Institutional Strengthening & Preparation of a Zoning & Physical Development Master Plan for Kingston Harbour

Literature Review Report

Submitted to the

National Environment and Planning Agency

Project No. ATN/SF-8164-JA

By

SMITH WARNER INTERNATIONAL
COASTAL & ENVIRONMENTAL ENGINEERING

September 2004

Document Objective

This document has been prepared as the first major deliverable for *Component A – Institutional Strengthening and Preparation of a Zoning and Physical Development Master Plan for Kingston Harbour* of the Inter-American Development Bank (IADB) project titled *Institutional Strengthening to Support Environmental Management of Kingston Harbour* (Project No: ATN/SF-8164-JA). This report presents the findings of a literature review of obtainable documents pertaining to the physical and ecological conditions and plans of Kingston Harbour. It is intended to be a summary document for the purpose of conveying pertinent information for the further completion of this project.

Executive Summary

Background

Kingston Harbour is considered to be one of the finest natural harbours in the world. The harbour is an elongated bay, or lagoon, extending 16.5 km from east to west and 6.5 km from north to south, with a total surface area of approximately 51 km^2 (Wade 1976). The city of Kingston, comprised of industrial, commercial and residential developments, lies to the north of the harbour and at the western end are the modern residential developments of Portmore and Independence City.

In its original state the harbour was contiguous at its western margin with a shallow embayment, Hunts Bay. The southern margin of the harbour is bounded by a shingle spit, The Palisadoes, a fascinating geological formation built by long-shore drift of sediments tying together a number of derelict coral cays to form a 15 km long tombolo (Goreau and Burke, 1966; Hendry, 1978). The entrance to the harbour is a 2 km wide channel in the south-west corner (Wade, 1976) and this leads naturally into a deep channel, which curves around the northwest side of the harbour providing navigable access to its inner basins. This channel, usually referred to as 'the ship channel,' is a natural formation, probably maintained originally by natural water circulation (cf. Goodbody, 1968, 1970).

Environmental Indicators

Several biological parameters have been studied over the years, and have been used to gauge the environmental health of Kingston Harbour. Notably, the conclusions drawn from the

comparative studies have all indicated that there has been a general decline in the environmental health of Kingston Harbour since the 1960s. Coliform concentrations, crustacean, fish and plankton abundance, as well as seagrass densities all point towards a deteriorating ecosystem. Many of the researchers attributed this decline to increased nutrient concentrations in the harbour as well as the input of several other significant pollutants.

A substantial amount of work has been done in Kingston Harbour with respect to gathering physico-chemical data. However, two major studies pertaining to the water quality in the harbour have been conducted during the past thirty years: the first by Wade (1976), and the second by SENTAR (1993). In general, the data indicates an increase in the nutrient, DO and phytoplankton (chlorophyll a) concentrations over the period. By contrast, the phosphate levels have remained roughly the same and the salinity has decreased. The general conclusions from these comparisons are that the harbour is receiving significant freshwater and nutrient inflows, which are contributing to an overall decline in the water quality of the harbour. Webber and Wilson-Kelly (2003) assessed the organic pollution to Kingston Harbour. They found that sewage is by far the most important contributor of organic pollution to Kingston Harbour, with Greenwich and Western sewage treatment plants being the most significant point sources of pollution to the harbour. River flow was found to be the second largest contributor to organic pollution to the harbour.

Water Quality

There are various categories by which water quality standards are grouped and set. These vary from drinking water (potable) standards, to recreational water standards, to effluent standards. The standards are generally applicable to the use of the water. Following a review of water quality standards and the known values for Kingston Harbour, some standards have been proposed for select water quality parameters for specific recreational areas, identified sensitive ecosystems and for general use of the harbour. The parameters selected reflect those deemed most indicative of ecosystem health and general pollution, and which are most feasible for analysis. These are indicated in the following table.

Parameter	*Recreational Areas*	*Sensitive Ecosystems*	*General Harbour*
DO	6	6	6
COD			100mg/L
BOD	20mg/L	20mg/L	30mg/L
TSS			20mg/L
Nitrate	0.5mg/L	0.01 mg/L	
Phosphate	0.1 mg/L	0.001mg/L	
Chlorophyll a	(0.4 mg chl a m^{-3})		
Parameter	*Recreational Areas*	*Sensitive Ecosystems*	*General Harbour*
pH	6-9	6-9	6-9

Faecal Coliform	<100 MPN/100ml	<1000 MPN/100ml
Total Coliform	<200 MPN/100ml	<250 MPN/100ml
Enterococci	<35 MPN/100ml	<35 MPN/100ml

Planning

To date, planning for Kingston on the part of government, quasi-government and private entities alike, has often been conducted in an "ad hoc" manner and has tended to be narrowly-focused, addressing a relatively short time horizon. Past planning efforts have not always involved broad stakeholder participation, while many completed plans have received insufficient dissemination. As a result:

- Plan recommendations remain unknown to stakeholders who could assist with implementation;
- Individual developments are not always coordinated;
- The potential cumulative impacts of a number of developments are not calculated or compared with carrying capacity; and
- Unnecessary effort is expended repeating the processes and the recommendations of earlier studies and plans.

The literature review has identified a number of plans that are still current or contain proposals that are still valid. These plans, which wherever appropriate will be incorporated as "givens" into the draft Kingston Harbour Waterfront Plan, include:

- The Shankland Cox and Marvin Goodman Downtown Plans;
- Vision 2020 Downtown Redevelopment Plan;
- The Port Royal Development Plan;
- The Port Royal-Palisadoes Protected Area Plan.

Review of several special purpose plans allows identification of existing or potential conflicts and alternative solutions. For example, resolution of conflicts between the Petrojam plant and the Greenwich Fishing Village may require a broader review of options available than has been the case to date. Additional work will be required by several agencies to identify a comprehensive set of siting criteria for fishing villages and other suitable siting opportunities.

The review is also allowing examination of the cumulative impacts of all recent, current and future infrastructure plans, including the Kingston Container Terminal, Norman Manley International Airport and the Coast or Foreshore Road. The examination to date has revealed that the total additional fill resulting from airport runway expansion, KCT 4, KCT 5 and KCT improvements beyond 2010 will amount to 99.3 ha (not including Highway 2000, toll plaza, fishing facilities, the Foreshore Road, etc.). Future fill may need to be undertaken in the context of a harbour-wide program of wetlands reclamation or creation.

Current planning efforts, especially on the part of the Kingston & St. Andrew Parish Development Committee and the Kingston Harbour Rehabilitation Project, are attempting to achieve:

- Incorporation of the Kingston Harbour into a holistic plan for managing influences on the Harbour;
- A level of coordination among waterfront users;
- The synergy that comes from integrated action;
- A long-term view of carrying capacity and sustainability; and
- Coordinated programs, such as wetlands mitigation banking.

Acknowledgements

Smith Warner would like to thank the following persons for their significant contribution to the content and preparation of this document: Mr. Maurice Jones, Ms. Alison Massa, Dr. Dale Webber, and Dr. Paul Wright.

Table of Contents

List of Figures

List of Tables

List of Acronyms

3M	Three -Mile
BOD	Biological Oxygen Demand
DO	Dissolved Oxygen
EPA	Environment Protection Authority (South Australia)
GOJ	Government of Jamaica
IADB	Inter-American Development Bank
JPS	Jamaica Public Service
KMA	Kingston Metropolitan Area
KRC	Kingston Restoration Company
KSA	Kingston and St. Andrew
KSAC	Kingston and St. Andrew Corporation
MLE	Ministry of Land and Environment
MPN	Most Probable Number
NEPA	National Environment and Planning Agency
NMIA	Norman Manley International Airport
PCJ	Petroleum Corporation of Jamaica
TSS	Total Suspended Solids
UDC	Urban Development Corporation
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WQ	Water Quality

1. Introduction

1.1. Background

Kingston Harbour is the main receiving water body for the city of Kingston, and accepts inflows from adjacent rivers, gullies, industrial and commercial facilities, as well as sewage treatment plants. Furthermore, Kingston Harbour is the primary port for the island, handling large volumes of marine traffic and the associated exposure to vessel-generated wastes and pollutants. The harbour water quality is badly degraded and numerous studies have indicated that, in fact, Kingston Harbour is contaminated and has suffered significant environmental degradation over the past several decades.

The poor condition of the harbour has long been recognized and over the past few decades there have been several attempts to address its environmental health. However, to date none of these efforts have been successful. It is now apparent that the failure of previous attempts to clean up the harbour is directly related to:

1. The lack of clarity as to the authority for and responsibilities of the many institutions that have a role in the use and management of the harbour, and
2. The limited communication and coordination between the relevant agencies.

This situation needs to be addressed sooner, rather than later, before the overall costs are so high that rehabilitation of the harbour becomes infeasible. The logical solution requires that the diverse number of stakeholders be coordinated through an institutional setting, such that ultimately an overall investment plan for the clean-up of Kingston Harbour can be supported and implemented.

Based on a recognition of the previous limiting factors to successful harbour rehabilitation, the Ministry of Land and Environment (MLE) led the Government of Jamaica (GOJ) in negotiations with the Inter-American Development Bank (IADB), to formulate a project for *Institutional Strengthening to Support Environmental Management of Kingston Harbour* (Project No: ATN/SF-8164-JA). The first component of this project, *Component A - Institutional Strengthening and Preparation of a Zoning and Physical Development Master Plan for Kingston Harbour* (KgnHrbr – A), seeks to specifically address the environmental management framework for the Harbour.

This document represents the first major deliverable for Component A, a Literature Review Report.

1.2. Scope of Work

The following is a presentation of the scope of work reported on in this first major deliverable for this project (KgnHrbr – A).

Task 1 Review existing literature on Kingston Harbour

It is recognised that there is a large amount of information that pertains to Kingston Harbour's environmental health and its surroundings. A review of the pertinent documents will require rapid digestion and summary, focusing attention on those that offer essential

information and those that help formulate a vision or visions for future action. Fortunately, members of the team have recently been engaged in similar literature reviews.

Sources of the review will include but not be restricted to the following:

The arrays of documents produced by:

- Prior Harbour clean-up investigation and modeling projects;
- The Palisadoes-Port Royal Protected Area program;
- The most recent Port Royal Development planning program;
- The papers produced for the KSAC/KSA Sustainable Development Planning program;
- Environmental Impact Assessments on projects and proposals affecting the Harbour;
- Documents and studies prepared by the Fisheries Division;
- Published plans for future development of the waterfront and adjacent lands;
- Published plans, policies and issue papers regarding urban area growth;
- Published plans and proposals for infrastructure improvement affecting the Harbour and its hinterland;
- Records of water quality monitoring and the condition of habitats and species of concern, over time;
- Laws, regulations and guidelines affecting future Harbour use, development and protection;
- Studies of socio-economic conditions in communities affected by and/or dependent on the Harbour;
- Plans and growth projections for future land use in the Hope, Rio Cobre and Yallahs Watersheds, to help establish general relationships between pollutant burdens on the harbour and land use, levels and types of growth, and environmental practices;
- Other studies assisting the establishment of linkages between land uses and practices, the growth of economic activities associated with the Harbour, and the health of the Harbour.

The output of this task will be a summary report on:

- *The environmental state of Kingston Harbour;*
- *Sources and relative contribution of contamination to the Harbour;*
- *Projected development in the harbour's hinterland, and proposed plans or ideas for future environmental and growth management; and*
- *Proposed plans and models for clean-up of the harbour and development of the surrounding waterfront.*

This report will be presented in a concise manner, for easy use by Government of Jamaica officials, as well as by project team members in the further implementation of this project.

Task 2 Review existing water quality standards for the different zones of the Harbor and revise as necessary

Existing water quality data, standards, uses of the harbour, and proposed zoning will be reviewed. As basis of comparison, the U.S., Canadian and European WQ standards for the selected parameters (uses) will be compiled. Those that are applicable to saline waters will be emphasized. The current Jamaican standards for various uses of water will then be compared and new targets proposed.

The output of this task will be target water quality parameters based on zoning preferences.

Task 3 Review and report on existing zoning and development data

Kingston Harbour presents a magnificent opportunity for improved development as a centre for commerce, tourism, fishing, housing and recreation. Worldwide, communities are recognizing the extraordinary value of their harbours or riversides. A development and zoning plan that recognizes, encourages and guides the varied uses that exist or will develop is critical.

A review of any existing plans, regulations, and planned developments will be undertaken, as described below.

Existing Plans:

A compilation and catalogue would be made of all the many plans, studies and proposals that have been made in the past to determine:

- Relevance
- Intentions, useful proposals, etc. and to incorporate them in this study.

These studies exist in many places including the UDC, KRC, Town Planning Department, KSAC, USAID, etc. The critical plan to be considered will be the Global Master Plan of KMA.

Current Developments

A survey and catalogue will be made of all current development plans including those for:

- Airport Redevelopment
- Transshipment Port
- Fisheries
- Port Royal Development
- Wharves
- JPS, PCJ, etc.

To determine how they can co-exist and form part of an overall development plan.

Future Developments

Based on consultations with all stakeholders including Government Departments, Housing Developers, Fishermen, and Businessmen, first a listing and then a plan, illustrating possible uses of existing or undeveloped land would be carried out to include:

- Housing
- Boating
- Tourism
- Ferry Service
- Free-zone Manufacturing
- Development of Prison lands
- Shipping
- Cruise shipping
- Fisheries
- Parks, etc.

These proposals would be developed as part of the overall KMA Sustainable Development Plan.

The data collection and proposals would be based on consultations with all stakeholders and include public and private presentations and consultations at all stages.

It will represent a shared vision and a coherent and viable guide to present and future development. These plans and procedures will also draw on the international experience of other cities and countries that have re-discovered and re-developed their waterfronts

A critical part of the Zoning and Planning proposals will be recommendations as to the institutional bases for carrying them out, and procedures to be followed. Training of designated personnel to carry out the implementation will form part of the procedures and tasks included.

The outputs of this task will be a summary report that identifies, reviews and catalogues applicable studies addressing zoning of Kingston Harbour and the development of the surrounding waterfront.

1.3. Modifications to Scope of Work

Subsequent to the submission of the proposal for this project, it was verbally agreed that the necessary interviews for the completion of Task 3 (Section 4 of this report) could not be conducted in the time allotted for this task. As such, it was decided that the contents of the report for Task 3 would not be a 'catalogue' of the plans, regulations and studies relevant to the zoning of Kingston Harbour and the surrounding waterfront as stipulated in the Terms of Reference, but rather would summarise the existing information on the topic. A more comprehensive presentation of plans for Kingston Harbour will be included in the final deliverable for this component, the Zoning and Strategy Report.

2. The State of Kingston Harbour

2.1. Site Description

Kingston Harbour is considered to be one of the finest natural harbours in the world. It is situated on the south coast of Jamaica at latitude 17º57' north, longitude 76º48' west (Figure 2.1). The harbour is an elongated bay, or lagoon, extending 16.5 km from east to west and 6.5 km from north to south, with a total surface area of approximately 51 km^2 (Wade 1976). The city of Kingston, comprised of industrial, commercial and residential developments, lies to the north of the harbour and at the western end are the more modern residential developments of Portmore and Independence City.

Figure 2.1 **Composite Satellite Photograph (2002 and 2003) of Kingston Harbour, showing Kingston and Portmore**

In its original state the harbour was contiguous at its western margin with a shallow embayment, Hunts Bay. In 1967 the mouth of this bay was partially occluded by a solid causeway with a narrow bridge to permit continued water exchange between harbour and bay. The southern margin of the harbour is bounded by a shingle spit, The Palisadoes, built by long-shore drift of sediments tying together a number of derelict coral cays to form a 15 km long tombolo (Goreau and Burke, 1966; Hendry, 1978). The entrance to the harbour is a 2 km wide channel in the south-west corner (Wade, 1976) and this leads naturally into a deep channel, which curves around the northwest side of the harbour providing navigable access to its inner basins. This channel, usually referred to as 'the ship channel,' is a natural formation, probably maintained originally by natural water circulation (cf. Goodbody, 1968,

1970). Over the years, the shape and configuration of the harbour has been altered by both natural and man-made activities (i.e. an earthquake causing the loss of half of Port Royal in 1692, construction of the airport, causeway and port facilities between 1960's and present day).

