Executive Summary

Introduction

The Government of Jamaica through the National Water Commission (NWC) intends to effect improvements in the potable water supply for the Greater Spanish Town (GST) and Southeast St. Catherine (SESC) sections of the Kingston Metropolitan Area (KMA), with financial assistance from the Japan Bank for International Cooperation (JBIC).

These sections of the KMA are presently supplied by a number of sources within St. Catherine, including the Rio Cobre Scheme (constructed in the early 1970's) and wells in Greater Spanish Town and Southeast St. Catherine.

The current state of repair of all existing production and relift pumping facilities is poor while existing service storage reservoirs and tanks exhibit some deficiencies.

Currently, about 95% of the population within Greater Spanish Town and SE St. Catherine has access to piped water but supply can be variable, with some NWC customers receiving water only for a few hours each day on occasion.

Current "maximum month" water demand in Greater Spanish Town is estimated at some 63.5 Mega-Litres per day (Mld) or 13.98 migd and this is projected to rise to some 90.6 Mld (19.94 migd) in 2026 (the project design year). With current available supply of some 58.2 Mld (12.82 migd) there is a current deficit of some 5.3 Mld (1.82 migd). In the absence of the proposed capital works of the Project (but assuming some reduction of leakage as a result of ongoing in-house NWC initiatives) the deficit will rise by 2026 to some 32.4 Mld (7.12 migd).

Current estimated "maximum month" water demand in SE. St. Catherine (Portmore and Hellshire) is some 52.8 Mld (11.62 migd) while currently available supply is limited to approximately 40.9 Mld (9 migd) – a current deficit of some 11.9 Mld (2.62 migd). Similarly, assuming some reduction of leakage as a result of ongoing in-house NWC initiatives, in the absence of the Project the deficit would increase to approximately 15.2 Mld (3.34 migd) by 2026.

In order to improve current service levels and to meet the increasing water demand of these developing and expanding sections of the KMA, it is necessary to rehabilitate the existing water supply production, relift pumping and service storage facilities and restore them to their original design capacities, to reduce the level of leakage from the existing water distribution networks and eliminate reservoir overflows, to reduce Unaccounted-for-Water (UfW) generally and to develop additional potable water sources.

The project objective is to provide a reliable 24 hour supply of potable water, of acceptable quality, at adequate pressures at customer taps, throughout the Greater Spanish Town and SE St. Catherine sections of the overall KMA.

Project Concept and Scope

The originally conceived KMA Water Supply Project, as defined for the 1996 Loan Agreement for the project between the Governments of Jamaica and Japan (as subsequently modified in 1999) , had the following components:

Lot 1

- UfW Reduction/Control and Mains Replacement - procurement and installation of bulk flow meters at all production facilities and for "District Metered Areas" (DMAs) within the water distribution systems and the replacement of mains in two sections of Greater Spanish Town (to reduce leakage levels in problematic areas of the existing system);
- Rehabilitation of existing NWC water production, treatment and distribution pumping facilities serving the project area (including the numerous existing wells tapping the alluvial and limestone aquifers of the Lower Rio Cobre Basin) – comprising those of the Rio Cobre Scheme, those in Spanish Town (including the Spanish Town Water Treatment Plant) and those in SE St. Catherine.

Lot 2

- Development of Groundwater Sources – new limestone and alluvial aquifer well development (collectively, of approximately 39Mld or 8.5 migd) together with the construction of upgraded transmission and

distribution facilities - including new pipelines, pumping stations, pressure control facilities and reservoirs - to ensure the distribution of water to all consumers at adequate supply pressures in a controlled and rationalized manner.

Lot 3

- Artificial Aquifer Recharge and Compensation Works for the Irrigation Sector
    - ❖ artificial recharge of the limestone and alluvial aquifers using water from the Rio Cobre Irrigation System (at times when water is available surplus to irrigation demands) to support the increased potable water abstractions from both aquifers under Lot 2 works;
    - ❖ the construction of surface water irrigation canals, lined earthen storage basins and associated pumping stations to re-introduce surface water irrigation into those areas of SE St. Catherine where well fed pressurized irrigation piping systems were established as part of the Agro 21 Crop Diversification Project of the 1980's - to enable groundwater abstraction rights from some of the wells associated with the pressurized irrigation systems to be ceded to the potable water sector.

AND

- Institutional Strengthening of the NWC – with particular reference to the reduction of leakage and UfW within the Project Area and improved operational performance and efficiency.

Consultancy services for the project are being provided by Nippon Koei Company Limited and MWH UK Limited supported by Thames Water International of the UK and a number of Jamaican consultants, including Environmental Solutions Limited (ESL) as the Environmental Manager.

Permitting and Legislative Requirements

The Environmental Permit and License System (P&L), introduced in 1997, is a mechanism to ensure that all developments in Jamaica meet required standards in order to minimize negative environmental impacts. The P&L System is administered by NEPA, through the Applications Section (formerly the Permit and License Secretariat). Permits are required by persons undertaking new development which fall within a prescribed category. Under the NRCA Act of 1991, the NRCA is authorized to issue, suspend and revoke permits and licences if facilities are not in compliance with the environmental standards and conditions of approval stipulated. An application for a Permit was prepared and submitted to NEPA. The TOR's for conducting the EIA were approved by NEPA.

Methodology

A multi-disciplinary team of experienced scientists and environmental professionals was assembled to carry out the required resource assessment, generation and analysis of baseline data, determination of potential impacts and recommendation of mitigation measures. An iterative approach among the environmental team members and other project professionals including engineers, surveyors and hydrologists was adopted. The team utilized the Charette-style approach to data gathering, analysis, and presentation whereby team members conducted the reconnaissance investigations together to determine the critical elements for analysis and the issues to be highlighted for the design and planning process.

Baseline data for the study area was generated using a combination of:

- Field studies
- Aerial observation
- Analysis of maps, plans, aerial photos
- Review of reports and background documents
- Structured Interviews
- Laboratory analyses

Data was also provided for this EIA by the KMA Water Supply Project team and the NWC. Detailed methodologies for the physical, biological and socio-economic aspects of the baseline survey are presented in the report.

The Existing Environment

Physical Aspects

The Rio Cobre basin like the remainder of Jamaica belongs to the seasonal tropics. It has a tropical maritime climate, with topography and distance from the sea being responsible for much of the local variation in climatic conditions.

The parish of St. Catherine like much of the southern regions of Jamaica that lie in the lee of the mountains, has a 30-year mean annual rainfall of less than 1500mm. There is marked seasonality in the rainfall, with about 70% occurring during the rainy season, from May to November. The rainy season exhibits some bimodality, with May and October being the wettest months of each year.

The geology, topography and soils of the Rio Cobre Basin and Southeast St. Catherine are integral in defining the proposed project, especially as this relates to well location and potential yield and the determination of potential aquifer recharge areas.

The geology of the Rio Cobre basin is dominated by upfaulted Tertiary limestone blocks of the White Limestone Super Group, separated by interior alluvial plains and low relief alluvial fan deposits of the Liguanea Formation.

Cretaceous rocks, mainly plutonics and volcaniclastics, cover about only 5 km^2 of the Rio Cobre Basin. These outcrop in inliers in the northwest, in the vicinity of Browns Hall, and in the northeast, around Lawrence Tavern and make up the basal aquiclude of the Rio Cobre Basin. The Yellow Limestone Group, of mid-lower Eocene age, lies adjacent to the Cretaceous rocks. It consists of a sequence of conglomerates, quartz sandstones interspersed with silty mudstones, and marly, fossiliferous impure limestones.

The Rio Cobre Basin can be divided into three physiographical regions, the upper drainage basin with bordering highlands and interior valley (Linstead, Bog Walk), the limestone uplands with the Rio Cobre Gorge and the low relief Rio Cobre alluvial fan/floodplain (St. Catherine Plains) interrupted by limestone massifs (Port Henderson and Hellshire Hills. The geomorphology is dominated by fluvial and karst processes.

A full review and study of the hydrology of the Rio Cobre Basin is to be presented to the Water Resources Authority as part of the detailed design stage of KMA Water Supply Project, and therefore only an overview is given in this EIA report.

There are two types of aquifers in the overall Rio Cobre Basin: limestone and overlying alluvial aquifers.

Although limestone is continuous under the overall Rio Cobre Basin, there is much variation and some discontinuities in its permeability, due to varying lithology, differing degrees of recrystallisation, the many intersecting faults and fractures, and the karst solution widening and opening of fractures.

The Upper White Limestone has its own, elevated water table. At the boundary between the Upper and Lower White Limestones, the groundwater is leaked or transmitted, via joints and fractures, to the Lower White Limestone, where it is stored or discharged via conduits.

Given the good environmental conditions for karst solution processes, and the favourable lithological and structural properties of the limestones, there is likely to be a network of caves and conduits within the limestones, allowing rapid groundwater movement. Additionally, the groundwaters are rich in calcium bicarbonate, the product of solution weathering by aggressive percolating rain and surface water.

The White Limestone of the Upper Rio Cobre Basin is recharged, primarily through dolines and sinkholes, by precipitation over the upper reaches of the basin and by sinking allogenic streams like the Murmuring Brook/Rio Cobre (where it sinks into the Worthy Park caves) and the Rio Pedro, before it becomes buried under the alluvial cover of the Linstead polje. The hydraulic gradient is largely southward.

Surface and Ground Water Quality

The Water Resources Authority (WRA) was commissioned by the client to undertake two blanket sample collection programmes for both ground and surface water throughout the project area – in April 2003 and February 2004. In 2003, 50 water samples were collected from various locations across the Lower Rio Cobre Basin (2 springs, 3 rivers, 2

canals, 1 tap sample and 43 well samples). Samples were analysed for coliforms, residual chlorine, turbidity, conductivity, pH, total dissolved solids, total alkalinity, total hardness, nitrates, chemical oxidation potential, silica, manganese, major anions and cations, and total phosphate. In addition 15 selected samples were also analysed for heavy metals (Hg, As, Cd, Cr, Pb, Ni, Se, Zn), common pesticides, chloroform, benzene, dichloroethanes and chloroform. A further 52 water samples were collected from various locations across the Lower Rio Cobre Basin (2 springs, 2 rivers, 3 canals, and 45 well samples) during February 2004. These were taken to determine the variability of water quality between the wet and dry seasons in Jamaica. Samples were analysed for coliforms, residual chlorine, conductivity, pH, total alkalinity, total hardness, manganese, calcium, magnesium, potassium and sodium. 25 samples were analysed for total iron concentrations. As these blanket sampling and analysis programmes identified manganese levels as a specific issue, ESL conducted its own sampling programme related to this specific parameter.

The data generated from the manganese blanket sampling conducted by the ESL/WRA team show widespread manganese contamination in the sampling areas. The degree of contamination ranged from low (at or slightly above the standard) to high (>100% above the standard). In the first sampling exercise seven of the sixteen (~44%) stations sampled were above the standard while seventeen of twenty-nine (~58%) stations had manganese levels above the standard in the second exercise. Three of the stations that exhibited high manganese concentrations in the first sampling event showed similarly high levels during the second sampling event, namely Dunbeholden, Pasture 2B and Portmore 2 wells.

From the data recorded during the two sampling events, iron contamination does not appear to be as widespread as the manganese contamination or follow similar distribution.

Air Quality and Noise

The ambient noise level at all stations monitored was on average below 75 dBA. On occasion, vehicular movements on the main roads caused noise levels to peak at 84 dBA.

There was great variation in the level of particulate matter in the air at the selected stations. Six stations showed respirable particulate levels within the PM10 guideline but all other stations were in breach of the NEPA standard. Stations located along main thoroughfares, were particularly high.

Biological Environment

The biological environment of the project area is generally characterized by secondary modified communities according to the classification by Grossman *et al* (1991). This includes agricultural lands (sugar cane cultivation, other crops and stud farms in South East St. Catherine) as well shrub-land in the Upper Rio Cobre Basin. Although some areas of dense trees do exist, none of the area can be characterized as a pristine environment as there has been a high level of human activity in most areas.

With the exception of commercially important crops and farm animals, no other commercially important species were noted. Several species of birds were observed but no rare, threatened or endangered species were identified during the course of the field studies. The American Crocodile, a native and endangered species does occur in the Rio Cobre and is sometimes seen in the associated waterways and irrigation canals.

The terrestrial environment of the Upper Rio Cobre Basin is best categorized as modified secondary communities with agricultural plantations. Areas under cultivation include large tracts of land under monoculture, particularly with citrus and banana. Within the rural community roadside verges and open space are overgrown with scrubland and ruinate vegetation.

Riverine ecology includes riparian vegetation along the banks of the Rio Cobre and its tributaries and closed canopy forest in the area of Tulloch Springs.

Bird species within the area include terrestrial species common to agricultural areas, gardens and roadside scrub, as well as species often found along riverbanks.

The ecology of the Lower Rio Cobre Basin is characterized by modified secondary communities, scrub-land and agriculture including sugar cane cultivations and subsistence farming.

Riverine ecology includes riparian vegetation along the banks of the Rio Cobre. The endangered American Crocodile, which is protected by both national and international legislation, is reported in the lower reaches of the Rio Cobre below the Headworks Dam, as well as in paved and earthen irrigation canals. The crocodiles enter the Rio Cobre from its mouth in Hunts Bay and swim up the river, although they are mostly reported near to the coast. They are also frequently observed in irrigation canals in the area.

The South East St. Catherine area can also be characterized as modified secondary terrestrial communities and is dominated by large tracts of agricultural land.

The area is very dry and sections which are not under cultivation or housing can be characterized as thorny scrubland dominated by *Acacia sp.*

The project area does not fall within any legislated park or protected area and is not a pristine ecological area.

Socio-economic Environment

The 2001 Census shows the population of Greater Spanish Town as 131,515 and the population of Portmore & Hellshire as 161,658. This represents increases over the 1991 Census of 14.34% and 64.01% respectively. The 2001 population within the Project Area (comprising both these areas) is therefore 293,173, which when compared to its 1991 population of 213,593, represents a population growth of 37.3%.

The data studied showed that the most significant communities in the sample, including some of the fastest growing communities, are, in order of population: Central Village, Friendship, Angels, Spanish Town Central, Gordon Pen and Ensom City.

The project area's land use pattern can be summarised as being almost exclusively residential in Greater Spanish Town (outside of Central Spanish Town) and Portmore; largely commercial in Central Spanish Town and agricultural and agro-industrial in Upper Rio Cobre and South East St Catherine; with industrial nodes.

The character of the Upper Rio Cobre Basin is essentially rural, with commercial arable agriculture and some peasant farming. Settlement is primarily linear with some clustering. Commercial establishments line the main (A1) road but the main commercial centre is Bog Walk. There is woodland interspersed with mixed cultivation on the limestone uplands.

The Lower Rio Cobre Basin and Suburban Spanish Town have an identical character – comprising almost purely low to middle income residential (dormitory) communities. The settlements consist of two distinct types: mass housing in planned schemes and unplanned, overcrowded, squatter-type settlements.

Central Spanish Town is largely commercial, with an extensive market district - both interspersed with individual low and middle income housing units. There are industrial nodes at Central Village and Twickenham Park.

South-East St. Catherine is characterised by a dichotomy of plantation agriculture with a few scattered workers' settlements and, carved out of it in increasingly greater portions, extensive dormitory communities identical to those of Greater Spanish Town, though larger. There are, however, considerably less of the large, unplanned settlements.

With a few exceptions (e.g. Little Portmore) unplanned, squatter-type settlement has developed on the base of older, rural villages, completely transforming their character – most notably, Gordon Pen, March Pen and Central Village.

Water supply conditions throughout the project area are highly variable. The Upper Rio Cobre Basin tends to be adequately and reliably served with water. Residents at higher elevation and in the poorer settlements of Bybrook nevertheless complain of inconsistent water supply, attributed to an endemic problem of leaking mains. In the Lower Rio Cobre Basin, the pattern appears to be that the water pressure diminishes the further the community is from the Spanish Town Water Treatment plant.

The problem associated with overstretched water supplies begins to get acute in Greater Spanish Town. Residents, and other users, complain of low water pressure, particularly in the mornings, evenings and weekends – the times of heavy domestic water usage. Entire communities and businesses supplement their supply with stored water and by other means. The problem appears to be even more acute in SESC (except for those communities getting their supply from the Spanish Town plant) where both

domestic and agricultural consumers suffer – the latter despite being equipped with a wide network of irrigation canals. It has served as a major disincentive to agricultural investment in the region. It has also led to the adoption of unhealthy practices in the poorer settlements bordering the canals, with the use of the canal for certain domestic functions and of canal water for drinking and cooking. There is also a question of the quality of the water, with residents complaining of over-chlorination and Port Henderson hotels advising their clients to drink bottled water only.

The ESL research team conducted a rapid assessment of the communities within the project area: Bybrook, Tulloch Springs, Kent Village and Rabys Corner. Interviews were carried out only in Bybrook and Kent Village, as it was noted that Tulloch Springs was not a populated area and Rabys Corner was a physical landmark and not a built community.

These four communities have a total population of some 1,760 persons, according to the 1991 Census. It is a sparsely populated area. The relatively large community of Kent Village is located in the southern quadrant, along one bank of the Rio Cobre in the gorge. Kent Village is the main population centre along both sides of the road through the Bog Walk Gorge and on one bank of the Rio Cobre.

The problem of water supply within the communities of the lower Rio Cobre Basin varies between one community and another. As a generalization, the closer to the Spanish Town Water Treatment Plant the community, is located the more likely that the community members did not complain about supply conditions. In Cow Market, water was a major problem. The main supply comes from wells in Ariguanabo, and a reserve tank overlooking the community, which was constructed in 2002 to serve the surrounding communities. Informants complain that although some persons had metered water, its availability was very uncertain. Those without metered water bought from those who had or relied on deliveries from Rapid Response trucks. Furthermore, no pipelines existed at the upper parts of the community, where a significant number of the community members reside.

By way of contrast, in Angels 1, a housing scheme at the foot of Cow Market, occupants claimed that their water supply was adequate, although the water pressure was low during heavy demand periods, such as on the week-ends.

Issues Identified

The main issues affecting the project, as identified by the Community Analysis are:

- *Project not addressing perceived needs in some communities*
- *Inadequate infrastructure*
- *Developments and water supply*
- *Suburban Spanish Town's unsatisfied water needs*
- Economic impacts
- *Asbestos Mains*
- *Squatter influx*
- *Informal settlements and public health & conservation*
- *Indiscriminate construction*
- *Highway 2000*
- *Flooding impediment*

Potential Impacts and Mitigation Measures

Findings of the impact assessment are presented in the report according to site preparation, construction and operation phases. The impacts have been determined as being significantly positive or negative, direct or indirect, long term or short term. Some impacts pertain to all aspects of the project while others relate to a specific Lot or an aspect within a Lot. For each of the impacts identified, mitigation measures are presented and the responsible arty identified.

The major components of the project are:

Lot 1 **-** *Rehabilitation of existing production and certain distribution pumping and service storage facilities - on the Rio Cobre System, in Greater Spanish Town (including the Spanish Town Water Treatment Plant) and in SE St. Catherine together with the installation of bulk flow meters at all production sites and the replacement of distribution mains in two sections of Spanish Town*.

Lot 2 (to be implemented as Lot 2A, GST and Lot 2B, SESC) - Development of Groundwater Sources from the Lower Rio Cobre limestone aquifer in the northern section of Spanish Town and the construction of new trunk transmission and distribution pipelines in both Greater Spanish Town and SE St. Catherine, together with the construction of new distribution pumping stations and new service storage reservoirs in Greater Spanish Town.

Lot 3 (to be implemented as Lot 3B) - Artificial Recharge - artificial recharge of the Lower Rio Cobre limestone aquifer, and the supply and installation of groundwater level and key climate parameter recording equipment at strategic locations covering both the Lower Rio Cobre Limestone and Alluvial aquifers;

and

Under separate, direct arrangements, the procurement and installation of certain bulk flow meters throughout the Project Area to monitor flow into discrete District Metered Areas (DMAs).

Main Issues Identified

The main environmental issues (other than temporary impacts of construction activities) identified for this project are:

Hydrology

Construction of new wells can have a negative impact on the hydrological regime if abstraction rates are not monitored and controlled, particularly as over-abstraction can result in saline intrusion (an issue primarily for the Water Resources Authority).

In the event of improper operation of the proposed water treatment facilities of the Aquifer Recharge component, there is a potential for contamination of the Lower Rio Cobre Limestone aquifer through the input of surface waters contaminated with faecal coliforms, petroleum products, pesticides, detergents or other substances.

Contamination of Water Resources by Inappropriate Sewage and Other Waste

Significant contamination of the existing surface and groundwater resources has already occurred within the project area through the inappropriate disposal of sewage and other wastes. Unless strong and appropriate actions are brought to bear on this matter the sustainability of the proposed project in the medium to long term could be severely compromised.

Hazard

Impacts during construction relate to the effect of seismic activity, flood events and stormwater run-off in the project area. Flooding is a major natural hazard to be considered in the planning of construction operations and such operations must not compromise existing drainage routes.

Man-made hazards are also possible during the construction and operation phase, through the operations of the facilities and the deployment and use of chlorination facilities.

With respect to man-made/technological hazards during construction, accidents can occur on-site and as a result of activities both on and off-site, such as transportation of

equipment and materials, well drilling, subterranean work, handling of hazardous materials and general construction activities.

Health and safety aspects must be considered with respect to workers, neighbouring communities, the motoring public and pedestrians.

Air Quality

Movement of trucks and heavy-duty equipment to and from the project area, as well as construction work, drilling, excavation and stockpiling of earth material, will contribute to fugitive dust. Construction activities will also result in the removal of some amount of vegetation that will expose and loosen soil which can become airborne with medium to strong winds. This would add fugitive dust to the area. Some sites sampled reported high levels of ambient particulates, mostly along the main thoroughfares. The transport of aggregate for construction will also contribute to the fugitive dust levels. Construction vehicles will emit air contaminants such as nitrogen and sulphur oxides as well as particulates. No major impacts are expected during the operational phase.

Noise

Noise levels are expected to increase during the construction phase for all three lots. This is due to the use of heavy machinery, pneumatic drills, earth moving equipment, and the use of construction and transportation vehicles. No major impacts are expected during the operational phase.

Loss of Vegetation

Construction activities for Lots 2 and 3 will require the removal of several hectares of vegetation, establishment of new pump stations. The removal of vegetation may result in the loss of some existing airshed purification functions. During construction, the removal of vegetation may also increase surface run-

off and result in sheet flow after heavy rainfall events which could also increase the potential for soil erosion.

Birds

Vegetation clearance will result in loss of habitat for both endemic and migratory bird species. The habitat within the project area includes small scale agricultural lands, sugar cane plantations, ruinate vegetation and scrub. Removal of vegetation is not expected to have a major negative impact on existing habitats for birds due to the diversity of habitats within the project area. Any birds dislocated during construction are likely to relocate to adjacent habitats.

Crocodiles

The project areas within Spanish Town and south east St. Catherine, particularly those under Lot 2 (Spanish Town Water Treatment Plant and neighbouring irrigation canals) and Lot 3B (Aquifer Recharge) are known habitat areas for the endangered American Crocodile. Both crocodiles and humans are at risk from the potential interactions. The American Crocodile (*Crocodylus acutus*) native to Jamaica is an endangered species, protected under national and international law, and may be a potential threat to unsuspecting humans in their habitat.

Disruption of Potable Water

Various work required under the project will unavoidably result in the temporary disruption of potable water service to existing NWC customers and appropriate planning coupled with comprehensive prior notification to particular consumers affected from time to time and the general public of inevitable interruptions in supply of an essential service (in accordance with NWC service standards established by the Office of Utilities Regulation and the NWC itself) is of critical importance in the context of public health.

Traffic, Transportation and Access Roads

Construction activities will see an increase in the movement of heavy vehicles and construction equipment. In particular Lot 1 which includes mains replacement in two sections of Spanish Town itself, will directly impact the transportation network and will require the alteration of traffic patters, creation of detours and restricted flow of traffic.

Disruption to Business Enterprises

Business enterprises will be disrupted, particularly in central Spanish Town in Lot 1 where extensive road closures and detours will occur.

Solid Waste Management

Solid waste generated from the construction activities will include construction debris, vegetation, solid waste generated from the construction camps, and decommissioned structures.

Public Health and Safety

Construction activities will result in the generation of solid waste and require transportation and storage of significant volumes of construction material. The proper disposal of construction spoil, decommissioned structures and hazardous waste is critical.

Increased levels of fugitive dust and construction noise (and water supply disruption, as noted above) are also public health issues.

The operation of chlorination facilities requires trained personnel and certified equipment. Workers responsible for maintaining and operating chlorination facilities must be appropriately trained and experienced and must utilize appropriate protective gear.

The NWC's Emergency Response Plan for chlorine emergencies should be adapted, if necessary, to include for all new chlorination facilities installed under the project.

Archaeological and Cultural Heritage

Spanish Town is a historical site with several buildings listed under the Jamaica National Heritage Trust Act. Construction could result in the unearthing and discovery of

artifacts, and the use of earth moving and heavy machinery could impact existing structures.

Employme

Employment opportunities will be created during the site preparation, construction and operation phases. This will mostly be unskilled labour for the duration of the construction activities. Additionally, economic opportunities will involve the sourcing of construction material and linkages created with local and regional suppliers and industries.

Summary and Conclusions

The KMA Water Supply Project as designed will see the implementation of several project works including the rehabilitation of existing facilities, replacement of obsolete parts and equipment, development of groundwater resources and recharge of a major aquifer. These project works will result in several positive impacts including an increase in the water supply for the provision of potable water to the Kingston Metropolitan Area, a reduction in unaccounted for water and a greater efficiency of operations.

Several environmental issues have been identified as being relevant to the project. In the physical environment the construction of new wells with the potential for over abstraction and the aquifer recharge programme will impact the existing hydrological regime. The potential for increased fugitive dust, noise and vibration during construction processes can affect air quality and human health. The mitigation measures detailed herein should be implemented.

In the biological environment loss of some vegetation is expected and along with it some potential dislocation of birds, reptiles and amphibians. No rare, threatened or endangered birds are expected to be impacted in the project area. The endangered American Crocodile, protected by law, may be impacted by the project works, as the project area is within known crocodile habitat that encompasses the lower reaches of the Rio Cobre and the irrigation network. Impacts are expected through the increase in human activity,

noise and earth moving equipment. More significant is the potential risk to humans from interaction with the crocodiles and the mitigation measures as detailed should be implemented, to minimize human/crocodile interaction and safe guard public safety in the event of interactions.

Within the social environment traffic and transportation routes are expected to be significantly impacted. Mitigation measures as detailed should be implemented to minimize disruption to businesses, reduce risks to public safety and to facilitate the smooth flow of traffic.

In addition to the potential impacts of the proposed project on the existing environment, a critical issue identified is the impact on the project due to the existing environmental context in which the project is placed. The success and sustainability of the project are dependent on the quantity and quality of the raw water supply. Several aspects of the existing conditions have been identified which if not curtailed, will negatively impact the project. These include illegal sand mining, approved housing developments, improper solid waste disposal, sewage effluent discharge, pesticide use, security and community use of irrigation network and associated facilities.

These issues and their expected impacts have been outlined. The main mitigation measures proposed will require a co-ordinated effort and the cooperation of several government agencies to ensure that the quality and quantity of water for the Kingston Metropolitan Area is not compromised. These are:

- ✓ Upgrading of sanitation systems
- ✓ Installation of adequate solid waste disposal systems
- ✓ Re-siting of sewage effluent disposal outfalls
- ✓ Re-siting of planned housing developments
- ✓ Enforcement for illegal sand mining activities
- ✓ Inter-agency co-ordination

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TABLE OF CONTENTS

List of Appendices

List of Tables

List of Figures

List of Figures - continued

List of Acronyms

EIA	Environmental Impact Assessment
ESL	Environmental Solutions Limited
GST	Greater Spanish Town
JBIC	Japan Bank for International Cooperation
JBI	Jamaica Bauxite Institute
KMA	Kingston Metropolitan Area – defined as the combined areas of Kingston and St. Andrew, Greater Spanish Town and Southeast St. Catherine (Portmore and Hellshire)
MGD	Mines and Geology Division
m^3	Cubic Metre
mig	Million imperial gallons
migd	Million imperial gallons per day
Mld	Mega-Litres per day
MLE	Ministry of Land and Environment
NEPA	National Environment and Planning Agency
NIC	National Irrigation Commission
NSWMA	National Solid Waste Management Authority
NTU	Nephelometric Turbidity Units
NWC	National Water Commission
ODPEM	Office of Disaster Preparedness and Emergency Management
PCA	Pesticide Control Authority
RE	Resident Engineer
SESC	Southeast St. Catherine
UfW	Unaccounted-for-Water
WRA	Water Resources Authority

1. INTRODUCTION

1.1 THE REPORT

This report presents the findings of the Environmental Impact Assessment (EIA) of the Kingston Metropolitan Area (KMA) Water Supply Project.

The first environmental assessment deliverable, the ***Inception Report*** was presented in March 2003; the second deliverable, the ***Environmental Baseline Data and Preliminary Impact Statement*** was presented in April 2004; and the third deliverable, the Draft EIA Report was submitted in September 2004. This document constitutes the Final EIA Report and reflects the outcomes of numerous engineering studies, which have informed the re-scoping of the originally conceived project.

1.2 BACKGROUND

The Government of Jamaica through the National Water Commission (NWC) intends to effect improvements in the potable water supply for the Greater Spanish Town (GST) and Southeast St. Catherine (SESC) sections of the Kingston Metropolitan Area (KMA), with financial assistance from the Japan Bank for International Cooperation (JBIC).

These sections of the KMA are presently supplied by a number of sources within St. Catherine, including the Rio Cobre Scheme (constructed in the early 1970's) and wells in Greater Spanish Town and Southeast St. Catherine.

The current state of repair of all existing production and relift pumping facilities is poor while existing service storage reservoirs and tanks exhibit some deficiencies.

Currently, about 95% of the population within Greater Spanish Town and SE St. Catherine has access to piped water but supply can be variable, with some NWC customers receiving water only for a few hours each day on occasion.

Current "maximum month" water demand in Greater Spanish Town is estimated at some 63.5 Mega-Litres per day (Mld) or 13.98 migd and this is projected to rise to some 90.6 Mld (19.94 migd) in 2026 (the project design year). With current available supply of some 58.2 Mld (12.82 migd) there is a current deficit of some 5.3 Mld (1.82 migd). In the absence of the proposed capital works of the Project (but assuming some reduction of

leakage as a result of ongoing in-house NWC initiatives) the deficit will rise by 2026 to some 32.4 Mld (7.12 migd).

