in the statistical exercise, calling for cautious interpretation of any estimations based on these numbers. Given a gross output value of $J506.0m, material inputs worth $J318.1m were derived, leaving the gross value added by the sector under government operation to stand at $J187.9m and net value added of $J169.16m after depreciation.

In order to estimate the net value added under privatisation, the cash flow analysis submitted by Future Water Inc. was used to obtain an idea of what the expected levels of value added would be. The cash flow analysis starts off on a different premise and items are classified to suit that purpose; e.g. operating revenues from all sources are categorised from domestic users, commercial users, revenue from fertiliser and irrigation etc. Operating surplus was then obtained by subtracting operating costs which include labour, materials, administrative costs, land lease etc.

To preserve the economist's definition of value added, these accounting cost items were reclassified, including payments to all factors of production in the value added estimate. Value added was derived as the total revenue from all sources minus the value of material inputs used up in the production process.

---

[2] See annex B, item 2 of data submitted by Francis A.

The year used in this exercise is 1998, where the cash flow analysis includes money set aside for depreciation. A net value added of $3,728,808 was derived from the input-output table. This was multiplied by an adjustment factor of 2.5 to allow for inflation and comparison, as the estimates by Future water included only sewage disposal, whereas the Statin estimate was for the water sector as a whole. This was then converted to Jamaican dollar terms using a (then) current exchange rate of $J22 to 1 US$, yielding a value added of $J205.08m.

The change in net value added expected after privatisation is thus determined as approximately $J39.52m.

This change in value added also has indirect effects on other sectors and on total output, captured by the extent to which changes in output of the sector affects productivity in other sectors of the economy. The change in net value added indirectly is derived as follows:

$$\sigma NVA_i = NVA_d . k$$

where NVA_i is the net value added indirectly and k is the income multiplier of the privatised sector. Assuming that the change in net value added directly serves to increase consumption on domestic goods and services with very small leakages in the form of savings and imports, then this direct increase in value added will spur on additional increases of output in other sectors via the income multiplier. Assuming an income multiplier of 2 (based on Canadian experience)[3] the indirect increase in net value added will be $J79.04m.

The total output effect of privatisation is then the sum of the indirect and direct output effects.

$$\sigma NVA = \sigma NVA_d + \sigma NVA_i$$

which is estimated to be $J118.56m.

Given the 1991 base year value of net domestic product of Jamaica we calculated the change in net domestic product and the change in net value added to obtain the rate of growth of the economy due to a privatised entity to be about 5%, based on the following formula;

$$r = \sigma NVA/\sigma NDP$$

[3] This value was chosen, based on estimates made for Canada, (See Lipsey, Purvis and Steiner; Macroeconomics, Seventh Canadian edition), on the assumption of marginal propensities of not spending of 0.5. There is the possibility that this may be higher for Jamaica due to lower savings rates.

method of payback was from a monthly surcharge on consumers. Another case is that of the City of Auburn, Alabama, which went into partnership with a private firm, to provide a $36m wastewater treatment system, for the use of the community.

These American examples are minor compared to trends in other European and Latin American countries. Recently, a concession was granted to a private firm (Aguas Argentina) for thirty years, to provide a water plant, upgrade existing systems and wastewater facilities for eight million people in Buenos Aires, Argentina. The total value of this project is $4b U.S.

Another example is that of Mexico City, where the public authorities (Comision del Aguas) have contracted out water distribution and collection services to a private firm. The value of this project was estimated at $120 million over two years, and includes metering and mapping of the city, billings and collections as well as customer service facilities.

Another major privatization attempt is in Malaysia, where a twenty year concession has been awarded to a private firm to provide water and sewerage services. The value of the project is estimated at $1.1 billion and is to be financed through a combination of debt and equity. Izmit, Turkey is yet another example with a 15 year concession, and a project worth $700 million. The bulk of the project is being financed with a loan from a Japanese bank.