2.2. Physical Characteristics

2.2.1. Bathymetry

The main Kingston Harbour can be divided into three areas with respect to bathymetry (Figure 2.2). The first is the Outer Harbour, a deep basin inside the mouth of the harbour, between Port Royal in the east and Port Henderson in the west. The second is the Inner Harbour, which extends along the main central east-west axis of the harbour. The third is the Upper Basin, in the eastern most part of the harbour. Somewhat distinct from the main harbour is Hunts Bay to the northwest.

Figure 2.2 Distinct Bathymetric Areas of Kingston Harbour (Composite 2002/2003 imagery)

Figure 2.3 following illustrates the bathymetry of the harbour. The Outer Harbour ranges in depths and has a maximum of 18m in the ship channel, while the Inner Harbour is fairly uniform in contours and is on average 10m deep. The Upper Basin is a deep basin of approximately 17m depth. By contrast, the average depth in Hunts Bay is 1.5m.

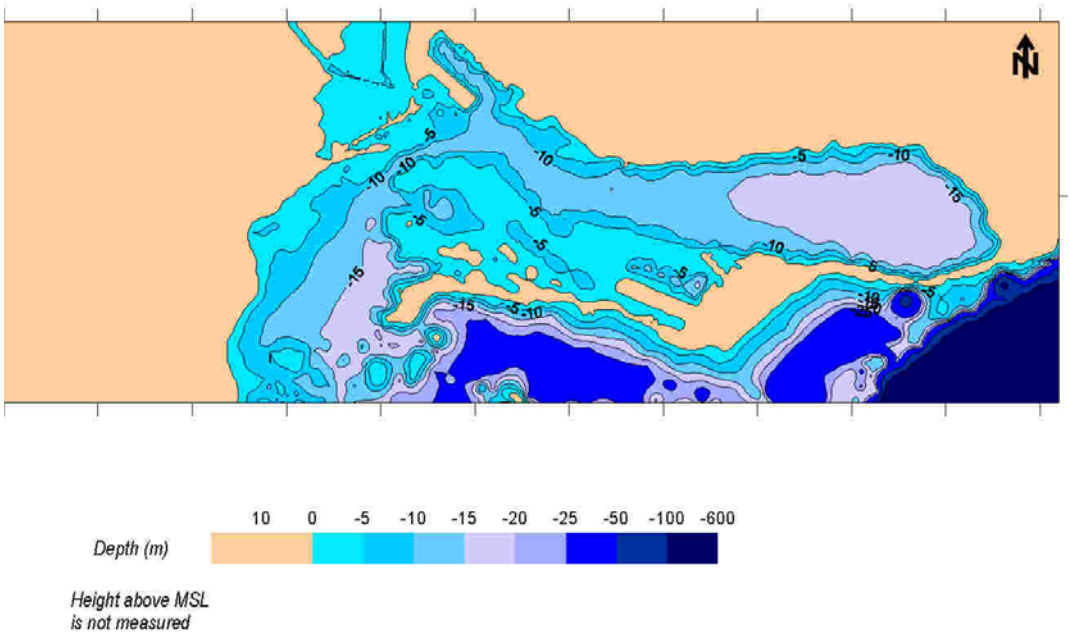

Figure 2.3 Bathymetry of Kingston Harbour (including Hunts Bay)

2.2.2. Tides

A 1968 GOJ study found that tides in Kingston Harbour are generally semi-diurnal when the moon is over the equator and diurnal during north and south declinations of the moon. Tidal amplitudes are generally small, with a mean value of 0.12m. Figure 2.4 following illustrates the monthly tidal fluctuations in Kingston Harbour, and shows both the larger semi-diurnal spring and smaller diurnal neap variations (Wade, 1976).

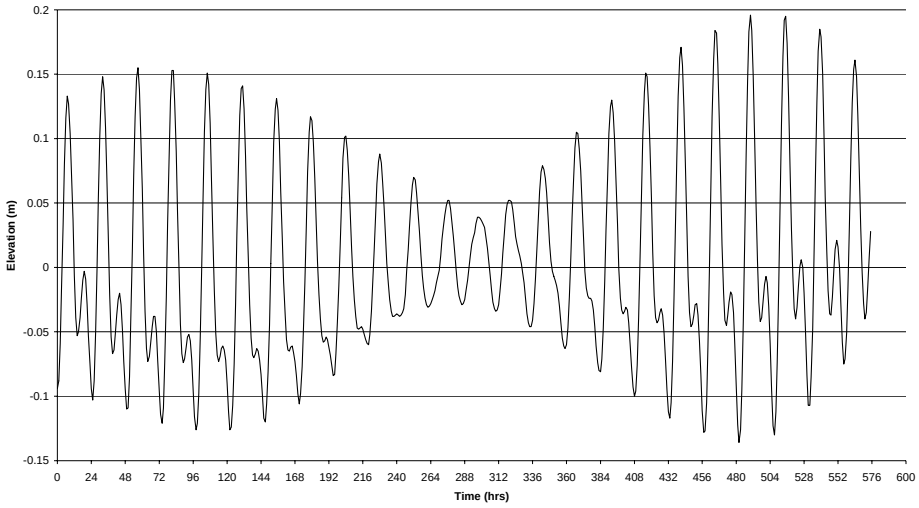

Figure 2.4 Typical month of tidal fluctuations in Kingston Harbour (Wade, 1976)

2.2.3. Circulation

Webber et al. (2003) have reported that the circulation in Kingston Harbour is influenced by tides, wind and freshwater inflows (Figure 2.5). Circulation patterns are therefore expected to be different under spring and neap tides, with and without wind and also between the wet and dry seasons.

Observations and computer modeling have shown that during low-flow conditions circulation patterns in the western part of Hunts Bay have anti-cyclonic curvature (clockwise movement), recirculating water from the Rio Cobre rather than draining it through the connection with the main harbour. The Duhaney River is shown to form the main tidal circulation within the bay. During flooding tide, the circulation is deflected into the northeast corner where the water flow is essentially zero.

Measurements and modeling by Bigg and Webber (2003) have shown the presence of a counterclockwise gyre in the Outer Harbour. This, in turn, appears to trigger a clockwise gyre between the Outer and Inner Harbours. North of the Norman Manley International Airport (NMIA), the circulation patterns change again to a counter-clockwise gyre.

The modeling suggests that a diffusive process drives the flushing of the Inner Harbour, with a resultant flushing time for this section of the harbour of the order of several months, maybe longer. It should be noted that work done by Sherwin and Deeming (1980) indicates a flushing times for the Inner Harbour of several weeks. These results indicate the possible range of flushing times, which are dependant largely on diffusive forcing functions.

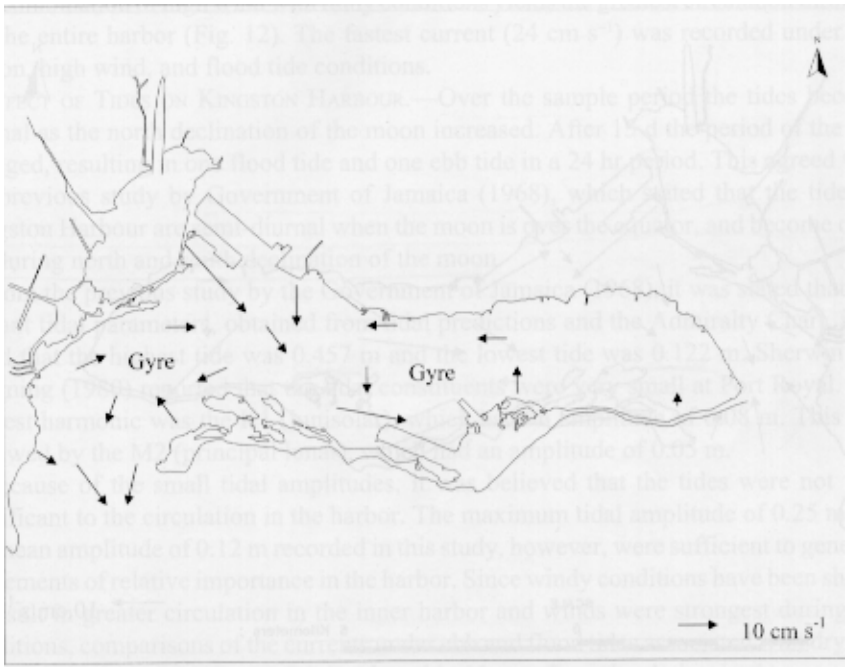

Figure 2.5 Circulation pattern in Kingston Harbour during dry, windy and ebb flow conditions ***(Courtesy of Webber et al., 2003)***

2.3. Environmental Indicators - Biological

Several biological parameters have been studied over the years, and have been used to gauge the environmental health of Kingston Harbour. Table 2.1 following lists the significant biological attributes studied and any major conclusions drawn about the environmental health of Kingston Harbour.

Table 2.1 List of Major Biological studies conducted in Kingston Harbour

Parameter	*Researcher*	*Date*	*Major Findings*	*Indication of change in Environmental Health*
Aves (Birds)	Alleng	1990	Kingston Harbour Mangroves an important nesting area – especially Refuge Cay	
Benthos (Seafloor)	Wade	1972	Species Diversity linked to environmental stress conditions. Diversity increases with a decrease in environmental stress	
Coelenterates	Fisher	1973		
Coliforms	GOJ	1968	Inner Harbour (northern shore) and Hunts Bay are polluted (>24,000 MPN/100ml recorded)	
	Wade	1972	Inner Harbour (northern shore), Buccaneer Beach, Dawkins Pond and Hunts Bay are polluted (>900 MPN/100ml recorded)	↓
	SENTAR	1993	Kingston Wharves, Newport East, Port Royal and Hunts Bay polluted (>24,000 MPN/100ml recorded)	↓
Coral Reefs	Aiken	1975	Cays dominated by five species: *Acropora cervicornis, Acropora palmate, Porites porites, Meandrina meandrites, Meandrina annularis*.	
Crustaceans	Warner	1967	Twelve species in the Mangroves.	
	Chin	1985		
	SENTAR	1993	Overall decrease in the production of panaeid shrimp in the Harbour	↓
Echinoderms	Sides	1975	Five species of brittlestar present.	
Fish	Aiken	1973		
	Wade	1975		
	Grant	1981		
	Harvey	1982		
	SENTAR	1993	No benthic species observed	↓
Fungi	Provan	1984		
Mangroves	Chapman	1944		
	Alleng	1991	Four species found	
Molluscs	Wade	1964		

Parameter	*Researcher*	*Date*	*Major Findings*	*Indication of change in Environmental Health*
	Thompson	1974		
	Siung	1976		
Plankton	Steven	1965	Number of species increases offshore. Inshore has higher primary productivity.	
	Graham	1974	Number of species increases offshore. Inshore has higher primary productivity.	↓
	Webber	1994	Comparative increase in Chlorphyll a and increased primary productivity.	↓
Seagrass	Greenaway	1976		
	SENTAR	1993		↓

Notably, the conclusions drawn from the comparative studies have all indicated that there has been a general decline in the environmental health of Kingston Harbour since the 1960's. Coliform concentrations, crustacean, fish and plankton abundance, as well as seagrass densities all point towards a deteriorating ecosystem. Many of the researchers attributed this decline to increased nutrient concentrations in the harbour as well as the input of several other significant pollutants.

2.4. Environmental Indicators – Physical and Chemical

A substantial amount of work has been done in Kingston Harbour with respect to gathering physico-chemical data. Only two *major* studies pertaining to the water quality in the harbour have been conducted during the past thirty years: the first by Wade (1976), and the second by SENTAR (1993). The average values for some significant physico-chemical parameters, taken from these two studies, as well as data presented in the Bulletin of Marine Science Vol. 73 No.2 are listed in Table 2.2 following.

Table 2.2 Average Values for Select Physico-chemical parameters in Kingston Harbour

Parameter	*Average value*
Temperature	28.4 °C
Salinity	31‰
Dissolved Oxygen (DO)	7.3 mg/l
Nitrate & Nitrite	3.2 uMol
Phosphate	0.67 uMol
Chlorophyll a	8.54 mg/m^3

A comparison between the Wade (1970's) study and the SENTAR study (1990's) is presented in Figure 2.6 for each of the major parameters assessed.

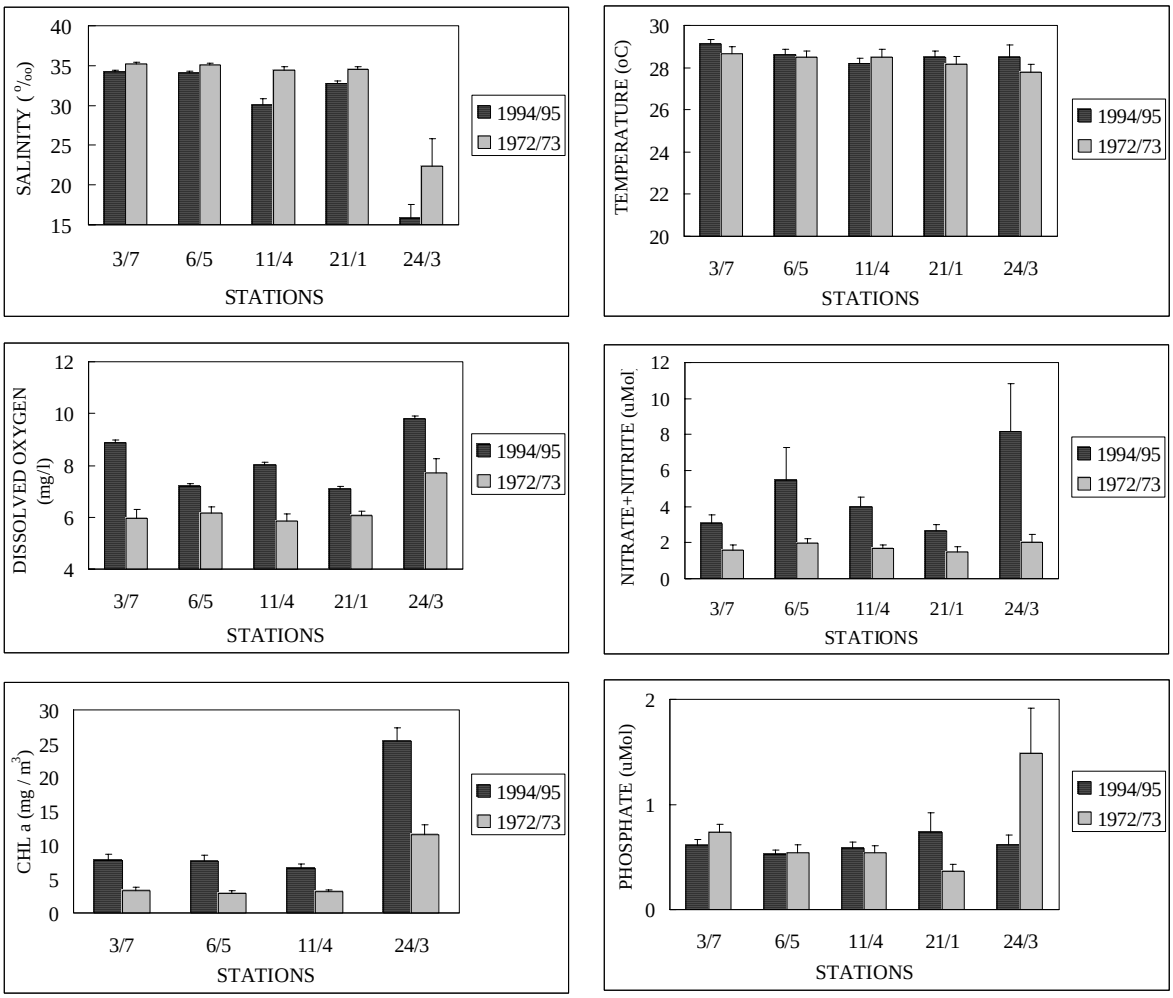

Figure 2.6 Comparison of select physico-chemical parameters between 1970s and 1990s

In general, the data indicates an increase in the nutrient, DO and phytoplankton (chlorophyll a) concentrations over the period. By contrast, the salinities have decreased and the phosphate levels have remained roughly the same. The general conclusions from these comparisons are that the harbour is receiving significant freshwater and nutrient inflows, which are contributing to an overall decline in the water quality of the harbour

A more detailed description of the water quality and its changes over time is presented in Section 3 of this document.