Current estimated “maximum month” water demand in SE. St. Catherine (Portmore and Hellshire) is some 52.8 Mld (11.62 migd) while currently available supply is limited to approximately 40.9 Mld (9 migd) – a current deficit of some 11.9 Mld (2.62 migd). Similarly, assuming some reduction of leakage as a result of ongoing in-house NWC initiatives, in the absence of the Project the deficit would increase to approximately 15.2 Mld (3.34 migd) by 2026.

In order to improve current service levels and to meet the increasing water demand of these developing and expanding sections of the KMA, it is necessary to rehabilitate the existing water supply production, relift pumping and service storage facilities and restore them to their original design capacities, to reduce the level of leakage from the existing water distribution networks and eliminate reservoir overflows, to reduce Unaccounted-for-Water (UfW) generally and to develop additional potable water sources.

The project objective is to provide a reliable 24 hour supply of potable water, of acceptable quality, at adequate pressures at customer taps, throughout the Greater Spanish Town and SE St. Catherine sections of the overall KMA.

The project location is shown in Figure 1.2 following.

Figure 1.2: Project Area

1.3 ORIGINAL PROJECT CONCEPT AND SCOPE

The originally conceived KMA Water Supply Project, as defined for the 1996 Loan Agreement for the project between the Governments of Jamaica and Japan (as subsequently modified in 1999) , had the following components:

Lot 1

- UfW Reduction/Control and Mains Replacement - procurement and installation of bulk flow meters at all production facilities and for "District Metered Areas" (DMAs) within the water distribution systems and the replacement of mains in two sections of Greater Spanish Town (to reduce leakage levels in problematic areas of the existing system);
- Rehabilitation of existing NWC water production, treatment and distribution pumping facilities serving the project area (including the numerous existing wells tapping the alluvial and limestone aquifers of the Lower Rio Cobre Basin) – comprising those of the Rio Cobre Scheme, those in Spanish Town (including the Spanish Town Water Treatment Plant) and those in SE St. Catherine.

Lot 2

- Development of Groundwater Sources – new limestone and alluvial aquifer well development (collectively, of approximately 39Mld or 8.5 migd) together with the construction of upgraded transmission and distribution facilities - including new pipelines, pumping stations, pressure control facilities and reservoirs - to ensure the distribution of water to all consumers at adequate supply pressures in a controlled and rationalized manner.

Lot 3

- Artificial Aquifer Recharge and Compensation Works for the Irrigation Sector
    - ❖ artificial recharge of the limestone and alluvial aquifers using water from the Rio Cobre Irrigation System (at times when water is available surplus to irrigation demands) to support the increased potable water abstractions from both aquifers under Lot 2 works;

- ❖ the construction of surface water irrigation canals, lined earthen storage basins and associated pumping stations to re-introduce surface water irrigation into those areas of SE St. Catherine where well fed pressurized irrigation piping systems were established as part of the Agro 21 Crop Diversification Project of the 1980's - to enable groundwater abstraction rights from some of the wells associated with the pressurized irrigation systems to be ceded to the potable water sector.

AND

- Institutional Strengthening of the NWC – with particular reference to the reduction of leakage and UfW within the Project Area and improved operational performance and efficiency.

The components of the originally conceived project are shown on Figure 1.3.

Consultancy services for the project are being provided by Nippon Koei Company Limited and MWH UK Limited supported by Thames Water International of the UK and a number of Jamaican consultants, including Environmental Solutions Limited (ESL) as the Environmental Manager.

Figure 1.3

1.4 PRELIMINARY ENGINEERING STUDIES TO REVIEW ORIGINAL PROJECT CONCEPTS

To review/confirm original project concepts, significant preliminary engineering investigations and studies were initially undertaken by the project consultancy team, as follows.

1.4.1 Existing Well Investigations

All existing NWC production wells currently serving GST and SESC, including those of the Rio Cobre Scheme, together with 3 existing unutilized wells proposed for use for additional production under Lot 2, were comprehensively investigated by down-hole video camera inspection and pump testing to determine their physical condition and to assess their individual reliable yield (within the context of total acceptable abstractions for potable water purposes from the relevant groundwater aquifers at pumping water levels consistent with established Water Resources Authority regulations designed to protect the aquifers from saline intrusion).

1.4.2 Ground Investigations on the SESC Plains

Exploratory borings and investigations were undertaken at numerous sites on the agricultural plains of SESC to assess site specific lithology for potential alluvial aquifer groundwater recharge facilities and potential new alluvial wells.

1.4.3 Integrated Ground and Surface-Water Model Development

A digital regional Integrated Ground and Surface Water Model (IGSM) comprehensively modeling all aspects of the hydrological cycle of the Lower Rio Cobre Basin was built to evaluate the availability of water for artificial aquifer recharge, aquifer recharge performance and to assess sustainable aquifer yields by simulation of historic performance and evaluation of alternative water resource development scenarios consistent with the original project concepts.

1.4.4 Water Quality Review

Historic water quality data was collated and substantial additional ground and surface water quality data for key locations throughout the project area were collected (through appropriate sampling and laboratory analysis) to review issues relating to potential

treatment requirements for both raw water for ultimate potable water production and issues related to the use of surface waters from the Rio Cobre Irrigation system for artificial aquifer recharge schemes (for both the limestone and alluvial aquifers).

1.4.5 Detailed Hydraulic Network Analysis

A digital model was prepared of the water distribution networks (based on NWC and other data sources) in GST and SESC and the performance of the systems against projected 2026 water demands simulated to identify, through optimization scenario runs, the necessary distribution upgrades required to ensure the proper distribution of water to end consumers up to that design year. The model incorporated detailed projections of future water demands.

1.5 FINAL PROJECT OVERALL SCOPE

As a result of the afore-noted preliminary engineering studies, the final scope of the capital works elements of the project was revised (and agreed with JBIC).

The main differences are that, as a result of the re-assessment of the sustainable yield of the Lower Rio Cobre alluvial aquifer indicating that there is no possibility of developing new well sources from this aquifer, even with extremely costly artificial recharge (and, indeed, that previous licensed abstraction rates of some 27 Mld, or 6 migd, are not sustainable):-

- while a selection of NWC wells tapping the alluvial aquifer will be rehabilitated under Lot 1, there will be no development of additional wells in that aquifer under Lot 2, and as a result
- there will be no development of an artificial recharge scheme for the alluvial aquifer, and as a result
- the Irrigation Compensation Works will not be implemented, and
- a duplicate large diameter trunk transmission main will be constructed from the existing Rio Cobre Scheme pipeline into SESC such that all projected demand in SESC will be serviced from the Rio Cobre Scheme up to the design year of 2026

The revised overall project scope is thus:

Lot 1

- Rehabilitation of existing production and certain distribution pumping and service storage facilities - on the Rio Cobre System, in Greater Spanish Town (including the Spanish Town Water Treatment Plant) and in SE St. Catherine, together with the installation of bulk flow meters at all production sites and the replacement of distribution mains in two sections of Spanish Town.

Lot 2 (to be implemented as Lot 2A, GST and Lot 2B, SESC)

- Development of Groundwater Sources from the Lower Rio Cobre limestone aquifer in the northern section of Spanish Town ONLY and the construction of new trunk transmission and distribution pipelines in both GST and SESC, together with the construction of new distribution pumping stations and new service storage reservoirs in GST.

Lot 3 (to be implemented as Lot 3B)

- Artificial Recharge - artificial recharge of the Lower Rio Cobre limestone aquifer ONLY, and

- The supply and installation of groundwater level and key climate parameter recording equipment at strategic locations covering both the Lower Rio Cobre Limestone and Alluvial aquifers – to allow detailed monitoring of these aquifers in the future for improved water resource management and to evaluate the performance of the artificial limestone aquifer recharge system;

and

- Under separate, direct arrangements, the procurement and installation of certain bulk flow meters throughout the Project Area to monitor flow into discrete District Metered Areas (DMAs) – so as to prioritize Unaccounted-for-Water initiatives.

The project components are shown on Figure 1.5: KMA Water Supply Project – Layout of Existing Facilities and Proposed Project Components at the end of this Section 1 and are described in detail in section 1.6 below.

Figure 1.5: KMA Water Supply Project – Layout of Existing Facilities and Proposed Project Components

1.6 DETAILED SCOPE OF FINAL PROJECT

1.6.1 Lot 1 Works

1.6.1.1 The Rio Cobre Scheme

The Rio Cobre System was constructed in the early to mid 1970's to supply 61.3 Mld (13.5 migd) to Kingston. Subsequently supplies to both GST and SESC have been drawn from the scheme's trunk transmission pipeline and currently the scheme comprises:

- the Tulloch Spring Pumping Station – drawing water from local springs and operated conjunctively with two (2) Augmentation Wells (Bybrook #'s 2 and 4), and
- the five (5) Eastern Headworks Wells (E, F, G, H and W).

The work at the Tulloch Springs Pumping Station comprises:

- Rehabilitation of the existing chlorination facilities, based on the continued use of tonne drums, to provide fail-safe disinfection of water production from both Tulloch Springs and the associated Augmentation Wells, with duty and standby dosing systems incorporating automatic chlorine drum/cylinder changeover and chlorine leak detection / mitigation equipment together with control systems linking operations at the site to operation at the two conjunctively operated Augmentation Wells;
- Replacement of the three (3) existing pumps with 4 new submersible dry well units together with replacement discharge manifolding and the replacement of associated switchgear and control equipment;
- Replacement of the existing production flow meter and general civil works and building rehabilitation.

The work at Augmentation Wells, Bybrook 2 and 4 (located at a single site) comprises:

- Cleaning of the wells themselves and the installation of additional casing together with pumping tests to confirm yield characteristics and well performance;

- Replacement of the pumps and motors together with the replacement of discharge piping including air valves, pressure gauges, check valves, gate valves, production flow meters and associated appurtenances;
- Replacement of the switchgear/ electrical control panels including installation of low well water level protective devices and operational control linkages with the Tulloch Springs site (for the control of chlorination of the total water conjunctively produced at Tulloch and these wells);
- General civil works and building rehabilitation.

The foregoing work will ensure reliable sustained production of some 38.6 Mld (8.5 migd) of potable water conjunctively into the upstream end of the main Rio Cobre Transmission main.

The work at the existing Eastern Headworks Wells comprises:

- Rehabilitation of the existing well structures themselves by a variety of work - ranging from simple cleaning through to the replacement of casings/screens and, in all cases, test pumping to confirm yield characteristics and well performance;
- Replacement of the well pumps and motors together with the replacement of discharge piping including air valves, pressure gauges, check valves, gate valves, production meters and associated appurtenances;
- Replacement of the switchgear / electrical control panels including installation of low well water level detection and other protective devices;
- General civil works and building rehabilitation;
- Replacement of existing chlorination facilities at two wells (Well W and G) together with the installation of new chlorination facilities at the other three wells (to ensure that all distributed water receives an appropriate chlorine dose with adequate contact time before potential first consumption of chlorinated water) - based on the use of 150lb. chlorine cylinders to provide fail-safe disinfection with duty and standby dosing systems incorporating automatic chlorine cylinder changeover and chlorine leak detection / mitigation equipment and control systems.

- At Well G, the existing well discharge arrangements will be reconfigured to allow local area supplies (currently boosted directly from Well G's discharge) to be drawn from the Rio Cobre main (with already chlorinated water) while well discharge will be piped via a new 200mm main, some 600m long, into the existing Rio Cobre trunk main downstream of connections into the Spanish Town distribution system.

The work at the Eastern Headworks Wells will provide a reliable production capacity of up to of some 39 Mld (8.6 migd) to supplement supplies, from the Tulloch Springs/Augmentation Wells at Bogwalk, for the overall Rio Cobre Scheme.

1.6.1.2 Existing Limestone Wells in GST

The following wells, tapping the Lower Rio Cobre Limestone aquifer within the GST area, were developed in the period of the 1950s to the 1970s for the supply of water to their immediate service areas:

- Golden Acres
- Ensom City
- Green Acres
- Friendship
- Brown's
- Little Greendale
- Yang's
- Twickenham Park
- Central Village

Angel's No. 1 Well, an original irrigation well converted in the early 2000s by a private developer for the water supply of new sub-divisions in northern Spanish Town, was recently handed over to the NWC. Because of the timing of design and documentation work of the various project "Lots", this well will be rehabilitated under Lot 2.

No work will be undertaken at Golden Acres and Ensom City wells as their re-assessed yields are too low for cost effective use and the NWC will ultimately decommission them under separate future arrangements.

At the remaining seven (7) existing GST wells, the rehabilitation work will comprise:

- Rehabilitation of the existing well structures themselves by a variety of work - ranging from simple cleaning through to the construction of replacement wells (at Friendship and Twickenham Park new wells will be drilled on the existing compounds within 5m of the existing wells) together with test pumping to confirm yield characteristics and well performance;
- Replacement of the well pumps and motors together with the replacement of discharge piping including air valves, pressure gauges, check valves, gate valves, production meters and associated appurtenances;
- Replacement of the switchgear/ electrical control panels including installation of low well water level detection and other protective devices;
- General civil works and building rehabilitation;
- Replacement of existing chlorination facilities with the installation of new chlorination facilities. These facilities will continue the use of 150lb. chlorine cylinders with duty and standby dosing systems incorporating automatic chlorine cylinder changeover and chlorine leak detection / mitigation equipment and control systems to provide fail-safe disinfection. To ensure that all distributed water receives an appropriate chlorine dose with adequate contact time before potential first consumption of chlorinated water, chlorine contact tanks with integral relift pumping sump and associated pumping equipment will be constructed at each site.

In addition, at the Well G, Green Acres and Yang's Well sites, new local area distribution relift pumping stations, using can type close coupled vertical turbine relift pump and motor sets, will be constructed inclusive of bulk flow meters.

Two such stations will each be constructed at the Green Acres and Well W sites. At Green Acres, one station will replace the existing Johnson Pen Pumping Station located along the St. John's Road – which the NWC will ultimately decommission under separate future arrangements. At Well G and Yang's Well the existing relift station(s) will be reconstructed at new locations.

1.6.1.3 Existing Spanish Town Water Treatment Plant

The Spanish Town Water Treatment Plant was originally constructed in 1925 and expanded in 1950. A new rapid gravity filter block together with new high lift pumping plant, switchgear and chlorination facilities were installed in the early 1990's.

The existing plant comprises:

- A raw water intake with three pumping units drawing raw water supplies from the NIC's main irrigation canal immediately adjacent to the treatment plant site;
- Alum dosing – to aid coagulation and settlement;
- Two (2) through-flow settling basins with point entry and draw-off arrangements, with settled solids removed at infrequent intervals by draining of a basin, excavation of sludge and disposal off site;
- The filter block consisting of five (5) filter cells, each originally rated at 4.5 Mld (1 migd), with backwash water discharged directly to the adjacent irrigation canal;
- Clear water tank;
- Chlorination equipment; and
- Relift (distribution) pumps.

The design capacity of the WTP is 18.2 Mld (4 migd) but existing maximum output is limited by the lack of adequate sedimentation facilities to some 15 Mld (3.3 migd) and the plant has to be taken off-line whenever raw water turbidity rises above some 20 NTU.

The proposed work at the Spanish Town Water Treatment Plant comprises the construction of a new flocculation/sedimentation facility with new coagulant dosing facilities *(while Aluminium Sulphate is the current coagulant used at the plant, the new facilities will have the flexibility of using this or other appropriate coagulants - including possibly poly-aluminium chloride)*, the construction of new sludge handling facilities and drying beds together with the repair of the filter machinery inclusive of the replacement of existing back-wash pumps by an elevated storage tank. In addition, the three raw water pump units and associated discharge pipework will be replaced and electrical switchgear and control systems throughout the plant appropriately upgraded. The new

flocculation/sedimentation and sludge drying beds will be constructed on space made available by demolition of existing sedimentation tanks (which currently serve no effective purpose).

The proposed works will be undertaken in such manner as to maintain critically essential existing supplies through the plant site to the maximum extent possible utilizing direct filtration only and with only one filter cell taken off-line at any one time.

The foregoing work will ensure restore reliable sustained production capacity at the plant, irrespective of raw water turbidity, to the design rating of 18.2 Mld (4 migd).

Rehabilitation of the chlorination system at the plant will be undertaken under Lot 2 - in conjunction with the construction of new service storage and low (transfer) and high lift (distribution) pumping stations.

1.6.1.4 Existing Service Storage in GST

The following existing service storage reservoirs/tanks in GST will be rehabilitated:

- Green Acres – a 454 m^3 (0.1 mig) circular steel tank;
- Mount View Estate (Sligoville Road) – a 1022 m^3 (0.225 mig) circular steel tank;
- Windsor Heights #2 – a 1362 m^3 (0.3 mig) circular steel tank;
- Patton Park 1and 2 – two 23 m^3 (0.005mig) circular steel tanks;
- Fraser's Content – a 4540 m^3 (1 mig) a rectangular reinforced concrete reservoir ;
- Twickenham Park – a 2270 m^3 (0.5 mig) a rectangular reinforced concrete reservoir

The work at steel tanks will include blast cleaning (the whole tank or sections, as required), repair or replacement of corroded tank sections and ladders etc., and repainting and, where appropriate, the installation/replacement of tank water level control valves (to eliminate overflows) and lightning grounding arrangements.

At the two concrete reservoirs the work will include crack repairs and rehabilitation/replacement of tank valving and, in the case of Fraser's Content, the addition of a screed to the roof to mitigate a rainfall ponding problem.

At all tank sites, general external works (access roads, fencing and drainage facilities) will be rehabilitated as required.

In addition to the foregoing, at the site of the bolted circular steel, glass fibre coated, Angel's Tank (constructed in 2003), a masonry wall will be built to ensure that the tank is protected from any rock falls that might occur on the cut slopes of the hillside at the rear of the tank compound.

1.6.1.5 Existing Alluvial Wells and Central Chlorination/Relift Station in SESC

The following wells, tapping the Lower Rio Cobre Alluvial aquifer within the SESC area, were developed in the period of the 1970s to the late 1990s for the supply of water to SESC:

- Portmore # 1 and 2
- Lime Tree
- HalfWayTree
- Dunbeholden
- Government Park #1
- Government Park #2
- Cookson
- Congrieve Park

The foregoing wells were developed to exploit a licensed potable water abstraction capacity from the alluvial aquifer of some 27 Mld (6 migd) but various structural problems with some of the wells themselves, the state of repair of some mechanical equipment and the general lowering of aquifer water levels, has resulted in only a limited number of these wells currently operating.

In view of the results of the re-assessment of aquifer and individual well yield under lowered ground water conditions (*and some problems of selected wells with manganese levels in the abstracted water – refer Section 5.1.6 below*), work under Lot 1 will be restricted to the rehabilitation of only a select number of existing alluvial wells – to

maintain the current supplies of between 14 to 18 Mld (3 to 4 migd) from the aquifer into SESC until the new duplicate large diameter trunk transmission main (that will ultimately allow all projected demand in SESC up to the design year of 2026 to be serviced from the Rio Cobre Scheme – rehabilitated under Lot 1) is constructed under Lot 2B. Once the new duplicate main is commissioned, the rehabilitated wells will be placed on standby duty by the NWC – for limited use during emergencies (drought or problems with the Rio Cobre Scheme supply) or seasonal use conjunctively with the Rio Cobre Scheme supply (if aquifer conditions allow) to optimize electrical energy consumption for pumping and increase Rio Cobre Scheme supply into the Kingston and St. Andrew section of the KMA.

Final selection of wells for rehabilitation will be made during the Lot 1 construction stage - based on the most cost effective approach using awarded contract rates and prices.

Specifically however, no work will be undertaken at the Portmore # 1 and 2 wells and the NWC will ultimately decommission them under separate future arrangements.

The remaining wells not selected for rehabilitation under Lot 1 will be "moth-balled" by the NWC for possible rehabilitation and re-commissioning in the longer-term future – if future conditions allow increased abstraction from the alluvial aquifer.

The rehabilitation work at the selected well sites will include the following:

- Rehabilitation of the selected existing well structures themselves by a variety of work - ranging from simple cleaning through, potentially, the construction of replacement wells (if selected for rehabilitation, replacement wells would be required at Cookson and Government Park #1, in close proximity to those existing) together with test pumping to confirm yield characteristics and well performance;
- Replacement of the well pumps and motors together with the replacement of discharge piping including air valves, pressure gauges, check valves, gate valves, production meters and associated appurtenances and inclusive of specific discharge flow control valves (to protect the rehabilitated wells from unintentional over-pumping at any individual well);

- Replacement of the switchgear/ electrical control panels including installation of low well water level detection and other protective devices;
- General civil works and building rehabilitation.
- Further, if the Cookson well is selected for rehabilitation, the existing chlorination facilities at this location will be rehabilitated with the continued use of 150lb. chlorine cylinders but with duty and standby dosing systems incorporating automatic chlorine cylinder changeover and chlorine leak detection / mitigation equipment and control systems to provide fail-safe disinfection.

In addition, as the discharges of the existing Lime Tree, HalfWayTree, Dunbeholden, Government Park #1 and Government Park #2 wells are chlorinated and relifted into distribution at the Central Chlorination and Relift Pumping Station at Goshen Pen, that pumping station will also be rehabilitated under Lot 1. The works at this site will include the rehabilitation of selected relift pump and motor sets and their associated discharge pipework and valving and the existing chlorination facilities will be rehabilitated - with the continued use of 150lb. chlorine cylinders but with duty and standby dosing systems incorporating automatic chlorine cylinder changeover and chlorine leak detection / mitigation equipment and control systems to provide fail-safe disinfection.

1.6.1.6 Existing Service Storage in SESC

The following existing service storage reservoirs/tanks in SESC will be rehabilitated:

- Marley Hill # 1– a 4540 m^3 (1 mig) a circular reinforced concrete reservoir;
- Mount Marley Hill # 2– a 9100 m^3 (2 mig) a rectangular reinforced concrete reservoir, and
- Hellshire Heights – a 450 m^3 (0.1 mig) circular steel tank.

At all three sites tank valving will be refurbished/replaced and general site works rehabilitated. For the first concrete reservoir, work will include structural repair of the post tensioning system while minor crack repair work will be undertaken at the second. At the steel Hellshire Heights Tank, minor repair and repainting of sections of the tank will be undertaken.

1.6.1.7 Existing Booster Stations in SESC

Supplies into the Hellshire Hills section of SESC are relifted within the SESC water distribution system at the Braeton Booster Station and rehabilitation at this station will include refurbishment/replacement of pumping plant and associated pipework and switchgear together with minor building and external work rehabilitation.

1.6.1.8 Mains Replacement in GST

Based on an assessment of past leakage repair reports to identify sections of the existing distribution system in Spanish Town where the condition of existing mains is critically poor, approximately 12 km of the aged water distribution network in Old Spanish Town and surrounding areas as well as 6.6 km in the Willowdene/ Hopedale area will be replaced. All existing service connections will be replaced and, at appropriate locations, new fire hydrant installations will be constructed.

The old mains will be replaced by 100 mm to 200 mm diameter water mains of either PVC or Ductile Iron while new service connections will generally be constructed of Medium Density Poly-Ethylene (MDPE) tubing with compatible fittings.

Existing mains that are replaced will be disconnected (but not recovered, except to the minimum extent necessary for new mains construction) and existing fire hydrants on these mains recovered (for possible refurbishment and re-use elsewhere).

1.6.2 Lot 2 Works

The Lot 2 works include:

Under Lot 2A - GST

- Limestone aquifer well development/rehabilitation in the northern section of Spanish Town with a combined production capacity of some 24 Mld (5.3 migd) together with associated discharge mains;
- Construction of the 1135 m^3 (0.25 mig) Angel's Hill Tank – to supplement system balancing storage in northern Spanish Town;
- Construction of two (2) large new service storage reservoirs (each 8000 m^3, or 1.75 mig, in capacity) and low (transfer) and high lift (distribution) pumping

stations at the Spanish Town Water Treatment Plant site, together with rehabilitation of the plant chlorination facilities;

- Strengthening of the water transmission and distribution system in GST.

Under Lot 2B - SESC

- Construction of a large diameter trunk transmission main from the existing Rio Cobre Scheme pipeline into SESC together with associated pressure control facilities, and
- Strengthening (in two locations) of the water distribution system in SESC.

1.6.2.1 Lot 2A - New Limestone Wells in GST

One disused irrigation well (Angel's No. 2) and two existing wells originally constructed for irrigation compensation purposes as part of the Rio Cobre Scheme of the 1970s (but never operated), Ariguanaboa Exploratory and Chung's, will be converted to potable water use and the existing NWC Angel's No. 1 well will be rehabilitated under Lot 2A.

The work at all four well sites will include well rehabilitation, by a variety of work ranging from cleaning through to reaming and installation of new casing and screens, together with yield development and pump testing to confirm yield characteristics and well performance.

At the three new potable water production wells, the work will additionally include:

- Supply and installation of vertical turbine pumping equipment complete with discharge pipework, inclusive of appropriate valving and flow meter, switchgear and instrumentation and controls;
- Supply and installation of new chlorination facilities using 150lb. chlorine cylinders with duty and standby dosing systems incorporating automatic chlorine cylinder changeover and chlorine leak detection / mitigation equipment and control systems to provide fail-safe disinfection;
- Supply and installation of standby generator with bulk fuel tank – designed taking into account existing regulations and with operational noise levels of the generators not exceeding 85dBA at one (1) meter;

- Construction of new Well Head building in reinforced concrete/blockwork to secure and house the wellhead, switchgear, chlorination equipment, generator and fuel tank in separate rooms, with building features providing secondary fuel oil containment;
- General civil/ site work including access road and security fence construction / rehabilitation.

Specific rehabilitation work at the existing Angel's No. 1 Well site will, in addition to actual well rehabilitation, include the replacement of existing pumping plant/discharge pipework, the rehabilitation of the chlorination facilities as per the standard approach to provide fail-safe disinfection and the provision of new building to house and secure the wellhead facilities.

For the Angel's No. 2 and Chung's Wells, discharge mains will be constructed to deliver production into the new Angel's Hill Tank while production from the Ariguanaboa Exploratory Well will be fed via a short connecting main into the existing rising main from Angel's No. 1 Well to the existing Angels Reservoir. No interconnections or service connections will be permitted from these pumping mains.

Angel's No. 1, Angel's No. 2 and Chung's Wells will become duty wells serving the GST generally.

The Ariguanaboa Exploratory Well will be a standby for Angel's No. 1 as, given the elevation of the area served by this well, in the event of a break down of this duty well there are limited opportunities for maintaining water service from the other sections of the GST distribution system.

1.6.2.2 Lot 2A - Angel's Hill Tank, GST

A 1135 m^3 (0.25 mig) reservoir will be constructed in reinforced concrete at Angel's Hill (in the Monticello area of north Spanish Town) with an all-weather access road from the existing sub-division road immediately adjacent to the tank site. The tank will occupy a small section of land under the control of the Ministry of Water and Housing which will otherwise remain undeveloped (as part of the green space reservation for the adjacent Ministry promoted sub-division) and with appropriate landscaping and planting will not

negatively impact the visual aesthetics of the overall plot of land perceived by the adjacent communities.

The tank will include a chlorine contact section (to ensure adequate chlorine contact time of the water produced by the Angel's No. 2 and Chung's Wells prior to potential first consumption) but the major portion of the tank volume will provide balancing distribution system storage on the general GST distribution system.

1.6.2.3 Lot 2A - Service Storage and associated pumping stations at the Spanish Town Water Treatment Plant

Two new 8000 m^3 (1.75 mig) circular service storage reservoirs will be constructed in reinforced concrete, at grade, on the site of old sedimentation basins at the Spanish Town Water Treatment Plant on the southern side of Job's Lane.

Existing high lift distribution pumps at the control building adjacent to the filter block on the existing plant compound on the northern side of Job's lane will be replaced with low-lift production transfer pumps (to raise treatment plant production into the new storage reservoirs) and a new high lift (distribution) pumping station will be constructed to relift stored water into the general GST water distribution system.

The additional service storage and the new high lift distribution pumping station (with a pumping capacity of up to some 55 Mld or 12 migd) will provide peaking flows into the system during high demand periods of each day – with the reservoirs providing balancing storage for both treatment plant production and, with inflows also derived from other sources serving GST through the distribution system, on the general GST distribution system.

In addition, under Lot 2A, the existing standby generator, installed in the early 1990's will be replaced with a new unit capable of maintaining full treatment plant operations at the rated capacity of some 18.2 Mld (4 migd) and of all transfer and relift pumping operations at the overall treatment, storage and pumping facilities at the location, in the event of main electrical grid supply failure.

Further under the Lot 2A work, the existing chlorination facilities at the treatment plant will be rehabilitated - retaining the use of 150lb. chlorine cylinders but with duty and

standby dosing systems incorporating automatic chlorine cylinder changeover and chlorine leak detection / mitigation equipment and control systems to provide fail-safe disinfection.

1.6.2.4 Lot 2A - Strengthening of the Water Distribution System in GST

The existing water distribution system in GST reflects the construction of discrete water sources for the supply of discrete areas as and when these have been developed in the past and, as such, lacks the effective overall transmission capability required for a large modern integrated system (which must be capable of maintaining supply throughout the totality of the service area in the event of any specific source failure, through flexibility of supply options).

As such, Lot 2A work includes the construction of some 28.7 kms of strategic new transmission and distribution mains in GST together with appropriate in-line pressure control facilities to ensure maximum operational flexibility and reliable supply to customers at adequate (but not excessive) service pressures at all times.

The mains, ranging in nominal diameter from 200 mm to 600 mm, will be constructed in uPVC or Ductile Iron and will incorporate standard appurtenances such as isolating line valves, air valves, washout facilities and various over and under-crossings (of drains, irrigation canals and railway track) and will be interconnected with existing mains at appropriate locations. Washouts will discharge into existing drainage facilities and will be operated only when capacity is available in the associated drainage facilities.

Where possible these mains will be constructed in the unpaved verges of existing roads but significant lengths will be constructed, by necessity, under existing paved carriageways.

1.6.2.5 Lot 2B – New Trunk Supply Main and Strengthening of the Water Distribution System in SESC

Given the re-assessment of the sustainable yield of the Lower Rio Cobre Alluvial Aquifer requiring all water demands in SESC to be serviced by supplies drawn form the rehabilitated Rio Cobre Scheme, a 700mm (28”) trunk transmission main from the

existing Rio Cobre Scheme pipeline into SESC together with associated strategic pressure control stations will be constructed under Lot 2B.