Table 2 shows a listing of privatization in water and sewerage and techniques used in each case. With the exception of Liberia, which is still in process, all of the above countries have completed these projects. The concessionary arrangement seems to be the most common method adopted, and is probably the best method for the water and sewerage sector in a country without much domestic savings. However, as shown in the case of the United Kingdom, the water and sewerage sector can also be privatized in a public offering of shares.

The concession method has been fully tried in France with good results, and has led to its application in many countries e.g. United Kingdom, Spain, Casablanca, and Macao. Its variant, the "affermage" differs only by length of contract and the fact that the government maintains certain rights of control. The private operator is legally responsible for the utility service, collects all water fees and under takes the operational risk. It may be required to build into rates an amount to be remitted to the owner to cover all aspects of financing costs of the asset as well.

Typically, in cases where the underlying assets have long been in existence, the private partner may make investments for renewal, and finance investment for expansion and construction, under a concessionary arrangement, but elements of the affermage, would be used for facilities that are already in existence.

TABLE 2 PRIVATIZATION TECHNIQIUES

Country	Enterprise	Activity	Method
Cote D'ivoire	Sodeci	Water Distribution	Affermage
"	Forexi	Water Prospecting	"
"	Sitaf	Wastewater Treatment	"
Guinea	Nwds	Water Distribution	Lease
Liberia	Water and Sew. Corp.		Concession
Malaysia		Water Supply	Mgmt Contract
Singapore		Water Distribution	Divestment(25%)
United Kingdom		Water Distribution	Public Offering

Source: "Techniques of Privatization", Vol.3 World Bank Technical Paper #90.

Table 3 below shows cases in which privatization has been attempted in either the water and sewerage sector or electricity sector or both. Due to lack of detailed information, it was not possible to ascribe it to either sector. The table thus shows countries that have attempted to do this in either sector and the method adopted in each case.

TABLE 3 PRIVATIZATION OF WATER AND ELECTRICITY

Country	Method
Austria	Public Offering
Canada	Private Sale
Chile	Private Sale/public Offering/ Employee Buy Out
France	Management Contract / Lease
Grenada	Private Sale
Guinea	Lease
Japan	Private Sale
Korea	Public Offering
Malaysia	Management Contract
Phillipines	Private Sale
Spain	Public Offering/ Management Contract

Source: "Techniques of Privatization" World Bank Technical Paper #90

This table shows that privatization in either water or electricity, has taken place in developed countries such as Canada and Japan, and in poorer ones such as Grenada and Chile. Three French companies are involved in the water sector in Cote D'Ivoire and also in Argentina and Malaysia. This suggests that investment in these sectors by foreign companies are possible, provided the correct incentives are put into place. The next section, discusses the conclusions and the necessary steps that may be taken to ensure a successful privatization attempt.

CONCLUSIONS

This review has shown that though privatization in the water and sewerage sectors are still in their formative stages, trends in the industry suggest that this method will become a permanent feature in many countries.

Private capital can be attracted to the privatization of water and sewerage utilities, provided incentives to do so exist. Since water and sewer utilities are generally capital intensive operations, investment in the sector is not attractive, unless the tax systems, tarriff regulations and concessionary periods are attractive. The period of time given by the concession should be sufficient for investors to amortize their investments.

Typically, privatization of a utility service would require some sort of restructuring, prior to privatization, in particular in terms of employment. Such restructuring may make the establishment more susceptible to attracting private capital. An outline of some of the steps that may be taken in the process is given below;

Readying Steps

(1) Creation of a public limited company
(2) Transfer of assets and liabilities
(3) Transfer of personnel
(4) Valuation of companies' worth
(5) Changes in accounting methods
(6) Establishment of regulatory framework
(7) Listing on stock exchange

While this process is indicative of cases where a public offering is made, adjustments could also be made in cases where there is an outright sale to a foreign company, or public/ private partnerships.

Privatization of public utilities require that the interest of the public be safeguarded. The government must ensure that adequate regulatory mechanisms are established. In particular, the basic accompanying measures to ensure quality and continuity in the provision of the service. A license may be granted to impose certain obligations and pricing mechanisms. The government may also legislate standards on labour.