2.5. Sources of Contamination

Numerous studies have revealed that the main contaminants of the harbor are nutrients (nitrogen and phosphorus), petroleum hydrocarbons, trace metals, pesticides and herbicides and bacteria. These enter the harbor through various sources such as domestic sewage, industrial effluents, agricultural run-off, contaminated groundwater (through leachates from pit latrines and soak-away pits), solid waste, shipboard and industrial spills and airborne pollutants. The main pathways by which these contaminants reach the harbour are through direct discharges, groundwater flow, streams and rivers, storm drainage systems and aerial transport (Webber 1996).

2.5.1. Freshwater Influences

Fresh water enters Hunts Bay via the Rio Cobre, the Duhaney river and the Sandy Gully, the last being part of the stormwater drainage system for Kingston (Figure 2.7). Several other smaller drainage gullies on the northern shore of the harbour contribute to the fresh water inflow and also add domestic and industrial wastes (Wade 1972).

Figure 2.7 Major Sources of Contamination to Kingston Harbour

Rio Cobre River

The major contributor of freshwater to the bay is the Rio Cobre River, a 30km long river with flow rates ranging from 1-20 m^3s^{-1} (Andrews et al, 1999). The river originates at an elevation of 300-500m in the Benbow Inlier, in the centre of the island and drains an area of approximately 1,256 km^2. The geology of the watershed is predominantly karstic limestone overlaid by alluvium in the central area. The river flows through agricultural, industrial and residential areas where it becomes subject to solid waste pollution and municipal runoff, especially during rain events. Potential organic matter inputs include natural vegetation and soil organic matter sourced from agricultural activities. Citrus and milk product processing wastes (around Bog Walk), landfill leachate and residential sources including Bogwalk, Linstead, Spanish Town and Portmore also contribute to the pollutant signature (Andrews et

al, 2001). Agricultural leachate from fertilisers can also occur during rain events, resulting in pollution by nitrates, phosphates and sulphates.

The river becomes estuarine approximately 2km upstream from its mouth (Andrews et al, 1999). As a result, the pH values at the mouth are typically estuarine (8.1-8.2). The water at the mouth is generally brown and very turbid, with secchi depths rarely exceeding 50cm. These characteristics are probably due to fluvial, transported sediment, coupled with the intense flocculation occurring at the estuarine boundary further upstream.

Duhaney River

The 13km long, very narrow Duhaney River originates at the foot of the Molynes Mountains. The flow is a composite of the 10km long Fresh River and the 1km long Salt River, joining approximately 2km from the Bay. The upper section of the river passes through areas of intensive agricultural activities including sugar cane, coconut and cattle rearing. The lower section of the river flows through industrial and residential areas and is subject to influence from the Riverton City dump/landfill and sewage outfall from the Duhaney Park treatment plant. The river enters the bay with a flow range of 1.3-3 m^3s^{-1} (Bigg and Webber, 2003).

Sandy Gully

The Sandy Gully is at the northern-most point of the Hunts Bay. It is fed, much like a river, by a series of smaller gullies (tributaries). These tributaries spread across much of the Kingston Metropolitan Area and, as such, pollutants from the corporate area influence the water quality in the gully.

Waterford Outfall/Portmore Gully

The Portmore gully system terminates in the south-western section of Hunts Bay, having drained the dense, residential Portmore area. The area is usually extremely malodorous with solid, detrital waste material floating freely in the water

The Three-Mile (3M) Corner

The 3M Corner is located in the northeast section of Hunts Bay with Spanish Town Road and Marcus Garvey Drive bordering the area along the north-eastern shore and the Sandy Gully located to the northwest. Due to the protrusion of the massive concrete guide walls of the Sandy Gully outlet into the bay, the 3M Corner is secluded when compared to the rest of the bay. This area receives outflows from several manufacturing plants representing a variety of industries.

2.5.2. Sewage

The Kingston Harbour has been receiving sewage loads from the city since it was first established as a small settlement over 400 years ago. The natural capacity of the harbour to effectively assimilate the sewage did not come into question until the mid 19th century when Europe was ravaged with the plague and clear correlations started to emerge between sewage pollution and water-related diseases. Construction of the lower truck sewage interceptor was started in 1892 and commissioned by 1898. Early treatment of the collected sewage was by overland flow at Greenwich Farm where the sewage was used to irrigate pastures used for mule and horse grazing. The first sewage treatment plant for the city was commissioned in 1938 at Western Treatment Works and many elements of this facility are still in service.

Treated or un-treated, sewage enters the harbour directly from sewage treatment plant outfalls or from diversions and overflows related to the sewer network. Sewage also enters the harbour from similar sources by virtue of the network of gullies that provide surface water drainage for the city and suburbs.

Webber and Wilson-Kelly (2003) carried out a survey of the sources of organic pollution to Kingston Harbour in 1996 and 1997. They analysed samples for coliform bacteria, TSS, BOD, nitrite + nitrate, and phosphates as signatures for organic pollution.

Their study found that sewage is by far the most important contributor of organic pollution to Kingston Harbour, with Greenwich and Western sewage treatment plants being the most significant point sources of pollution to the harbour. River flow was found to be the second largest contributor to organic pollution to the harbour. Summaries of their findings are presented in Figure 2.8 - Figure 2.10 following.

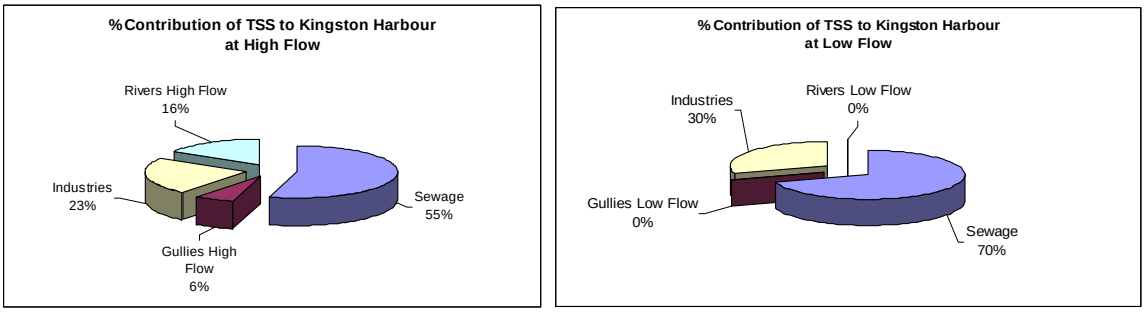

Figure 2.8 Percentage Contribution of TSS to Kingston Harbour, High Flow and Low Flow

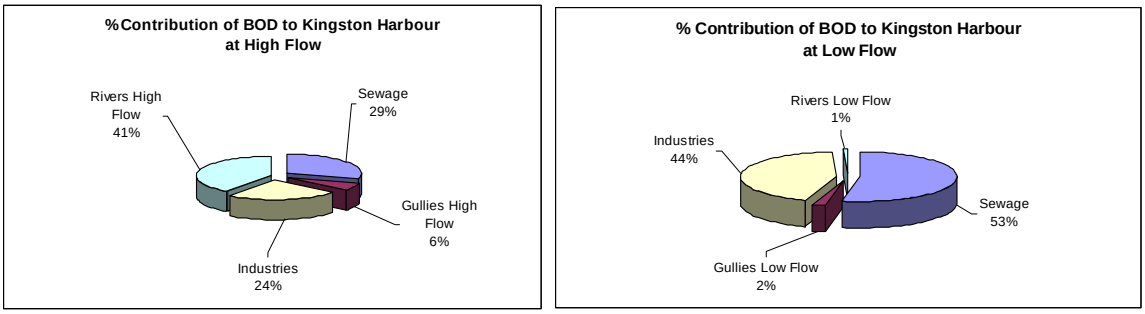

Figure 2.9 Percentage Contribution of BOD to Kingston Harbour, High Flow and Low Flow

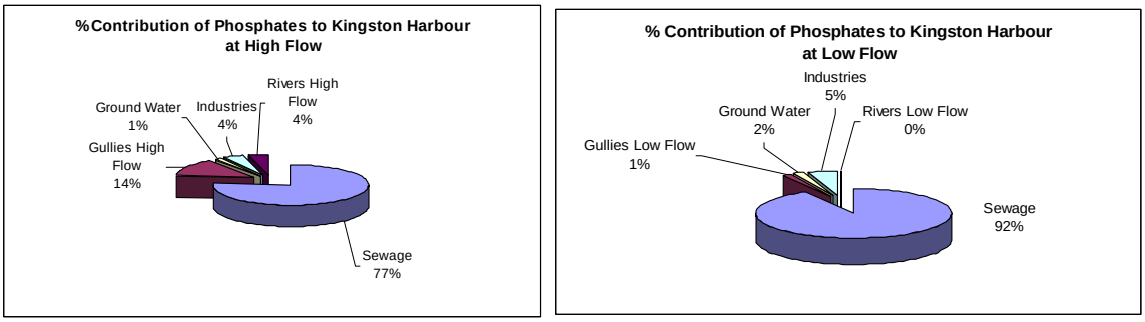

Figure 2.10 Percentage Contribution of Phosphates to Kingston Harbour, High Flow and Low Flow

Figure 2.8 shows that sewage contributes to more than 50% of the Total Suspended Solids (TSS) in the harbour during both high and low flow events. During high flow events rivers contribute the greatest percentage to the Biological Oxygen Demand (BOD) content in the harbour. During low flow periods, however, sewage contributes to more than 50% of the BOD content in the harbour (Figure 2.9). Figure 2.10 illustrates that sewage contributes to more than 75% of the phosphate content of the harbour in both low flow and high flow periods.

2.6. Sewage Treatment

The most comprehensive assessment of sewage flow to the Kingston Harbour was carried out by SENTAR Consultants Limited 1993 as a part of the Kingston Harbour Environmental Project. Reid Crowther documented the KMA sewerage system between 1970 and 1985 in a series of planning studies which developed a Flow East, a Combined Flow East and West and the endorsed Flow West Sewerage Collection, Treatment and Disposal Schemes.

SENTAR estimated the sewage related pollutant loads from direct sewage discharges to the harbour in 1993 as set out in Table 2.3 following.

Table 2.3 Estimated sewage loads of BOD, N-NH_3+NO_3, P-PO_4 by SENTAR 1993

Plant	Flow (MiGD)	Flow (m^3/d)	Concentration (mg/l)			Loading (tonnes/y)		
			BOD	N	P-PO_4	BOD	N	P-PO_4
Greenwich	12	54553	157	37	5.7	3126	737	113
Western	3.5	15911	73	15.5	2.6	424	90	15
Portmore Area	4.5	20457	90	20	3.2	672	149	24
N Manley Airport	0.12	546	81	18	2.9	16	4	1
TOTAL						**4238**	**980**	**153**

Sentar 1993

Flows to the Western and Greenwich plants were based on estimates by NWC staff and for the Portmore area the flow was population derived. The N Manley Airport flow was taken as the nominal design capacity of the plant. Phosphorus loads were estimated based on published North American data which shows phosphorus to be 3.6% of the BOD in sewage.

Based on new data published since the SENTAR 1993 report and personal information from work done by Fluid Systems with various sewage plants in the Portmore area, an updated estimate of loading is set out in Table 2.4 following.

Table 2.4: Estimated sewage loads of BOD, N-NH_3+NO_3, P-PO_4 for 2004

Plant	Flow (MiGD)	Flow (m^3/d)	Concentration (mg/l)			Loading (tonnes/y)		
			BOD	N	P-PO_4	BOD	N	P-PO_4
Greenwich	12	54553	157	37	10	3126	737	199
Western	3.5	16016	73	15.5	7	427	91	41
Harbour View West	0.45	2046	160	20	10	119	15	7
N Manley Airport	0.22	1000	20	15	7	7	5	3
Independence City	2.8	12729	110	15	10	511	70	46
Bridgeport	1.8	8183	110	15	10	329	45	30
Caymanas Gardens	0.15	682	30	15	7	7	4	2
TOTAL						**4527**	**966**	**328**

Fluid Systems Estimate 2004

Adjustments have been made to the estimated organic and nutrient load from sewage to the harbour. These are related to strength and quantity changes from some of the sources. Portmore sewage discharges reflect a settled sewage. The airport adjustment is based on work done on the upgrading of the facility by the Airport Authority, 1999 – 2001. Phosphorus loads used by SENTAR were not typical of domestic sewage levels in Jamaica.

Figure 2.11 following illustrates the sewage and major industrial discharges to Kingston Harbour.

2.6.1. Current Plans for Sewage Collection, Treatment and Disposal

The National Water Commission has recently completed Phase 1 of the Kingston Water and Sanitation Project. A Master Plan review was carried out for the proposed expansion of the KMA sewerage scheme and treatment options were evaluated in light of emerging standards for the protection of public and environmental health. Figure 2.12 following sets out the existing and proposed expanded sewerage network.

Phase 1 of the development plan is for the installation of new gravity and pumped sewers to facilitate the collection of sewage flows currently terminating at Western and Greenwich Works. There will also be extensions of the network in the Barbican and Mona areas, where several sewered areas served by package or small treatment plants will be intercepted.

Phase 2 of the plan is for the extension of the systems in the East Kingston area including the Rockfort industrial area but not extending to the Cement Company.

Phase 3 of the plan is for the extension of the system into the area bordered by Maxfield Avenue, Constant Spring Road to the east, Washington Boulevard to the north and Spanish Town Road to the west.

The National Water Commission has also entered into an agreement with a design/build contractor, for the refurbishment of the Harbour View sewerage system. This will see the repair of the Harbour View West and East pump stations and the diversion of the currently untreated sewage being discharged in the harbour to a refurbished treatment works.

2.6.2. Sewage Pollutant Loads – After Phase 1 Development

Phase 1 development works for the Kingston Sanitation Project will see a 60% reduction in the organic loads to the harbour and 30% reductions for nitrogen and phosphorus nutrient pollutants (Table 2.5).

The Urban Development Corporation, National Housing Trust and ASHTROM are partners in a major housing renewal project for Kingston. In association with this project, there are proposals on the table for implementing the main components "or intent" of the Phase 1 project. There is a commitment to the construction of a pond-based sewage treatment facility at Soapberry and, for this aspect of the works, the National Water Commission joins the partnership.