The main will be constructed in Ductile Iron, paralleling the existing 24" (600mm) along a cane interval on Caymanas Estates from the existing 30" diameter Rio Cobre Transmission main to the Mandela Highway and thence southwards across Crum Ewing road bridge to the roundabout adjacent to the Highway 2000 junction into Portmore. It will be interconnected at this location to the existing 24" main (via a Pressure Control Station) and will then travel southwards along the verge of the new main road to Braeton (the "I95") and then to the existing Marley Hill Reservoirs. Additional connections, through pressure control stations, will be constructed into larger (400mm and 450mm diameter) existing mains at the southern section of Independence City and in the Braeton area respectively.

This main and the existing 24/18/20" trunk mains between Caymanas and Marley Hill will enable flows of up to some 57 Mld (12.5 migd) to be delivered into SESC from the Rio Cobre Scheme and will allow peak period demands to be supplementally met from backflows from the Marley Hill storage reservoirs.

In addition, two sections of the existing distribution system (along the Naggo Head Drive / Portmore Parkway and at the northern end of Germaine Road) will be reinforced by the construction, in either uPVC or Ductile Iron, respectively of new 300mm and 200mm diameter distribution mains, interconnected into existing mains at strategic locations.

1.6.3 Lot 3B Works

1.6.3.1 Artificial Limestone Aquifer Recharge

Facilities to abstract water from the NIC's Innswood irrigation canal, treat it to an appropriate quality and to recharge the treated water into the Lower Rio Cobre Limestone aquifer will be constructed just to the west of the Innswood Sugar factory under Lot 3A.

While all facilities will be designed for the potential ultimately envisaged maximum throughput capacity of 36.5 Mld (8 migd) and intake, conveyance and discharge/recharge facilities will be constructed at that capacity, only an initial Phase 1 of the treatment facilities of 50% capacity will be constructed under Lot 3A. During the early years of

operation of the initially constructed facility the efficacy of the actual recharge (based on careful local and overall aquifer monitoring (see below)) and the need for/benefits of adding Phase II treatment will be reviewed and the Phase II treatment facilities, duplicating Phase I, will be constructed under separate implementation arrangements in the future if and when appropriate and warranted.

New intake facilities will be constructed in reinforced concrete on the NIC's irrigation canal to allow abstraction of up to of canal water - when water surplus to irrigation needs is available. The water will be conveyed to the downstream treatment site in an 800mm gravity pipeline laid in Ductile Iron below the existing access roadway adjacent to the irrigation canal.

The initial treatment facilities, comprising two large sedimentation basins with earthen embankments constructed by appropriate cut and fill work supplemented by imported fill materials and four (4) large constructed wetland beds, will treat the abstracted canal water to close to potable water standards.

The facilities will incorporate extensive flow metering and regulation facilities to enable full control of flows through the treatment process and appropriate overflow and "drain-down" facilities will be provided to handle any emergency (whether due to severe upstream raw water contamination that could compromise aquifer water quality or due to extreme rainfall events such as hurricanes). Raw and treated water quality will be regularly monitored for major contamination constituents - to ensure that water of inadequate quality is not recharged into the aquifer.

Treated effluent will be conveyed by gravity pipeline to three (3) existing sinkholes and one (1) existing limestone well immediately downstream.

Works at the sinkholes will protect them from receiving, as they currently do, poor quality storm water drainage and will meter the recharge flows discharged directly into them. Appropriate headworks will also be constructed at the existing borehole to allow full control of recharge flows and flow metering, while ensuring that air is not entrained into the aquifer itself.

1.6.3.2 Aquifer Monitoring Facilities

Under Lot 3A, groundwater level and key climate parameter recording equipment will be installed at strategic locations to allow detailed monitoring of both the Lower Rio Cobre Limestone and Alluvial aquifers – to promote appropriate informed water resource management of these resources in the future and to evaluate the performance of the initial phase of the artificial limestone aquifer recharge system.

2. SCOPE OF WORK

2.1 DEVELOPMENT OF ENVIRONMENTAL GUIDELINES

ESL has been working with Nippon Koei Company Limited and MWH UK Limited in the identification of critical environmental parameters for the project and environmental quality objective criteria that need to be developed for designing and implementing the project.

The environmental consultants reviewed the findings and recommendations of numerous engineering studies undertaken by the Project consultancy team during the preliminary design stage of the project and identified environmental issues for the project team so that the engineering designs would be consistent with sound environmental principles.

Hazard vulnerability and risk reduction have been integrated into the environmental analysis. In addition, the study has examined the possible exacerbation or creation of hazards from the project and includes a social impact component in the environmental assessment.

NOTE: Previous deliverables by ESL, namely the environmental study ***Inception Report,*** *presented in March 2003, the* ***Environmental Baseline Data and Preliminary Impact Statement*** *presented in April 2004 reflected original scheme concepts as outlined in Section 1.2. This document, constituting the Final EIA Report, reflects the final project scope as detailed in Sections1.5 and 1.6.*

2.2 ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Under the NRCA Act (1991) the entire island of Jamaica has been declared a Prescribed Area and an Environmental Impact Assessment (EIA) is required for certain prescribed categories including water treatment facilities and other water resources development projects. Administered by the NRCA/NEPA, the Environmental Permit and Licence System was introduced in 1997 and is a mechanism to ensure that all Jamaican facilities (developments) meet required standards in order to minimize negative environmental effects. The NRCA requires that a Permit Application be completed and submitted to the agency along with a Project Information Form (PIF) for development within a prescribed area.

Additionally, a fundamental principle of the Japan Bank for International Cooperation (JBIC), a Japanese Government financial institution, which will be one of the funding agencies for the project, is to confirm that the executor of a project proposed for JBIC financing takes into account appropriate environmental considerations. To this end JBIC established Guidelines for Confirmation of Environmental and Social Considerations on April 1, 2002 for implementation from October 1, 2003. Key items set forth in the new guidelines include Environmental Checklists, Category Classification and Disclosure, and Disclosure of Environmental Review. The JBIC Environmental Guidelines have been taken into account along with the Jamaican National Guidelines for Conducting Environmental Impact Assessments.

The EIA covers the relevant areas of the project including:

1. UFW Reduction/Control and Mains Replacement
2. Rehabilitation of Existing Facilities
3. Development of Groundwater Sources
4. Artificial Recharge

2.3 TERMS OF REFERENCE FOR THE EIA

The proposed Terms of Reference (TOR) for conducting the Environmental Impact Assessment (EIA) of the Project were prepared by Environmental Solutions Ltd. and submitted to the National Environment and Planning Agency (NEPA) in September 2003 for approval. These proposed Terms of Reference are set out below:

1. Introduction – Identification of the Kingston Metropolitan Area Water Supply Project as the development project to be assessed, and explanation of the executing arrangements for conducting the Environmental Impact Assessment.

2. Background Information – A brief description of the major components of the proposed project, the implementing agents, the financing arrangements, and a brief history of the project and its current status.

3. Study Area – The project area for the KMAWSP comprises the specific areas of Greater Spanish Town and SE St. Catherine, and is located within the Rio

Cobre hydrological basin. Specification of the boundaries of the study area for assessment will be given, as well as any adjacent or remote areas which should be considered with respect to the project.

4. Scope of Work – Standard environmental impact assessment techniques including site reconnaissance, literature review, analysis of maps and aerial photographs, desktop research, field work, data analysis and interviews with appropriate personnel, will be utilized in order to satisfy the Terms of Reference.

In particular the following will be done:

A. Review of Existing Documentation and Maps

- Review reports on environmental condition of existing water supply – Spanish Town, Portmore, Kingston (area supplied from the Rio Cobre source)
- Review Water Resources Master Plan
- Review outputs from watershed studies of sources of KMA supply - Hope, Wagwater, Yallahs and Rio Cobre systems, Wells
- Review previous water supply and sanitation improvement plans (within past 10 years)
- Review of maps of the project area, well locations, treatment plants, irrigation system and artificial recharge facility location.

B. Data Collection and Analysis

Field investigations will focus on the following aspects:

- **Physical** attributes of selected areas for source, supply, treatment and distribution - climate, geology, slope, hydrology, water quality, hazard vulnerability, soils, geotechnical , opportunities for enhancement
- **Biological** attributes of selected areas for source, supply, treatment and distribution – ecological systems, flora, fauna, endangered species, opportunities for enhancement

- **Social** attributes of selected areas for source, supply, treatment and distribution. Demographics, land use, livelihoods, health indicators, waste management practices, environmental sensitivity

NEPA approved the TOR by letter dated May 27, 2004 with points for incorporation therein (Appendix I). The TOR which include NEPA's comments or recommendations, are:

Task 1: Description of the Proposed Project. A full description of the project and its existing setting using maps as appropriate. This is to include general layout, size, location, physical setting, ecological setting, demographic setting, socio-cultural setting, institutional setting, purpose and necessity of the project. (The Client will be expected to provide an aerial survey photograph of the site, a topographical survey map of the site.)

Task 2: Description of the Environment. Assemble, evaluate and present data on the relevant characteristics of the study area, including the following:

- **Physical environment:** geology, topography, soils, surface and groundwater hydrology, air quality and noise, vulnerability to hazards during construction and post construction phases.
- **Biological environment:** existing flora, fauna, rare or endangered species, sensitive habitats, terrestrial and riverine ecosystems, species of commercial importance, nuisance species, pests and vectors.
- **Socio-cultural environment:** land use, land acquisition, proposed developments within the project area, watershed issues, relocation of existing utilities, identification of projected affected persons (dislocation), public health considerations, demographics, traffic flow, hazard management, archaeological and cultural heritage listed monuments.

Task 3: Legislative and Regulatory Considerations. A description will be given of the pertinent regulations, standards and regulatory bodies governing environmental quality, health and safety, protection of endangered species, siting

and land use control, land acquisition, protection of archaeological and cultural heritage.

Task 4: Determination of Potential Impacts of the Proposed Project. Impacts will be determined as significantly positive or negative, direct or indirect, short-term or long-term, unavoidable or irreversible. Special emphasis will be placed on:

- Conservation/Protection of Water Resources
- Terrestrial and Riverine Ecology
- Watershed Conditions
- Land Use and Socio-economic Disruption
- Protection of Archaeological and Cultural Heritage Resources
- Public Information and Conflict Resolution
- Hazard Management
- Potential impact from climate change.
- Waste Management (Construction and Operations)
- Impacts on traffic flow should be explicitly stated as well as solid waste generated from earth works and decommissioned infrastructure.

Task 5: Mitigation and Management of Negative Impacts. Recommendations will be made for feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels. Indicative costs of these mitigation measures will be provided.

Task 6: Recommendations for the development of a Monitoring Plan/Management Guidelines and Staff Training. Recommendations will be made for the development of a Monitoring Plan to ensure implementation of the mitigation measures and long-term minimization of negative environmental impacts. Additionally, recommendations will be made for the development of Management Guidelines and appropriate Staff Training.

Task 7: Assist in Inter-Agency Coordination and Public Participation. As, and if required by the NRCA, we will assist in the public participation/review process through meetings with relevant governmental agencies and in obtaining the views of civil society.

Task 8: Report – the Environmental Impact Assessment report will be concise and limited to the significant environmental issues. The main text will focus on findings, conclusions and recommended actions, supported by summaries of the data collected and citations for any references used in interpreting those data. The report will be organized according to, but not necessarily be limited by, the outline below:

- Executive Summary
- Description of the Proposed Project
- Description of the Environment
- Policy, Legal and Administrative Framework
- Significant Environmental Impacts
- Analysis of Alternatives
- Mitigation Measures
- Recommendations for Monitoring Plan, Management Guidelines and Staff Training
- List of References
- Photographs, Maps and Plans as appropriate

2.4 ENVIRONMENTAL SPECIALIST

The Environmental Specialist for the project will work with the design team throughout the planning stage. The roles and responsibilities of the Environmental Specialist will include:

- Liaison with relevant authorities to determine relevant government standards
- Provision of environmental design criteria for various elements of the project
- Establishment of environmental guidelines and standards for criteria to be met
- Assessment of impact of deviations from standards and criteria
- Advocacy

2.5 ENVIRONMENTAL DELIVERABLES

Deliverables for environmental approval and permitting include:

- Processing and submission of the Permit Application Form
- Processing and submission of the Project Information Form (PIF)
- Processing and submission of the Terms of Reference and incorporation of NEPA's comments

- Preparation and submission of the Inception Report
- Preparation and submission of the Baseline Data and Preliminary Impact Statement
- Preparation and submission of the Draft Environmental Impact Assessment (EIA) Report
- Preparation and submission of the Final Environmental Impact Assessment (EIA) Report

All documents and addenda will be supplied as hard copies and electronic format to the Client as well as to NEPA (Final EIA Report only). On completion of the EIA, eight hard copies and one electronic copy will be submitted to NEPA for review.

3. LEGISLATIVE FRAMEWORK

This section of the report describes legislation and regulations relevant to the KMA Water Supply Project.

3.1 PERMIT AND LICENCE

Under the Natural Resources Conservation Authority Act (1991), the Natural Resources Conservation Authority (NRCA), now the National Environment and Planning Agency, (NEPA) is authorized to issue, suspend and revoke permits and licences. The Permit and Licence System was established in 1997 to ensure compliance with Sections 9 & 12 of the NRCA Act, which gives the NRCA the right to issue permits for new developments and request EIA studies where necessary.

A Project Information Form (PIF) and a Permit Application (PA) was completed and submitted to NRCA/NEPA (May 2003) with the requisite application fee of J$1,000. The Terms of Reference for conducting the EIA were submitted to NEPA for approval in September 2003. Response was received from NEPA, dated May 27, 2004 (Appendix I) with the requirements noted in Section 2.3.

3.2 NATIONAL LEGISLATIVE AND REGULATORY CONSIDERATIONS – NATURAL ENVIRONMENT

3.2.1 Natural Resources Conservation Act (1991)

The Natural Resources Conservation Act was passed in the Jamaican Parliament in 1991 and provided the basis for the establishment of the Natural Resources Conservation Authority (NRCA) with primary responsibility for ensuring sustainable development in Jamaica through the protection and management of Jamaica's natural resources and control of pollution. Sections 9 and 10 of the NRCA Act stipulate that an Environmental Impact Assessment (EIA) is required for new projects and existing projects undergoing expansion.

3.2.2 Wildlife Protection Act (1945)

The Wildlife Protection Act of 1945 prohibits removal, sale or possession of protected animals, use of dynamite, poisons or other noxious material to kill or injure fish, prohibits discharge of trade effluent or industrial waste into harbours, lagoons, estuaries and

streams, and authorizes the establishment of Game Sanctuaries and Reserves. Protected under the Wildlife Protection Act are six species of sea turtle, one land mammal, one butterfly, three reptiles and several species of birds including rare and endangered species and game birds.

3.2.3 The Endangered Species (Protection, Conservation and Regulation of Trade) Act (1999)

This Act deals with restriction on trade in endangered species, regulation of trade in species specified in the schedule, suspension and revocation of permits or certificates, offences and penalties, and enforcement. Many species of reptile, amphibian and birds that are endemic to Jamaica but not previously listed under national protective legislation, or under international legislation, are listed in the Appendices of this Act.

3.2.4 The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996)

The island of Jamaica and the Territorial Sea of Jamaica has been declared a Prescribed Area. No person can undertake any enterprise, construction or development of a prescribed description of category except under and in accordance with a permit. The Natural Resources Conservation (Permits and Licenses) Regulations (1996) gives effect to the provisions of the Prescribed Areas Order.

3.2.5 Water Resources Act (1995)

The Water Resources Act of 1995 established the Water Resources Authority (WRA). This Authority is authorized to regulate, allocate, conserve and manage the water resources of the island. The Water Resources Authority and the Ministry of Health are both responsible for water quality control for potable water. The Water Resources Authority is required under Section 4 of the Act to provide upon request to any department or agency of Government, technical assistance for any projects, programmes or activities relating to development, conservation and the use of water resources.

It is the responsibility of the WRA as outlined in Section 16 to prepare, for the approval of the Minister, a draft National Water Resources Master Plan for Jamaica. The Second Draft of this document entitled A National Water Resources Master Plan for Jamaica was

completed in September 2005 and is currently undergoing the process of public review and consultation. Areas covered in this Draft Master Plan include a water resources inventory, water demands inventory (2005 and the future), water resources surpluses or deficits and a water management plan. The Plan is supported by information on the developmental setting and the biophysical setting.

Section 25 of the Water Resources Act advises that the proposed user will still have to obtain planning permission, if this is a requirement, under the Town and Country Planning Act. In addition, Section 21 of the Act stipulates that if the water to be used will result in the discharge of effluents, an application for a license to discharge effluents will have to be made to the Natural Resources Conservation Authority or any other relevant body as indicated by the Minister.

With regard to underground water, Section 37 states that it is unlawful to allow this water to go to waste. However, if the underground water "interferes or threatens to interfere with the execution or operation of any underground works", it will not be unlawful to allow the water to go to waste in order to carry out the required works provided that there is no other reasonable method of disposing of the water. The Authority also has the power to determine the safe yield of aquifers (Section 38).

3.2.6 Country Fires Act (1942)

Section 4 of the Country Fires Act of 1942 prohibits the setting of fire to trash without prior notice being given to the nearest police station and the occupiers of all adjoining lands. In addition, a space of at least fifteen feet in width must be cleared around all trash to be burnt and all inflammable material removed from the area. Section 6 of the Act empowers the Minister to prohibit, as may be necessary, the setting of fire to trash without a permit. This permit may be obtained by the local Constabulary Forces office in the area.

Offences against this Act include:

- Setting fire to trash between the hours of 6.00 p.m. and 6.00 a.m. (Section 5a);
- Leaving open-air fires unattended before they have been completely extinguished (Section 5b);

- Setting fires without a permit and contrary to the provisions outlined in Section 6 (Section 8);
- Negligent use or management of a fire which could result in damage to property (Section 13a);
- Smoking a pipe, cigar or cigarette on the grounds of a plantation which could result in damage to property (Section 13b).

3.2.7 Air Quality Standards

The Federal Clean Air Act which came into force in the United States in 1990 established air quality standards for six pollutants: ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), respirable particulate matter (PM10) and lead (Pb). An allowable level for each of these pollutants has been set by the United States Environmental Protection Agency (US EPA) whose objective is to protect the public from exposure to dangerous levels. National standards, known as the National Ambient Air Quality Standards (NAAQS), were established and they were categorized into two groups. In one group, there are the primary standards, designed to protect human health and in the other, there are the secondary standards designed to protect the environment and limit property damage.

3.2.8 The Natural Resources Conservation Authority (Air Quality) Regulations, 2002

Part I of this Act stipulates license requirements and states that every owner of a major facility or a significant facility shall apply for an air pollutant discharge license. Part II speaks to the stack emission targets, standards and guidelines.

The Act states that no person shall emit or cause to be emitted from any air pollutant source at a new facility, any visible air pollutants the opacity or pollutant amount of which exceeds the standards.

Every owner of a facility with one or more air pollutant sources or activities shall employ such control measures and operating procedures as are necessary to minimise fugitive emissions into the atmosphere, and such owner shall use available practical methods

which are technologically feasible and economically reasonable and which reduce, prevent or control fugitive emissions so as to facilitate the achievement of the maximum practical degree of air purity.

Under this Act a "major facility" is described as any facility having an air pollutant source with the potential to emit:

(a) one hundred or more tonnes/y of any one of total suspended particulate matter (TSP);
(b) particulate matter with a diameter less than ten micrometres (PM10);
(c) sulphur oxides measured as sulphur dioxide (SO2);
(d) carbon monoxide (CO);
(e) nitrogen oxides (NOx) measured as equivalent nitrogen dioxide;
(f) five or more tonnes/y lead;
(g) ten or more tonnes per year of any single priority air pollutant; or
(h) twenty-five or more tonnes per year of any combination of priority air pollutants;

Table 3.2.8: Standards for Air Pollutants

POLLUTANT	AVERAGING TIME	STANDARD µg/m^3	
Total suspended particulates	Annual	60	
	24h	150	
PM10 (particulates with diameter <10 microns)	Annual	50	
	24h	150	
Sulphur dioxide		Primary	Secondary
	Annual	80	60
	24h	365	280
	1h	700	
Carbon Monoxide	8h	10,000	
	1h	40,000	
Nitrogen Dioxide	Annual	100	

The stack emission standards specified in the Twelfth Schedule shall apply to all new facilities with air pollutant sources. The installations for the KMA Water Supply Project will not be releasing stack emissions.

3.2.9 Noise Standards

To date, Jamaica has no National legislation for noise, but World Bank guidelines are often used for benchmarking purposes. The NRCA is currently preparing a draft document for National Noise Standards.

3.2.10 Water Quality NRCA Act (1990)

The NRCA has primary responsibility for control of pollution in Jamaica's environment, including pollution of water. National Standards exist for industrial and sewage discharge into rivers and streams while WHO Guidelines are generally used for drinking water. There are no national standards for ambient water quality of riverine systems.

3.3 NATIONAL LEGISLATIVE AND REGULATORY CONSIDERATIONS – HUMAN, CULTURAL AND SOCIAL ENVIRONMENT

3.3.1 Town and Country Planning Act (1958)

Section 5 of the Town and Country Planning Act authorizes the Town and Country Planning Authority to prepare, after consultation with any local authority, the provisional development orders required for any land in the urban or rural areas, so as to control the development of land in the prescribed area. In this manner, the Authority will be able to coordinate the development of roads and public services and conserve and develop the resources in the area.

Any person may, under Section 6 of the Act, object to any development order on the grounds that it is:

- impractical and unnecessary;
- against the interests of the economic welfare of the locality.

However, if the Minister is satisfied that the implementation of the provisional development order is likely to be in the public interest, he may, under Section 7 (2) of the Act, confirm it with or without modification by publishing a notice in the Gazette.

Section 8 of the Act also gives the Minister the authority to amend a confirmed development order.

Section 10 of the Act states that a development order must include:

- clearly defined details of the area to be developed;
- regulations regarding the development of the land in the area specified;
- formal granting of permission for the development of land in the area.

If the provisions of section 9A of the Natural Resources Conservation Authority (NRCA) Act apply to the development, the application can only be approved by the Planning Authority after the NRCA has granted a permit for the development (Section 11 (1A). The Authority may impose a "tree preservation order" under Section 25 of the Act if it considers it important to make provision for the preservation of trees and woodlands in the area of the development. This order may:

- prohibit the cutting down, topping, lopping or willful destruction of trees;
- secure the replanting of any section of the woodland area in which trees were felled during the forestry operations permitted under the order.

The tree preservation order is not applicable to the cutting down of trees which were already dead, dying or had become dangerous and the order can take effect only after it has been confirmed by the Minister.

The Minister can, under Section 26 of the Act, make regulations to restrict and regulate the display of advertisements in any area to be developed if he considers this to be in the interest of public safety. Section 28 of the Act empowers the local authority to require the owner or occupier of land in the development area to take the steps necessary to ensure its proper maintenance.

3.3.2 Land Development and Utilization Act (1966)

Under Section 3 of the of the Land Development and Utilization Act (1966), the Land Development and Utilization Commission is authorized to designate as agricultural land, any land which because of its "situation, character and other relevant circumstances" should be brought into use for agriculture. However, this order is not applicable to land which has been approved under the Town and Country Planning Act for development

purposes other than that of agriculture. Among the duties of the Commission outlined in Section 14 of the Act is its responsibility to ensure that agricultural land is "as far as possible, properly developed and utilized".

3.3.3 The National Solid Waste Management Authority Act (2001)

The National Solid Waste Management Authority Act (2001) is “an act to provide for the regulation and management of solid waste; to establish a body to be called the National Solid Waste Management Authority and for matters connected therewith or incidental thereto”. The Solid Waste Management Authority (SWMA) is to take all steps as necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, sorted, transported, recycled, reused or disposed of, in an environmentally sound manner and to promote safety standards in relation to such waste. The SWMA also has responsibility for the promotion of public awareness of the importance of efficient solid waste management, to advise the Minister on matters of general policy and to perform other functions pertaining to solid waste management.

3.3.4 Jamaica National Heritage Trust Act (1985)

The Jamaica National Heritage Trust Act of 1985 established the Jamaica National Heritage Trust (JNHT). The Trust's functions outlined in Section 4 include the following responsibilities:

- To promote the preservation of national monuments and anything designated as protected national heritage for the benefit of the Island;
- To carry out such development as it considers necessary for the preservation of any national monument or anything designated as protected national heritage;
- To record any precious objects or works of art to be preserved and to identify and record any species of botanical or animal life to be protected.

Section 17 further states that it is an offence for any individual to:

- willfully deface, damage or destroy any national monument or protected national heritage or to deface, damage, destroy, conceal or remove any mark affixed to a national monument or protected national heritage;
- alter any national monument or mark without the written permission of the Trust;

- remove or cause to be removed any national monument or protected national heritage to a place outside of Jamaica.

It should be noted that Spanish Town is a Declared Historic District and any works taking place there should be reported to the Jamaica National Heritage Trust, thereby allowing them the opportunity to asses the potential archaeological impacts of the proposed project and to perform a Watching Brief.

3.3.5 Land Acquisition Act (1947)

Section 3 of the Land Acquisition Act (1947) empowers any officer authorized by the Minister to enter and survey land in any locality that may be needed for any public purpose. This may also involve:

- Digging or boring into the sub-soil;
- Cutting down and clearing away any standing crop, fence, bush or woodland;
- Carrying out other acts necessary to ascertain that the land is suitable for the required purpose.

The Minister is authorized under Section 5 of the Act to make a public declaration under his signature if land is required for a public purpose provided that the compensation to be awarded for the land is to be paid out of the:

- Consolidated Fund or loan funds of the Government;
- Funds of any Parish Council, the Kingston and St. Andrew Corporation or the National Water Commission.

Once the Commissioner enters into possession of any land under the provisions of this Act, the land is vested in the Commissioner of Lands and is held in trust for the Government of Jamaica in keeping with the details outlined in Section 16. The Commissioner shall provide the Registrar of Titles with a copy of every notice published as well as a plan of the land. The Commissioner will also make an application to the Registrar of Titles in order to bring the title of the land under the operation of the Registration of Titles Act.

3.3.6 Registration of Titles Act (1989)

The Registration of Titles Act of 1989 is the legal basis for land registration in Jamaica, which is carried out using a modified Torrens System (Centre for Property Studies, 1998). Under this system, land registration is not compulsory, although once a property is entered in the registry system the title is continued through any transfer of ownership.

3.3.7 Involuntary Resettlement Policy

Jamaica's experience in resettlement has come mainly as a result of urban renewal and bauxite mining but documentation of the process has been limited. Proposed policy guidelines for involuntary resettlement were outlined in a draft report by McHardy (1997). The following measures were recommended as the principles and objectives of the policy:

- Avoid unnecessary displacement
- Give the population the option of selecting their choice among possible alternatives
- Prepare Rehabilitation Action Plans which will ensure that the project-affected people regain at least their "former standard of living and earning capacity after a reasonable transition period"
- All project-affected people should be entitled to benefit from the rehabilitation measures even if they are not holders of legal property titles
- Compensation money due to the persons being displaced should be paid well in advance of the date of their removal

Rehabilitation measures should include:

- Cost of moving to the new site
- Compensation for losses to be incurred
- Subsistence/maintenance allowance during the transition period
- Development programme to assist those resettled in regaining or improving on their previous living standards
- Considerations geared to minimize disruption during rehabilitation

3.3.8 Toll Roads Act (2002)

The Toll Roads Act was tabled in the House of Representatives in February 2002. The Act was passed into law by the end of the legislative year on March 31, 2002. This is an Act to provide for the designation of specified roads as toll roads, the establishment of the Toll Authority, the operation and maintenance of toll roads, the collection and retention of toll, and for other connected matters. (1) The Minister may, by order (a) subject to subsection (2), designate any road as a toll road for purposes of this Act; and (b) authorize any person, in return for undertaking such obligations as may be specified in an agreement with respect to the design, construction, maintenance, operation, improvement or financing of a toll road, to enjoy the rights conferred in the order, including the right to levy, collect and retain toll in respect of the use of the toll road. (2) No road shall be designated as a toll road under subsection (1) (a) unless in the area in which the toll road is to be established there is an alternative route accessible to the public by ferry, vehicular or other traffic.

3.4 INTERNATIONAL LEGISLATIVE AND REGULATORY CONSIDERATIONS

3.4.1 Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region) (1983)

Adopted in March 1983 in Cartagena, Colombia, the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, also known as the Cartagena Convention, is the only legally binding environmental treaty for the Wider Caribbean. The Convention came into force in October 1996 as a legal instrument for the implementation of the Caribbean Action Plan and represents a commitment by the participating governments to protect, develop and manage their common waters individually and jointly.

Ratified by twenty countries, the Cartagena Convention is a framework agreement which sets out the political and legal foundations for actions to be developed. The operational Protocols, which direct these actions, are designed to address special issues and to initiate concrete actions. The Convention is currently supported by three Protocols. These are:

- *The Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region* (The Oil Spills Protocol), which was adopted and entered into force at the same time as the Cartagena Convention;
- *The Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region* (The SPAW Protocol), which was adopted in two stages, the text in January, 1990 and its Annexes in June, 1991. The Protocol entered into force in 2000;
- *The Protocol Concerning Pollution from Land-based Sources and Activities in the Wider Caribbean Region* (LBS Protocol), which was adopted in October, 1999.

3.4.2 Biodiversity Convention

The objectives of the Convention on Biological Diversity are "the conservation of biological diversity, sustainable use of its components and the fair equitable sharing of the benefits arising out of the utilization of genetic resources". This is the first global, comprehensive agreement which has as its focus all aspects of biological diversity: genetic resources, species and ecosystems. The Convention acknowledges that the "conservation of biological diversity is a common concern of humankind and an integral part of the development process". In order to achieve its goals, the signatories are required to:

- Develop plans for protecting habitat and species.
- Provide funds and technology to help developing countries provide protection.
- Ensure commercial access to biological resources for development.
- Share revenues fairly among source countries and developers.
- Establish safe regulations and liability for risks associated with biotechnology development.

Jamaica’s Green Paper Number 3/01, entitled Towards a National Strategy and Action Plan on Biological Diversity in Jamaica, speaks to Jamaica’s continuing commitment to its obligations as a signatory to the Convention.

3.5 JAPAN BANK FOR INTERNATIONAL COOPERATION (JBIC)

3.5.1 Japan Bank for International Cooperation (JBIC) Guidelines

The JBIC established 'Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations' on April 1, 2002. These guidelines combined two previous environmental guidelines applied to International Financial Operations and Overseas Economic Cooperation Operations, respectively.

3.5.2 JBIC Policy on Environmental Considerations

A fundamental principle of JBIC, as a government financial institution, is to confirm that the executor of the project proposed for JBIC financing takes into account appropriate environmental considerations. JBIC has an affirmative policy to finance those projects that are designed to improve the environment, including those that reduce the emission of greenhouse gasses.