However, the private investor may also seek government to commit to freedom of transfer of capital, and distributed income. They may also ask for assurances that they can wind up the firm, and some freedom from price controls.

These different objectives mean that the government must be clear and sure of the types of incentives and assurances that they are prepared to offer. The success of any privatization attempt depends on tactful negotiation and the political will to do so.

TABLE 1

INTERNATIONAL EXAMPLES OF PRIVATIZED WATER AND SEWERAGE SYSTEMS

City/Country	Type of Agreement	Financial	Value of Project U.S.$
West Frankfurt Illinois	Public/Private	Bonds	$4.3M
Buenos Aires Argentina	Concession		$4.0B
Mexico City Mexico	Contracting Out		$120.0M
New Orleans Louisiana	Management Lease		
Houston Texas	Management Lease		
Izmit Turkey	Concession		$750.0M
Malaysia	Concession	Equity Debt	$1.1B
Brno Czechozlovakia	Lease Contracts		
Auburn Alabama	Public/Private Partnership	Bonds	$36.0M
Chandler	Public/Private Partnership	Bonds	

Benefits

The Kingston Harbour Environmental project forecasts a $300 million cost for a sewerage system to accomplish significant Harbour improvements such as would affect the welfare of private individuals, government profits in the economy. The benefits of this investment would be an aggregate of the effects on each of these factors. The effect on these factors depends on how this investment is financed. If the project is publicly financed (e.g. through a tax mechanism), then there would also be effects on the expenditures of private individuals who would otherwise have had more discretionary income. If the "sale" is to domestic consumers, e.g. through pension funds, the effect would depend on the effect on capital markets and the changes in interest rates that might occur as a result. These changes in interest rate would determine whether investments in other sectors of the economy would be affected. For example, if workers are compelled to purchase shares, this would reduce their opportunity to place savings elsewhere, and some investment would be crowded out. If workers were saving nothing before, then we expect the capital market repercussions would be minimal. Foreign funding can be seen as an addition to domestic resources, and may enhance gains from privatization. However the gains may be limited by the constraints that may arise from the eventual need to repatriate capital or service debt.

In the macroeconomic approach described earlier in this report, the effects of privatization were assessed from the increase in net value added as a result of privatization. This was described as having subsequent effects on employment, the government's budget, and the balance of payments.

Employment Effects

In order to assess the effects of different levels of investment, we proceed in a similar manner by assuming that all of the investment is an exogenous infusion of capital, and has no effect on investment in other sectors of the economy.

Employment effects for different levels of investment are shown in Table 1 following. Employment effects are subject to wide variation, as labour markets do not operate on a single logic, especially in a developing country with many market imperfections. It is important to note that the Kingston Harbour Environmental Project is capital intensive, and hence employment impacts may not be the overwhelming effect. Estimates from Sentar's cost analyses suggest operating and maintenance costs ranging between 3% to 7% of total costs, with the bulk of long term employment effects arising through maintenance and operation, after the initial construction has been completed. Employment due to construction would be high initially and then taper off as the capital and machinery is put in place. Other indirect employment would likely vary in proportion to the direct employment generated. From a more macroeconomic perspective on privatization in general, we can assume that the total effects are the sum of direct and indirect effects. Direct effects are calculated as the difference in privatized employment and non-privatized employment due to the privatization, added to any changes in government employment that may occur after privatization. Indirect effects on employment (e.g. through higher construction industry employment etc.) are estimated by the employment multiplier of privatized employment, and government employment. At the level of operations in 1984, the USAID study of the National Water commission estimated that there were about 77[1] people employed per 1000 connections in Jamaica. Given a level of 79,000 connections (1984), then total employment by the sector was approximately 6000. One of the objectives of privatization is to improve efficiency, however the specific instance provides a new expanded facility with added elements, increasing the level of service, hence yielding about 100 new jobs rather than fewer jobs. This was derived as the difference between new employment in the newly privatized entity and employment in the preprivatized entity plus any change in government employment that may occur due to this, (which has been set at zero in this exercise). This number compares with Sentar's analysis, which suggests a direct employment level of 30 people for the new system, once the facility has been built. Hence, an investment of $300 million to finance privatization would presumably change employment levels more in an indirect manner than directly.