Table 2.5: Estimated sewage loads of BOD, N-NH_3+NO_3, P-PO_4 for "2008"

Plant	Flow (MiGD)	Flow (m^3/d)	Concentration (mg/l)			Loading (tonnes/y)		
			BOD	N	P-PO_4	BOD	N	P-PO_4
Soapberry	20	90922	20	15	6	664	498	199
N Manley Airport	0.24	1091	20	15	7	8	6	3
Independence City	2.8	12729	110	15	10	511	70	46
Bridgeport	1.8	8183	110	15	10	329	45	30
Caymanas Gardens	0.15	682	30	15	7	7	4	2
TOTAL						**1519**	**622**	**280**

Fluid Systems Estimate 2004

Figure 2.11 Sewage and Major Industrial Discharges to Kingston Harbour

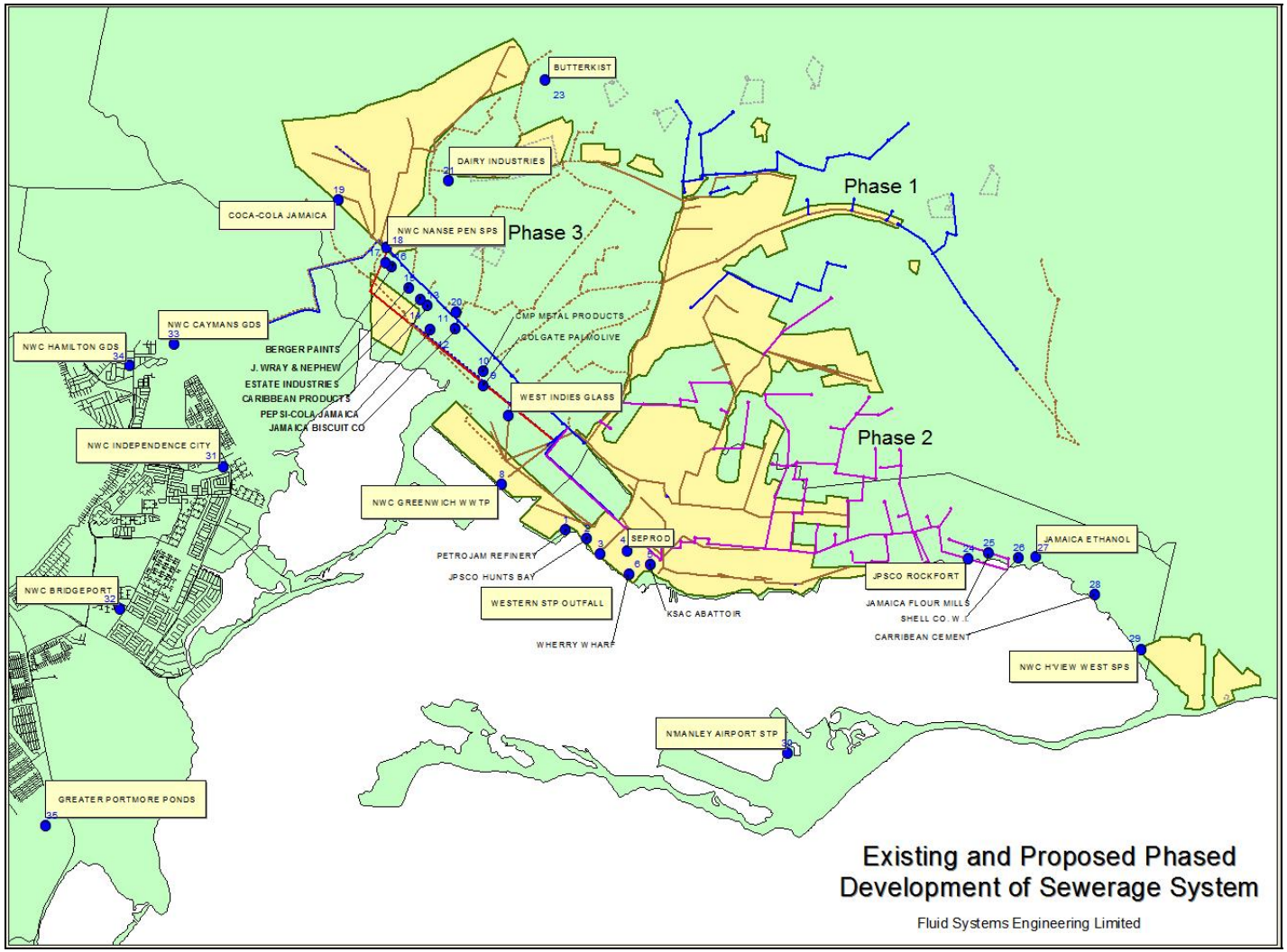

Figure 2.12 Existing and Proposed Phased Development of Sewerage System

3. Water Quality

3.1. Overview of Water Quality

Kingston Harbour has a well-documented pollutant history (Wade, 1972; Webber, 1997; and Andrews, 1998). Early work by Wade (1972) showed that the Harbour was eutrophic in the late 1960's and early 1970's due to large nutrient inputs from the domestic wastes of Kingston. This situation has not changed (Webber, 1997), with the majority of the nutrients being sourced from non-functioning sewage plants in Kingston contributing approximately 20 million gallons per day (SENTAR, 1993). Another source of nutrients is riverine flushing of the Inner Harbour through the Hunts Bay estuary, into which the harbours' main freshwater sources terminate (Bigg and Webber, 1996) (see Section 2.5.1).

Figure 3.1 Composite Satellite Photograph (2002/2003) of Kingston Harbour

Steven (1966) was among the earliest researchers to indicate that there was measurable eutrophication in Kingston Harbour. Subsequent investigations of the water quality, phytoplankton and zooplankton of the harbour, adjacent areas and oceanic waters (Goodbody, 1970; Wade 1972, Grahame 1976; Moore and Sander, 1979; Moore and Sander, 1982) indicated that certain environmental factors in Kingston Harbour were at their critical limit.

One of the most comprehensive studies of water quality in Kingston Harbour was conducted by Wade between 1972 and 1975. His study revealed that throughout the major section of the harbour there are considerable differences in the quality of surface water as compared with that of the bottom water. He ascertained that the water quality was best in the Outer Harbour and the worst in Hunts Bay and the extreme eastern end of the Inner

Harbour (Upper Basin). It was suggested by Wade that waste discharge was the most likely factor responsible for the observed increase in nutrients which, in turn, contributed to the increased frequency of phytoplankton blooms in all parts of the harbour. Wade concluded that Kingston Harbour is a typical eutrophic body of water.

A more recent comprehensive assessment of the water quality of the harbour was carried out in 1992-3 (SENTAR). The study provided a sound basis on which to evaluate the changes (deterioration) in the harbour over the past twenty years. Overall, the SENTAR study showed that Kingston Harbour continues to be a eutrophic water body, characterized by high nutrient concentrations, low oxygen concentrations and low species diversity.

Table 3.1 following presents a summary of the range of values determined for the major water quality parameters assessed by Wade, SENTAR and research published in the Bulletin of Marine Science Vol. 73 No.2.

Table 3.1 Summary Ranges for Major Parameters Assessed in Kingston Harbour

Parameter	*Location*	*Value/Range*
Temperature	Harbour	26.3 - 29.7°C
Salinity	Offshore Hunts Bay	35.0 -36.0 %0 33.0-35.7 %0
Transparency	Harbour Hunts Bay	2.5 - 11m 0.5 - 1.5m
Dissolved Oxygen	Bottom Layers Top Layers	0 – 4 mg/L 4.1 – 5.7 mg/L
Biological Oxygen Demand	Harbour Hunts Bay	12 – 18 mg/L 25 – 35 mg/L
Nitrates	Harbour	46 – 686 µg/L
Phosphates	Harbour	0.005 – 0.56 µg/L
Silicates	Harbour Hunts Bay	3.69 – 11.02 µg/L 22.7 – 34.0 µg/L
pH	Harbour	6.85 – 8.85
Ammonia-N	Harbour	0.06 – 9.67 µg/L
Particulate Organic Carbons	Harbour	30 - 2320
Faecal Coliforms	Harbour	>16,000 MPN/100ml
Total Coliforms	Harbour	>24,000 MPN/100ml
Chlorophyll a	Harbour	1.01 – 24.5 mg chl a m^{-3}

3.2. Target Water Quality Parameters

There are various categories by which water quality standards are set. These vary from drinking water (potable) standards, to recreational water standards, to effluent standards.

The standards are applicable to the use of the water. This section addresses the various applicable water quality standards for Kingston harbour, with consideration of the harbour as a multi-use area including industrial, commercial and recreational, and with ecosystem importance.

3.2.1. Jamaican Water Quality Standards

Jamaica currently has no published standards for ambient marine water quality. However, the National Environment and Planning Agency (NEPA) has established standards for trade and sewage effluent into receiving waters, including marine environments. These are summarized in Table 3.2 .

Table 3.2 Summary of Jamaican Effluent Standards

Parameter	*Sewage Effluent Limit**	*Trade Effluent**
BOD	20 mg/l	30 mg/l
TSS	20 mg/l	150 mg/l
Total Nitrogen	10 mg/l	10mg/l
Phosphates	4 mg/l	5mg/l
COD	100 mg/l	100mg/l
pH	6 – 9	6.5 – 8.5
Faecal Coliform	1000 MPN/100ml	100 MPN/100ml
Residual Chlorine	1.5 mg/l	

Sourced from http://www.nepa.gov.jm/policies/index.htm

3.2.2. Ecosystem Health Standards

Several assessments have been done globally as to the tolerance of marine ecosystems to various concentrations of a variety of water quality parameters. Table 3.3 following summarises the recommended maximum concentrations for ecosystem health in tropical marine waters as given by the South Australian Environmental Protection Authority (EPA) (2003) and a study done in Barbados by Delcan in 1994.

Table 3.3 Recommended Maximum Concentrations for Ecosystem Health in Tropical Marine Waters

Parameter	*South Australia EPA (2003)*	*Delcan (1994*)*
Nitrate	0.002 – 0.008 mg/l	
Ammonia		0.014 mg/l
Total Nitrogen	5 mg/l	0.014 mg/l
Phosphates		
Soluble Reactive Phosphorous	0.1 mg/l	
Biological Oxygen Demand	10 mg/l	0.8 mg/l
Dissolved Oxygen	> 6 mg/l	
Chlorophyll a		0.4 mg/m^3

Suggested maximum threshold levels for Barbados, for marine water quality characteristics in nearshore marine waters in the vicinity of coral reefs.

From this table, it is apparent that there is no real consensus on the parameters or concentrations to be considered for ensuring ecosystem health in tropical marine environments. However, it is agreed that these ecosystems do have nutrient and pollutant thresholds, which require further investigation.

3.2.3. Recreational/Human Health

There is more general agreement as to the health implications of pollution and the acceptable limits of select parameters for the use of marine waters for recreation. Table 3.4 presents a summary of the standards considered to be safe for recreational/human health use of coastal tropical marine waters, as established by the Caribbean Blue Flag group (2002), the Cartegena Convention, and the South Australian EPA (2003).

Table 3.4 Recommended Maximum Concentrations for Recreational/Human Health in Tropical Marine Waters

Parameter	*Caribbean Blue Flag (2002)*	*Cartegena Convention (Class I)*	*South Australia EPA (2003)*
Enterococci			35 MPN/100ml
Total Coliforms	<250 MPN/100ml	<200 MPN/100ml	
Faecal Coliforms	<100 MPN/100ml		150 MPN/100ml
pH	6.5 – 8.5	5 - 10	
Nitrates	0.6 mg/l		
Phosphates	0.1 mg/l		
TSS		30 NTU	
BOD		30 mg/l	

3.2.4. Sewage Effluent Standards

Sewage effluent standards have been established for Jamaica and the wider Caribbean in general. These are presented in Table 3.5.

Table 3.5 Recommended Sewage Effluent Standards for Tropical Coastal Waters

Parameter	*NEPA (2001)*	*UNDP – Wider Caribbean*
BOD	20 mg/L	30 mg/L
TSS	20 mg/L	30 mg/L
Total Nitrogen	10 mg/L	10 mg/L
Phosphates	4 mg/L	1 mg/L*
COD	100 mg/L	150 mg/L
pH	6 – 9	
Faecal Coliform	1000 MPN/100ml	
Residual Chlorine	1.5 mg/l	

* Total Phosphorous

3.2.5. Summary of Water Quality Parameters

In summary, the water quality parameters and acceptable concentrations cited in the literature varies depending on the use of the water. Table 3.6 is a comparative summary. The orange columns represent sewage effluent standards, the blue columns represent recreational standards, the yellow column is a combination of recreational and ecosystem health standards, and the green column is strictly ecosystem health standards. The final column is a summary of the findings in Kingston Harbour.

3.2.6. Proposed Standards

Following the review of the standards and the known values for Kingston Harbour, Table 3.7 presents some proposed standards for select water quality parameters for specific recreational areas, identified sensitive ecosystems and for general use of the harbour. The parameters selected reflect those deemed most indicative of ecosystem health and general pollution, and which are most feasible for analysis.

Table 3.6 Summary Water Quality Standards

	NEPA	***UNDP***	***Blue Flag***	***Cartagena***	***Aus. EPA***	***Delcan***	***Kingston Harbour***
DO (mg/L)					>6		0 – 6
COD (mg/L)	100	150					
BOD (mg/L)	20	30		30	10	0.8mg/L	12 - 35
TSS	20 mg/L	30 mg/ L		30 NTU			
Total Nitrogen	10 mg/ L	10 mg/ L			5 mg/ L	0.014mg/ L	
Nitrate			0.6 mg/ L		0.002 – 0.008 mg/ L		
Ammonia (mg/L)		5 mg/ L			0.05mg/ L	0.014mg/ L	<0.01 mg/ L
Phosphate (mg/L)	4 mg/ L		0.1 mg/ L				<0.0005 mg/ L
Total Phosphorous		1 mg/ L					
SRP					0.1mg/ L		
pH	6 - 9		6.5 – 8.5	5 - 10			6.9 – 8.9
Faecal Coliform (*MPN/100ml)	1000*		<100*		150*		>16,000
Total Coliforms (*MPN/100ml)			< 250*	<200*			>24,000
Enterococci (*MPN/100ml)					35*		
Chlorophyll a (mg chl a m^{-3}) †						0.40mg/ m^3	1.01 – 24.5†
Residual Chlorine	1.5 mg/ L						

Effluent Standards – NEPA, UNDP
Recreational/Human Health Standards – Blue Flag, Cartagena
Ecosystem/Recreational – Australian EPA
Ecosystem - Delcan

Table 3.7 Proposed Water Quality Parameters and Standards, By Use

Parameter	*Recreational Areas*	*Sensitive Ecosystems*	*General Harbour*
DO	6	6	6
COD			100mg/L
BOD	20mg/L	20mg/L	30mg/L
TSS			20mg/L
Nitrate	0.5mg/L	0.01 mg/L	
Phosphate	0.1 mg/L	0.001mg/L	
Chlorophyll a	(0.4 mg chl a m^{-3})		
pH	6-9	6-9	6-9
Faecal Coliform	<100 MPN/100ml		<1000 MPN/100ml
Total Coliform	<200 MPN/100ml		<250 MPN/100ml
Enterococci	<35 MPN/100ml		<35 MPN/100ml

The specific use areas within Kingston Harbour have yet to be determined. However these proposed standards are intended to be applied to the determined use zones in the harbour.

4. Development and Zoning Plans for Kingston Harbour

4.1. Introduction

This section of the summary report identifies and reviews plans, regulations and studies relevant to the zoning of Kingston Harbour and the development of the surrounding waterfront.

Documents have been identified and reviewed in many cases. In others, their whereabouts have been identified and meetings will be conducted to discuss and obtain the documents. Physical plans will be scanned and geo-referenced for overlaying on IKONOS 2003 sheets for the harbour when available.

As an adjunct to this task, the Consultants believe it would be desirable to assemble maps, photographs and recollections of historical conditions around the harbour. While not strictly necessary to the overall work and not addressed in the scope of work, adding time for such an effort would be instructive for the public education component as well as providing insight into the former shoreline and into former uses and activities that might be revived.