3.5.3 Standards to Confirm Appropriate Environmental Considerations

JBIC confirms in principle that the project will comply with the laws and regulations and environmental standards pertaining to the natural environments in the country where the project is located. In the event that environmental standards in that country diverge significantly from Japanese or international standards, or that local environmental regulations are yet to be established, Japanese or international standards are taken into account to confirm that appropriate environmental considerations are made.

In addition to considerations for natural environments, appropriate considerations, including adequate explanation must be given to the social environment particularly when local and neighboring populations will be subject to involuntary resettlement. In that event of a dispute JBIC will confirm the appropriateness of environmental consideration by referring to internationally recognized principles and procedures.

The Jamaican national environmental guidelines closely conform to the elements outlined in the JBIC environmental guidelines, and both follow closely the World Bank principles. These principles cover a wide range of aspects to be considered under the physical, biological and socio-economic environments.

4 METHODOLOGY

The methodology for this EIA was initiated through discussions between ESL and the client, Nippon Koei Co. Ltd.,/MWH UK Ltd. and a determination of the environmental management requirements of the proposed project. An application for an environmental permit was submitted to NEPA, who requested an EIA for the project. The Terms of Reference for conducting the EIA were prepared by ESL using the NEPA EIA Guidelines (NRCA, 1997). The TOR was submitted to NEPA for review and approval, and their comments and suggestions were incorporated.

A review of published and unpublished data, documentation from the WRA, NWC, other government agencies, as well as current field studies and collection of baseline data, were all used to inform the EIA. Data presented in the EIA includes current data generated for the project (either by ESL, the Client, the Engineers or other team members of the project during the years 2003, 2004, 2005 and 2006), as well as data previously gathered.

4.1 GENERAL APPROACH

A multi-disciplinary team of experienced scientists and environmental professionals was assembled to carry out the required resource assessment and generation of baseline data. An iterative approach among the environmental team members and other project professionals was adopted and will continue to be used to allow for the continuous integration of knowledge generated from the scientific data collected.

The team utilized the Charette-style approach to data gathering, analysis, and presentation whereby team members conducted the reconnaissance investigations together to determine the critical elements for analysis and the issues to be highlighted for the design and planning process. Team meetings were held to discuss the progress of investigations and analyses and facilitate integration of data toward an understanding of the systems at work in both the natural and built environment.

Baseline data for the study area were collected using the following methods:

- Windshield Survey / Site Reconnaissance
- Aerial Survey
- Analysis of Maps and Plans

- Literature Review
- Desk Top Research
- Stakeholder Consultations
- Field Studies
- Laboratory Analyses
- Charette Style Consultations

4.2 PHYSICAL ENVIRONMENT

Information was gathered on the existing physical environment, particularly as related to geology, topography, soils, hydrology and drainage, riverine water quality, air quality and noise.

4.2.1 Geology, Topography, Soils

Information on the climate, geology, topography, soils, drainage and hydrology was obtained by compiling existing data from reports as well as from source agencies. Aerial photos, satellite imagery and other published maps were also examined.

Field work was carried out to augment and verify existing information relating to geology and soils and to obtain first hand knowledge of the topography.

4.2.2 Hydrology and Drainage

A literature review was conducted to identify the elements of the hydrologic cycle that were likely to impact on the project and the possible impact that the project could have on the hydrologic regime. Maps, aerial photographs and plans were reviewed.

4.2.3 Air Quality

Ambient air quality measurements were essential to provide a description of the existing conditions, to provide a baseline against which changes could be measured and to assist in the determination of potential impacts of the proposed project on air quality conditions. Ambient background measurements were done at four locations.

The air quality assessment involved the determination of ambient levels of respirable particulates, PM10(<10µm). Particulates were measured using Sensidyne (BDX 530)

personal vacuum pumps (suction 2-3 1/min), attached to pre-weighed millipore filters. The pumps were placed at the approximate respiratory height of pedestrians for a specified period of time, after which the filters were stabilised and weighed to determine a Time Weighted Average (TWA) value for the particulates.

4.2.4 Noise

Noise level readings and any unusual local noise sources were recorded. Measurements were taken using Quest Electronics sound level meters, which conformed to ANSI S1.4 - 1983, TYPE 2 and IEC 651 - 1979, TYPE 2 standards. The meter was calibrated before and after each set of readings.

4.2.5 Water Quality

The objective of the baseline water quality programme was to determine pre-construction water quality conditions and the nature and extent of current impacts. Water quality assessments were conducted at rivers, springs, irrigation canals and wells within the project area.

Available data relating to historic ground and surface water quality were collated and provided by the project consultancy team.

Blanket water quality sampling programmes were undertaken by the project team with surface and groundwater samples collected at various points in the Lower Rio Cobre Basin. Samples collected were analysed by NWC Laboratories, Kingston, Jamaica with additional selected samples analysed by Southern Water Laboratories, Falmer, UK.

Additional sampling and analysis by carried out by ESL in conjunction with the WRA. All samples collected were stored in pre-cleaned 2 litre polyethylene and 250/500 ml glass bottles (transparent and opaque). Bacterial samples were collected at the water surface in sterilized 100 ml glass bottles. Dissolved oxygen and conductivity measurements were taken in situ at all sampling stations. Laboratory Analyses were performed at the Environmental Solutions Laboratory Division using certified methodology from Standard Methods for Water and Wastewater Analyses (Eaton et al, 1995).

4.3 BIOLOGICAL ENVIRONMENT

The status of the flora and fauna of the study area was determined by a review of literature relevant to the area, and a field assessment of both terrestrial and riverine environments.

4.3.1 Flora

The vegetative communities were identified using the method of Grossman et al (1991) and classified into community types. Identification of dominant tree species, assessment of stage of growth (mature or sapling) and assessment of canopy cover, constituted the investigation.

4.3.2 Fauna

Information on avifauna was gathered from existing literature on reported species as well as observations in the field. Information gathered for reptilian species was restricted to the native and endangered American Crocodile, known to inhabit parts of the project area. No information was gathered for lower species (insects, mollusks, etc.) as these were not deemed to be relevant to the proposed activities of the project.

4.4 SOCIO-ECONOMIC ENVIRONMENT

An understanding of the human, social and cultural environment of the Project Area was achieved though utilization of Rapid Rural Appraisal methodology, though there were significant differences in its application in the main urban area, Central Spanish Town.

The main instrument utilized was a semi-structured questionnaire, supplemented by drive-through observations, key informant interviews and examination of available statistical data.

4.4.1 Initial Profiles

The Consultants first drove through the area to identify the communities to be sampled and developed from observations an initial profile, including:

- main typology (urban, rural, unplanned residential, housing scheme, etc.)
- socio-economic classification
- main land uses

- developments underway
- evidence of sand mining
- activities in river/canals
- community facilities
- water sourcing and storage facilities
- waste management practices

These observations were recorded on a "Special Observations Form".

A list of possible key informants (data resource personnel) was then developed from Social Development Commission sources, a listing of schools in the area, a listing of Local Government representatives, important private sector establishments and personal knowledge. Additions to this list were made in the course of interviewing.

4.4.2 Questionnaire Design and Administration

A semi-structured questionnaire was designed for ease of recording. In addition, to be able to capture some quantitative data, a Response Sheet was also designed for use with all random interviewees and some key informants. This form was sectionalized in the same way as the semi-structured questionnaire.

The team then visited each community and attempted to contact and interview each listed key informant as well as to conduct random interviews, preferably with groups of persons, in different sections of the community. Group responses were, as a rule, consensus views. Further observations were carried out during this exercise.

In addition to the fieldwork, desk interviews of certain key informants were undertaken. Desk research also included visits to the Statistical Institute of Jamaica (STATIN) to identify the Enumeration Districts (EDs) within which the respective communities were situated and to extract the 2001 population data for these EDs. Because the 2001 Map Book had not yet been prepared, it was necessary to first identify the communities from the 1991 Map Book and then seek to identify the new populations for the current census.

Data recorded on the Special Observation Forms, the Questionnaire and the Response Sheets were entered in a separate statistical programme (Statistical Package for Social Sciences - SPSS) and analysed and quantified, where possible.

4.4.3 The Communities Sampled

The scope of work was based on the following areas (with the Rio Cobre Basin divided into four sub-regions or project areas – refer Figure 5.1):

I. Upper Rio Cobre Basin:

- Bybrook
- Tulloch Springs
- Kent Village
- Raby's Corner

11. Lower Rio Cobre Basin:

- Golden Acres
- Angels
- Gordon Pen
- Cow Market
- Ariguanabo

III. Spanish Town:

- Johnson Pen
- Green Acres
- Friendship
- Mewton Park
- Ensom City
- Thompson Pen
- Twickenham Park
- Central Village
- Sydenham
-

IV. South East St. Catherine:

- Lime Tree
- Phoenix Park
- Dunbeholden
- Goshen
- Salt Pond
- Independence City
- Port Henderson

- March Pen
- Hill Run

4.4.4 The Issues Examined

The Special Observation forms, the questionnaires and response sheets were designed to cover the following issues, as appropriate for each community:

- Community demographics
- Land use and livelihoods – whether conflicting or compatible
- Community facilities
- Water supply conditions
- Public health and safety
- Archaeological and cultural heritage
- Transportation and traffic
- Waste management
- Developments underway
- Flood experience
- Evidence of sand mining
- Use of irrigation canals/river – implications for environmental health

The intention was to determine the following:

- Urban functions – social dislocation in Spanish Town, etc.
- Conflicting/compatible proposed land use
- Agricultural investments
- Housing developments
- Portmore development – effect on demand
- Projected water demand – commercial, industrial, social infrastructure
- Expansion of other utilities – possibility for integrated "digging"
- Storage, treatment, distribution of potable water – proximity to settlements
- Occupational Health and Safety (OHS)– safety construction and operational phases
- Waste management proposals

4.4.5 Methodology for Spanish Town

In Central Spanish Town, the Rapid Rural Appraisal methodology was not thought to be appropriate, because of the need for more quantitative data. Instead, a detailed count was

done of residences, business establishments and vending stalls on the major streets designated for replacement of mains.

Ten of the eleven streets, identified by the Spanish Town Police traffic department as Priority 1 and 2 streets for purposes of traffic control during the construction work, were surveyed. Adelaide St. was not selected because the section of it on which mains will be replaced was at one end of the street that did not intersect with any other street.

A stratified 'random' canvass of five persons on each street was conducted to determine their perceptions of the impact that the capital works would have on their lives and livelihood and the extent to which they would tolerate the disruption to their lives. The stratification was applied so that each category of persons was represented, i.e., residents, businesses and vendors. A total of fifty (50) interviews were done.

Despite the care taken to ensure non-bias in the sample selection, it cannot be regarded as a scientific poll and no attempt was made to extrapolate from it. However, the results are deemed to give a good indication of the level of people's perception of how the project would affect them and their level of tolerance of this disruption.

A field survey was carried out in central Spanish Town to determine the extent of disruption of people's lives and economy that the proposed replacement of mains would bring and to canvass public opinion on the cost-benefit of this exercise to them.

4.4.6 GIS Mapping of Major Socio-Economic Features

The features of respective communities were mapped by colour coding the respective Electoral Districts that make up those communities.

The following three features were mapped:

i. Existing Land Use, indicating the main usage for each community;
ii. Public Health, using the results of the Community Toilet Type 1 cross tabulation and chart;
iii. Rating of Water Project, using the table and chart of that name.

The mapping parameters used are provided in Appendix II.

5 TECHNICAL DESCRIPTION AND ANALYSIS OF THE PROJECT AREA

In order to facilitate analysis, the Rio Cobre Basin was divided into four sub-regions (Figure 5.1). Detailed description and analysis of the overall project area and of these sub-regions, as appropriate, are given under the following categories:

Physical Environment

- Climate
- Geology
- Soils
- Topography and Geomorphology
- Hydrology
- Water Quality
- Noise and Air Quality
- Hazards

Biological Environment

Demographics

Socio-Economic Environment

Community Analysis: Perceptions of Project and Anticipated Impacts

5.1 PHYSICAL ENVIRONMENT

5.1.1 Climate

The Rio Cobre basin like the remainder of Jamaica belongs to the seasonal tropics. It has a tropical maritime climate, with topography and distance from the sea being responsible for much of the local variation in climatic conditions.

5.1.1.1 Temperature

The temperature is high all year with an annual 30-year mean of about 27^0C and a small annual range of about 5^oC. Diurnal ranges are higher; averaging 12 in the summer months. The mean temperatures for South East St Catherine are given in Table 5.1.1.1

Table 5.1.1.1: Bernard Lodge Temperature 30 year mean (1951 -1980)

^{0}C	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Max	30	30	31	31	32	32	33	33	33	32	32	31	**32**
Min	18	18	18	19	21	21	21	22	22	21	20	19	**20**
Mean	24	24	25	25	27	27	27	27	27	27	26	25	**26**

Temperature variation is mainly a factor of altitude, with the limestone uplands and the Upper Rio Cobre experiencing annual means a few degrees below the average for the entire basin. A temperature lapse rate of 3.2 degrees Fahrenheit per 1000 feet of elevation has been calculated for this area.

5.1.1.2 Wind Speed and Direction

The prevailing wind is from the northeast.

Wind data is limited for the area. Average wind speed at Bernard Lodge is of the order of 6 km/hr tending to be highest in June increasing up to about 10 km/hr and decreasing to about 3 km/hr in November.

The diurnal variation in temperature produces land and sea breezes and subsequently a similar diurnal variation in wind speeds, with a marked increase in the early afternoon, to about 37km/hr (20 knots). Extremely high wind speeds are associated with tropical systems, especially hurricanes that can attain speeds up to 320 km/hr.

5.1.1.3 Humidity

Mean annual values for humidity are of the order of 85% with higher humidity associated with the rainy season. There is also a strong diurnal variation with high values associated with the morning hours falling off rapidly to relatively low values in the afternoon.

5.1.1.4 Rainfall

The parish of St. Catherine like much of the southern regions of Jamaica that lie in the lee of the mountains, has a 30-year mean annual rainfall of less than 1500mm (Table 5.1.1.4). There is marked seasonality in the rainfall, with about 70% occurring during the rainy season, from May to November (Table 5.1.1.4). The rainy season exhibits some bimodality, with May and October being the wettest months of each year.

Much of the rainfall occurring in the rainy season is the result of convectional thunderstorms, while synoptic scale tropical systems, such as the tropical storms and hurricanes that affect the island between June and November, can generate extremely high rainfall. During September to November prolonged, intense rainfall is caused by the convergence of convectional systems and cold fronts that approach from North America.

Table 5.1.1.4 shows the variation in rainfall across the project area. There is a marked decline in rainfall totals as one proceeds southward; the upper basin with its higher elevation, also receives orographic rain.

Table 5.1.1.4: 30 year mean rainfall (mm) (1951-80) in the Rio Cobre Basin

Station	J	F	M	A	M	J	J	A	S	O	N	D	Total
Upper Rio Cobre Basin													
Linstead	55	52	60	100	217	207	169	172	210	223	123	97	**1685**
Tulloch	61	64	74	132	239	193	188	229	216	292	152	81	**1921**
Bog Walk	48	44	58	74	168	163	138	178	142	196	108	65	**1382**
Bybrook	109	68	57	107	193	172	152	187	195	234	118	88	**1680**
Lower Rio Cobre Basin													
Angels	36	43	53	76	145	107	97	145	137	260	34	114	**1247**
Greater Spanish Town													
Spanish Town	27	28	32	53	119	89	41	65	101	305	76	45	**981**
South East St Catherine													
Bernard Lodge	29	20	23	48	95	81	34	69	99	188	76	37	**799**
Half Way Tree	15	22	23	42	78	77	30	59	88	181	65	32	**712**
Mean	**48**	**43**	**48**	**79**	**157**	**136**	**106**	**138**	**149**	**235**	**94**	**70**	**1301**

5.1.2 Geology

5.1.2.1 Introduction

The geology, topography and soils of the Rio Cobre Basin and Southeast St. Catherine are integral in defining the proposed project, especially as this relates to well location and potential yield and the determination of potential aquifer recharge areas.

The geology of the Rio Cobre basin is dominated by upfaulted Tertiary limestone blocks of the White Limestone Super Group, separated by interior alluvial plains and low relief alluvial fan deposits of the Liguanea Formation. Figure 5.1.2.1 shows the vertical cross section through the sub-basin.

Figure 5.1.2.1: Vertical cross section through the sub-basin

5.1.2.2 Cretaceous and Lower Eocene - Inliers

Cretaceous rocks, mainly plutonics and volcaniclastics, cover about only 5 km^2 of the Rio Cobre Basin. These outcrop in inliers in the northwest, in the vicinity of Browns Hall, and in the northeast, around Lawrence Tavern and make up the basal aquiclude of the Rio Cobre Basin. The Yellow Limestone Group, of mid-lower Eocene age, lies adjacent to the Cretaceous rocks. It consists of a sequence of conglomerates, quartz sandstones interspersed with silty mudstones, and marly, fossiliferous impure limestones.

5.1.2.3 Tertiary - Limestone Uplands and Hellshire Hills

The main rock outcrops are the relatively pure and hard Eocene Troy/Claremont Limestone (from the Lower White Limestone) and the late Eocene – Miocene Upper White Limestone Series.

The Troy/Claremont and Somerset Lower White Limestones range from thick-bedded and dense, through vuggy and coarse grained, to fine-grained, chalky micrites that have been recrystallised, dolomitised and well fractured and jointed. The Troy limestone ranges in thickness from about 90m in the north, to almost 250m around Innswood.

The Upper White Limestone series is a partially recrystallised sequence of chalky, poorly bedded, rubbly and fossiliferous limestones that may be as much as 1,200m thick beneath the St Catherine Plains. In the south, in the Hellshire Hills, it outcrops as the Newport Formation.

Generally, the White Limestones are quite hard and structurally strong, capable of supporting features such as the Riversdale Natural Bridge and the Bog Walk gorge.

5.1.2.4 Quaternary - St Catherine Plains and Upper Basin

In the Upper Rio Cobre, the White Limestone has also been partially buried with residual clays from limestone weathering, colluvium, and alluvial deposits from the Cretaceous inliers. These deposits thicken southward, toward the river confluences and the Bog Walk Fault.

On the St Catherine Plains, the White Limestone has been buried by thick alluvial deposits of the Liguanea Formation. This consists first of a layer of clays that may represent a marine transgression.

The uplift and subsequent denudation of the Cretaceous Inlier and surrounding White Limestone resulted in the deposition of the Rio Cobre alluvial fan complex, with the fan apex at the southern end of the Bog Walk Gorge. These fan deposits include layers of clays, derived from both the limestones and the volcanics, and siliciclastic sands and gravels brought down from the Cretaceous Inliers. Much of the sand and gravel deposits are localised, representing buried river channels and former levees. While the Rio Cobre now exits into Kingston Harbour, it has meandered widely over the St Catherine Plains, and there is some evidence, in the form of a probable buried channel 180m deep, that the river once exited through the Salt Pond Gap.

5.1.2.5 Structure

The structure of the Rio Cobre basin is basically fault controlled. Major E-W and NW-SE trending pre-Eocene or 'basement' faults that have been reactivated during the Miocene control much of the topography, geomorphology and hydrology of the basin.

There is little folding; beds are either horizontal or dip very gently to the south. Smaller, more recent, but less influential E-W and N-S tension faults exert some control in the Hellshire Hills.

The major faults are:

- Bog Walk Fault – E-W trending, is the hydrological divide between the Upper and Lower Rio Cobre Sub-Basins; separates the upfaulted limestone uplands from the interior basin with a dramatic north-facing 200m high escarpment.
- Ferry Hill – E-W trending,
- Red Ground, Bog Walk Gorge and Molynes Mountain – NW-SE trending
- Innswood, Cudjoe Hill – NE-SW trending

These faults exert strong structural control on the topography, geomorphology and especially the hydrology of the Rio Cobre Basin.

5.1.3 Soils

Over the White Limestone outcrops, soils are thin and discontinuous, with limestone rubble. With the high purity of the White Limestone, there is little weathering residue.

5.1.4 Topography and Geomorphology

The Rio Cobre Basin can be divided into three physiographical regions, the upper drainage basin with bordering highlands and interior valley (Linstead, Bog Walk), the limestone uplands with the Rio Cobre Gorge and the low relief Rio Cobre alluvial fan/floodplain (St. Catherine Plains) interrupted by limestone massifs (Port Henderson and Hellshire Hills. The geomorphology is dominated by fluvial and karst processes.

The overall topography and geomorphology are shown on Figure 5.1.4.

5.1.4.1 Upper Rio Cobre Basin

The Upper Rio Cobre Basin is a large enclosed limestone depression or basin with a gently undulating to flat floor of residual clays and alluvial deposits. It is largely fault controlled, a downfaulted limestone block with a steeply rising 100 to 200 metre high fault-scarp limestone border on the south (Bog Walk Fault). Gentler, more irregular limestone dissected by dry valleys borders on the west, north and northeast and non-limestone fluvially dissected Cretaceous rocks border the east. Slope processes, landslides and other slope failures modify the bordering highlands, especially in the easily weathered and impermeable Yellow Limestone and the volcanics.

This interior valley can be considered a rand or border polje, as it is dominated by allogenic (non-limestone) rivers that bring in igneous sediment from deeply dissected Cretaceous Inliers. The Rio Cobre/Black River tributary, although flowing out of limestone, originates further out in the west in the Cretaceous Juan de Bolas Mountains, as the Murmuring Brook/Rio Cobre. The Rio Magno flows from the north through limestone.

Figure 5.1.4: Topography and Geomorphology

Many of the smaller streams are ephemeral or seasonal and cut numerous gullies in the alluvial floor. The main tributaries are perennial in their upper reaches but may seasonally lose their flow over the limestone. They have well developed channels that meander across the polje floor, and the Rio d'Oro has a small floodplain. They all converge on the southern, alluvial-filled, fault-bounded border of the polje and exit as the Rio Cobre via the Bog Walk Gorge.

The convergence of the streams, the almost flat relief and the clay-rich alluvium around Bog Walk make flooding a frequent occurrence during the rainy season.

5.1.4.2 Limestone Uplands and Bog Walk Gorge

The Limestone Uplands display a hummocky relief that may be characterised as subdued polygonal or cockpit karst with internally drained, enclosed depressions separated by elongated isolated hills and ridges; the elongation reflecting the structural controls of the basement faults. The highest elevation is 735m at Montpelier and the main surface gradient is to the south.

Drainage is largely internal, with ephemeral surface runoff disappearing down sinkholes and dolines. The most impressive feature is the fluvio-karst Bog Walk Gorge, where the perennial Rio Cobre exploits the structural weakness of the Bog Walk Gorge Fault/Fracture. The gorge is narrow (100m in places), and deep (more than 250m between Bog Walk and Kent village) bounded in places by near-vertical limestone cliffs.

Karst solution is the most common process, exploiting the well-defined fractures and joints. Fluvial incision appears active, particularly during flood, and rock fall is common on the well-bedded and jointed steep slopes of the gorge.

5.1.4.3 Alluvial Fan/Floodplain Complex

The emergence of the Rio Cobre from the Bog Walk Gorge has produced a very low relief alluvial fan that ranges from 60m at the apex to sea level at the coast, though much of it lies below 20m asl. This is likely to be largely relict or at most, ephemerally active, as the Rio Cobre is well confined to its channel.

The Plains have a surprisingly high drainage density, given the relatively low rainfall, but this is due largely to the allochtonous nature of the recharge and drainage. Numerous

small streams drain the western and southern portions of the plains, and are not hydrologically connected to the Rio Cobre. They do, however, drain or traverse the plains and therefore are part of the drainage basin. Several streams rise from wet season springs emerging from the alluvial aquifer and many are short-lived, either disappearing again underground or drying up before reaching the coast. Those that rise as springs in the bordering limestone are largely perennial. The Mountain River/World End's Gully, which drains the Cretaceous Inlier before flowing through limestone, resurges onto the St Catherine Plains as the Coleburns's Gully.

Just as it emerges out of the confinement of the Bog Walk Gorge, a significant portion of the flow in the Rio Cobre is diverted into the Rio Cobre Irrigation Headworks Canal, which provides irrigation water to the St Catherine Plains. The main irrigation water stream, flowing through well-defined channels, meanders through Greater Spanish Town and the St Catherine Plains with surplus water exiting at the end of the canal system into various drainage gullies ultimately draining into the micro-tidal and sheltered Hunts Bay , the Great Salt Pond and Old Harbour Bay.

The coastline of the alluvial plain, interrupted by the limestone massifs, is dominated by low-lying morass or swamp and mangroves that trap sediment carried by the Rio Cobre and the many streams and gullies that drain the Plains. At Portmore, the morass and mangroves have been cleared for settlement. Salt ponds, including the Great Salt Pond, Jamaica's second largest, separates the morass from the sea. Coral reefs litter the nearshore at Hellshire.

5.1.4.4 Geomorphic Features

North of the project area is the Riversdale Natural Bridge, a karst feature, under which the Rio D'Oro flows. The Riverhead Cave, in the headwaters of the Rio Cobre and the Bog Walk Gorge, is a distinct geological formation which is located between the Upper and Lower Rio Cobre Basins.

The Hellshire and Port Henderson Hills rise from near sea level, adjacent to the alluvial plains, to over 200 m altitude. The massifs are rounded, with fairly smooth surfaces interrupted by small, linear fault scarps. There is very little surface drainage; but some fluviokarst valleys radiating off the Hellshire Hills suggest the presence of ephemeral

flow. The massifs display some incipient karst, with occasional sinkholes and collapse dolines. There are several caves, including Two Sisters Cave and Owl Cave, both exposed through collapsed dolines, and though dry, indicating the presence of former flowing groundwater.

5.1.5 Hydrology

A full review and study of the hydrology of the Rio Cobre Basin is to be presented to the Water Resources Authority as part of the detailed design stage of KMA Water Supply Project, and therefore only an overview is given in this EIA report.

There are two types of aquifers in the overall Rio Cobre Basin: limestone and overlying alluvial aquifers.

Although limestone is continuous under the overall Rio Cobre Basin, there is much variation and some discontinuities in its permeability, due to varying lithology, differing degrees of recrystallisation, the many intersecting faults and fractures, and the karst solution widening and opening of fractures.

The Upper White Limestone has its own, elevated water table. At the boundary between the Upper and Lower White Limestones, the groundwater is leaked or transmitted, via joints and fractures, to the Lower White Limestone, where it is stored or discharged via conduits.

Given the good environmental conditions for karst solution processes, and the favourable lithological and structural properties of the limestones, there is likely to be a network of caves and conduits within the limestones, allowing rapid groundwater movement. Additionally, the groundwaters are rich in calcium bicarbonate, the product of solution weathering by aggressive percolating rain and surface water.

The White Limestone of the Upper Rio Cobre Basin is recharged, primarily through dolines and sinkholes, by precipitation over the upper reaches of the basin and by sinking allogenic streams like the Murmuring Brook/Rio Cobre (where it sinks into the Worthy Park caves) and the Rio Pedro, before it becomes buried under the alluvial cover of the Linstead polje. The hydraulic gradient is largely southward.

At the lower end of the Linstead polje, the Bog Walk fault acts as an impermeable barrier to groundwater flow and the confined groundwater is forced up to the surface to enter the surface water system. The Upper Rio Cobre limestone aquifer therefore presents an artesian basin, with confined flow under the alluvial layer in the lower portions of the polje .

The Bog Walk Fault thus forms the major divide between the Upper Rio Cobre Sub-Basin and the Lower Rio Cobre Sub-Basin. The only hydraulic connection between the two sub-basins is the Rio Cobre via the Bog Walk Gorge.

Precipitation over the Limestone Uplands of the Lower Rio Cobre Sub-basin recharges that basin's limestone aquifer. Limestone aquifer ground water discharges though springs on the eastern and western ends of the sub-basin and into the lower reaches of the Rio Cobre and is abstracted through wells.

Under the St Catherine plains the limestone aquifer is confined below the alluvium as clays effectively minimize transfers of groundwater between the aquifers.

The limestone outcrops again from under the St Catherine Plains as the Port Henderson and Hellshire Hills. These limestone outcrops have only perched fresh water lenses not hydraulically connected with the larger limestone aquifer.

The Lower Rio Cobre alluvial aquifer is of variable porosity and permeability due to interbedded clay lenses. Discrete sand and gravel deposits represent buried former river channels and levees within the overall alluvium.

The alluvial aquifer is bounded by the limestone outcrops and elsewhere extends out to the sea, where the presence of morass indicates the fresh/salt water interface.

Recharge of the Lower Rio Cobre alluvial aquifer is from precipitation, excess applied irrigation water (and thus indirectly from the Rio Cobre via the Rio Cobre Irrigation system) and from leakage from the water distribution system (and hence indirectly partially from the limestone aquifer).

The Rio Cobre is 'perched' on the alluvium to the southeast of Spanish Town and there is some interaction between the river and the alluvial aquifer particularly in the lowest reaches of the river, where the bed lies below the height of the water table,

The alluvial aquifer also discharges into small wet season springs on the St Catherine Plains and to the sea through the morass bordering the coastline.

The Rio Cobre is perennial. Flood flows originating from Luidas Vale have broader hydrographs and lower peaks, while those generated over the basal aquiclude/Cretaceous rocks, have higher peak flows and are often the most destructive. This is due to the greater travel times as drainage from Luidas Vale is diverted underground before emergence at Bog Walk, while flows from the northeast flow very quickly overland.

5.1.6 Water Quality

5.1.6.1 Introduction

This section presents a discussion on the nature and quality of the ground and surface waters in the project area.

A review of available historical water quality data is first presented.

Specifically as part of the preliminary engineering studies undertaken by the project's consultancy team, the Water Resources Authority (WRA) was commissioned by the client to undertake two blanket sample collection programmes for both ground and surface water throughout the project area – in April 2003 and February 2004. In 2003, 50 water samples were collected from various locations across the Lower Rio Cobre Basin (2 springs, 3 rivers, 2 canals, 1 tap sample and 43 well samples). Samples were analysed for coliforms, residual chlorine, turbidity, conductivity, pH, total dissolved solids, total alkalinity, total hardness, nitrates, chemical oxidation potential, silica, manganese, major anions and cations, and total phosphate. In addition 15 selected samples were also analysed for heavy metals (Hg, As, Cd, Cr, Pb, Ni, Se, Zn), common pesticides, chloroform, benzene, dichloroethanes and chloroform. A further 52 water samples were collected from various locations across the Lower Rio Cobre Basin (2 springs, 2 rivers, 3 canals, and 45 well samples) during February 2004. These were taken to determine the variability of water quality between the wet and dry seasons in Jamaica. Samples were analysed for coliforms, residual chlorine, conductivity, pH, total alkalinity, total hardness, manganese, calcium, magnesium, potassium and sodium. 25 samples were analysed for total iron concentrations. Water samples collected during the

blanket sampling rounds were analysed by NWC Laboratories, Kingston, Jamaica with additional selected samples analysed by Southern Water Laboratories, Falmer, UK. Further samples from August 2004 and January 2005 were submitted for pesticide (69 including glycophosphate), titanium, PAH (6 named) and PCB (7 congeners) analyses to Southern Water Laboratories.