TABLE 1 : EMPLOYMENT EFFECTS

Direct Effects		Indirect Effects[2]	
E_p	= 6100	E_p	= 6100
$-E_g$	= 6000	$-E_g$	= 6000
$+E_c$	= 0	$* m$	= 10
σE_d	= 100	$+ E_c m$	= 0
		σEi	= 1000

NOTES: The following are the meaning of the letters used.

E	=	employment
Ec	=	indirect public sector employment
Ed	=	direct employment
Ei	=	indirect employment
p	=	privatized
g	=	non privatized
m	=	employment multiplier

Total effects, as given by the sum of direct and indirect effects, therefore add up to 1100 new jobs. Two other levels of investment from the total of \$300 million were also considered - \$85 million and \$150 million. These levels roughly represent a possible first stage, and a minimum "ultimate" system respectively, whereas \$300 million is the approximate cost for sewering the entire city. The levels of employment for \$85 million of investment and for \$150 million, are extrapolated as lying between 400 and 600 new jobs respectively.

[2] Assuming that the employment multiplier was 10, then we expect an increase in indirect jobs of 1000. This multiplier is fairly arbitrary given no information on its actual value for Jamaica, but is believed to be fairly conservative since it measures employment responses throughout the economy. The direct employment response is, however, the more important estimate here.

Budget Effects

Budgetary effects dwell on the fiscal impact of privatization, in particular on the effect on subsidies and debts on the government's balance sheet. The IMF's basic approach in this area is to set up the specific relationship between public sector accounting and the government's budget[3]. An analysis of different levels of investment requires that a part of these levels of investment be treated as capital revenue to the government, and the other part treated as loan repayment.

For example if the government sells all assets that it held for its own use, then the revenue may be treated as capital revenue. If it sold its interest in a public enterprise then it is a sale of equity and may enter government accounts as loan repayment. In the case of water and wastewater treatment, privatization affords the government both a capital revenue and a loan repayment. The instantaneous impact would be the value of sale proceeds on the government's budget. Assuming that 10%[4] of this investment accrues to the government as capital revenue then at $300 million U.S. level of investment, we expect governments budget to improve by $30 million U.S., or $15 million U.S. and $8.5 million U.S. if the lower levels of investment prevailed; or $J660 million, $J396 million , or $J187 million in terms of local currency.

Improvements in the budget situation of the Jamaican government would have important monetary and financial implications for the economy as a whole. In particular, reductions in the level of government's deficits would lower the cost of borrowing, and moderate the levels of inflation in the economy. All of these should contribute to improving the balance of payments as goods tend to be more competitive in a low inflationary environment.

---

[3] See Ali Mansoor " Fiscal impact of Privatisation" IMF TECHNICAL PAPER #87

[4] This assumption is based on the fact that the required financing of various levels of investment may mean that the bulk of investment would be from abroad, in which case a 10% share of proceeds payable to government is fairly typical. Note that this exercise assumes that government would utilize such proceeds to reduce its debt. There have been cases where governments have instead directed proceeds into other activities; e.g. Turkey, where the government invested in housing instead, hence foregoing any fiscal benefits to the sale.

Editor's Note

The assumption also presupposes the financial ability of the system users to support not only the rates forecast for the system but also to support the payment to the Government and a return to the operators - an unlikely scenario based on the financial analysis of Sentar's report.

Table 2 shows the summary of the fiscal effects. Assuming that 10% of investment accrues to the government as sale proceeds, and using the values obtained for subsidies and debt incurred for the sector, we obtain the immediate effect of such a sale.