The following (Table 4.1) is a list of known plans and ongoing planning activities. With regard to ongoing and future plans, it should be noted, as stated in Section 1.3, that at this stage in the project it has not been possible to contact all stakeholders regarding their current and future plans and to obtain copies of key documents. Some of the older documents are scarce and a number of these have yet to be obtained for review. Many of them contain ideas or proposals that are still valid and need to be implemented and others that need to be implemented or revisited to determine their continuing validity and feasibility. The Consultants would appreciate a critical review of the list for completeness and the assistance of reviewers and stakeholders in indicating the availability of hard or electronic copies to aid with the assembly of the needed library of plans.

Section 4.2 presents summaries of key documents and recommendations of existing plans available at this time. Section 4.3 addresses current planning activities and discusses some of the issues raised by the review.

4.1.1. Past and Current Plans – The "Givens"

The following plans have been identified as having relevance to Kingston Harbour Rehabilitation and Zoning because they have been approved and are being implemented, or they are products of careful planning efforts and broad review that need to be implemented.

Table 4.1 Past and Current Plans

Name	*Author/ Agency*	*Date*	*Obtained*	*Note Re Use/Availability*
Kingston Downtown Plan	Marvin D. Goodman & Associates	1988	Ó	The remaining copy needs to be scanned
Vision 2020 Master Plan for	Strategic Planning	1994	Ó	

Name	***Author/ Agency***	***Date***	***Obtained***	***Note Re Use/Availability***
Redevelopment of Downtown Kingston	Group/UDC			
Cruising in Kingston Harbour	UDC	1994		
Harbour Street Development	KRC			
Port Royal Master Plan	Pragma/Marvin D. Goodman & Associates	2001	Ó	Plan maps and text need to be scanned
Norman Manley International Airport Runway Extension Plan	Airports Authority of Jamaica		Ó	Earl Richards Presentation, November 6, 2003
Kingston Container Terminal --KCT4 and KCT5 Project Plans	Port Authority		Ó	Ian Blair Presentation, November 6, 2003
Highway 2000 alignment	ESL/NROCC			Requested from Wayne Reid, NROCC
The Palisadoes-Port Royal Environmental Policy Framework	USAID/NRCA DEMO	1997	Ó	
The Palisadoes-Port Royal Protected Area Management Plan zoning proposals	USAID/NRCA DEMO	1998	Ó	
Coast road alignment	ESL, TEMN and CALL EIAs		Ó	NEPA Document Centre
Rae Town fishing village plan	UDC			
Windward Road Bus Terminal EIA	TEMN		Ó	NEPA Document Centre
Bellevue (Manley Meadows) EIA	ESL		Ó	NEPA Document Centre
Traffic studies & plans; various studies of roads, etc.,	UDC, KRC.			
Various neighbourhood develop-ment studies (Jones Town, Tivoli	UDC/etc. (MDG)			

Name	*Author/ Agency*	*Date*	*Obtained*	*Note Re Use/Availability*
etc.)				
Market Plans (including craft market)	UDC/etc. (MDG)			
Portmore Development Plans, etc.	WIHCON/UDC			
Proposed Bus Depot at 100 Windward Road	TEMN		Ó	Final decision required
Others that may be identified				

4.1.2. Plans Currently Under Consideration or in Preparation

Table 4.2 Plans Currently Under Consideration or in Preparation

Name	*Author/ Agency*	*Date*	*Obtained*	*Note Re Use/Availability*
KSAC Sustainable Development Plan.	KSAC, NEPA/ENACT		Ó	
Development of Kingston Container Terminal, Gordon Cay Western Extension	TEMN			
Port Authority / KCT post 2010 expansion			Ó	To be discussed with Robert Stephens, Port Authority
Port development (including freezone)				To be discussed with Robert Stephens, Port Authority
Kingston Wharves plans				
Cross Harbour pipeline to NMIA				To be discussed with Petrojam
Greenwich fishing village relocation plan	ESL for Petrojam		Ó	To be discussed with Petrojam, Fisheries Division
Relocation of Fort Augusta				
Hunts Bay Reclamation Work	ESL Hydraulic, Environmental			

Name	***Author/ Agency***	***Date***	***Obtained***	***Note Re Use/Availability***
	Study			
Sanitation – most likely Flow West				Need decision, maps from NWC
Other sewage disposal/water plans, various agencies				
Airport sewage treatment				To be discussed with Patrick Salter, Airports Authority
Airport Freezone				To be discussed with Patrick Salter, Airports Authority
Ministry of Housing/National Housing Trust, various proposals				To be discussed with Pat Stanigar
Development of cement land & waterfront, Caribbean Cement Co.				To be discussed with Ruth Crooks,
Proposed Alternative Fuel Facility at Caribbean Cement Company	CDA EIA		Ó	
Gunboat Beach "7th Harbour" Plan/Development proposal	Allied Business Cons./Rivi Gardner		Ó	Need EIA from NEPA
Draft Waterfront Plan	UDC	2004	Ó	
Draft Downtown Improvement Plan	KCCIC/BID	2004		

4.1.3. Potential Development Plans

Table 4.3 Potential Development Plans

Name	*Author/ Agency*	*Date*	*Obtained*	*Note Re Use/Availability*
Highway 2000, toll plaza, maintenance depot, fish landing				To be discussed with NROCC, PA, Fisheries Department…
Relocation of Helsinki fishermen to Matalon marina –on seaside at Hunt's Bay or at Port Henderson.				To be discussed with NROCC, PA, Fisheries Department…
Highway 2000/Freeport, 250-300 acres				To be discussed with John Algrove
Port Authority cruise ship plans/ideas				To be discussed with Robert Stephens, PA
Marine transportation and ferry development plan -- Port Royal, Portmore, Port Henderson, downtown Kingston, etc.	Ministry of Transportation	1985?		
Jamaica Flour Mills: own reception facility and plans for Rockfort ?				To be discussed with Dennis McGhee, CEO, JFM.
Ferry terminal home porting facilities – space and spatial relationship requirements				
Relocation of General Penitentiary and restoration, redevelopment.				
Piscinao, possibly at Gunboat/Buccaneer beaches.	Web research			

4.1.4. Needed Plans/Alternatives/Decisions

Table 4.4 Needed Plans, Alternatives and Decisions

Name	*Author/ Agency*	*Date*	*Obtained*	*Note Re Use/Availability*
Dredge spoils disposal location.				
Location of reclamation for airport runway construction.				
Location(s) of wetlands mitigation/recreation in exchange for airport expansion.				
Plans for Port Henderson shoreline and historic structures, inc. Fort Augusta and Rodney's Arms	UDC			
Newport East fish processing plant.	PCJ, ESL, FD			
Locations for Marina and fishermens' villages				To be discussed with PA Fisheries Division, etc.
Pier One plans				To be discussed with B. Francis
Railway reuse.				

4.2. Existing Plans

4.2.1. Kingston & St. Andrew Metropolitan Area Development Order

Strictly speaking, as part of the Kingston and St. Andrew Metropolitan Area, the Kingston Harbour is governed by the Kingston Development Order adopted in 1968. An update of the DO prepared in 1985 was not adopted and the Kingston & St. Andrew Corporation is in the process of formulating a Sustainable Development Plan for the two parishes. The Draft Kingston Development Plan of 1985 (Figure 4.1) includes the following zoning proposals for Kingston and Urban St. Andrew:

- Residential along the ocean side of the Palisadoes from just west of Little Plumb Point to a point approximately south of Fort Rupert.
- Residential along the ocean side of the Palisadoes from the southeast corner of airport lands to a point just east of Gunboat Beach.

- A designation of "Government Purposes and Statutory Undertakings" applied to the mangroves on the Harbour side of the Palisadoes from Plumb Point to Port Royal, including the Coaling Wharf, Admiralty House and the Old Naval Dockyard.
- Public open space is shown along the Palisadoes at the tip of Port Royal, between Fort Rupert and Buccaneer Beach, from Gunboat Beach to Harbour View (with a small site reserved for the gypsum storage area).
- Along the Kingston shoreline, public open space was limited to the area bounding the Cement Company, the Bournemouth waterfront and Rae Town. Otherwise open space designations are limited to a few mini-parks on the downtown waterfront.
- The remainder of the waterfront is shown in industrial use.

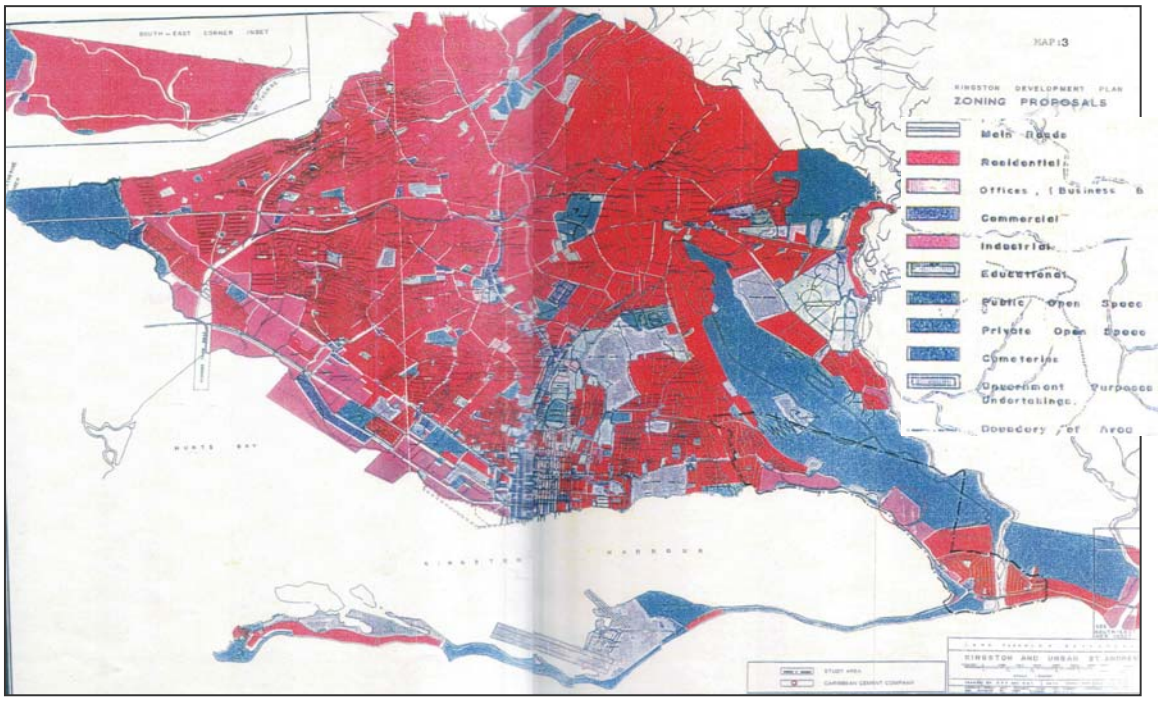

Figure 4.1 Draft Kingston and St. Andrew Development Order, 1985

4.2.2. The Shankland Cox Waterfront Plan

This plan proposed a cruise ship pier and craft market at the foot of Princess Street, as well as a number of hotels. The proposed cultural center and concert hall at the foot of King Street became the Conference Center. The proposed waterfront also contained offices and apartments and appears to have been conceived as having a hard edge with piers at East Street, King Street and Pechon Street and a marina (Figures 4.2 and 4.3).

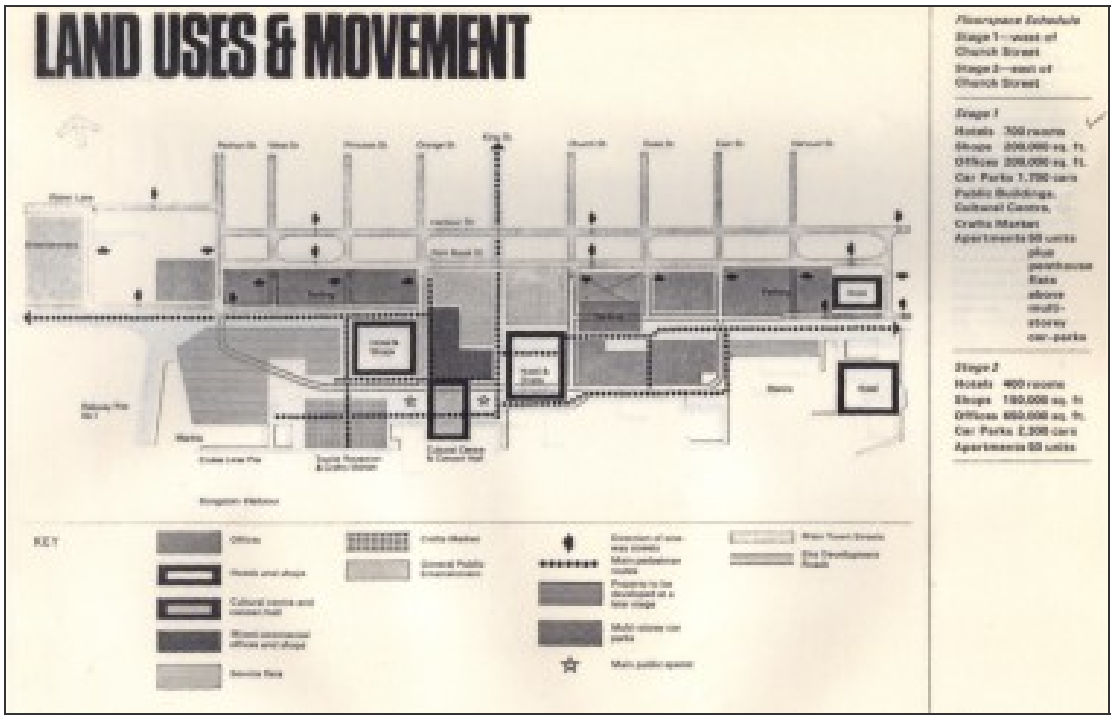

Figure 4.2 The Shankland Cox Downtown/Waterfront Plan, Proposed Land Use and Circulation

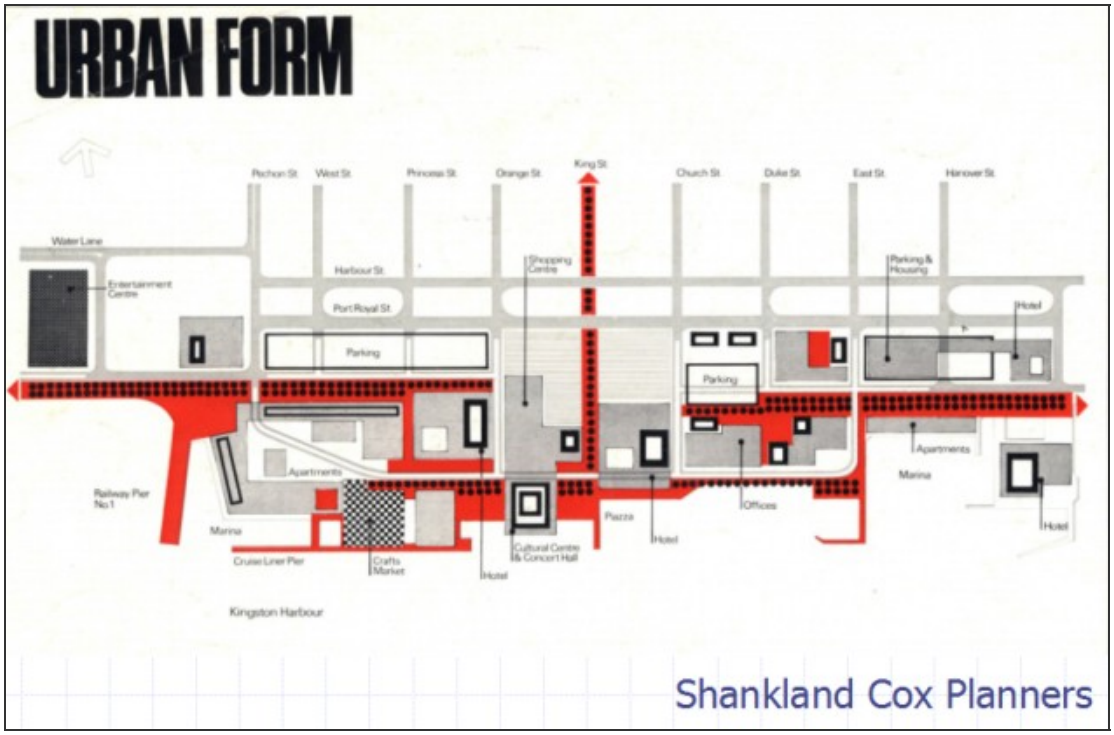

Figure 4.3 The Shankland Cox Downtown/Waterfront Plan, Principle Elements of Urban Form

4.2.3. Downtown Redevelopment Plan

Marvin D. Goodman & Associates' Downtown Plan is a historic document that contains many recommendations that are still relevant to downtown improvement. The remaining copy needs to be summarized and scanned and the zoning recommendations need to be included in a "Planning Givens" layer to be overlaid on IKONOS 2003.