A review of the results from these programmes is presented below. Baseline data is given in Appendix VII.

As these blanket sampling and analysis programmes identified manganese levels as a specific issue, ESL conducted its own sampling programme related to this specific parameter and a review of this work is finally presented.

5.1.6.2 Historical Water Quality

The UNDP and FAO study of 1974 reviewed Water Quality (among other pertinent issues) of the Rio Cobre Basin and noted that both surface and groundwaters throughout the basin are predominantly calcium carbonate waters - the waters of the alluvial aquifer being high in calcium carbonate as that aquifer is significantly recharged with karstic waters.

From the data available at the time, which focused on the chemical constituents of the water, the variation in quality of surface waters was considered to depend on the time of year (wet or dry season) and the drainage area. Generally, spring waters tended to be clear with only mild turbidity (although there are noticeable variations in the chemical quality depending on the travel time before discharge) with surface streams exhibiting high turbidity, “dirty brown coloration” and high suspended solids during the rainy season.

Contamination of the water systems at that time was identified as originating from subsurface saline intrusion and human activities.

5.1.6.3 ESL Review of the KMA Project Blanket Water Quality Programmes

Under the Blanket Sampling and Analysis Programmes undertaken for the project consultancy team both subsurface and surface waters (springs, rivers, and canals) were tested for a number of physiochemical and bacterial parameters. The suite of parameters

analysed was sufficiently broad to provide an effective assessment of the quality of the surface and ground water systems in the project area.

According to the data report supplied, raw water quality in the project area was generally good. The levels of some parameters at a few stations were higher than the NRCA Ambient Water Quality Guidelines; 4% of the samples collected showed elevated manganese and iron levels, and 16% had fecal coliform levels exceeding the standard. Heavy metals and 24 D concentrations were also measured at above detectable levels in some samples although within acceptable international and local standards.

a) Raw Groundwater – Wells Sampled in KMA project Blanket Exercise

Much of the groundwater flowing through this region is karstic water; rich in calcium carbonate, having flowed over or through limestone rock.

Generally, physiochemical parameters were within the drinking water standards. However, elevated manganese levels were measured in samples from Pasture 2B (0.36mg/L) and the Bernard Lodge Canal (0.07mg/L) (Table 5.1.6.3a). Elevated iron levels were also measured at two wells. Four wells (Brampton, Browers, Goshen and Bodles Exploratory) had total coliform levels above the drinking water standard and two (Thetford Hall 4A and Central Village) had both elevated total and fecal coliform levels (raw data for bacterial parameters tested was not provided; see Appendix VII).

Potential contamination of groundwater by direct discharge from on-plot soakaways etc., or by inadequately treated effluent disposal was indicated by the relative high levels of nitrate in a number of samples from wells in or close to certain urban areas but all levels remain below the recommended WHO recommended maximum contaminant level of 50 mg/l.

Selected parameters from surface water quality analysis results are presented in Table 5.1.6.3a overleaf.

Aquifer	Upper Rio Cobre Limestone aquifer	Greater Spanish Town – Lower Rio Cobre Limestone Aquifer					South East St Catherine – Lower Rio Cobre Alluvial Aquifer								NRCA Ambient Water Quality Guidelines
Well / **Parameter**	**Bog Walk #2 Well**	**Green Acres**	**Golden Acres**	**Friendship (St. Johns Road)**	**Twickenham Park**	**Yangs Well**	**Bernard Lodge**	**Goshen 3A Well**	**Pastures 2B**	**Govt. Pk #2**	**Half Way Tree #5**	**Lime Tree 3A**	**Phoenix Pk #3**	**Matrix Ice Well**	
Conductivity (umho/cm)	567	611	1132	912	978	1204	1021	1121	1133	1254	622	956	834	2356	**150 - 600**
pH	7.49	7.26	7.06	7.07	7.16	7.3	7.67	7.65	7.78	7.09	7.27	7.25	7.45	7.19	**7 - 8.4**
Total Dissolved Solids (mg/L)	322	375	813	457	644	773	803	676	631	926	406	538	601	1437	**120 – 300**
Total Alkalinity (mg/L)	261	266	283	288	312	290	312	356	347	325	279	311	326	254	**--**
Total Hardness (mg/L)	265	292	443	350	319	381	451	455	379	468	282	381	313	565	**<300**
Nitrates(mg/L)	4.8	20.6	8.4	10.7	11.4	15	ND	ND	6.2	1.4	ND	11.3	25.8	23.4	**0.10 – 7.5**
Sodium (mg/L)	10.8	9.7	66.2	31.4	94.8	115.2	63	56	66.4	53	23.1	31.2	42.8	169	**4.5 – 12**
Sulphate (mg/L)	5	ND	31.8	23	36.2	64.8	69.2	66.4	48	34	15.6	30.4	15.6	21	**3 – 10**
Chloride (mg/L)	15	18	198	95	133	225	175	110	120	180	20	92.5	35.5	540	**5 - 20**
Calcium (mg/L)	--	96.3	91.3	116	--	--	--	--	--	--	--	--	--	--	**40-101**
Magnesium (mg/L)	--	12.5	52.2	14.7	--	--	--	--	-	--	--	--	--	--	**3.6-27**
Manganese (mg/L)	--	--	--	--	--	--	0.07	ND	0.36	0.02	ND	ND	ND	--	**--**

Table 5.1.6 3a: Selected Parameters - Blanket Sampling of Groundwater April 2003

b) *Surface Waters Sampled in KMA project Blanket Exercise*

Tulloch Spring was sampled and generally the physiochemical parameters were within NRCA standards. Tulloch Spring is a freshwater spring. Though located adjacent to a banana plantation, pesticides and trihalomethane levels were not detectable, but there were trace concentrations of arsenic (0.8µg/L) and zinc (9µg/L). Faecal and total coliform bacterial levels at this spring exceeded drinking water standards though it was not clear from the methodology whether the sample was collected after the chlorine injection point (if the sample were collected after chlorination then the presence of coliform bacteria would be of serious concern).

Ferry Spring is a brackish water system with total coliform counts at the springhead exceeding drinking water standards, though this is not unusual for open spring systems prior to treatment.

Samples were collected form the Rio Cobre at two locations, from the Spring Garden River, and from irrigation canals at Bernard Lodge, Innswood and the Spanish Town filter plant. The parameters of most concern are total and faecal coliform. Six stations recorded faecal bacterial levels between 500 and 23000, well in excess of the NEPA standard for surface water systems.

Trace concentrations of mercury (8 µg/L), arsenic (1.2 µg/L), and chromium (0.8 µg/L) were detected in the Spring River Plant Canal, as was the pesticide, 24 D (210 ng/L).

Detectable manganese levels (<0.03 mg/l) were recorded at several stations.

Generally, the levels of the physiochemical parameters were found to be within the requisite standards.

Key surface water quality analysis results are presented in Table 5.1.6.3b overleaf.

Table 5.1.6.3b: Key Surface Water Quality Results (Samples collected by WRA) – April 2003

Parameter	Tulloch Springs	Rio Cobre River	Bernard Lodge Canal	NRCA Ambient Water Quality Guidelines
Conductivity (umho/cm)	442	452	438	**150 - 600**
pH	7.4	8.31	8.32	**7 - 8.4**
Total Dissolved Solids (mg/L)	257	370	267	**120 – 300**
Total Alkalinity (mg/L)	208	233	222	
Total Hardness (mg/L)	211	228	217	**<300**
Nitrates(mg/L)	ND	ND	ND	**0.10 – 7.5**
Manganese (mg/L)		0.02	0.02	
Sodium (mg/L)	6.7	16.9	19.2	**4.5 – 12**
Sulphate (mg/L)	0.83	18.3	19.1	**3 – 10**
Chloride (mg/L)	9.5	13.5	14	**5 - 20**

c) Pesticides in KMA project Blanket Exercise

Generally, pesticides within samples collected under the KMA Project blanket sampling and analysis exercises were below detection limits. However in view of the proposed artificial recharge of ground water aquifers using irrigation canal water, specific attention was paid to pesticide levels in such water samples. Table 5.1.6.3c details the determinands found to be above detection limits in the Southern Water pesticide analyses and detected levels are compared in the table against WHO (2004 and 1998) and UK Drinking Water Standards (which implement the EU Drinking Water Directive). Pesticide concentrations did not exceed drinking water standards except for Diuron in the Lime Tree Canal. In addition, the sum of pesticide concentrations in both the Lime Tree and Innswood Canals in August 2004 exceeded the UK Drinking Water Standards. Diuron is one of the top three pesticide imports into Jamaica and is widely used. The decrease in pesticide concentrations between August and January is considered to be due the sample timing at the beginning of the wet season and at the end of the sugar cane

growing season in August, as opposed to the end of the wet and growing seasons in January. This would cause a decrease in the volume of pesticide applied to the land, and flushed into the canal system.

No PCB were found above detection limits and the only PAH detected was fluoranthene. The concentrations of fluoranthene detected were lower than the drinking water standards.

Table 5.1.6.3c – Pesticide and other trace analytes in Canal Water Samples

Determinand	Water Quality Standard	Innswood Canal	Lime Tree Canal	Bernard Lodge Canal
August 2004 Sample Round				
Titanium (µg/L)		9	7	
Fluoranthene (µg/L)	4 [c]		0.004	
Simazine (ng/L)	2000 [a]		14.3	10.2
Terbutryn (ng/L)	1000 [b]	18.6	41.4	
Carbetamide (ng/L)	1000 [b]		17.4	
Diuron (ng/L)	1000 [b]	980	**5770**	148
Dicamba (ng/L)	1000 [b]		100	
Glycophosphate (ng/L)	1000 [b]	75		
Atrazine (ng/L)	2000 [a]	16.9		13.1
Desmetryn (ng/L)	1000 [b]	15.8		
Chlortoluron (ng/L)	1000 [b]	92.4		30.7
Propazine (ng/L)	1000 [b]			11.8
Total Pesticides (µg/L)	0.5 [b]	**1.2**	**5.94**	0.21
January 2005 Sample Round				
Titanium (µg/L)		2	3	10
Fluoranthene (µg/L)	4 [c]	0.009	0.009	0.01
Atrazine (ng/L)	2000 [a]		20	16.8
Chlorthal (ng/L)	1000 [b]			15
Carbetamide (ng/L)	1000 [b]	22.9		
Total Pesticides (µg/L)	0.5 [b]	0.02	0.02	0.03

a – WHO Drinking Water Guidelines 2004,
b – UK Water Supply (Water Quality) Supply Regulations 2000
c – WHO Drinking Water Guidelines 1998

d) Nitrate in KMA project Blanket Exercise

Nitrate levels above normal anticipated background levels were evident in some blanket groundwater samples taken from locations in or close to populated areas and these are potentially indicative of sewage contamination.

While all nitrate levels were below the WHO recommended maximum contaminant level of 50 mg/l, the maximum level found was at the existing NWC limestone well at Central Village. Coupled with poor bacteriological parameters, this is clearly indicative of sewage pollution from the immediately adjacent squatted community of Windsor Heights where inappropriate sewage disposal is prevalent within the congested "informal" housing settlement.

To assess the trends in nitrate concentrations in the limestone aquifer, Mann Kendal trend analysis was carried out by the project consultancy team (Table 5.1.6.3d). The Mann Kendall technique produces an indication of trend and a probability percentage for that trend. The nitrate trend analysis indicates an increasing trend in nitrate concentrations in 4 out of the 6 wells analysed.

Table 5.1.6.3d – Historical nitrate trends in the Limestone Aquifer (mg/L)

Date	**1972**	**1974**	**1975**	**1975**	**1976**	**1976**	**2003**	**Trend**
Whim Works						16.0	9.2	80% Increasing
Bodles Exploratory	13.2	6.9		4.9	6.6	18.0	7.1	Neither
Bushy Park (Hendricks)		8.6	7.1	2.5	5.6	14.0	13.0	Neither
Spring Garden		7.2	7.3	5.8	5.5	12.0	10.7	80% Increasing
Golden Acres		4.9		3.8	4.3		8.4	80% Increasing
Friendship		6.7	6.3	3.4	5.7	10.0	10.7	80% Increasing
Central Village					6.8	21.0	25.6	90% Increasing

5.1.6.4 ESL Blanket Manganese Sampling Programme

As blanket sampling and analysis programmes undertaken directly for the project consultancy team identified manganese levels in the alluvial aquifer and in the irrigation canals intended to provide water for artificial aquifer recharge as specific project issues, Environmental Solutions and Water Resources Authority personnel conducted three blanket manganese water-quality sampling exercises; samples were collected April 14 - 15, August 18 -19, 2004 and January 26 – 27, 2005.

a) Iron and Manganese in Drinking Water

Iron and manganese are commonly found in the earth's crust as minerals. These minerals are dissolved by groundwater and may then be either held in solution or precipitated (depending the REDOX potential of the particular groundwater) or because of specific bacterial action. Iron or manganese bacteria are non-pathogenic (not health threatening) and occur in soil, shallow aquifers and some surface waters feeding on iron and manganese in the water. These bacteria form red-brown (iron) or black-brown (manganese) slime in toilet tanks and can clog water systems.

Water with dissolved constituents may appear clear but when exposed to oxidants (including air and chlorine), dissolved iron and manganese are oxidized and change from the colourless, dissolved forms to coloured, solid forms. Oxidation of dissolved iron in water changes the iron to white, then yellow and finally to red-brown solid particles that settle out of the water. Iron that does not form particles large enough to settle out and remains suspended (colloidal iron) leaves the water with a red tint. Manganese in groundwater is usually in solution (dissolved) but some shallow wells may contain colloidal manganese evidenced by the black tint of the water or particulate matter (precipitated by oxidation processes or bacteria).

Iron and manganese in drinking water is not considered a health hazard but present aesthetic and economic problems. Manganese is objectionable in water even when present in smaller concentrations than iron.

Iron and manganese can affect the flavour and colour of food and water. They may react with tannins in coffee, tea and some alcoholic beverages to produce a black sludge, which

affects both taste and appearance. Iron will cause reddish-brown staining of laundry, porcelain, dishes, utensils and even glassware. Manganese acts in a similar way but causes a brownish-black stain. Soaps and detergents do not remove these stains, and use of chlorine bleach and alkaline builders (such as sodium and carbonate) may intensify the stains. Iron and manganese deposits will build up in pipelines, pressure tanks, water heaters and water softeners and accumulations become an economic problem when extensive flushing of water supply facilities are required or when consumer equipment must be replaced.

b) Iron and Manganese Standards

Jamaica does not currently have legislated drinking water standards; the National Water Commission uses both World Health Organisation (WHO) and United States Environmental Protection Agency (USEPA) drinking water standards. The USEPA standards for drinking water fall into two categories: Primary Standards and Secondary Standards. Primary Standards are based on health considerations and are designed to protect people from three classes of pollutants: pathogens, radioactive elements and toxic chemicals. Secondary Standards on the other hand are based on taste, odour, colour, corrosivity, foaming and staining properties of water. Iron and manganese are both classified under the Secondary Maximum Contaminant Level (SMCL) standards. The recommended maximum contaminant level for iron in drinking water is 300 micrograms per litre (µg/l) and 50µg/l for manganese. Drinking water with less than these concentrations will generally not have an unpleasant taste, odour, appearance or side effect.

c) Surface Water Quality Determined for Samples collected by ESL/WRA

For the surface water samples collected, most of which were along irrigation canals, the sodium, chloride and sulphate levels were higher than NRCA/NEPA standards for drinking water, though within the WHO standards of 200, 250 and 250 mg/l respectively. Manganese and Iron levels were high at many stations (Table 5.1.6.4c).

Table 5.1.6.4c: ESL/WRA Blanket Sampling Exercise, 2004 - Surface Water Quality at Selected Irrigation Canal Stations

Parameter	**Standard**	**Rio Cobre Headworks**	**Spanish Town IC**	**Lime Tree IC**	**Lime Tree IC**	**Bernard Lodge IC**	**Bernard Lodge IC**	**Dunder Waste Drain**
	NEPA	Aug 18	Aug 18	Apr 15	Aug 18	Apr 15	Apr 15	Apr 15
PH	7-8.4	8	8	8	8	8	8	6
Eh		-72	-70	-83	-72	-73	-67	-46
Manganese ug/l	50	66	59	46	103	576	855	780
Iron ug/l	30	<20	600	51	<20	<20	<20	3810
Aluminium mg/l		0.2	1	1	2	12	20	15
Sodium mg/l	4.5-12	36	30	23	20	100	34	161
Calcium mg/l	40-101	86	81	87	69	106	90	147
Magnesium mg/l	3.6-27	12	11	15	11	36	15	161
Chloride mg/l	5-20	16	16	24	12	8	34	265
Alkalinity		225	184	238	197	344	238	139
Sulphur mg/l	3-10	19	4	24	25	19	0	33

IC – Irrigation Canal

d) Ground Water Quality Determined for Samples collected by ESL/WRA

Analysis results for ground water samples collected by ESL/WRA are presented in Table 5.1.6.4d overleaf. They demonstrate the extent of manganese in sections of the alluvial aquifer in SESC.

Table 5.1.6.4d: ESL/WRA Sampling Exercise, 2004 - Ground Water Quality at Selected Stations (with surface water reference data)

Parameters	Spn Twn NWC (Irrig. canal)	Bernard Lodge Factory Well (Process water)		South Syndi-Cate Irrigation Well	Pastures 2B Irrigation Well			Dunbeholden Well (NWC)		Govern - ment Park 2 Well (NWC)	Congrieve Park 4R Well (NWC))		Portmore 2 Well (NWC)			Salt Pond Irrig. Well	WICHON Well (See Note 1)
	Apr 15	Feb 15	Apr 15	Feb 15	Feb 15	Apr 15	Aug 18	Apr 15	Aug 18	Aug 18	Feb 15	Aug 18	Feb 15	Apr 15	Aug 18	Apr 15	Feb 15
PH	8.13	7.05	6.94	6.73	7.21	7.1	7.8	7.23	6.7	7.5	7.38	7.2	7.33	7.21	7.5	7.59	5.35
Eh	-77.7	-1.8	-6.8	15.2	-10.7	-21.9	-43.8	-27.8	11.4	-30.8	-7.5	-14.4	-18.1	-34.4	-31.8	-45.2	98.8
Manganese µg/l	14.2	197	218	197	244	225	215	707	780	100	212	208	176	660	100	317	1.66x10 3
Iron µg/l	311	----	<20.0	----	----	<20.0	80	102	<20.0	40	----	<20.0	----	347	30	3280	----
Dissolved Iron µg/l	82	----	<20.0	----	----	<20.0	<20.0	<20.0	<20.0	<20.0	----	<20.0	----	238	<20.0	240	----
Aluminium mg/l	0.3	----	<0.05	----	----	<0.05	0.049	0.05	0.011	0.027	----	0.023	----	<0.05	0.007	0.16	----
Sodium mg/l	17.2	----	77.9	----	----	70.1	73.2	120	111	80	----	62.1	----	181	177	133	----
Calcium mg/l	89.5	----	163	----	----	93.6	101	144	111	133	----	67.9	----	73.5	85.1	108	----
Magnesium mg/l	38	----	37.9	----	----	30.5	28.2	36	38.5	39.7	----	39.5	----	24.9	24.6	37.7	----
Chloride mg/l	22.4	----	187.3	----	----	89.6	48	179.2	184	176	----	56	----	156.8	176	89.6	----
Alkalinity	187	----	297	----	----	241	327	305	396	366	----	564	----	329	308	311	----
Sulphur mg/l	21	----	65	----	----	43	44	50	49	49	----	52	----	53	74	73	----
PH		1436	----	1466	684	----	----	----	----	----	898	----	616	----	----		12.51

Note 1: The WICHON well, used for process water at their concrete casting yard, had been acidised approximately one week before the sample was collected (to mitigate accumulated manganese deposits and the analysis results are clearly related to this prior activity and do not represent general background aquifer characteristics.

e) Conclusion re Manganese

The data generated from the manganese blanket sampling conducted by the ESL/WRA team show widespread manganese contamination in the sampling areas. The degree of contamination ranged from low (at or slightly above the standard) to high (>100% above the standard). In the first sampling exercise seven of the sixteen (~44%) stations sampled were above the standard while seventeen of twenty-nine (~58%) stations had manganese levels above the standard in the second exercise. Three of the stations that exhibited high manganese concentrations in the first sampling event showed similarly high levels during the second sampling event, namely Dunbeholden, Pasture 2B and Portmore 2 wells.

From the data[♣] available the emerging trend potentially suggests that the stations with manganese contamination are associated with high organic loading of the ground water. This may be attributed to waste from sugar processing, sewage or 'stud farms' (in this case, horse manure - as horse rearing in this area of St. Catherine is extensive and has been in existence for over thirty years).

f) Conclusion re Iron

From the data recorded during the two sampling events, iron contamination does not appear to be as widespread as the manganese contamination or follow similar distribution. Five of sixteen (~31%) stations showed high iron levels during the first event whereas five of twenty-nine (~17%) showed elevated levels during the second event. Two stations, the irrigation canal at Spanish Town and at Lime Tree, consistently showed elevated iron levels on both sampling exercises.

[♣] In addition to water sampling in relation to manganese levels, sediment samples were collected from sand and clay horizons during the artificial recharge site investigations by the project consultancy team and submitted to International Centre for Environmental and Nuclear Sciences at the University of West Indies for analysis for manganese. Samples were sieved and the fine fraction (<100 micron mesh) crushed, pelleted and the manganese concentration quantified by neutron activation analysis. The measured Mn concentrations are within the normal range for soils derived from magmatic and volcanic rocks (CICAD 63), and were not considered by the analytical scientist to be unusual for Jamaican soils.

5.1.7 Noise and Air Quality

5.1.7.1 Noise

The ambient noise level at all stations monitored was on average below 75 dBA. On occasion, vehicular movements on the main roads caused noise levels to peak at 84 dBA.

5.1.7.2 Air Quality

The locations of air quality stations are shown at Figures 5.1.7.2a through 5.1.7.2d for the Upper Rio Cobre, Lower Rio Cobre, Greater Spanish and SE St. Catherine respectively.

There was great variation in the level of particulate matter in the air at the selected stations (Tables 5.1.7.2a and 5.1.7.2b).

PM_{10}s are defined as those particulates with diameter less than 10 microns; when inhaled by humans, these fine particles may pose health risks if the concentrations are above the specified guideline. The PM_{10} guideline set by National Environment and Planning Agency is 150 $\mu g/m^3$ per 24 hour period.

Stations 1, 2, 3, 4, 5 and 10 showed respirable particulate levels within the PM10 guideline but all other stations were in breach of the NEPA standard. Stations located along main thoroughfares, such as Stations 7, 8, 9, 11, 14, 16 and 17 were particularly high.

Respirable particulate levels are therefore presently high in the areas where the mains replacements are being proposed and there will be excavation and earth movement

Table 5.1.7.2a: Air Quality Results, November 18, 2003

LOCATION (KMA)	Station #	PARTICULATE CONCENTRATION /μg/m^3 Actual duration 6 - 8 hrs	Results extrapolated to μg/m^3 /12 hrs. (NEPA Guideline = 150μg/m^3/24hrs)
Community Center Henderson Rd.	1	98.8	148.1
McNeil Park Cook Shop #7	2	100.2	150.3
St. Catherine Infirmary	3	98.6	147.9
Old Square Museum #1	4	91.4	137.2
LOJ Shopping Center March Pen Rd.	5	43.0	64.5
St. Jago High #2	6	172.4	258.5
Ribbon Pub #8 Brunswick Ave.	7	229.6	344.4
Check Point Bar Port Henderson	8	184.0	276.0
Shell Station #4	9	147.4	221.1

Station Locations by number in Figure 4.2.3

Table 5.1.7.2b: Air Quality Results, November 21, 2003

LOCATION (KMA)	Station #	Particulate Conc. /μg/m^3 Actual duration 6 - 8 hrs	Results extrapolated to 12 hrs.
Congreve Park along Braeton main road	10	42.7	64.1
Patrick's Auto (#2 on map)	11	384.0	576.0
Behind GC Foster College (#1on map)	12	209.3	314.0
Stratmore Gardens Children's Home	13	142.7	214.1
Ardene Road, Passage Forth bus stop	14	459.4	689.1
Lime Tree in front of STP	15	229.2	343.8
Marley Hill	16	438.3	657.5
Shop on Park Blvd., Fair View Park (#3 on map)	17	401.1	601.7

Figure 5.1.7.2a

Figure 5.1.7.2b

Figure 5.1.7.2c

Figure 5.1.7.2d

5.1.8 Hazards

Like the rest of Jamaica, the Rio Cobre Basin is susceptible to a number of natural and human induced hazards, including tectonic, geomorphic, climatic and technological hazards.

5.1.8.1 Climatic Hazards

a) Storms and Hurricanes

Jamaica is threatened by tropical systems (cyclones) from July to October every year. During the last 120 years, Jamaica has been affected by more than 50 storms, with 15 of these making landfall (Gray, 1990, Anon., 2005). Damage from sustained high winds (60 – 320 kph) are only experienced when the centre of a storm or hurricane travels directly overhead or very close to the island, and this occurs infrequently, but very heavy rains and storm surges may be experienced from systems that pass offshore. This contributes to the flood and slope failure hazard.

Storms and hurricanes not only cause loss of life and damage or destruction of infrastructure and agricultural land, but can also severely disrupt the supply of essential services, such as the potable water, electricity, transportation and communication.

All low-lying coastal areas are at risk of flooding by storm surge produced during the passage of hurricanes.

b) Drought

Seasonal drought may be experienced during the dry season months, particularly March through to May. This results in restrictions in potable water and irrigation supply, loss of livestock, and with higher concentrations of water-borne pollutants, in an escalation of diseases like ringworm.

c) Climate Change and Sea-level Rise

Should sea-level rise occur as expected, there will almost be the slow, gradual inundation of the lower portions of the basin, intrusion of saline waters up the channel of the Rio Cobre and intrusion of the saline front well inland of its present alignment.

The more immediate hazard, however, is an intensification and spatial extension of already existing hazards. With an increase in sea level of even only a few centimetres, much higher storm surges can be expected. Higher temperatures from global warming may result in a higher frequency of more intense hurricanes, which will result in an even greater storm surge hazard. Flooding will also threaten a more extensive area.

5.1.8.2 Geomorphic Hazards

a) Flooding

Flooding is perhaps the most frequent hazard. The project area is vulnerable to both flash flooding and slow inundation. During periods of heavy rainfall, as with the passage of tropical systems, the Rio Cobre and its tributaries can become raging torrents that weaken the stability of riverbanks, threaten riparian vegetation and settlement and rip up road surfaces. At the upstream end of the Bog Walk Gorge, where both overland flow and groundwater flow from both the limestone and perched alluvial aquifers are confined, the 'backed-up' waters can flood this low-lying portion of the polje and protrude up the channels and floodplains of the Rio Cobre and tributaries.

Detailed Flood Plan analysis has been undertaken (UNDP 2003) and Figure 5.1.8.2 illustrates the 10, 25, 50 and 100-Year flood boundaries for south-central Spanish Town.

A major effect of river floods is on services. The Flat Bridge in the Bog Walk Gorge, a major artery for motor traffic to the north coast from the KMA, becomes impassable when inundated and the road surface is often damaged. Another effect is the disruption of water supply. The high turbidity of surface waters after heavy rains and floods places stress on the water supply systems.

Another serious secondary hazard of flooding is the threat of water-borne diseases such as gastrointestinal diseases and the spread of vectors of other diseases such as mosquitoes (dengue) and rats (leptospirosis). Mosquito infestation can occur when pools of stagnant water persist for long periods and gastorintestinal diseases can be caused by contaminated floodwaters leaking into storage facilities and pipes, or where disruption of water supply forces residents to use untreated water. There may also be an increase in incidences of mosquito transmitted diseases and fungal infections like ringworm.

Figure 5.1.8.2: 10-, 25-, 50- and 100- year Inundation (Source: UNDP/GOJ/UWA, 1994)

b) ***Slope Failure***

Slope failure, particularly in the form of landslides and debris flow, is a hazard on the slopes and lowlands adjacent to the limestone. Along the Bog Walk Gorge in the Limestone Uplands, rock falls and debris avalanches are also a threat. These failures re most often triggered by intense or prolonged rainfall evens and by earthquakes.

5.1.8.3 Tectonic Hazards

a) *Earthquake*

Jamaica is seismically active and therefore vulnerable to earthquakes and their secondary effects. A number of active faults run through the project areas and they are therefore susceptible to slope failure, ground shaking and displacement, liquefaction and the associated damage to structures and disruptions to communications, transport and utility supply. Earthquakes with epicentres located offshore or outside the project areas can still have just as serious effects as those occurring within the project area.

One potentially serious hazard to the water supply is damage to storage tanks, reservoirs and pipelines because of limestone slope failures and on the alluvial plains where the gravels, sands and clays are susceptible to liquefaction.

b) *Tsunamis*

No comprehensive history of tsunami occurrence in Jamaica exists but recent history indicates that there is a significant tsunami hazard. As recently as 1907, tsunami waves of 1.8 to 2.4 m were reported off the south coast (Lander, 1997). Given the low elevations in much of South East St Catherine and its proximity to the coast, there is the risk of flooding and related effects by tsunamis, although the broad shelf offshore should afford some attenuation of wave energy.

5.1.8.4 Technological Hazards – Water Pollution

Given the high density of population on parts of the basin and extensive agricultural activities on the St. Catherine Plains, there is the potential for both surface and ground water pollution from domestic, agricultural and industrial waste.

The limestone aquifers, with their high secondary permeability through joints and karst conduits, are particularly susceptibility to contamination. They can have high infiltration capacities and relatively low natural treatment capacity. Pollutants from both point and diffuse sources, even high in the catchment areas, for example in Luidas Vale, or Ewarton, can therefore travel down gradient relatively quickly.