TABLE 2: FISCAL EFFECTS OF INVESTMENT

Investment :	**($300M)**	**($150M)**	**($85M)**
10% Of Sale Proceeds	$30M	$15M	$8.5M
In Jamaican $ Terms	$J660M	$330M	$187M
Less Subs. And Debt.	$J527.8M	$J527.8M	$J527.8M
Impact Effect	$J133.0M	$J-197.8M	$J-340.0M

The results show that the investment level of $300M would have the effect of reversing the deficit, while the $150M and $85M investment would reduce, but not reverse the budget stance.

In the next subsection we focus our analysis on welfare considerations of these levels of investment, moving away from the quantitative "best guesses" to a more qualitative assessment of welfare effects. The three main effects considered are the effect on consumption, profits, and government. A project aimed at providing sewerage services may have a great impact on improving living conditions of consumers, whether this would translate into increased consumption is another issue. Profits in the economy may also be affected and finally the government is affected financially by the project. We accorded government funds a pivotal role in the effect on the economy as a whole, and hence, gave it the greatest weight in the ranking. It is also shown that whereas these rankings may not differ much by way of the level of investment, consumption effects are ranked higher than profits when the highest level of investment is pursued. The major justification for this ranking is the ultimate objective of economic growth, and the importance of government funds in achieving this end.

TABLE 3 : BENEFITS FROM INVESTMENT

INVESTMENT LEVEL (Millions U.S.)	**$300**	**$150**	**$85**
Welfare Considerations (Ranking)*			
(A) Consumption Effects	5	2	1
(B) Profits	3	3	2
(C) Government Revenue	7	5	2
TOTAL	12	10	5

*** Qualitative Ranking**

Based on these welfare considerations. the higher level of investment appears to be a preferred level for Jamaica. Given that a higher level of investment affords more connections to customers, then welfare gains to consumers are also higher when the level of investment is greater. Government funds are highest under that level of investment, and consumer benefits are also maximized.

Of course, this assessment does utilize a subjective, although relative, assignment of point values, hence is not a rigorous analysis.

NOTES:

Freeman, A Myrick (1990) " Water Pollution Policy" in Public Policies for Environmental Protection, (ed) Portney Paul R., Resources for the future, Washington D.C.

Mansoor Ali (1991) "Fiscal impact of privatization" In Privatization in less developed countries (ed) Cook P. and KirkPatrick C.

Stren Richard E. (1991) "Urban Services in Africa" in Privatization in less developed countries (ed) Cook P. KirkPatrick C.

Tietenberg Tom (1992) Environmental and Natural Resource Economics, 3rd edition, Harper Collins Publishers.

INTERNATIONAL EXAMPLES OF PRIVATIZED WATER AND SEWERAGE SYSTEMS

This section presents some information on privatization experience in the water and sewerage sectors in several countries. It describes the methods and options that were used in each case. The report does not give uniform information for each case, due to the unavailability of such information. It provides information (where available) on the type of agreement, financing, value of the project, and the method of payback.

Privatization of water and sewerage facilities are not common, but they are increasingly becoming a solution to debt ridden governments of both the developed and less developed countries. The importance of the water and sewerage sectors in most countries makes the issue of privatization more sensitive, as governments are wary of putting into private hands, sectors that provide services for the public good. Nevertheless, trends in the industry seem to suggest that, privatized utility services could become a permanent feature in many countries in the 1990's.

The techniques used include

(A) Public Offering Of Shares
(B) Private Sale Of Shares
(C) New Private Investment
(D) Sale Of Government Assets
(E) Reorganization Into Parts
(F) Management/employee Buy Out
(G) Lease And Management Contracts

These methods have all been applied either partially or totally, and several combinations exist as well. They can be used for either partial or total divestiture or denationalization. Naturally the best option and technique used depends on the nature of the sector to be privatized. Table 1 following, shows cases of privatization with the options chosen varying from management leases to concessions. Most of the cases in the United States show Public/Private partnerships, where the private party sees to the construction and operation of the system, and the public authority is responsible for all financing. In the case of the City of West Franfurt in Illinois, the private company was given the task of designing, building and replacing the entire water system. The value of the project was $4.3m, which was financed by insured general obligation bonds. The