4.2.4. Vision 2020 Redevelopment Strategy, Strategic Planning Group

The Vision 2020 Plan, prepared by UDC focuses on physical and socio-economic improvements required to renew downtown and achieve its goals for the 21st century (healthy downtown business and residential communities). Given the constraints and opportunities identified during the planning process, the Plan recommended the following:

- Utilize entertainment as a catalyst to attract the local population back downtown.
- Relocate government offices back downtown.
- Redress the socioeconomic degradation experienced by downtown residents.
- Operationalize the Kingston Market and develop the westside transportation hub.
- Restore downtown's traditional retail/office facilities and revitalize the retail activities of downtown.
- Resettle downtown Kingston and reestablish its traditional character as a resident community.
- Reserve and restore downtown's unique historic buildings.

The Plan noted:

"The emergence of Kingston as a regional centre for trade and commerce greatly influenced the development and character of Jamaica. As the capital of Jamaica and its greatest city, Kingston is the focus of transportation and the place where a majority of the nation's business is conducted.

"At one time downtown Kingston was the centre of government and finance, the location of foreign consulates and embassies and host to international tourism. For the most part - government, the finance and insurance industry and the representation of foreign governments have relocated to the New Kingston area. Tourism has moved to the northern and western coasts of Jamaica. Ironically, this exodus from downtown Kingston has produced the conditions which can today be transformed into attractive opportunities for reinvestment and redevelopment. To produce a successful renewal programme, several factors external to the downtown need to be considered."

The Plan proposed the following Corrective Actions:

Ecological Restoration of Kingston Harbour:

- Short term - Construct culverts through the Palisadoes Causeway to permit a natural flushing of the Harbour by the tidal currents (a proposal not necessarily endorsed by being quoted);

- Long term - Construct adequate sewage treatment facilities to satisfy existing and future demands. Also, develop interceptor basins or cribs along gullies with clean-out provisions to reduce polluted runoff into the harbour. Enforce environmental laws to stop existing violations.

Restoration of Services

- The Jamaican Railroad System – "Reestablishment of this transportation service is necessary to interlink the nation and facilitate the movement of goods, produce and people to and from Kingston. Failure to do so will lead to the further deterioration of the national highways due to the increased burden of absorbing all of Jamaica's transportation needs."
- Municipal services must be restored in the downtown neighborhoods. Some communities, such as Rae Town can attribute economic deterioration to inadequate or few services and utilities.
- Public bus services need to be restored to higher standards. Mass transit services have deteriorated, become inadequate and, at times, hazardous.

Completion of In-Progress Projects

- The Oxford Market and the development of the West Kingston Market District – "No single event would improve the conditions for the redevelopment of the Central Business District (CBD) of downtown Kingston as would the completion of this project. A successful DKDA Redevelopment Programme is not dependent on the completion of the market. However, it would result in consolidation of higglers and other market activities into a market facility and restore the CBD streets and walkways to their intended use. The CBD would be relieved of its congestion, trash and pollution and other social problems it endures today."
- Ocean Boulevard should be continued along the harbour eastward to Rockfort, forming a first class entrance boulevard to downtown from the east and from Norman Manley International Airport.
- The Harbour Street utilities improvement programme must be completed in a timely manner to support the investment and development programme envisioned in Vision 2020.

The Plan advocated a Coordinated Tourist Development Programme, noting that "Kingston and its immediate environs are a treasury of history and cultural assets and a place of incredible natural beauty. A programme of historical tours and cultural presentations could become a major attraction of tourism and a source of national pride. The architectural heritage of downtown, along with the fascinating legends of Port Royal and the dramatic beauty of the Blue Mountains, all comprise a remarkable set of attractions. Cultural presentations of traditional and modern music and dance and tours of historic downtown would restore Kingston as a Mecca for tourism."

Vision 2020 recommended establishing a Downtown Management District (DMD) to unite the stakeholders of the Central Business District into a special improvement programme. As

well as improved opportunities for new development and private investment, the strategy encompassed physical design improvements, chief among them being:

- A Harbour Marketplace Centre, a waterfront festival marketplace and entertainment centre,
- Completion of the Kingston's Oxford Market project,
- Establish an aggressive marketing programme to benefit the Jamaica Conference Centre,
- A Multi-modal Transportation Centre (bus, train, ferry and taxi) located along Pechon Street,
- A Ward Theatre Performing Arts Centre,
- A programme to consolidate government offices downtown,
- A Chinatown ethnic district, and
- Promotion of the resettlement of the DKDA.

The Vision 2020 report observed: "No redevelopment effort will be successful if residential redevelopment does not occur. Ultimately, downtown Kingston needs to once again become a 24-hour environment. This area of Kingston historically housed over 60,000 people and employed tens of thousands of residents. The infrastructure that supported that population is largely in place.

Furthermore, downtown's four major neighborhoods have begun to work together as demonstrated by the extensive effort they contributed to the formulation of Vision 2020.

"The strategy for restoring and expanding the housing supply of the residential districts is based on two separate but interrelated components: market rate housing and low income housing. The major deterrent to development of housing in the greater Kingston metropolitan area is reported to be unavailability of land having a full complement of infrastructure. The opposite is true in downtown Kingston. Vision 2020 calls for mid-high rise market driven residential units within two areas: one, on UDC waterfront land located between Gold Street and Hanover Street south of Harbour Street and the second, reuse of the Penitentiary site. Low and moderate income, low-rise residential development is largely based on rehabilitation and infill housing within the Tel Aviv, Southside, Rae Town and Bridgeview communities. Low and moderate income housing alternatives include Urban Homesteading (the use of 'sweat equity'), Core Housing and Infill Housing. Creative funding will be required to mix cash and credit subsidy programmes with charitable sources and cross-subsidy development linkages."

4.2.5. The Palisadoes-Port Royal Protected Area, 1997-1998

The Palisadoes-Port Royal Environmental Policy Framework (EPF) produced in 1997 by the NRCA contains a summary of environmental conditions and stresses based on studies commissioned from UWI Life Sciences Department on: geology, water quality, fisheries,

seagrass beds, mangroves, corals, terrestrial vegetation, wildlife and archaeology. The findings are summarized in Figure 4.4, designed for printing at a large scale.

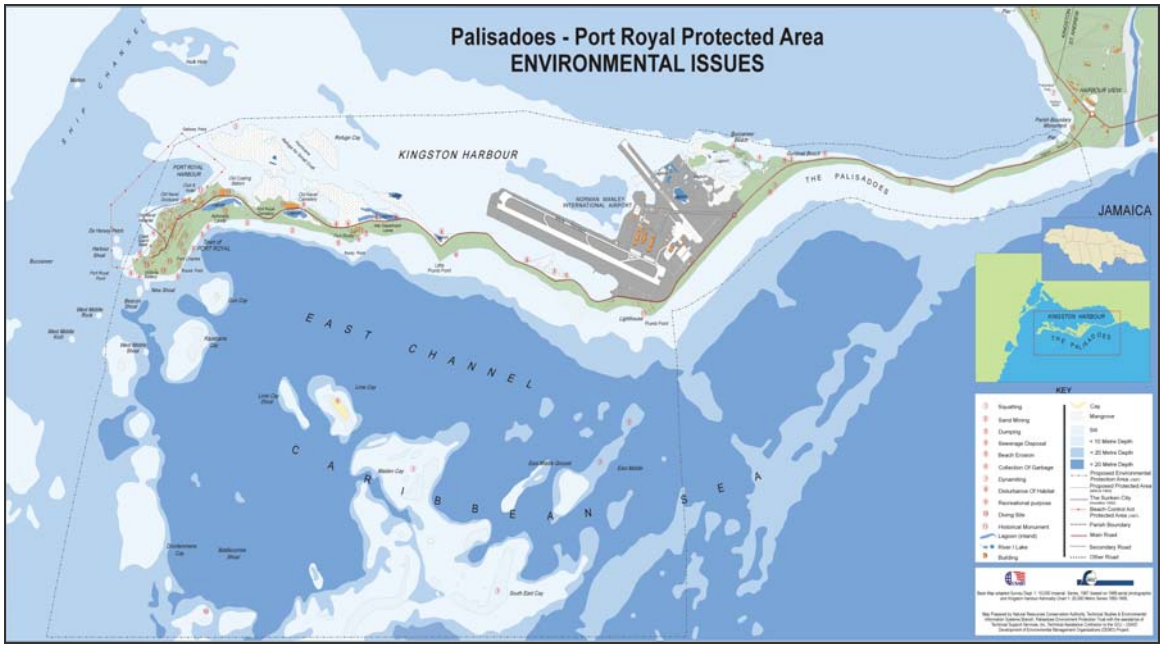

Figure 4.4 Palisadoes-Port Royal, Environmental Issues

During preparation of the EPF, stakeholders identified a range of potential improvement projects. The six projects deemed of highest priority (including signage, water taxi operator training and certification, Lime Cay sanitation, Palisadoes environmental warden patrols, and ferry terminal repair) were designed and implemented with the involvement of local residents and other stakeholders.

Based on the EPF and stakeholder support expressed during its preparation, the Palisadoes-Port Royal Protected Area was declared on August 5, 1998. The intention was that it would be managed as a National Protected Land and Seascape.[1]

The Palisadoes-Port Royal Management Plan, 1998, provides zoning for Environmental Management of the Protected Area, comprising the entire tombolo and surrounding waters. The specific land use and zoning proposals (Figure 4.5) address five sub-areas:

- Palisadoes Entrance Strand (Harbour View to Gunboat Beach)
- Airport and Adjacent Development (Gunboat Beach to Little Plumb Point)
- Mangroves, Dune and Thorn-Cactus Bush (Little Plumb Point to Port Royal)

[1] A category of the protected area based on the International Union for the Conservation of Nature (IUCN) classification system. The NRCA has not yet developed specific regulations for this category and is using the National Park regulations.

- Port Royal Town
- Southern Lagoon, Cays and Reefs.

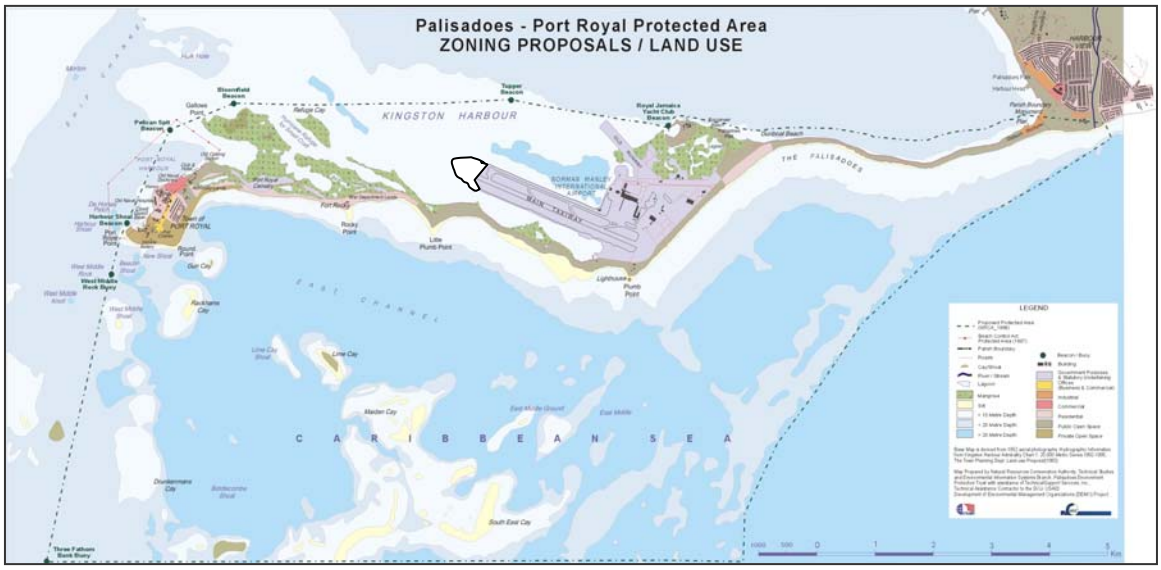

Figure 4.5 Palisadoes-Port Royal, Zoning Proposals/Land Use

4.2.6. Port Royal Development Plan

A 2001 planning proposal for the redevelopment of Port Royal was prepared for the Port Royal Development Company (PRDCL) by Pragma, Marvin D. Goodman, The Jerde Partnership, (Architects), Thomas Consultants and others.

The plan was prepared within the framework of a Definitive Agreement with the Government of Jamaica, based on broad stakeholder input. Zoning recommendations build on previous studies by Oliver Cox, UDC, etc. They also reflect the findings of the following completed studies and plan components:

- Interpretive Master Plan
- Socio Economic Impact Assessment
- Archeological Impact Assessment
- Housing Study
- Security Plan
- Architectural Drawing – Preliminary
- Environmental Impact Assessment
- Engineering Designs – Sewage & Water Systems
- Retail Plan
- Business Plan

The plan addresses several distinct zones or theme areas shown on Figure 4.6 and proposes:

- Excavation of Chocolata Hole Bay;
- Cruise ship pier construction at the entrance to Chocolata Hole Bay;
- Installation of a zone of "seamless retail" businesses around Chocolata Hole Bay, adjacent to the cruise ship pier (main recreation, entertainment and shopping area with restaurants, shops, taverns and sidewalk cafés -- all buildings constructed in the architectural style of the 17th Century with a 2- story maximum);
- Use of the Naval Hospital as a museum and construction of an Afro-Jamaican Pavilion to the northeast of the Naval Hospital;
- Restoration of Admiralty House and surrounding structures;
- Redevelopment of Fort Rocky for use as an entertainment venue;
- Restoration of structures at the Naval Dockyard as tour center and naval museum; improvement of the lagoon for eco-tours (see detailed diagram, Figure 4.7).