Possible point sources of pollutants to both the aquifers and surface waters include:

- Caustic soda effluent from Ewarton Bauxite/alumina Works
- Other industrial waste
- Animal manures and wastes from livestock rearing
- Sewage discharge from housing developments
- Hazardous material spills

Non-point sources include:

- Excess fertilisers from agriculture (nitrates)
- Pesticides from agriculture
- Sewage
- Various household chemicals, petrochemicals and organic waste
- Petrochemicals from motor vehicle repair and maintenance
- Solid waste (garbage)

The improper disposal of effluent, especially sewage, resulting in increasing nitrate contamination in the surface and groundwater systems, is of concern. The disposal of inadequately treated sewage effluent from adjoining housing developments into the Rio Cobre, irrigation canals and drains and the seepage of this effluent into the limestone aquifer in Spanish Town and South East St Catherine has negative implications for domestic water – particularly from limestone wells.

The possibility of saline intrusion, especially due to over-abstraction of wells, is a possibility that must also be considered and guarded against.

Pollution is possibly one of the greatest but most preventable threats to the sustainability of the KMA Water Supply.

5.2 BIOLOGICAL ENVIRONMENT

The biological environment of the project area is generally characterized by secondary modified communities according to the classification by Grossman et al (1991). This includes agricultural lands (sugar cane cultivation, other crops and stud farms in South East St. Catherine) as well shrub-land in the Upper Rio Cobre Basin. Although some areas of dense trees do exist, none of the area can be characterized as a pristine environment as there has been a high level of human activity in most areas.

With the exception of commercially important crops and farm animals, no other commercially important species were noted. Several species of birds were observed but no rare, threatened or endangered species were identified during the course of the field studies. The American Crocodile, a native and endangered species does occur in the Rio Cobre and is sometimes seen in the associated waterways and irrigation canals.

5.2.1 Upper Rio Cobre Basin

The terrestrial environment here is best categorized as modified secondary communities with agricultural plantations.

Areas under cultivation include large tracts of land under monoculture, particularly with citrus and banana.

Within the rural community roadside verges and open space are overgrown with scrubland and ruinate vegetation.

Riverine ecology includes riparian vegetation along the banks of the Rio Cobre and its tributaries and closed canopy forest in the area of Tulloch Springs.

Bird species within the area include terrestrial species common to agricultural areas, gardens and roadside scrub, as well as species often found along riverbanks.

A list of the species reported to inhabit this area, with ecological characteristics, is given in Table 5.2.1.

This area does not fall within any legislated park or protected area and is not a pristine ecological area.

Table 5.2.1: Bird species recorded in the Upper and Lower Rio Cobre Basins

Common Name	Scientific Name	Status	Range	Habitat
John Crow/ Turkey Vulture	*Cathartes aura*	Common resident	Greater Antilles, N,C and S America	All habitats, found around dead and decaying matter
Jamaican Euphonia	*Euphonia jamaica*	Common resident	Jamaica. An endemic species	Widespread in gardens and open areas with large trees from sea level to the mountains
Common Galinule/ Common Moorhen	*Gallinula chloropus*	Very common resident	Worldwide. North American migrants increase local populations in winter	On fresh and brackish water
Nightingale/ Northern Mockingbird	*Mimus polyglottos*	Very common resident	Bahamas, Greater Antilles and N America	In gardens, pastures, secondary growth and cultivated areas
Tricoloured Heron/ Gaulin	*Egretta tricolor*	Fairly common resident. Local populations increased by migrants in winter	Greater Antilles and the Americas	Wetlands and ponds islandwide
Cattle Egret	*Bubulcus ibis*	Very common resident	Worldwide	Pastures and open areas
Pea Dove/ Zenaida Dove	*Zenaida aurita*	Common resident	Bahamas, Lesser and Greater Antilles, Yucatan	From sea level to the mountains in wooded cultivations and gardens
Bananaquit	*Coereba flaveola*	Abundant and widespread resident	Jamaica - Endemic subspecies. Species occurs in C and S America and the West Indies.	Found wherever flowering plants occur
Olive-throated Parakeet	*Aratinga nana*	Common and widespread resident	Jamaica – Endemic subspecies. Another subspecies in C. America	Widespread in wooded hills, mountain slopes at lower elevations, scrub in humid or semi-arid areas, cultivations and gardens
Baldpate/Ball Plate	*Columba leucocephala*	Common resident	Breeds in Florida Keys, Bahamas and islands of the Caribbean	Wooded areas inland and by the coast

5.2.2 Lower Rio Cobre Basin

The ecology of the Lower Rio Cobre Basin is characterized by modified secondary communities, scrub-land and agriculture including sugar cane cultivations and subsistence farming.

Riverine ecology includes riparian vegetation along the banks of the Rio Cobre. The endangered American Crocodile (*Crocodylus acutus)* (Plate 1), which is protected by both national and international legislation, is reported in the lower reaches of the Rio Cobre below the Headworks Dam, as well as in paved and earthen irrigation canals. The crocodiles enter the Rio Cobre from its mouth in Hunts Bay and swim up the river, although they are mostly reported near to the coast. They are frequently observed in irrigation canals in the area. The crocodiles nest along the riverbanks and can be aggressive during mating season, nesting season, and in defence of their young. A management plan for construction works has been developed so as to minimize risk to workers and the reptiles. The ecological characteristics of *C. acutus* are given in Table 5.2.2.

Table 5.2.2: Ecological characteristics of *Crocodylus acutus*

Scientific Name	Common Name	Range	Characteristics
Crocodylus acutus	American Crocodile	Caribbean waters, including Florida (indigenous to Jamaica)	Occurring naturally in wetland areas where there is brackish water and adequate food. Populations in Jamaica primarily along the south coast.

Bird species within the area include terrestrial species common to agricultural areas, gardens and roadside scrub, as well as species often found along riverbanks. A list of the species reported from this area with ecological characteristics is given in Table 5.2.1.

This area does not fall within any legislated park or protected area and is not a pristine ecological area.

5.2.3 Greater Spanish Town

The old capital city is dominated by Spanish Heritage buildings, narrow roads and congested communities. There are small areas of subsistence farming and roadside vegetation but very little terrestrial vegetation or associated wildlife.

5.2.4 South East St. Catherine

The South East St. Catherine area can be characterized as modified secondary terrestrial communities and is dominated by large tracts of agricultural land.

The area is very dry and sections which are not under cultivation or housing can be characterized as thorny scrubland dominated by *Acacia sp*. (Plate 2).

A relatively extensive acreage is under large farm monoculture dominated by sugar cane cultivation. However, there are smaller tracts of land under mixed cultivation, particularly callaloo and various cash crops. Emphasis on cash crop agriculture started in the 1980's under the Agro 21 Programme and has continued, although some areas previously under cultivation have been allowed to become ruinate.

Earthen and paved canals (Plates 9, 10 and 11) are extensive throughout this agricultural area and they provide travel ways for the endangered American Crocodile.

Stud farms and horse stables are also dominant in this area (Plates 3 and 4).

Bird species within the area include terrestrial species common to agricultural areas and scrubland. A list of the species reported from this area with ecological characteristics is given in Table 5.2.4.

Several species of butterfly were observed in the aquifer recharge area.

This area does not fall within any legislated park or protected area and is not a pristine ecological area.

Table 5.2.4: Bird species recorded from the project area in South East St. Catherine

Common Name	Scientific Name	Status	Range	Habitat
Smooth Billed Ani	*Crotophaga ani*	Common resident	Most Caribbean islands except Barbados, North, Central and south America	Cultivated land, pastures and wet meadows
Northern Mockingbird	*Mimus polyglottos*	Very common resident	Bahamas, Greater Antilles and N America	In gardens, pastures, secondary growth and cultivated areas
Black Necked Stilt	*Himantopus mexicanus*	Common resident	N and S America and West Indies	Salt marshes and shallow coastal bays, fresh and saline ponds
American Kestrel	*Falco sparverius*	Very common resident	*F.s. dominicensis* in Jamaica, Hispaniola and adjancent islands. Also Cuba, other WI islands, N, C, and S America.	All habitats.
Killdeer	*Charadrius vociferous*	Common resident	*C.v. ternominatus* in the Greater Antilles and Bahamas	Sandy areas and short grass
Lesser Yellowlegs	*Tringa flavipes*	Fairly common winter visitor	North America, winter south to South America	Mudflats
Great Egret	*Egretta alba*	Common resident	*C.a. egretta* in the Bahamas and Greater Antilles, also worldwide	Wetlands

Table 5.2.4: Bird species recorded from the project area in South East St. Catherine - *Continued*

Common Name	Scientific Name	Status	Range	Habitat
Glossy Ibis	*Plegadis falcinellus*	Rare resident and common winter visitor	Worldwide	In flooded fields (of Mandela Highway near Ferry) and open marshes (near Caymanas)
Cattle Egret	*Bubulcus ibis*	Very common resident	Worldwide	Pastures and open areas
Great Blue Heron	*Ardea herodias*	N, C and S America, West Indies	Common winter visitor	Wetlands
Greater Antillean Grackle	*Quiscalus niger*	Other subspecies in Cuba, Cayman, Hispaniola	Jamaica – endemic subspecies *Q.n. crassinostris*	Cow pastures, cultivated land and around human habitations.
Turkey Vulture (John Crow)	*Cathartes aura*	Common resident	Greater Antilles, N,C and S America	All habitats, found around dead and decaying matter
European Starling	*Sturnus vulgaris*	Introduced and now in large numbers	Many countries worldwide	Lowlands, parks, gardens and pastures.
Yellow-faced Grassquit	*Tiaris olivacea*	Locally common resident	*T.o. olivacea* in Cuba, Hispaniola, Jamaica and Cayman. Other subspecies in Puerto Rico, Mexico C. and S. America	Gardens, grasslands, edges of forests and woods and cleared areas.

5.3 DEMOGRAPHICS

5.3.1 Population

5.3.1.1 General

The 2001 Census shows the population of Greater Spanish Town as 131,515 and the population of Portmore & Hellshire as 161,658. This represents increases over the 1991 Census of 14.34% and 64.01% respectively. The 2001 population within the Project Area (comprising both these areas) is therefore 293,173, which when compared to its 1991 population of 213,593, represents a population growth of 37.3%.

Table 5.3.1.1 shows the total population figures for the Electoral Districts (EDs) that could be identified for the 2001 Census. It is to be noted that these are not the population figures for the entire project area, but for those communities sampled within the project area. The population of these communities represents 31% of the population of the Project Area. These communities have themselves grown by 104 % between the censuses.

5.3.1.2 Population Growth

The doubling of population was the case for both the Lower Rio Cobre Basin and Spanish Town, which together constitute Greater Spanish Town.

The SE St. Catherine increase was considerably more modest because the sample is primarily of the rural communities, located within the aquifer, rather than the Portmore built-up area, including the newer developments in Greater Portmore. The SESC population and its increase are therefore considerably understated quoted in Table 5.3.1.1.

The data shows that the most significant communities in the sample, including some of the fastest growing, are, in order of population: Central Village, Friendship, Angels, Spanish Town Central, Gordon Pen and Ensom City. (Eltham Park was not in the sample.)

Table 5.3.1.1: Population Growth in Communities Sampled

COMMUNITIES	1991 ED #	2001 ED#	1991	2001	Increase
Bybrook	EC 13-14	EC 26-27	491	565	15.00
Tulloch Springs	EC 26		176		
Kent Village	EC 29		688		
Rabys Corner	EC 56		366		
Total: Upper Rio Cobre Basin			**1721**		
Ariguanabo/Strathmore Gardens	C 1	C 8	601	981	63.00
Cow Market/Angels	C 2-9, C 13	C 1-13	4789	7330	53.00
Golden Acres	C 16	C 18, 19, 23	701	1449	106.00
Gordon Pen	C 10	C 29-37	267	4806	1700.00
Sub-Total: Lower Rio Cobre			**6358**	**14566**	129.00
Friendship	C 124	WC 58-71	607	7932	1207.00
Johnson Pen/Green Acres	WC 61-63	WC 75-78	652	2283	250.00
Sydenham	C 129-131	SW 40-43, 104,105	1367	1930	41.00
Ensom City	C 36-48	C 52-64	4912	4713	-4.00
Mewton Park	C 67	C 66-67	766	901	-18.00
Spanish Town Central		C 65, 69-71, 93-103		7126	
Thompson Pen	EC 90	SC 20, 21, 24	565	1633	189.00
Twickenham Park	EC 72-73	SC 1-3, 10, 16, 48	969	3211	231.00
Central Village	S 19-29	SC 7-9,11-15, 50-58	5447	9488	74.00
Sub-Total: Spanish Town			**15285**	**39217**	157.00
Total: Greater Spanish Town			**21643**	**53783**	149.00
Independence City	SE 1-8	SE 38-44	3913	3340	-15.00
Port Henderson	SE 87	SE 109	737	937	27.00
Lime Tree Grove	S 10	S 8	1473	1488	1.00
Phoenix Park	S 5	S 26	104	1696	1531.00
Dunbeholden	S 89		822		
March Pen/Salt Pond/Goshen/Hill Run	S 90	S 21-25	1565	3491	123.00
Total: S/E St. Catherine			**8614**	**10952**	27.00
TOTAL: PROJECT AREA			**31978**	**65300**	104.00

Although their populations remain relatively insignificant, the trend of rapidly increasing population figures for the rural SESC communities, located in the aquifer, should be carefully noted.

5.3.1.3 Age Structure

The age distribution within the communities tends to depend on the age of the particular development. Older schemes, like Angels Court, Independence City and Ensom City, generally have an ageing population, while more recent ones, such as the Angels developments, and the unplanned suburbs, like Central Village and Gordon Pen, all tend to have a young population. The density in the unplanned settlement is greater (with five persons per household, according to informants) than in the schemes, with a norm of three persons per household. Both the unplanned settlements and the recently constructed affordably priced schemes are said to have a majority of female-headed households.

5.3.1.4 Employment

The working age population of the housing estates are generally fixed-income employees of both white collar and blue-collar occupations, working in Kingston and, to a much lesser extent, in Spanish town. Unemployment has started to become a problem among the adult children of the householders. The residents of the more depressed communities, on the other hand, tend to be involved in a variety of "hustling" activities to mitigate their state of unemployment. There is some seasonal employment provided from the dynamic construction activity characteristic of the region. The industrial and processing activities in Bernard Lodge, Bybrook, Central Village and Twickenham Park provide much less stable employment than in a bygone era.

5.4 SOCIO-ECONOMIC ENVIRONMENT

5.4.1 Land Use

The project area's land use pattern can be summarised as being almost exclusively residential in Greater Spanish Town (outside of Central Spanish Town) and Portmore; largely commercial in Central Spanish Town and agricultural and agro-industrial in Upper Rio Cobre and South East St Catherine; with industrial nodes.

The character of the Upper Rio Cobre Basin is essentially rural, with commercial arable agriculture and some peasant farming. Settlement is primarily linear with some clustering. Commercial establishments line the main (A1) road but the main commercial centre is Bog Walk. There is woodland interspersed with mixed cultivation on the limestone uplands.

The Lower Rio Cobre Basin and Suburban Spanish Town have an identical character – comprising almost purely low to middle income residential (dormitory) communities. The settlements consist of two distinct types: mass housing in planned schemes and unplanned, overcrowded, squatter-type settlements.

Central Spanish Town is largely commercial, with an extensive market district - both interspersed with individual low and middle income housing units. There are industrial nodes at Central Village and Twickenham Park.

South-East St. Catherine is characterised by a dichotomy of plantation agriculture with a few scattered workers' settlements and, carved out of it in increasingly greater portions, extensive dormitory communities identical to those of Greater Spanish Town, though larger. There are, however, considerably less of the large, unplanned settlements.

With a few exceptions (e.g. Little Portmore) unplanned, squatter-type settlement has developed on the base of older, rural villages, completely transforming their character – most notably, Gordon Pen, March Pen and Central Village.

5.4.2 Urbanization

Rapid urbanisation continues apace in Greater Spanish Town and South East St Catherine (Table 5.4.2). Some half a dozen housing developments are ongoing at the western end of Greater Spanish Town alone. The intrusion of such schemes into the Bernard Lodge lands should be closely monitored to ensure the sustainability of the aquifer below, which supplies SESC and its fast growing population.

Table 5.4.2: Some Major Developments Currently Underway or Recently Completed

Developments	Developers	No. of Units	Status
1. Angels Phase 1	New Era Homes	446	Completed
2. Angels Grove	WIHCON	630	Completed
3. Spanish Village	Black Brothers	504	Start Up
4. Innswood Village	Gore	733	314 Completed 419 to be Constructed.
5. White Water	Can Cara	744	600 completed, 144 to be Constructed
6. Magil Palms	Magil Palms Ltd	458	Start Up
7. Twickenham Park	NHT	935	Start Up
8. The Palace (Bernard Lodge)	Information not available		
9. Hill Run	Ziadie	Building Lots	Limited activity & small scale
10. Highway 2000	Phase 1		Started

5.4.3 Infrastructural Development

Water supply conditions throughout the project area are highly variable. The Upper Rio Cobre Basin tends to be adequately and reliably served with water. Residents at higher elevation and in the poorer settlements of Bybrook nevertheless complain of inconsistent water supply, attributed to an endemic problem of leaking mains. In the Lower Rio Cobre Basin, the pattern appears to be that the water pressure diminishes the further the community is from the Spanish Town Water Treatment plant.

The problem associated with overstretched water supplies begins to get acute in Greater Spanish Town. Residents, and other users, complain of low water pressure, particularly in the mornings, evenings and weekends – the times of heavy domestic water usage. Entire communities and businesses supplement their supply with stored water and by other means. The problem appears to be even more acute in SESC (except for those communities getting their supply from the Spanish Town plant) where both domestic and agricultural consumers suffer – the latter despite being equipped with a wide network of irrigation canals. It has served as a major disincentive to agricultural investment in the region. It has also led to the adoption of unhealthy practices in the poorer settlements

bordering the canals, with the use of the canal for certain domestic functions and of canal water for drinking and cooking. There is also a question of the quality of the water, with residents complaining of over-chlorination and Port Henderson hotels advising their clients to drink bottled water only.

5.4.4 Environmental Health and Issues

The significant public health problems that have been alluded to above are increased by unhygienic practices, such as bathing and washing in the canals, faecal material sometimes being deposited in the canals, as well as the common practice of dumping garbage on the banks of the canals. This practice is widespread and even trucks belonging to building contractors were observed engaging in it.

Another threat of pollution of the groundwater is posed by the absence of sewage treatment facilities in the Upper Rio Cobre, in Central Spanish Town and in SESC, outside of Portmore – within the regions from which potable water supply is sourced. Modern concrete structures generally use septic tanks and soak-away pits, even if they have to be flushed with canal water or stored water. Most of the unplanned settlements use primarily pit latrines as their main form of sanitary convenience.

Most of the project area is flood prone. In periods of moderate rainfall, the streets in most housing schemes will flood but floodwaters usually run-off before houses are affected. During heavy rainfall, however, there is the constant threat of houses flooding. The worst affected area is in Hill Run, where several purchasers of real estate serviced lots have reportedly not thought it prudent to start building until the problem is mitigated.

5.4.5 Sand Mining in the Rio Cobre in and above Spanish Town

The team observed evidence of sand mining at Angels Phase II, Tulloch Springs, Ensom City/Nugent St. Bridge (where sand is bagged and sold at the roadside) and Lakes Pen (where the river bed appears to be completely mined of sediment).

5.5 COMMUNITY ANALYSIS: PERCEPTIONS OF PROJECT AND ANTICIPATED IMPACTS

5.5.1 Upper Rio Cobre Basin

5.5.1.1 General Profile and Demographics

The ESL research team conducted a rapid assessment of the communities within the project area: Bybrook, Tulloch Springs, Kent Village and Rabys Corner. Interviews were carried out only in Bybrook and Kent Village, as it was noted that Tulloch Springs was not a populated area and Rabys Corner was a physical landmark and not a built community.

These four communities have a total population of some 1,760 persons, according to the 1991 Census. It is a sparsely populated area. The relatively large community of Kent Village is located in the southern quadrant, along one bank of the Rio Cobre in the gorge.

Windshield survey of Bybrook indicated an agro-industrial centre, which seems to have attracted the development of unplanned residential units around the factories. The original factory was a sugar factory, but this has been replaced in recent times by a milk condensary, two citrus juice-manufacturing plants and a marble house-ware factory. The informants reveal, however, that the employment offered these residents has declined in recent years and the population is mainly employed in short-term "hustling" activities to ease their state of permanent unemployment.

Within, or on the outskirts of, central Bybrook where the industrial enterprises are located are the following communities: August Town, Princess Field, High Mountain, Swamp Lane and Cow Gully. These all display the features of depressed suburbs, including informal housing, poor sanitation and deteriorating infrastructure.

Kent Village is the main population centre along both sides of the road through the Bog Walk Gorge and on one bank of the Rio Cobre. On sight, this gives the appearance of being a rural community intensively cultivated with permanent tree crops and cash crops. Investigations reveal, however, that the crops are largely for domestic consumption and the residents regard themselves as "hustlers", earning a living primarily from trade with passing motorists – mainly by patronizing bars, food shops and roadside vendors. Food

items traded, mainly fruits and vegetables, are purchased from the Linstead and Guys Hill markets.

The buildings on the riverbank are prone to flooding from the river and slippage, resulting in structural damage. One informant, Mr. Eric Donaldson, a widely known entertainer, showed the consultants his own building, virtually abandoned due to damage by flooding.

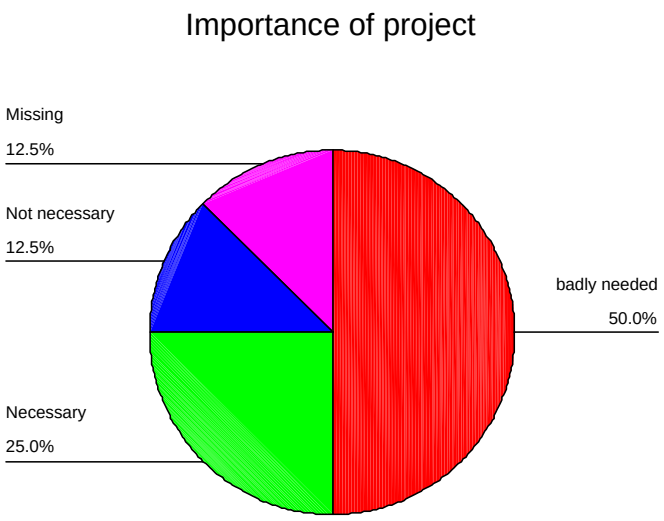
One informant claims that the population of Kent Village is 520 persons; according to the 1991 Census, it is an Electoral District (ED) of 688. Both communities are described by the residents as being primarily comprised of young adults (18 to 35 years).

There was evidence of sand mining, associated with Matadon's Quarry near Tulloch Springs, but this was reported to be a licensed operation.

5.5.1.2 The Proposed Works and Anticipated Impact on Upper Rio Cobre Communities

The only activity planned for this area is the rehabilitation of existing facilities of the Rio Cobre Scheme. This comprises Bybrook Wells #2 and #4 and the Tulloch Spring source. Residents welcome the project, primarily because they are of the opinion that the leaking mains will be replaced eventually – which is what they identify as their greatest (water related) need.

Figure 5.5.1.2: Perception of the Importance of Proposed Works by Residents in Upper Rio Cobre



5.5.1.3 Existing Land Use & Livelihoods

The land use comprises commercial agriculture (citrus and sugar cane) and an industrial cluster in Bybrook/Middleton. The rest of the area consists of residential areas with "backyard" gardens and small livestock, interspersed with small commercial establishments, primarily in food retailing. The factories comprise three agro-processing enterprises – two citrus extraction plants and a milk condensery – and a marble plant.

Adult residents are primarily engaged in "hustling" activity. A significant proportion is also employed in the agricultural/industrial operations. The remainder is engaged in subsistence agriculture, mainly in small livestock.

Tulloch Springs was carved out of a larger estate; as a result, banana is cultivated along the riverbank. Sand mining and quarrying also provide some income for the neighbouring settlement of Breadfruit Gully. About eight cubic metres of sand is extracted daily. This could have implications for flood damage/control, which is an issue also in the gorge, where houses have had to be evacuated. The dispersion of dust unto the river and even the creation of rubble that finds itself into the river are issues that need to be monitored.

In Kent Village as noted above, one informant claims that 90% of employment is hustling and only 10% wage earning, employed in the commercial establishments. Most of these wage earners are from outside the community. A small plantation on an alluvial flat

across the river is reported to provide employment for only one person from the village. Goods and workers are ferried across the river by raft.

At Rabys Corner only a few scattered smallholdings seem to exist.

Whereas specific issues relating to the project and existing land use and livelihoods will be highlighted in other sections, as a general conclusion, the project as defined will not impact significantly on the land use and livelihoods of the community.

5.5.1.4 Compatibility of Developments Underway and Planned

The main water supply issue, common to all areas surveyed, is an inadequate supply of water delivered to residential communities. Industrial/commercial users also expressed the need for additional water and the need for mitigation of turbidity that was affecting water quality into their plants.

Raw water is drawn from the Rio Cobre, its tributaries and from underground sources. Any impact of planned development within the area will mainly have implications for their impact on local water resources and demand.

Nestlé has applied to the Water Resources Authority (WRA) to sink a well to serve their Middleton plant. The extraction rate is anticipated to be 2 m^3 or 2000 litres per minute. This rate of extraction could have implications for the yield of the Bybrook wells and will need to inform WRA's decisions.

Residents of Swamp Lane report that work on that road started immediately prior to the Local Government elections. Excavation work on the road resulted in water pipes being burst and, in turn, water leaking from these pipes created channels in the road under construction. This speaks to the need for coordinated provision of public services. One informant offered the suggestion that the mains need to be buried deeper in the ground to minimize the incidents of bursting from construction activity.

An expansion of the True Juice factory is also in the planning stage. No plans for new developments in Kent Village have been identified.

5.5.1.5 Water Supply Conditions and Quality

Central Bybrook receives its domestic water from the Jericho pump; while the outlying communities of Shenton, Knollis, West Prospect and others, have theirs augmented from Bybrook #3, having originally been served by Bybrook #1, which is now out of operation. There is good water pressure in the low lying areas of Bybrook, but upland communities (such as August Town, Princess Field and High Mountain) complain of an inadequacy of water supply, requiring trucking of water and fetching from the river.

Sources at the NWC, however, claim that more than adequate water is available to these areas. Community members acknowledge that some attempts at rectifying the problem in these areas resulted in water being diverted from a Bybrook well (Bybrook #3). This resulted in increasing the pressure, but resulting leakages from burst mains left these communities none the better from this initiative. Residents identify this as the main problem with their water system. Compounding their problem is the periodic shutdown of the pumps at Bybrook due to JPS power cuts.

Residents report that during heavy rains the pump is flooded and this results in the water being “dirty” (turbidity).

Most residences receive domestic water supply from the public water system, but very few are metered. In the Bybrook communities they receive water by arrangement with metered customers and, one would suspect, illegal connections. They supplement this with rainwater collected in drums and water drawn from the river. The river is also used to wash and bathe. In Kent Village there is little if any metering, but the residents have themselves made connections to an NWC feeder main. Periodic attempts are made by the NWC to regularize this situation.

Kent Village is the first community that receives water from the Tulloch Springs system before it reaches Spanish Town. The off take into Kent Village is through a two-inch pipe, which residents claim is totally inadequate to meet their needs. They feel that unless a four-inch main is installed, the community will continue to lack an adequate supply.

However, the NWC informants are of a contrary opinion. Kent Village is getting more water than needed at a desired level of pressure. At issue for the NWC is for the residents

to apply for their water supply and have their accounts regularized so that water consumed is paid for.

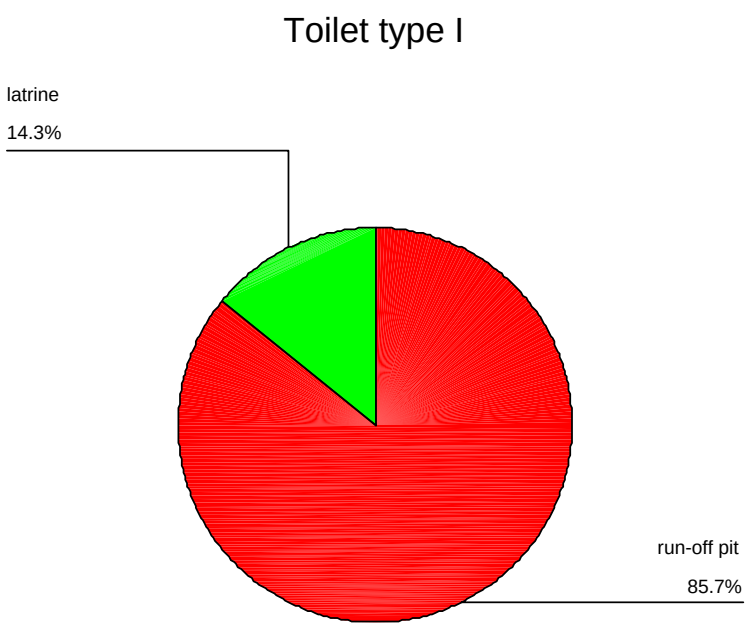
5.5.1.6 Public Health, Safety and Conservation

Upper Rio Cobre community members report that the predominant form of sanitary convenience is the water closet (Figure 5.5.1.6), connected to a run off pit (soak away pit). A significant but smaller number is reported to use pit latrines, and one key informant estimated the number without sanitary conveniences as about 5%. One Swamp Lane informant estimates the proportion of water closets to pit latrines in that area as being as high as 50:50.

It is also reported that the Government constructed pit latrines in the upper Bybrook settlement of Pineapple, to reduce deposition of human waste on the train line. There is a consensus that there is little or no deposition of human waste directly in the river.

However, the absence of central sewage systems raises concerns about contamination of the ground water. A pertinent issue is whether the communities can afford communal sewerage system charges. An important policy issue must be whether continued contamination of the aquifer (and this applies within the entire project area) is an acceptable alternative to the consideration of “the inability to pay”.

Figure 5.5.1.6 Sanitary Facilities in Upper Rio Cobre



In respect of solid waste management, it is reported that more recently, the Parish Council has been removing garbage, with trucks coming in at least twice weekly. The consensus seems to be that the communities are kept reasonably clean, reflecting a certain level of civic pride – as evidenced by claims to be living in "developed communities". The commercial and industrial enterprises are reported to monitor their plant environs carefully, employing help to keep the properties and canals clean, and monitoring the use of the river. As a result, there is said to be no dumping of solid waste in the river or canal.

Despite this improved system of solid waste disposal, Swamp Lane residents pointed to the fact that garbage is blocking the drains, thereby contributing to a flooding problem. In Kent Village, prior to the improved sanitation practices, some garbage was deposited in a dump located on the bank of the river.

People utilize the river for bathing and washing clothes thereby increasing phosphate levels. Popular spots for bathing seem to be an area near to where the train line crosses the river on the Bybrook estate and at Rabys Corner. The fact that the Rio Cobre was a major source of water supply means the use of the river by the community for these activities was a concern throughout the basin. Fishing was also a major activity.

Flood hazard was also of concern. During more severe flood events, the farmlands around Bybrook were also flooded out. Flooding in the Bog Walk Gorge was a well-

known and not infrequent phenomenon. Periodically, houses along the bank in Kent Village were damaged, due to river erosion. A major river training effort was underway in the Kent Village area.

5.5.1.7 Heritage, Social Dislocation & Transportation Issues

There were no issues of concern in the Upper Rio Cobre communities. The disused hydroelectric station just south of Kent Village will not be impacted by the project works.

5.5.1.8 Summary of Main Issues

- **Depressed conditions:** As a general observation, all of the communities visited within the cluster exhibit depressed conditions, including informal housing, poor sanitation and deteriorating infrastructure. Receiving an adequate domestic water supply is a problem faced by all of these communities. Industrial water supply appears to be less of a challenge, mainly because companies have tapped into the river, public wells or sunk their own wells.
- **Unsatisfied water needs:** The work planned for this area is the rehabilitation of existing facilities in the Rio Cobre system. This comprises wells at Bybrook and a pumping station at Tulloch Springs. However, the reality is that the proposed works will not significantly address the water needs of these communities – contrary to the expectations of the residents. The depressed suburbs of Bybrook welcome the project, primarily because they are of the opinion that the leaking mains will be replaced eventually – which is what they identify as their greatest need.
- **Turbidity:** Residents report that during heavy rains one of the Bybrook stations becomes flooded and high turbidity results in poor water quality.
- **Sand mining & flood control:** Sand mining and quarrying occurs in the settlement of Breadfruit Gully, near Tulloch Springs. About eight cubic meters of sand are extracted daily. This could have implications for flood control, which is an issue also in the gorge, where houses have had to be evacuated. The dispersion of dust unto the river and even the creation of rubble that finds itself into the river are issues that need to be monitored.

- **Developments and water resources:** These developments include Nestles' application for permission to sink a well, the NHDC serviced lots scheme if confirmed and a planned expansion of the filter plant of the Condensary. An expansion of the True Juice factory is planned. Demand studies are essential and integral to supply planning.
- **Inadequate infrastructure:** Residents of Kent Village anticipated little benefit from the project unless the size of the service pipe into the community was increased.
- **Ground water contamination:** There was a consensus that there was little or no depositing of human waste directly into the river. However, the absence of central sewage systems raised concerns about contamination of the underground water. In some of the more depressed neighbourhoods, pit toilets abound and there was at least one such community (Pineapple) where there appeared to be a general absence of sanitary facilities. There was no dumping of solid waste in the river or canal according to community members.
- **Pollution concerns:** Residents utilized the river for bathing, washing clothes and fishing. Popular spots for bathing were an area near to where the train line crossed the river on the Bybrook Estate and at Rabys Corner. The fact that the Rio Cobre was a major source of water supply raised pollution-related health concerns. Water quality results would help to inform required mitigation measures.

5.5.2 Lower Rio Cobre Basin

5.5.2.1 General Profile & Demographics

During the survey, the Lower Rio Cobre Basin was found to be a fast growing cluster of primarily residential communities north of Spanish Town. The 1991 Census indicated the population of the communities sampled in the cluster to be just over 6,000; the 2001 Census indicated that this had subsequently increased several fold. This is an important contributor to the increased demand in Greater Spanish Town for which part of the projected supply increase of 24 Mld (5.3 migd) is intended. The communities in question include:

- Ariguanabo
- Golden Acres
- Cow Market
- Angels
- Gordon Pen
- Eltham Pen

The research team did a rapid appraisal of the first five stated communities. These generally fell into one of two profiles:

- low to middle income housing estates, or
- informal urban settlements, with poor sanitation and displaying other features of urban blight.

The housing schemes were Golden Acres, Angels and Eltham; while the informal settlements were Ariguanaboa, Cow Market, Gordon Pen and the fringes of the Angels communities where they touched on the old sugar estate canal. The latter had all been grafted on to pre-existing rural settlements.

Cow Market is located on the slopes above Angels Phase I, on the western side of the Bog Walk-Spanish Town main road. There were perhaps 200 houses, most undergoing some construction activity. Its total population was under a thousand residents.

South of Cow Market, on a craggy hillside overlooking the abandoned Ariguanaboa industrial park, is the small settlement of Ariguanaboa – also known locally as Angels Heights. It was contained within an ED (electoral division) that had a population of only 601 persons in 1991. The Secretary of the Crescent Primary School stated that this was a young community, with children under 18 comprising as much as 75% of the population, with young adults 18-35 constituting most of the remainder. He estimated the average household size as being above five while half of the households were headed by females in single-parent families.

South of Ariguanaboa is the housing development of Golden Acres, containing some 300 lots with houses in varying stages of construction – although marketing began in the early seventies. The population was 701 at the time of the 1991 Census. The abandoned structures represent housing starts built in an attempt to attract the market of returning

residents. Some purchasers did not find these starts to their liking. There is also a playfield, community centre and NWC limestone aquifer well water source. The road infrastructure, however, is quite deplorable and the southern section of the settlement is inundated after any moderate shower of rain. The NWC's well station is also subject to this fate during flood rains and the pumping equipment has to be turned off until the water quality improves. In fact, there is a constant pool of water settled at the (northerly) entrance to the scheme, right next to the pumping station and attributed to it.

The Angels sugar estate started to be sub-divided for housing development some time in the 1960s. The first scheme took the name of the estate – Angels, or Angels Court, to distinguish it from the rest. It was followed by Avon Park and Monticello. Dynamic construction activity is continuing in the latter two settlements, both in the erection of new structures and in expanding existing ones. The citizenry tended to be progressively younger, moving from the original Angels to Monticello. Long-time residents estimated that 65% of the population of Angels Court was middle-aged (36-59) and only 15% young adults, with a sizeable population (10%) of senior citizens; while in Monticello the proportions were reversed, with 65% young adults, 15% middle-aged and a negligible proportion of senior citizens. The average family size, as expected, was said to be only three in Angels Court but four in Monticello.

The most recent developments in Angels, currently ongoing, were the Italian styled Angels Phases I and II and the very basic one-bedroom housing starts of the Angels Grove – a combined total of some 1,600 units. These had swollen the population – noted in the 1991 Census to be over 4,000 – by a further 4,000 persons. Both the Principal/Proprietor of the Early Childhood Centre in Phase I and the wife of the founding President of the Phase II Citizens' Association estimate the population of their respective schemes as some 70% young adults (18-35), 20% children under 18 and a negligible number of senior citizens. They estimated the average family size to be four.

Mr. Benedetto Pusichilli, Director of New Era Homes, advised that the two schemes had a combined total of 1,000 units. Residents of Angels Grove estimated a very similar population distribution: 50% young adults, 20% children, 15% middle-aged and less than

5% senior citizens. Interestingly, all Key Informants estimated that 60% of households in these new settlements were headed by single female parents.

The several settlements were served by the Crescent Primary School and the modern Angels Primary & Junior High, Angels Early Childhood Development Centre and a basic school in Angels Phase I. Proper playfield facilities were provided in all the settlements and community centres were in Angels Phases I & II; a shopping complex was also being constructed in Phase II. Churches and commercial establishments were scattered generously throughout the older settlements, as were the "capture lands" hugging the canal. The latter were a source of concern to the project.

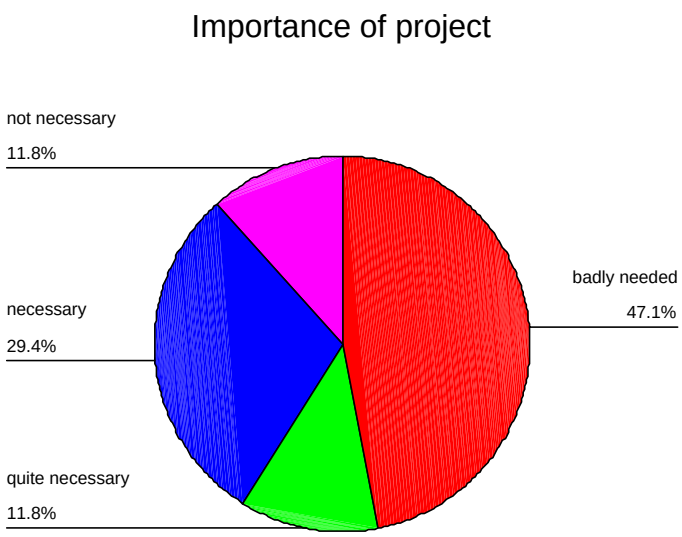
Gordon Pen is located west of Angels, contiguous to and south of the new housing estate of Eltham Park. Starting as a small, isolated rural community of a few hundred residents in 1980, its population has burgeoned to some 6,000, as estimated by the Principal of the Gordon Pen Basic School, herself an Enumerator in the 2001 Census. She attributed the genesis of this rapid urbanisation to political refugees of the violent 1980 General Election campaign in Kingston. The main road was littered with small commercial establishments typical of a rural township in the throes of rapid urbanisation, including grocery stores, bars, go-go clubs and hardware stores. There were lanes leading off the eastern side of the main road to the banks of the Rio Cobre, where the rootless were concentrated in sub-standard conditions. At the end of one of these lanes, in Monkey Town, the riverside is the location for popular community based entertainment.

5.5.2.2 Proposed Works and Anticipated Impact on Lower Rio Cobre Communities

Construction activities in this sub-region include existing well rehabilitation, new well development together with the construction of new mains and the Angel's Hill Tank.

The perception of the importance of the project in this area is high as illustrated by Figure 5.5.2.2 overleaf.

Figure 5.5.2.2 Perception of Importance of Proposed Works to Lower Rio Cobre Residents.



5.5.2.3 Existing Land Use and Livelihoods

As stated above, the Lower Rio Cobre consists almost entirely of residential communities.

Cow Market is the northernmost community in this cluster. When it was visited it displayed informal residential usage of land supplemented by some cash crop farming. Unemployment and under-employed "hustlers" made up most of the adult work force. The community presented a typical squatter profile, in that the housing stock ranged from shanties to more substantial dwellings. The community was evidently expanding, judging from the number of new housing starts observed, but construction on several units seemed to be intermittent.

Golden Acres is a middle class housing scheme. When it was visited it exhibited a high percentage of owner-occupants, a large number of them being returning residents. A member of the Citizens' Association estimated the number of lots to be 300-400, several of which were undeveloped. The only other buildings were a community centre and a pump-house. Recently, concern had arisen over the introduction of home-based businesses: a backyard repair garage and a cabinet making operation. Most of the workforce consisted of fixed income employees, working in Kingston or Spanish Town. A significant number of residents were pensioners.

Ariguanaboa was the site of a failed industrial park on the western side of an access road, in close proximity to two squatter communities. The larger settlement, on the eastern side of the access road, was also known locally as Angels Heights. The industrial park housed the Ariguanaboa Textile Mill and two other factories, all of which had gone out of operation. There was, however, a factory, which had been built 8 years ago, which housed the New Lite Windows and Doors factory, linked to New Era Homes, the developers of Angels Phases I & II.

The GC Foster Sports College is also located at Ariguanaboa, with a student and staff population of 620 – a high proportion of them residential. The community employment was primarily hustler operations. A small percentage of the workforce was employed in low-wage skills, such as domestics, some factory work and some backyard gardening. The Secretary of the Crescent All-Age School estimated unemployment at 40%.

Angels Phase I is located on the western side of the Bog Walk to Spanish Town main road; while Phase II is located on the eastern side and is of more recent construction. Together they comprise a thousand units, according to one of the Directors of the development – 480 units in Phase I and 520 in Phase II. Therefore, land use was predominantly residential, with some basic facilities provided by the developer: a playfield and community centre in both phases, a Basic School in Phase I and 20,000 square feet of shop space under construction. Residents tended to be permanently employed, mainly blue-collar occupations (70%) and white-collar occupations (30%), according to several informants. Since the types of occupations broaden with income, it was not possible to determine the main occupations.

Angels Grove is a WIHCON development, constructed in 2002 and containing over 600 units. It is located south of Angels Phase II and shares a common access road. Apart from the residential units, there were two new residential institutions: Angels Primary School and Angels Early Childhood Development Centre. There was no clear occupational profile for Angels Grove, but it was clearly a lower income community than Angels Phases I and II.

Monticello, Avon Park and Angels Court (listing from North to South) are the original subdivisions of the Angels Estate – though developed in the opposite order. They also are

residential communities, with commercial elements predominating where they intersect with the Bog Walk-Spanish Town main road. With the exception of Angels Court, the oldest of the three communities and showing signs of decay, these Angels communities exhibited dynamic construction activity both in the expansion of existing residences and new construction. At the eastern extremities of the roads through these three communities and bordering the canal squatter communities have sprung up, which use these roads for access. In Monticello and Avon Park, livelihoods were said to comprise about 45% wage earners in essentially blue-collar occupations and the rest were either unemployed or engaged in hustler-type occupations and part-time employment. Angels Court was purchased largely by Civil Servants in the 1960s and 1970s and therefore this group constitutes the predominant occupational group, including retirees.

Gordon Pen is residential, with the typical commercial activity along the main road associated with an unplanned but growing country town. When visited there were a number of churches, basic schools and a primary school. The lanes leading eastward off the main road terminated in squatter communities which, in this instance, border the Rio Cobre itself. Unemployment and hustling activities accounted for about 70% of the labour force, according to several informants, including the Principal of the Eltham Park Primary School and the Principal of the Gordon Pen Basic School.

5.5.2.4 Compatibility of Developments Underway and Planned

Within the sampled communities, the main developments underway and planned were limited in terms of the number of communities involved and their residential scope.

For example, of the six communities surveyed only two, Angels II and Ariguanaboa had significant developments underway or planned. In Ariguanaboa, Lite Windows and Doors had tentative plans to expand its factory, though this remained within an uncertain timeframe. One interesting comment by the owner, Mr. Pusichilli, was that a main hindrance to implementing the plan was the inadequacy of water supplies. He opined that all the wells in the Lower Rio Cobre Basin were ‘gone’, implying that they could no longer be relied upon as a source of supply. He indicated that, nevertheless New Era Homes 2000 Ltd was planning a large housing scheme to the south west of the present factory and plans were already in the Approvals Process. To achieve this, his group

would have to be prepared to put in a sewage treatment plant. While the size of this housing development was not disclosed and is still to be determined by the consultants, a number of other real estate developers were mentioned as planning developments in the Lower Rio Cobre Basin and could collaborate on the construction of the sewage treatment plant. These developers include the Black Brothers Inc. Ltd., Magil Construction (of Old Harbour Road/St Johns Rd.) and Can Cara. In fact, Gore Developments had already laid a main through the community, as part of its infrastructural preparations for its development. The National Housing Trust was also mentioned as a downstream developer. The only other large institution in this community, the GC Foster College, reported no planned developments of its own.

The Western sector of the Lower Rio Cobre Basin is a large flat alluvial plain, in many ways very well positioned for rapid development. It is easily accessible to Spanish Town, Kingston and Highway 2000. The main road to the North Coast forms its eastern boundary. An active train line (bauxite) runs through it to a port complex. It is located in the northern belt of an area expected to accommodate the current and future expansion of the KMA including Greater Spanish Town. The area therefore presents a formidable challenge to both local and central government for ensuring planned development. As a result of the Highway 2000 alignment several development applications have been submitted to government agencies, as developers seek to capitalize on the opportunities presented by the highway. A one-year moratorium (for the year 2004) has been placed on the approval of development applications along the Highway 2000 corridor until the relevant government agencies have reviewed the planning issues.

Angels II was completed, but for the 20,000 sq ft of shops currently under construction. The only other construction activities detected within this cluster were the inevitable additions being made to units within housing schemes, small establishments or new home construction on individual lots.

While this KMA project was essentially seeking to upgrade existing supply by refurbishing existing and drilling and equipping new wells in conjunction with capital works upgrading including replacing mains, the perception by developers that water was

a major constraint to future development of this Western section underscored the need for accurate future demand projection.

5.5.2.5 Water Consumption, Supply Conditions and Quality

The problem of water supply within the cluster varies between one community and another. As a generalization, the closer to the Spanish Town Water Treatment Plant the community, is located the more likely that the community members did not complain about supply conditions. In Cow Market, water was a major problem. The main supply comes from wells in Ariguanabo, and a reserve tank overlooking the community which was constructed in 2002 to serve the surrounding communities. Informants complain that although some persons had metered water, its availability was very uncertain. Those without metered water bought from those who had or relied on deliveries from Rapid Response trucks. Furthermore, no pipelines existed at the upper parts of the community, where a significant number of the community members reside.

By way of contrast, in Angels 1, a housing scheme at the foot of Cow Market, occupants claimed that their water supply was adequate, although the water pressure was low during heavy demand periods, such as on the week-ends. A JPS informant indicated that the main problem occurred when the 310 circuit on its system, which serves the area, tripped out, requiring perhaps 2-3 hours to be restored, assuming no other complications.

Some indication of the frustrations with water supplies commonly expressed throughout the cluster can be appreciated when key informants in Angels II, a recently completed and significant middle and lower middle class housing scheme (580 units) complained that in the early mornings and between 6:00 PM to 8:00 PM daily, almost no water was available. Furthermore, when the reserve tank (see above) was put into service during JPS power outages, turbidity occurs. This was also the complaint of an informant in Angels Grove, the WIHCON project bordering Angels II.

To the south, in the bordering communities of Monticello, Avon Park, and Angels Grove residents had few complaints about their water supply. The main problem being experienced was the poor condition of the water mains, which were constantly leaking. One retired resident and informant in Angels Grove pointed out a roadside drain by his

gate, in which, despite repeated reports, water has been heard running steadily for the past 5 years.

In Gordon Pen, the most easterly community within this cluster, random informants and both principals of educational institutions confirmed that the water supply was very good. It was noted by one Principal that water along the finger roads of the community was mainly social non revenue water, while those establishments fronting the main road were metered.

In keeping with all of the communities visited, the eastern boundary of Gordon Pen gives way to squatter settlements on the Rio Cobre.

5.5.2.6 Public Health, Safety and Conservation

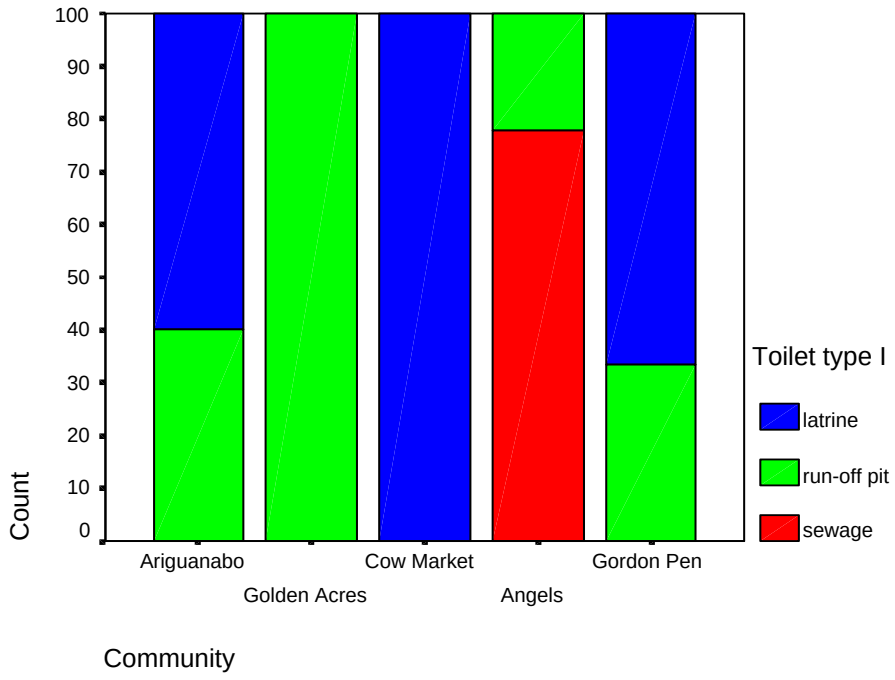
Public health conditions vary according to the type of community.

For example with respect to sanitary conveniences, the newer housing schemes (for example Angels I & II and Angels Court) are sewered, the older housing developments (Golden Acres, Monticello, Avon Park and Angels Court) use WCs with run off pits, and Gordon Pen and the informal settlements used a combination of WCs with run off pits and pit latrines (Figure 5.5.2.6).

In these latter settlements, a significant proportion of residents have no form of sanitary convenience.

For example, in the informal settlements of Ariguanaboa and Cow Market the predominant form of sanitary convenience was the pit toilet. Informants in Ariguanaboa estimate it to be as high as 80%. Even those houses in Cow Market that had dual systems could rarely use the WC with run off pits, because of the lack of piped water. Residents relied on trucked water.

Figure 5.5.2.6: Sanitary Facilities in Lower Rio Cobre



There seemed to be a reasonably efficient system of garbage collection throughout the cluster. This service was provided by the Parish Council. However in those parts of informal settlements not having easy access to the main roads, garbage was disposed of through a combination of methods which included, recycling edibles as animal feed, burning or burying non recyclables, and storing and selling recyclables. The problem of improper garbage disposal was more evident in those squatter communities that fringed on both canals and the river itself. Here garbage was dumped on the banks of the waterways. Periodically, in order to control the volume, burning was practiced. Some blockage of drains by garbage was reported.

In these squatter settlements there was little evidence of any form of sanitary conveniences. Bathing was reportedly done both in the canal and in the river, and clothes-washing was observed first hand in the Rio Cobre. The implications for the pollution of the waterways were obvious.

Sand mining was reported as an activity along the banks of the Rio Cobre where it passes Angels II and the Consultants also saw evidence of both this activity and dumping by trucks.

5.5.2.7 Heritage Issues

No heritage issues were identified for this section of the project area.

5.5.2.8 Social Dislocation and Transportation Issues

Pipe laying will be taking place in a number of sections of this sub-region. In Golden Acres, which was sampled, the residents opined that they would welcome the early start of these construction activities, since they had been informed that rehabilitation of their roads would have had to await the completion of excavations for the mains replacement under these roads.

5.5.2.9 Summary of Main Issues

- **Rapid urbanisation:** The Lower Rio Cobre Basin was a fast growing cluster of communities with a population of just over 6,000 in 1991. It was an important contributor to the increased demand for potable water in Greater Spanish Town for which a significant portion of the projected supply increase of 24 Mld (5.3 migd) under the project is intended. The communities sampled generally fell into one of two profiles: low to middle income housing estates or informal urban settlements, with poor sanitation and displaying other features of urban blight.
- **Developments and water sources & demand:** The Lower Rio Cobre consists almost entirely of residential communities. A number of real estate developers were identified as planning developments in the Western section of the Lower Rio Cobre Basin. The planned developments identified would have important implications for water demand in the Basin. The perception by developers that water was a major constraint to future development of the Western section requires in depth consideration.
- **Raw water:** The Rio Cobre itself is an important source of domestic, if not drinking, water.

- **Informal settlements, public health and conservation:** The informal settlements presented the most visible challenge to public health and safety. With respect of waste disposal, both human and solid, river bathing, washing, and sand mining along the banks of the Rio Cobre.

5.5.3 Spanish Town Central

5.5.3.1 Socio-Economic and Land Use Profile

Central Spanish Town can be described as that section of the city roughly bordered by Brunswick Ave. and Kent St. to the north, Burkes Rd. to the south, Barrett and Monk streets to the east and Belmore, Prince and Railway lanes to the west. It is basically the older part of the city set on a grid pattern.

The town "centre" consists of about a dozen streets running north to south and eight major intersecting streets and a few minor streets and lanes running east to west. During the survey there was generally little to distinguish the streets from the lanes, as even the major streets tended to be quite narrow and pot-holed. The potholes and drainage channels at the sides of the streets were reportedly often filled with water and sewage. These tended to divert attention away from the old Georgian red brick architecture and ruins interspersing the often equally derelict twentieth century structures housing the businesses and working class residents.

According to the 2001 Census, some 7,126 residents live within this business and market district. The Parish Council claimed that there were 1,000 vendors in the main market alone.

The count of establishments/buildings along that section of each of the ten major streets of Old Spanish Town on which mains will be re-laid was as shown in Table 5.5.3.1a:

Table 5.3.3.1a: Count of Commercial & Residential Units on Major Streets

Street	Residences	Businesses	Stalls	Special Blds.	Total	% Commercial
Barrett	4	11	5	1	21	80.95
White Church	15	9	3	4	31	51.61
Old Market	11	32	17	7	67	83.58
King	20	30		5	55	63.64
Nugent	69	40	2	9	120	42.50
Wellington	2	55	19	1	77	97.40
Oxford	2	46	48	1	97	97.94
Young	45	96	41	5	187	75.94
Cumberland	13	71	50	1	135	90.37
William	24	24		1	49	51.02
TOTAL	**205**	**414**	**185**	**35**	**839**	**75.57**

Considering only those streets on which residential or commercial activity constitute at least a third of the total, then only four streets can be considered to have mixed usage, namely, White Church St., King St., Nugent St. and William St. The remaining six are almost entirely commercial. Residential buildings tended to be located towards the northern extremities of the streets. (William St. is located in the north and runs east to west.) As shown by the high proportion of vendors' stalls, sections of the following streets, where they converge on the market, can be considered market streets: Wellington St., Oxford St, Young St. and Cumberland St. as well as Old Market St.

The following were the number and proportions of persons canvassed (Table 5.3.3.1b):

Table 5.3.3.1b Number of Persons Canvassed On Major Streets – Spanish Town

Position	Frequency	Percent	Cumulative Percent
Owner/Manager	18	36.0	36.0
Supervisor	9	18.0	54.0
Worker	6	12.0	66.0
Vendor	5	10.0	76.0
Resident	12	24.0	100.0
Total	50	100.0	

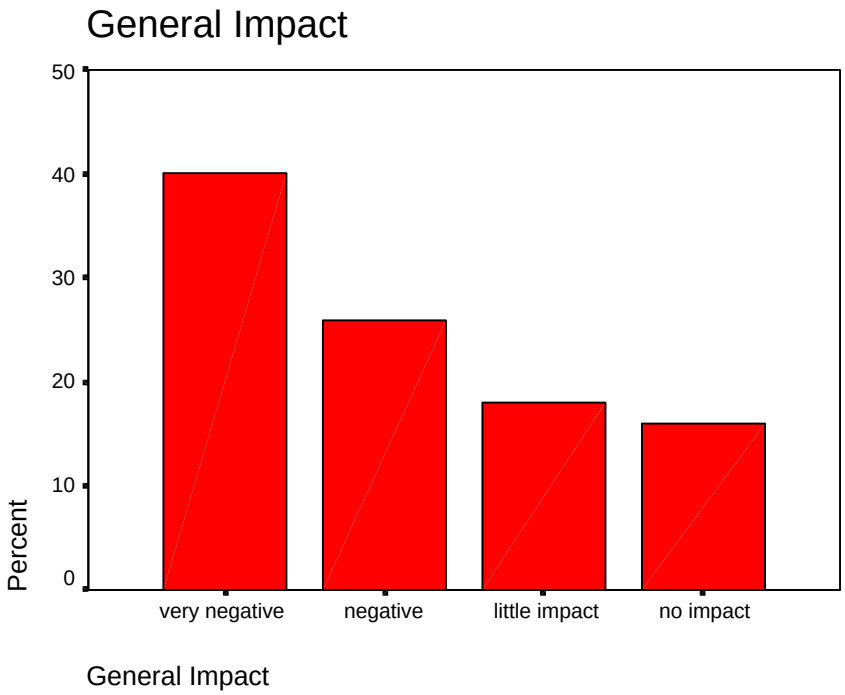
It will be observed that the proportion of residents canvassed closely approximates the proportion of residences in the total number of establishments in the previous table.

The 36 businesses and vendors who responded had an average (mean) of seven employees, the minimum being one and the maximum 63, amounting to 253. Of that number, 98 (38.7%) were female employees.

5.5.3.2 General Impact and Acceptance

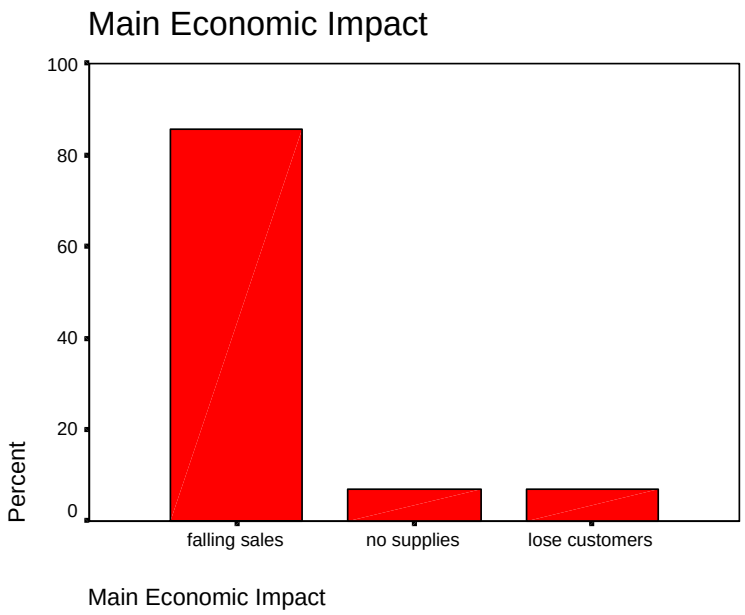
Respondents generally thought that the road excavation and pipe laying would have a very negative impact on their lives and livelihood, but nevertheless they had a positive attitude to the project and a high level of tolerance to the necessary disruption. Some 66% of respondents thought the road works would have a negative impact or worse on their volume of business (Figures 5.5.3.2a and 5.5.3.2b).

Figure 5.5.3.2a: Impact of Project on Residents of Spanish Town Central



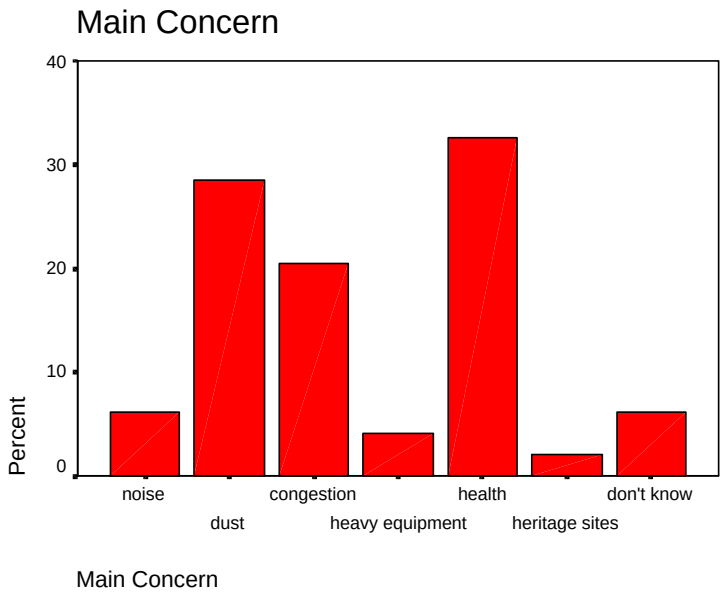
Eighty-six percent (86%) of respondents believed that the main economic effect on their business would be that their sales would fall. Curtailment of deliveries and loss of customers to other providers was of concern.