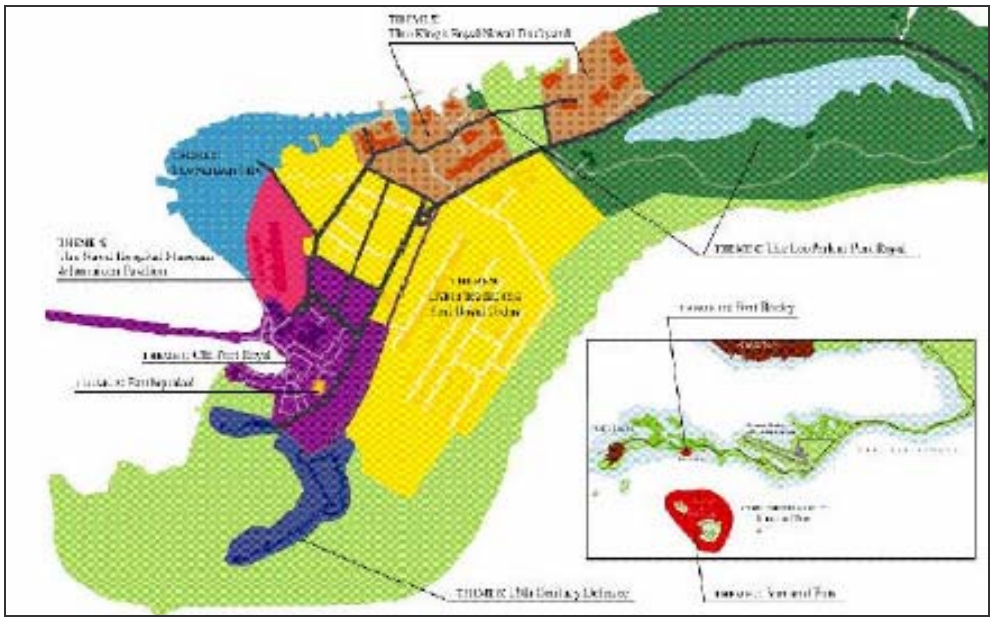

Figure 4.6 Proposed Port Royal Zoning

Figure 4.7 Port Royal Lagoon Plan

Assuming GOJ and investor backing in the near future, the plan for phased development anticipates reaching an average of 10,000 visitors/day by 2025.

While extensive studies have already been undertaken, further design work and environmental analysis will be required to ensure the adequacy of and safety of vehicular access and parking, ferry access, water supply, wastewater collection and treatment, solid waste management, etc. to support the anticipated visitor load.[2] The Development Plan states that a comprehensive environmental impact assessment of the overall project will be carried out as well as detailed environmental impact assessments for each of its infrastructure development components will be completed in five parts by 2000. It is not clear if these are available.

At present, the plans address these issues as follows:

- The area where the boats are parked at the Naval Dockyard will be converted to a bus and car park area. The boats will be moved closer to the seashore and separated from the bus and car park area.
- Water demand will grow to 585,000 gallons per day (expected to be met by surplus in the new 10" line to NMIA and the existing 300,000 gallon storage at Port Royal);
- Design and construct new water supply and wastewater collection, treatment and disposal systems. "This will not include the housing scheme south of Morgan's Line (existing water mains, septic tanks)."[3]
- Design and install garbage disposal receptacles.

[2] Note: The Final Engineering Report was completed by Wallace Evans Jamaica Limited in December 1995, before the proposed size of the project reached its final extent.

[3] Quotations taken from the Definitive Agreement, 1998

4.2.7. Other Completed or Approved Development/Improvement Plans

Numerous and relatively recent projects have altered or have the potential to affect the waterfront. The following (Table 4.5) Environmental Impact Assessments on these projects provide (or will provide when copies are obtained) siting/alignment and other information relevant to overall waterfront planning.

Table 4.5 Relevant Environmental Impact Assessments

Report	*Author*
Kingston Foreshore Road	Technological and Environmental Management Network Limited
Kingston Harbour Coast Road Project	Environmental Solutions Limited
Kingston Harbour Coast Road Project phase 3	CALL Associates Consultancy Limited
Bellevue Lands Housing Development, Paradise Palms Project	Environmental Solutions Limited
Proposed Installation of Alternative Fuel Facility at Caribbean Cement Company Limited. (Final Report)	Conrad Douglas & Associates
Proposed Bus Depot at 100 Windward Road	Technological and Environmental Management Network Limited
New Kingston Sub-station and Transmission Lines	Geomatrix Jamaica Limited / Jamaica Public Service Company
National Water Commission, Kingston Metropolitan Area Water Supply, Sewerage Rehabilitation and Corporatization Project	Environmental Solutions Limited
Port Royal Heritage Tourism Project	Environmental Solutions Limited
Development of Kingston Container Terminal, Gordon Cay Western Extension. (Final Report)	Technological and Environmental Management Network Limited
Hydraulic and Environmental Study: Hunts Bay Reclamation Work	Environmental Solutions Limited
Highway 2000 – Kingston - Portmore	Environmental Solutions Limited

4.3. Current Developments and Plans

The following sections discuss ongoing planning efforts. Note that in several instances, plan documents are still being prepared. It has thus been necessary to provide a summary of

presentations made at the Kingston Harbour Seminar held in November 2003. Questions noted will be posed to the relevant agencies during the next set of tasks.

4.3.1. Airport Redevelopment

The following is based on a presentation by Earl Richards of the Airports Authority of Jamaica at the November 2003 Kingston Harbour Seminar.

Ongoing and future development must meet the demands of:

- Traffic growth (pax – 1.5m in 2002, projected to reach 2.8m by 2025 -- and aircraft movement);
- New and advanced aircraft designs – implications for runway numbers and length;
- Aviation security* – need summary of requirements and implications;
- Customs and Immigration procedures* -- need summary of requirements and implications;
- New air navigation technology -- need summary of requirements and implications; and
- Changes in regulatory requirements: International Civil Aviation (ICAO) Standards and Procedures (ICAO Aerodrome Certification, 2003.11.27) require Runway End Safety Areas (RESA), not currently provided.

For all these reasons, additional land reclamation and runway construction is required. To meet the RESA standard, the runway and parallel taxiway will need to be extended further into Kingston Harbour by 400m (inc. 60m landing strip extension). The estimated area of needed land "reclamation" (creation) is 20ha (400m x 500m), involving 700,000 cu m. of fill (at a cost of $560M for *in situ* fill). Note: the reason for 500m width is not fully understood.

Present Runway Characteristics	*Long Term Characteristics (Desired)*
Designation - 12/30 (w/e)	
Length - 2,716 m (8,911 ft)	Length - 3,048 m (10,000 ft)
Width - 46 m (151 ft)	Width - 46 m (151 ft)

Environmental studies have not yet been conducted. They need to address:

- The impacts of proposed growth on the Palisadoes Road;
- Other potential forms of access;
- Potential sources of fill and the effects of lagoon expansion;
- New sewage treatment plant – effluent acceptable to NEPA – what treatment level?
- Solid waste management – 15 ton incinerator under construction;

- Soil remediation of hydrocarbon pollutants;
- Oil water separators installed;
- Parking; and
- Tombolo stability

Questions:

- How will the 400m extension and larger planes alter approach zone requirements, including height restrictions?
- How will runway extension affect Port Authority operations?
- Broader questions that need to be addressed, considering Palisadoes stability, airspace, access, waste management, wetlands protection, reclamation source material and mitigation, include:
    - Currently NMIA is the principal port of entry for nationals. However, as efforts to increase tourism in the Kingston region, clearly NMIA will receive more tourist passenger traffic.
    - How will Vernam Field impact on the growth of cargo traffic through NMIA?
    - How can Jamaica plan for very long-term air traffic growth? What is the maximum sustainable extent and volume of NMIA?

4.3.2. Gunboat and Buccaneer Beach

Allied Business Consultants (plus Rivi Gardner) presented the following proposal to NEPA on January 24, 2002. "7th Harbour is being planned as a multi-use facility on the Gun Boat Beach site located on the Palisadoes peninsula. The site is adjacent to the Norman Manley International Airport and comprises approximately 105 acres of land (Figure 4.8). The project is being planned in two phases and the preliminary plans envisage the following activities:

Phase I

- Boat Tour Facility
- 100 slip Marina and Marine Fuel Station
- Boat Building and Repair Yard

Phase 11

- Nature Park.
- Restaurant
- Day Spa
- 150-room hotel
- Entertainment Complex with capacity for 15,000 patrons
- IT Park and Warehouse Complex

"Preliminary plans have been completed and detailed plans are now being finalized for selected activities in Phase I" (restaurant, boat tour facility, day spa) "to 'jump start' the larger development."

Figure 4.8 Allied Business/Rivi Gardner Proposal for 7th Harbour at Gunboat and Buccaneer Beaches

The two beaches (Figure 4.9) offer a possible site for a "piscinao," following the Brazilian model Piscinao de Ramos (Figure 4.10), as a recreational and safe bathing facility during the period of harbour water quality improvement.

Figure 4.9 Aerial Photo of Gunboat and Buccaneer Beaches

Figure 4.10 Photo of Piscinao de Ramos

4.3.3. Port of Kingston

The presentation by Ian Blair of the Port Authority at the November 2003 Kingston Harbour Seminar provided the following summary of port expansion needs and options.

- Kingston Container Terminal (KCT) is the 63rd largest container port in the world and the 3rd largest in the Caribbean (Figure 4.11).
- Over the year ended August 2003, KCT handled 1,042,282 twenty-foot equivalent units (teus), 1,522 ship calls.
- The PAJ has undertaken three previous developments of the KCT:
  - KCT 1 - Original development on the North Terminal, 1973 to 1975. Terminal capacity 400,000 teus.
  - KCT 2 - First phase development of the South Terminal (Gordon Cay) eastern end, 1995 to 1997. Capacity increased to 800,000 teus.
  - KCT 3 - Second phase development of Gordon Cay, Dredging of the ships channel, land reclamation at Hunts Bay, Fort Augusta and Gordon Cay, 1999 to 2001.

These improvements increased terminal capacity to 1,200,000 teus.

Figure 4.11 Aerial Photo of Kingston Container Terminal

Proposed improvements:

1. **KCT 4 Project (2004-2005)**

To be completed by First Quarter 2005, this project to increase KCT capacity by 300,000 teus will (Figure 4.12):

- Extend the South (Gordon Cay) Terminal berth by 91m and 7.7 ha of container yard space; and
- Construct 502m of new berths at North Terminal and 5.2ha of new container yard space.

Other improvements are proposed at KCT 1 to upgrade efficiency.

2. **KCT 5 Project (2007-2008)**

- Increases the KCT capacity by 500,000 teus to an estimated 2,000,000 teus.
- Construction of approximately 450m of new berths connecting the North berth to the South berth.
- Construction of 66.4ha of container yard space (+ 4 super post-panamax cranes).

Container Shipping Requirements Beyond 2010

- Channel depth of approximately 15 metres from Port Royal point to container terminal.

- Sufficiently wide turning area for vessel larger than 9,OOO teus.
- Highly productive container terminal capable of productively levels of 50 container moves per hour per crane.

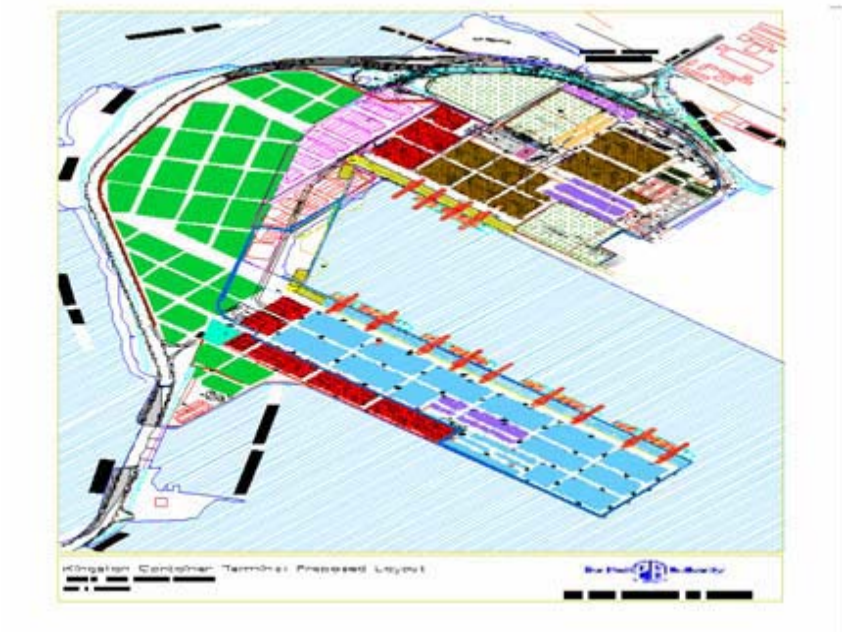

Figure 4.12 Proposed improvements to Kingston Container Terminal

Constraints include:

- Hunts Bay storm water flow/discharge;
- Highway 2000 corridor;
- Norman Manley Airport runway approach and take-off corridor;
- Fort Augusta heritage conservation;
- Predetermined (?) wind direction;
- WHICON Marina; and
- Deeper water, more expensive reclamation and increased wave action south of Fort Augusta.

Opportunities include:

- Deep water for large vessel turning in at least two areas;
- Shallow water at Fort Augusta for land reclamation.

Questions:

- Do requirements beyond 2010 require more land reclamation or better equipment/greater efficiency?
- Are there access and distribution thresholds that would set limit on traffic?

4.4. Future Plans

4.4.1. Downtown Kingston and Waterfront Plans

The Urban Development Corporation is developing a plan for the downtown waterfront, which will examine and make recommendations for connections with a number of related downtown and transportation elements. Plans are also underway for development within the Business Improvement District. Both sets of plans are required in hard and electronic form.

4.4.2. KSAC Sustainable Development Plan

Eight technical studies are to provide the basis for plan formulation. To date, two have been completed: lnfrastructure (Beverline Brown) and Environment & Development (Alison Massa). The latter paper takes a "whole systems" approach to the conditions that ultimately are reflected in the state of Kingston Harbour and proposes the following actions:

- Rebuild the rehabilitated sewage treatments plants with tertiary sewage treatment by using existing and created wetlands to polish effluent (employing organic, not geometric design) that will:
    - Permit regeneration of corals as well as harbour cleanup by adding effluent polishing in existing and new created wetlands;
    - Provide another element in the array of attractions/educational opportunities for tourists and residents;
    - Provide another source of employment; and
    - Provide a productive reason for reserving shoreline land for sediment accretion.
- Rebuild green gullies with vegetated, permeable channels and stepped, vegetated gabion basket walls, and check dams to manage storm flows, that will:
    - Allow filter runoff, recharge and permit clean up of the Liguanea Aquifer;
    - Allow sediment deposition within the Liguanea Plain and along the shoreline instead of in the harbour and out to sea;
    - Support urban agriculture using permaculture principles as part of a productive urban forest providing employment, livelihood and recreational opportunities;

  - Filter polluted air;
  - Reduce heat island effects;
  - Restore the urban area to a more green and aesthetically pleasing state; and
  - Provide alternate pedestrian and bicycle circulation routes.
- Promote exploration of redevelopment options among citizens and competitions for projects that apply Jamaican vernacular style to highly efficient, urbane and defensible community design models that can:
  - Accommodate a majority of the growth projected for the southeast and protect agriculture and watershed land from further costly sprawl;
  - Open up land for green gullies while supporting increased densities over time;
  - Provide more support for effective public transportation, non-vehicular circulation, community activities, recreation and education opportunities; and
  - Maintain or reflect the functional and historic character of old Kingston.
- Build into all new and redevelopment projects provision for garbage separation, transfer and composting (producing further sources of employment/livelihood and material for use in the productive urban forest).
- Recommit to permanent protection of flat and hillside agricultural land, by policies and programs that:
  - Aggressively support a transition to organic agriculture, (or controlled use of less damaging chemicals/integrated pest management) to reduce nutrient and toxin runoff loads (especially to the Rio Cobre);
  - Promote crops that are particularly or uniquely suited to Jamaica and to its regions;
  - Create a culture that focuses on food security and specialized exports to high-end markets and makes it socially unacceptable to support cheap imports that support global agribusiness;
  - Expand the use of drip irrigation and treated effluent; and
  - Focus population and housing growth within the existing urban area in well-designed higher density neighborhoods.
- Recommit to protection of undisturbed forest and regeneration of degraded, disturbed forest through:
  - Replanting with the pre-existing mix of trees;
  - Replacing invasive species with hardwoods; and
  - Enforcing and expanding Forest Reserve and Protected Area designations.

These actions are illustrated in preliminary, diagrammatic form in Figure 4.13.

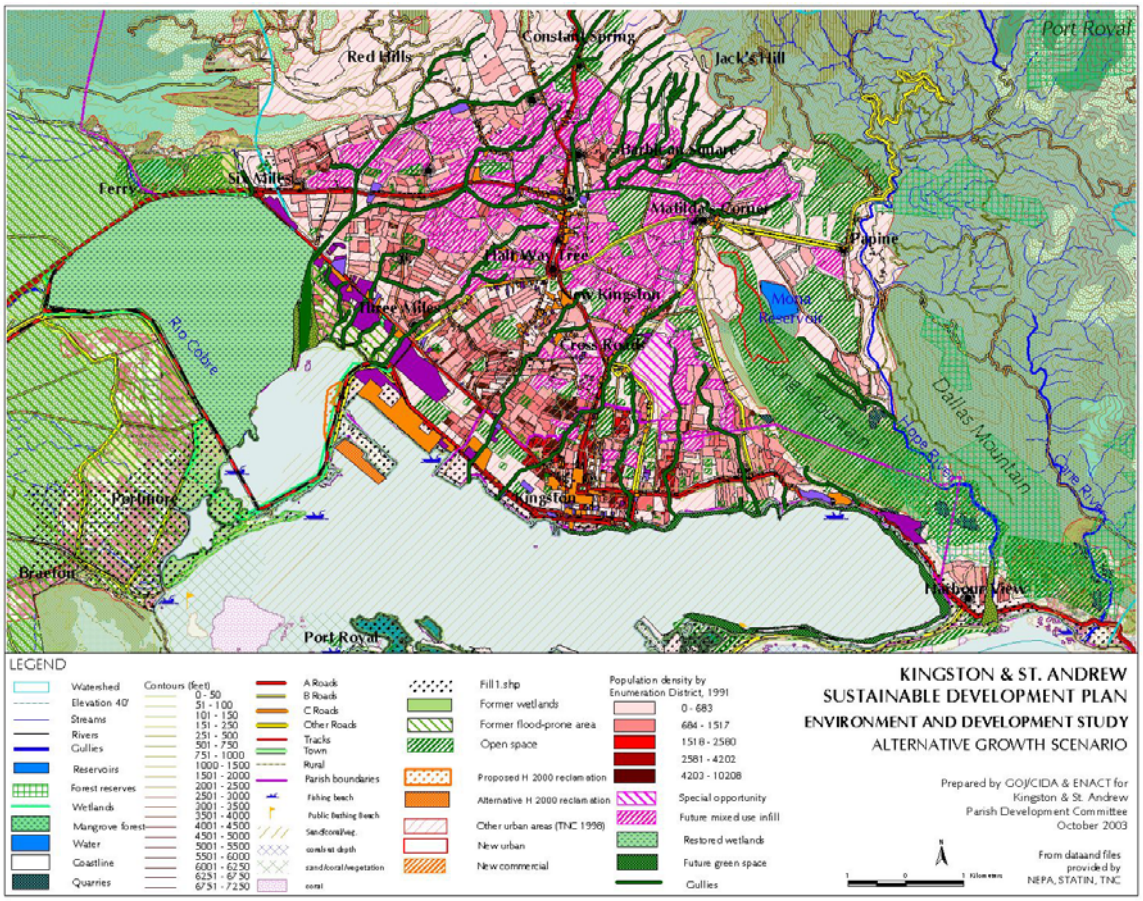

Figure 4.13 The Kingston & St. Andrew Parish Development Committee's Vision of a Green Frame, a Green Waterfront and a network of Green Connections between the two

Experience with the clean-up of Chesapeake Bay supports such an integrated whole systems/whole watershed approach, within which incremental actions can be taken by a wide range of actors.

The Environment and Development paper also recommends that the new plan emphasize urban design standards and a performance standards-based approach, rather than a strict land use plan. An excellent recent assessment of the value of the 1972 Urban Design Plan for the City of San Francisco includes a discussion of the value of performance standards that supports the recommendations for Kingston.

4.5. Summary of the Literature Review to Date

To date, planning, on the part of government, quasi-government and private entities alike, has often been conducted in an "ad hoc" manner and has tended to be narrowly-focused, addressing a relatively short time horizon. Past planning efforts have not always involved broad stakeholder participation, while many completed plans have received insufficient dissemination. As a result:

- Plan recommendations remain unknown to stakeholders who could assist with implementation;
- Individual developments are not always coordinated;
- The potential cumulative impacts of a number of developments are not calculated or compared with carrying capacity; and
- Unnecessary effort is expended repeating the processes and the recommendations of earlier studies and plans.

The literature review has identified a number of plans that are still current or contain proposals that are still valid. These plans, which wherever appropriate will be incorporated as "givens" into the draft Kingston Harbour Waterfront Plan, include:

- The Shankland Cox and Marvin Goodman Downtown Plans;
- Vision 2020 Downtown Redevelopment Plan;
- The Port Royal Development Plan; and
- The Port Royal-Palisadoes Protected Area Plan.

Review of several special purpose plans allows identification of existing or potential conflicts and alternative solutions. For example, resolution of conflicts between the Petrojam plant and the Greenwich Fishing Village may require a broader review of options available than has been the case to date. Additional work will be required by several agencies to identify a comprehensive set of siting criteria for fishing villages and other suitable siting opportunities

The review is also allowing examination of the cumulative impacts of all recent, current and future infrastructure plans, including the Kingston Container Terminal, Norman Manley International Airport and the Coast or Foreshore Road. The examination to date has revealed that the total additional fill resulting from airport runway expansion, KCT 4, KCT 5 and KCT improvements beyond 2010 will amount to 99.3 ha (not including Highway 2000, toll plaza, fishing facilities, the Foreshore Road, etc.). Future fill may need to be undertaken in the context of a harbour-wide program of wetlands reclamation or creation.

Current planning efforts, especially on the part of the Kingston & St. Andrew Parish Development Committee and the Kingston Harbour Rehabilitation Project, are attempting to achieve:

- Incorporation of a holistic plan for managing influences on the Harbour;
- A level of coordination among waterfront users;
- The synergy that comes from integrated action;
- A long-term view of carrying capacity and sustainability; and
- Coordinated programs, such as wetlands mitigation banking.

5. References

Aiken, K. A. 1975. Aspects of the Biology, Ecology and Bionomics of the Families Balistidae Trigger Fishes and Chaetodontidae (Butterfly and Angelfishes) in Jamaican and Adjacent Waters. Msc. University of the West Indies.

Alleng, G. P. 1990. Historical Developments, Present Status and Management Guidelines for the Port Royal Mangal, Jamaica. MPhil. Thesis University of the West Indies, p 171.

Andrews, J.E., A.M. Greenaway and P.F. Dennis, 1998. Combined Carbon Isotope and C/N Ratios as Indicators of Source and Fate of Organic Matter in a Poorly Flushed, Tropical Estuary: Hunts Bay, Kingston Harbour, Jamaica. Estuarine, Coastal and Shelf Science 46: 743-756.

Andrews, J.E., A.M. Greenaway, G.R. Bigg, D.F. Webber, P.F. Dennis and G.A. Guthrie, 1999. Pollution History of a Tropical Estuary Revealed by Combined Hydrodynamic Modelling, Geochemistry and Sedimentology. Journal of Marine Systems 18: 333-343.

Bigg, G.R. and D.F. Webber, 1996. The Impact of Development, and Coastline Change, on the Flushing Time of Kingston Harbour, Jamaica. Submitted to Caribbean Journal of Marine Studies.

Bigg, G.R. and D.F. Webber. 2003. The Impact of Coastline Change and Urban Development on the Flushing Time of a Coastal Embayment, Kingston Harbour, Jamaica. Bul. Mar. Sci. 73(2): 291-305.

Chin, A. N. 1991. Studies on Populations of Shallow Water Penaeid Shrimps and Blue Crabs from the South Coast of Jamaica. MPhil. Thesis University of the West Indies. pp 188.

Delcan. 1994. Feasibility Studies on Coastal Conservation. Nearshore Marine Water Quality of the West and Southwest Coasts of Barbados: Present Status and Management Recommendations. Government of Barbados Ministry of Tourism, International Transport and the Environment, Coastal Conservation Project Unit.

Dillon Consulting. 1999. Wastewater Treatment System Upgrade for the Norman Manley International Airport Kingston, Jamaica.

Fisher, E. 1973. The shallow water Actinaria and corallimorpharia of Jamaica with special reference to the genus Bunodeopsis. MSc, University of the West Indies. pp 219.

Goodbody, I.M. 1968. The Impact of Development on Kingston Harbour. Jamaica Architect 2, 42 - 47.

Goodbody, I.M. 1970. The Biology of Kingston Harbour. Info. Bull. S.R.C. Ja. 1: 10 - 34.

Goreau, T. and K. Bourke. 1996. Pleistocene and Holocene Geology of the Island Shelf Near Kingston Jamaica. Mar. Geol. 4:207-225.

Government of Jamaica. 1968. Kingston Harbour Study, vol. 1 - 4.

Grahame, E. S. 1976. The Occurrence of *Lagenisma coscinodisci* in *Palmeria hardmaniana* from Kingston Harbour, Jamaica. Br. phycol J. vol 11, p 57 -61.

Grahame, S.E. 1977. The Ecology of Plankton in Kingston Harbour Jamaica. Part 2 The phytoplankton. Research Report from the Zoology Dept. U.W.I. No. 4. pp. 104.

Grant, C. J. 1981. Gill Net Selectivity and Catch Rates of Coastal Pelagic Fish in Jamaica. Est. Coast. Shelf Sci. Vol. 12 p 167 - 175.

Greenaway, M. 1976. The Grazing of *Thalassia testudinum* in Kingston Harbour, Jamaica. Aquatic Botany, vol. 2, p 117 - 126.

Harvey, G. C. McN. 1986. Aspects of the Biology and Artisanal Fishery of Three Caribbean Clupeids (Pisces: Clupeidae) in Jamaican Waters. PhD. Thesis. University of the West Indies. pp 522.

Hendry, M.D. 1978. Evidence of Shoreline Evolution for the Palisadoes, Kingston. J. Geol. Soc. Vol. XVII:39-48.

Kellogg Brown and Root 2003. Kingston Water and Sanitation Project, Final Project Report, Volumes 1 – 4. National Water Commission.

Mansingh, A. and A. Wilson. 1995. Insecticide Contamination of Jamaican Environment # 3: Baseline Studies on the Status of Insecticide Pollution of Kingston Harbour. Mar. Poll. Bull. vol. 30 (10) p 640 - 645.

Marshall, Macklin, Monohan. 1966. Report on Pre-Design Study, Sewage Collection System and Treatment Works for Harbour View, Parish of St. Andrew Jamaica W.I.

Moore, E. and F. Sander. 1979. A Comparative Study of Zooplankton for Oceanic Water and Shelf and Harbour Waters of Jamaica. Biotropica. 11:196-208.

Moore, E. and F. Sander. 1982. Nutrient Phytoplankton-Zooplankton Relationships at a Highly Eutrophic Tropical Station. Carib. J. Sci. 18:1-4.

Provan, M. 1984. The Status of Oil Pollution in Kingston Harbour. M.Phil. Thesis. University of the West Indies. Pp.184.

Reid Crowther. 1983. Report on Preliminary Engineering, Book No. 1. Kingston and St. Andrew, Jamaica Sewage Program. Wastewater Reclamation and Agricultural Re-Use Project - FLOW WEST PROJECT.

Reid Crowther. 1985. Pre-Design Study of Wastewater Treatment Plants, Kingston, St. Andrew and St. Catherine. The National Water Commission Jamaica.

Reid Crowther. 1985. Report on Kingston, St. Andrew and St. Catherine Sewerage System and Recommendations for Upgrading Four Wastewater Treatment Plants. The National Water Commission Jamaica.

Reid Crowther, Joint Consultants, United Engineers. 1980. Wastewater Pollution Control Study for S.E. St. Catherine, Jamaica. Prepared for the Jamaica Pre-Investment Programme and the National Water Authority.

SENTAR 1993. Kingston Harbour Environmental Project Phase 1 Report - Volume 2. Appendix 1 - Harbour Condition assessment. Prepared for NWC, Jamaica. pp186.

SENTAR 1993. Kingston Harbour Environmental Project, Phase I Report, Volume 1 Main Report and Appendices II – XI. Prepared for NWC Jamaica W.I. Section 3 Current Pollution Sources and Loadings

SENTAR 1993. Kingston Harbour Environmental Project, Final Phase II Report, Volume 2 of 3 Appendices. Prepared for NWC Jamaica W.I.

Sherwin, J. and K.R.Deeming, 1980. Water Circulation and its Relation to Pollution in Kingston Harbour, Jamaica. Project Report U80-1. UCES Marine Science Laboratories, menai Bridge, Anglesay. 97p.

Sides, E.M. 1975. A study of Niche Separation in Three Species of Opiocoma (Echinodermata, Ophiuroides) in Jamaica. M.Sc. Theseis. University of the West Indies. Pp.90.

Siung, A. M. 1976. Studies on the Biology of Three Species of Mangrove Oysters (*Isognomon alatus Gmelin*, *Crassostrea rhizophorae* Guilding and *Ostrea equestris* Say) in Jamaica. PhD. Thesis University of the West Indies. pp312.

Steven, D.M. 1966. Characteristics of a Red Water Bloom in Kingston Harbour, Jamaica W.I. J. Mar. Res. 24:113-123.

Wade, B. A. 1972. Benthic Diversity in a Tropical Estuary. The Geological Society of America vol. 133 p 499 - 515.

Wade, B. A. 1976. The Pollution Ecology of the Kingston Harbour; Jamaica. Scientific Report of the U.W.I. - O.D.M. Kingston Harbour Research Project 1972 - 1975, vols. 1, 2 & 3.

Warner, G. F. 1967. Studies on the Ecology and Biology of Jamaican Mangrove Crabs with Particular Reference to the Tree Crab *Aratus pisoni* (Milne Edwards). PhD. Thesis University of the West Indies. pp 355.

Webber, D.F. 1990. Phytoplankton Population on the Coastal Zone and Nearshore Water of Hellshire, St. Catherine, Jamaica. Ph.D. Thesis, University of the West Indies. Mona. 283p.

Webber, D.F. 1997. The Water Quality of Kingston Harbour Some Sources and Solutions. Pages 45-63 *in* M.Bardowell and A. Vassel, eds. Proceedings of the Seventh Annual Conference on Science and Technology. Scientific Research Council, Kingston, Jamaica.

Webber, D.F. and P.Wilson-Kelly, 2003. Characterisation of Sources of Organic Pollution to Kingston Harbour, the Extent of Their Influence and Some Rehabilitation Recommendations. Bul. Mar. Sci., Vol. 73 September 2003, No. 2., p257 – 271.

Webber, D.F., 1996. The Water Quality of Kingston Harbour, some Sources and Solutions. Proceedings Scientific Research Council, 7th National Conference on Science and Technology, Kingston, Jamaica.

Webber, D.F., M.K. Webber and D.D. Williams. 2003. The Relative Importance of Meteorological Events, Tidal Activity and Bathymetry to Circulation and Mixing in Kingston Harbour, Jamaica. Bul. Mar. Sci. 73(2):273-289.

Webber, M.K., and D.F. Webber (eds.) 2003. A Collection of Studies Conducted from the Port Royal Marine Laboratory on the Status of Kingston Harbour, Jamaica, in Relation to Continued Organic Pollution. Bulletin of Marine Science, Vol. 73. No.2.