Figure 5.5.3.2b: Economic Impact of Project on Central Spanish Town



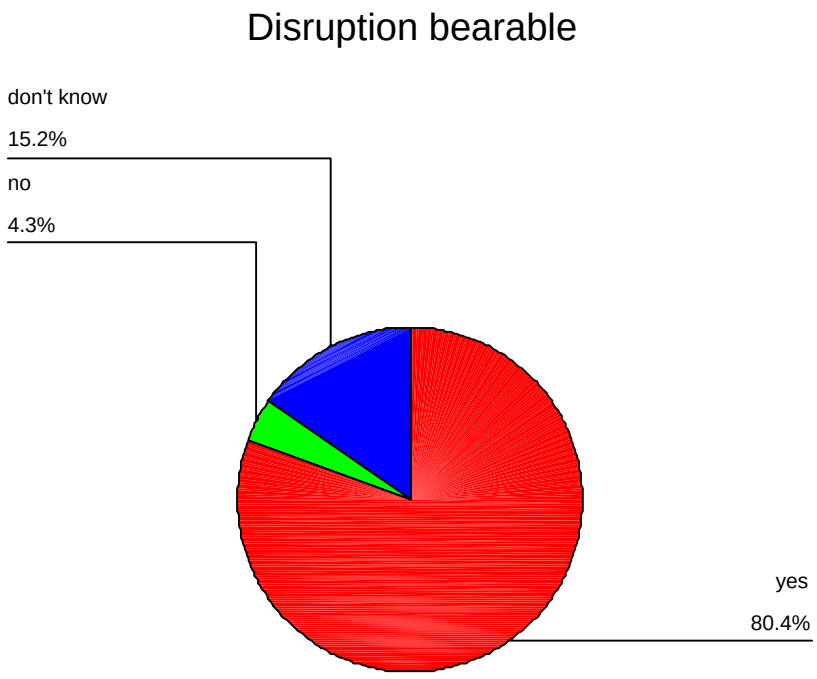
Health issues, dust nuisance and road congestion, were cited as major concerns.

Figure 5.5.3.2c: Main Concerns cited regarding Construction Activities



Notwithstanding the impacts named above, 80% of respondents were prepared to tolerate the disruption. Only four percent were not prepared to tolerate the anticipated level of disruption. Several persons voiced the hope that the roads would be further repaired at the same time.

Figure 5.5.3.2d: Tolerance of Anticipated Disruption in Central Spanish Town



Even among those respondents who anticipated a very negative impact on their livelihoods, more than two-thirds of "negative' and "very negative" respondents, there was a high level of acceptance of the project and willingness to bear the consequences. This is explained by the level of importance that the respondents attach to the project, 66% of them believing that it was more than just "necessary".

5.5.3.3 Street Analysis

A street-by-street survey confirmed the general view: that most respondents on most streets thought that the works would have a negative or very negative impact on their economic activity. There were three streets, however, that did not share this view (Figure 5.5.3.3a). Nugent St., King St. and Old Market St. all have significant proportions of

private dwellings. A majority of their respondents believe the project should have little or no impact on their economic operations. This is partly explained by the perception of significant proportions of respondents on Nugent and Old Market streets that the traffic flow was light or moderate on these streets (Figure 5.5.3.3b, traffic).

Figure 5.5.3.3a: Street-by-Street Impact Analysis for Central Spanish Town

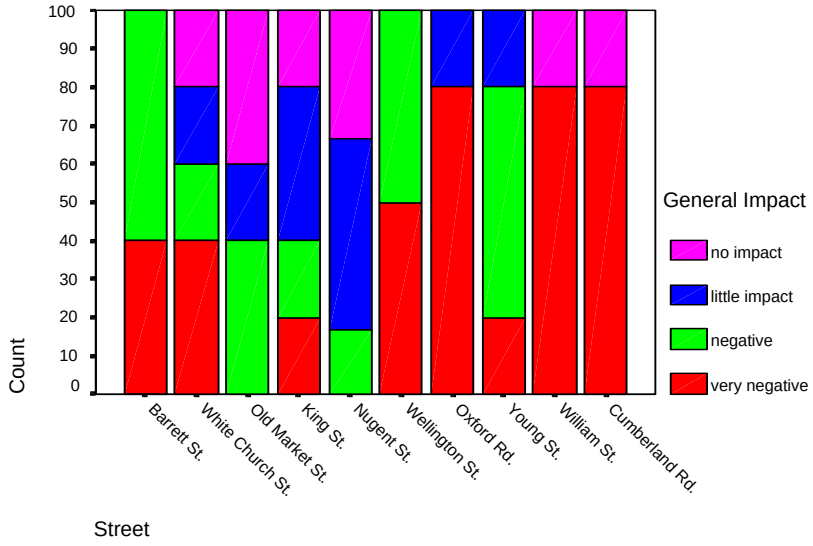
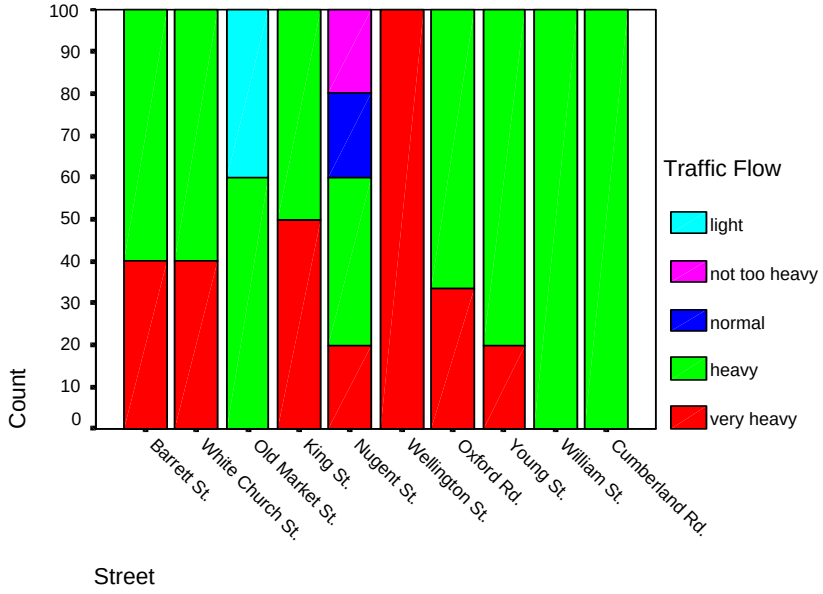


Figure 5.5.3.3b: Perceptions of Traffic Flow in Central Spanish Town



All other streets were perceived to have heavy to very heavy traffic flows (Figure 5.5.3.3b); Wellington St. respondents were unanimous in their conviction that the traffic flow thereon was very heavy. This is fairly consistent with the police rankings (Table

5.5.3.3) where five of these streets have a No. 1 ranking for possible congestion and Nugent St. and Old Market St. have No. 2 rankings. Cumberland and William streets are ranked No 2 by the police and their traffic flow is rated only "heavy" by their occupants. Barrett St. is also ranked No. 2 by the police, but their occupants seem to disagree. The rankings were derived after discussions with the senior officer in charge of the Traffic Department, in St. Catherine and a representative of the NWC. On all but one of the streets surveyed, the respondents were prepared to make the trade-off between congested streets and improved water supply.

Table 5.5.3.3 - Streets by Ranking of Likely Congestion

Streets For Mains Replacement	Ranking*
King Street	1
Oxford Road	1
Wellington Street	1
White Church Street	1
Young Street	1
Adelaide Street	2
Barrett Street	2
Nugent Street	2
Old Market Street	2
Cumberland Road	2
William Street	2
Ellis Street	3
French Street	3
Hanover Street	3
Manchester Street	3
Martin Street	3
Chambers Lane	4
Condrans Lane	4
Monk Street	4
Railway Lane	4
Red Church Street	4
Rivoli Avenue	4
Kent Street	4
Road Connecting Martin Street with Nugent Street.	4

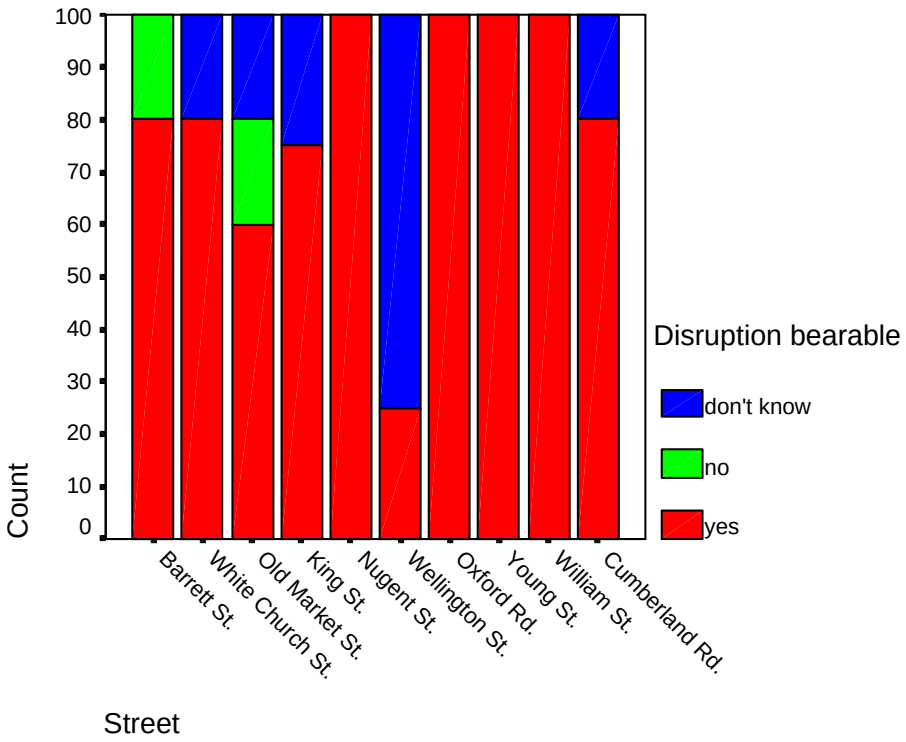
* Ranking
1 = Major disturbance to orderly traffic flows in Central Spanish Town (CST).
2 = Noticeable disturbance to orderly traffic flows in CST.
3 = May or may not create moderate disturbance to orderly traffic flows in CST
4 = Minor or no effect to orderly traffic flows in CST

Wellington St. might be a special case that needs to be treated as such. It is possibly the busiest street – a bustling market street with very few residential structures. It received a

No. 1 ranking from the police and was perceived to have a very heavy traffic flow by all its respondents (a unique case in this respect). A majority of its respondents are not prepared to make the trade-off, again uniquely so.

Figure 5.5.3.3c Tolerance of Anticipated Disruption in Central Spanish Town

(Street-by-Street Analysis)



The solution might lie in working at night or on Sundays to avoid confrontation with vendors and merchants.

5.5.3.4 Reducing Congestion

Peak traffic periods were identified as occurring between 6:30AM and 8:30 AM, between 2:00 PM and 3:00 PM and again between 3:0 PM to 8:30 PM. Within any working day therefore, seven hours fall within one of the three “peak” period.

In discussions with the police traffic department in St. Catherine, and with reference to Table 5.22 it was advised that the following guidelines be provided to the project contractor.

- No two #1 ranked roads be undergoing mains replacement at the same time.

- No one #1 ranked and one #2 ranked roads be undergoing mains replacement at the same time
- No two #2 ranked roads be undergoing mains replacement at the same time.

5.5.3.5 Occupational Analysis

The expected negative impact would appear to increase as we go up the scale of economic control, from residents and vendors to owners and managers of businesses.

Most vendors and residents believed that the works would have little or no impact on their livelihoods; a majority of workers and supervisors responding on behalf of their establishments believed the works would have a negative or very negative impact; 70% of owners and managers believed they would have a very negative impact.

Although all occupational groups were prepared to make the trade-off, owners/managers and vendors had a significant proportion of their number being opposed to or ambivalent about the proposed works.

It might be necessary to have some prior consultations with these two important interest groups. Similarly the opinions of transport operators should be canvassed separately.

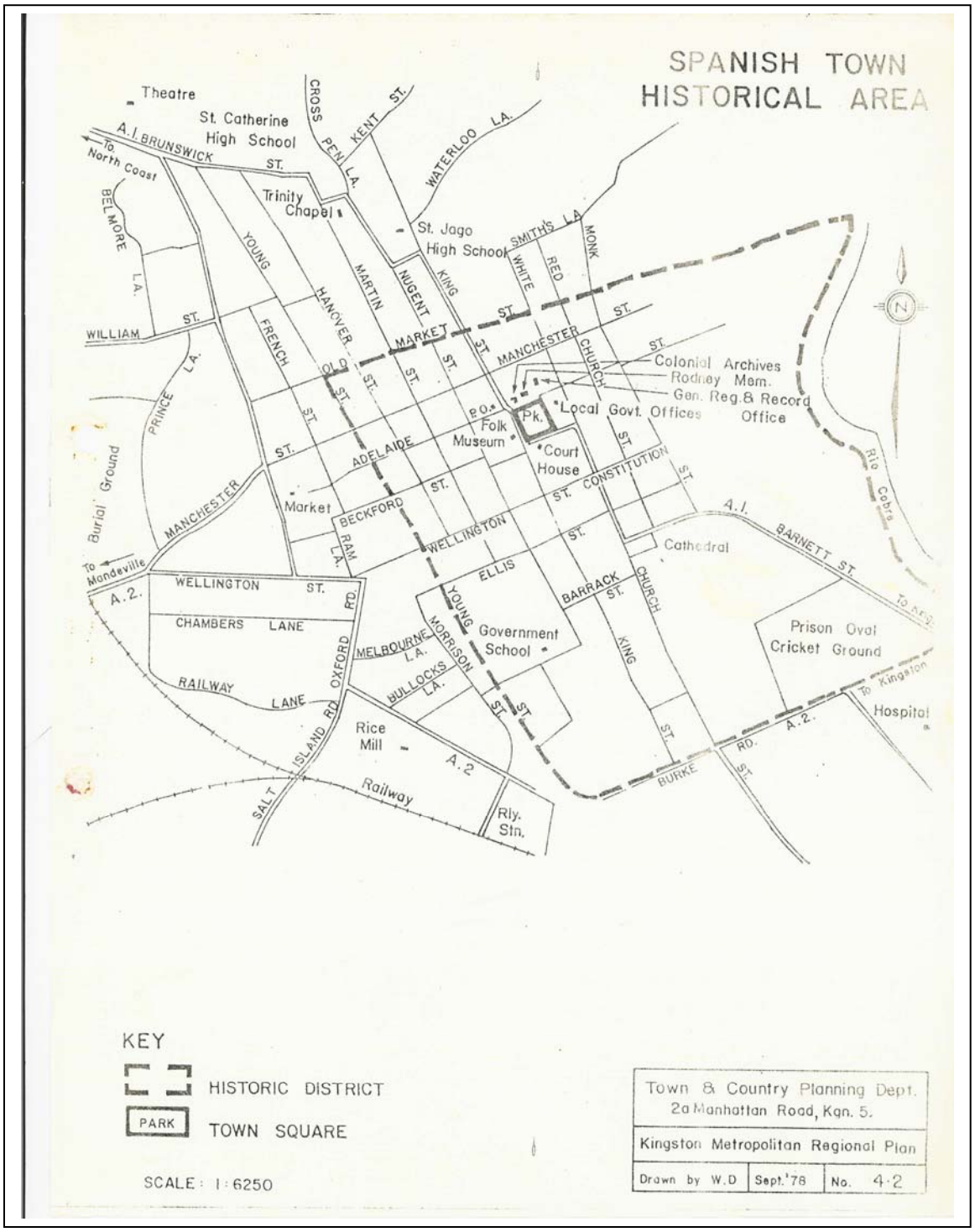
5.5.3.6 Archaeological Heritage

The Jamaica National Heritage Trust Act protects listed sites.

Central Spanish Town is defined as a National Heritage Site and activities that may have an impact on attributes of this site must be guided by the provision of the Jamaica National Heritage Act. The original sixteenth century layout of its streets under Spanish colonial rule has remained relatively intact. Over time several plans have been advanced for its conservation and its development as a heritage attraction.

The principal historical structures and sites are contained within the area shown in Figure 5.5.3.6 overleaf.

Figure 5.5.3.6: Spanish Town Historical Area



The streets slated for mains replacement, transit or run within this National Heritage Site are listed in Table 5.5.3.6.

Table: 5.5.3.6: Roads Slated For Mains Replacement

Streets Within Historic Area	Streets Outside of Historic Area
Adelaide Street	Chambers Lane
Barrett Street	French Street
Condrans Lane	Oxford Road
Ellis Street	Railway Lane
King Street	
Monk Street	
Nugent Street	
Old Market Street	
Red Church Street	
Rivoli Avenue	
Wellington Street	
White Church Street	
And Along Principal Streets	
Hanover Street	Cumberland Road
Manchester Street	Kent Street
Martin Street	William Street
Young Street	
Road Connecting Martin Street with Nugent Street.	

Notwithstanding that some streets lie outside of the main Historic Area, structures with heritage value can be found on all streets. Therefore, for purposes of this Project all of these streets should be treated part of the Historic Area. This is particularly appropriate, since excavation is one of the main types of construction involved.

In keeping with one of the policies of the National Heritage Trust, it will be necessary for an officer of the Trust to monitor the excavation work along these roads. A 'watching brief' will need to be established with the JNHT and provisions made for rescue archaeology.

5.5.3.7 Summary of Main Findings

- According to the 2001 Census, some **7,126 residents are packed within this business and market district**.

- **Four streets were considered to be of mixed usage**: White Church St., King St., Nugent St. and William St. **The remaining six were almost purely commercial**.
- **Residential buildings** tend to be located towards the northern extremities of the commercial district.
- As shown by the high proportion of vendors' stalls, **sections of the following streets,** where they converge on the market, **can be considered market streets**: Wellington Street, Oxford St, Young St. and Cumberland St. as well as Old Market Street.
- The **36 businesses and vendors** who responded to the survey **had a mean average of seven employees**. Of that number, 38.7% were female employees.
- **Respondents generally thought that the road excavation and pipe laying activities would have a very negative impact on their lives and livelihood, but nevertheless had a positive attitude to the project and a high level of tolerance to the necessary disruption.**
- **Dust nuisance, health issues, noise, and road congestio**n from dust or pooling of water were named as some of their main concerns.
- **Wellington Street was a special case**. It was possibly the busiest street – a bustling market street with virtually no residential structures. It received a No. 1 ranking from the police, is perceived to have a very heavy traffic flow by all respondents (a unique case in this respect) and a majority of its respondents would not be prepared to make the trade-off for a better water supply – again, uniquely so. The answer might lie in working at night or on Sundays to avoid confrontation with vendors and merchants.
- **Although all occupational groups were prepared to make the trade-off, owners/managers and vendors had a significant proportion of their number which were opposed to or ambivalent about the proposed works**. Some prior consultations with these two important stakeholders could be beneficial to facilitate implementation of the works.

- **Archaeological** considerations are paramount in this community and as such, any safeguards for protecting heritage assets, required by the JNHT must be observed.

5.5.4 Greater Spanish Town

5.5.4.1 General Profile & Demographics

The suburbs of Spanish Town consist of two main types of settlement:

1. Planned modern housing estates
2. Unplanned, depressed squatter-type settlements.

These settlements account for the major part of the increased water demand in Greater Spanish Town, their population having more than doubled from some 15,000 (in the communities in the sample) in 1991 to some 39,000 in the same communities at the time of the 2001 census. The communities in this cluster include the following:

- Friendship
- Johnson Pen
- Green Acres
- Sydenham
- Ensom City
- Mewton Park/Ensom Acres
- Thompson Pen
- Twickenham Park
- Central Village
- Windsor Heights
- Winter's Pen
- Featherbed Lane.
- Job's Lane
- Willowdene
- Fairview Park
- Keystone
- St. Jago Heights
- Lauriston
- Tredegar Park
- Homestead
- Hampton Green

The first nine communities were selected for sampling.

Green Acres is the most westerly community, located on the St. John's Road as it begins its rise into the hills, just east of the Dovecot cemetery. It is an attractive, sprawling

community of middle and upper income houses built on large lots. The 1991 census states the population of Green Acres and Johnson Pen as 652; the more recent census shows a more than three-fold increase to 2,283. Several informants estimated that the population consists overwhelmingly of middle-aged and retired residents. One key informant estimates that pensioners and returned residents make up a third of the population. All respondents estimated that persons 35 years and under accounted for less than 25% of the population.

East of Green Acres, on the plains, lays the overcrowded rural suburb of Johnson Pen. Here the land lies in ruinate and there is no sign of construction activity. Poor drainage has damaged the road surface. The demographic profile is reversed, with its young population surviving on casual work, primarily on nearby construction sites. There is believed to be a preponderance of female-headed households.

Further to the east, the community of Friendship no longer exists, having been displaced by the housing developments of Royal Place, with 160 units, and Ebony Vale, with 500. At Innswood Village, Gore Developments Ltd. has an ongoing residential development, and similarly at Spanish Villas, Black Brothers Ltd. The 2001 population census records a thirteen-fold increase from 607 in 1991 to 7932. The new scheme of Royal Place is reported to have an overwhelmingly youthful population, while the older scheme of Ebony Vale is said to have an overwhelmingly middle-aged (36-59) population.

On the Old Harbour Road itself, from west to east, are White Water, Phases I & II, detailed below, Sydenham Villas, with 400 units and Sydenham Cottages, with 200. The Sydenham schemes were originally considered low-cost, but the occupants have since improved their value considerably. The population presently stands at 1,930 – a moderate 41% increase over 1991. The largest population group is said to be the young adults of 18-35, with children, the middle-aged and retirees being fairly evenly distributed.

The other communities are located north of Spanish Town (Ensom City and Ensom Acres) and east of the old city – Thompson Pen, Twickenham Park and Central Village, moving from west to east. Ensom City is a middle class housing scheme built about 35 years ago, located south of Gordon Pen and north of Spanish Town. It is one of only two communities (the other being Independence City) in the project area that have recorded a

reduction in population between censuses – from 4,912 to 4,713. The adjoining community of Ensom Acres has displaced the settlement of Mewton Park. Here, a modest 17% population increase has taken place, with the population now standing at 901.

Thompson Pen is a community that has grown from a little rural village of 565 residents in 1991 to a suburban slum of 1,633 residents in 2001 – a near three-fold increase. The Superintendent of the Rio Cobre Juvenile Correctional Centre believes that it is a largely transitory population. The more stable population is an ageing one. As seems to be the norm for depressed suburbs, female-headed households are said to predominate.

The character of Twickenham Park is three-fold: commercial complexes along both sides of the main road from Kingston to Spanish Town; an upscale housing development in Twickenham Gardens, or Greendale, on the northern side of the main road; and a depressed squatter-like settlement in Jones Pen, on the southern side. This community has also experienced a three-fold increase, from just under a thousand residents in 1991 to 3,211 ten years later. Greendale appears to be an ageing community. Construction activity continues to be much in evidence. The commercial complex on the Greendale side is more upscale than that on the Jones Pen side of the road; a small number of industrial enterprises lie at the eastern extremity on the Greendale side.

The shanties and zinc-hidden structures in Jones Pen were estimated to house an average of six persons per household.

Immediately due east of Twickenham Park, on the southern side of the south coast A1 road is **Central Village**. The character of Central Village is similar to that of Jones Pen: commercial enterprises line the AI road, with an extensive industrial complex housing some of the island's most significant local manufacturing companies lying to the east; behind the shops lie the sprawling "ghetto" of Big Lane (Central Road) which envelops the small oasis of a housing development, Spaulding Gardens; furthest west is the 1960s low-cost Government housing scheme of Twickenham Gardens.

Infrastructure construction works were in progress for a new housing development between Twickenham Gardens and the Jose Marti School. In Central Village, there was a comparatively moderate 75% population growth, from 5,447 to 9,448.

The most populous settlement, Big Lane, extends southwards to the banks of the Rio Cobre, where dumped garbage was observed. The President of the Twickenham Gardens Citizens' Association described that settlement as an oasis of peace in an otherwise violent Central Village.

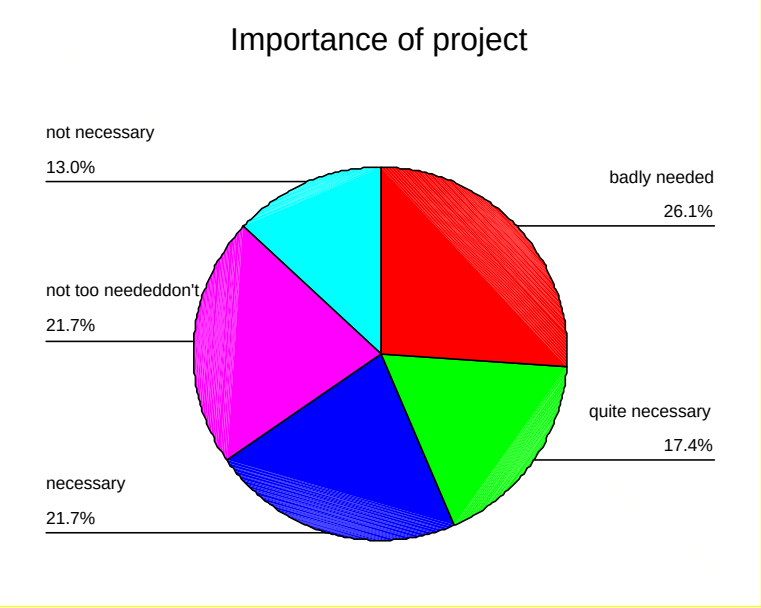
5.5.4.2 Proposed Works in Greater Spanish Town

As indicated above, the greater part of the potable water demand in Greater Spanish Town which the increased supply is expected to satisfy comes from these burgeoning communities.

No new source facilities are planned for this area, but it is proposed that existing facilities will be rehabilitated and, where possible, brought back to maximum efficiency as per original design specifications and additional distribution system capacity will be provided by the proposed new mains. Additional water to serve this area will come from the Lower Rio Cobre limestone aquifer, with four new wells in the Angels-Ariguanaboa area. Old water mains would be replaced in sections of the Willowdene-Hopedale area. (The latter three communities were not included in our sample.)

The attitude of residents to the project is shown in Figure 5.5.4.2.

Figure 5.5.4.2 Perception of Importance of Proposed Works to Residents of Greater Spanish Town



5.5.4.3 Land Use and Livelihoods

Land use in greater suburban Spanish Town is predominately residential. This applies to both the communities sampled and neighbouring communities. However, important pockets of manufacturing and commercial activity exist, as for example in both Twickenham Park and Central Village. All communities have small business establishments fronting their main roads, the standard pattern being that the residential areas of these communities lie behind these trading zones.

Agricultural land use mainly sugar cane cultivation, remains evident in areas just south of the cluster, but these tracts are fast being converted into housing. White Water Phases 1 & 2 bordering Sydenham, are good examples. Two formal industrial parks are located on the eastern approach to Central Village, and in Twickenham Park. Although several other communities also contain or border one or two large enterprises no other communities have comparable commercial blocks.

The main livelihoods within the sampled communities are associated with white and blue-collar jobs for those living in housing schemes and mainly blue collar jobs and hustling in the unplanned settlements. Typically these occupations would include teachers, policemen, civil servants, factory and manual workers; and trades people and hustlers, respectively. Some communities have occupations that reflect their main demographic characteristic; for example, pensioners represent the second largest occupational grouping in Green Acres, after white-collar workers, Green Acres being an important 'returning resident' community.

Some communities benefit to a greater extent than others because of construction work in progress. For example, Johnson Pen is the location for the recently completed Royal Place Estate and the ongoing Spanish Village. Vegetable farming is also an important occupation in the Johnson Pen area. With the exception of communities with a high proportion of retirees, housing schemes tend to be dormitory communities for Kingston and Spanish Town.

Sydenham Villas, presents an interesting case, in that, the development was bought by the National Commercial Bank in association with Victoria Mutual Building Society and

made available to their staff. As a consequence ownership within this scheme remains essentially among former or current staff of both institutions.

As a general observation, however, and in terms of sheer densities, a significant proportion, if not the majority, of the population within Suburban Spanish Town live in unplanned communities, which invariably include squatter elements, with low-income profiles and their associated occupations.

5.5.4.4 Compatibility of Developments Underway and Planned

Developments within this cluster, both existing and planned, were mainly construction for housing. Figure 5.5.4.4 shows Highway 2000 corridor development plan produced by the Planning Institute of Jamaica (2005), which illustrates the proposed land use options along Highway 2000.

Within this corridor, the projects deemed to be significant in relation to the demand for water are:

Sydenham - Magil Palms Ltd was currently pre-selling Magil Palms, comprising a total of 458 one bedroom and two bedroom units. Construction was scheduled to commence in December 2003. This development would have its own sewage treatment plant. Immediately bordering this development is White Water, being constructed by Can-Cara Developments Ltd. This development comprised 600 2-bedroom units that had already been completed and an additional 144 was to have been constructed.

Johnson Pen - Black Brothers Ltd was currently installing infrastructure for its housing development, Spanish Village, to comprise a total of 504 two and three bedroom units. Its sewage would be routed to shared facilities with other existing developments.

Lying south of Johnson Pen on lands formerly owned by Innswood Estate is a large ongoing residential development Innswood Village, developed by Gore Developments Ltd. Although this area lies outside of the sampled cluster the development was sufficiently large to require inclusion here. The development comprises 315 completed two and three bedroom units, with 428 more to be completed. It has its own sewage treatment plant.

Figure 5.5.4.4: Highway 2000 Corridor Development Plan – Portmore to Clarendon Park (Source: PIOJ, 2005)

Twickenham Park - The National Housing Trust was currently putting in infrastructure to serve 935 housing solutions, comprising a mix of town houses and a four-storey apartment block. This development lies between Central Village and the Jose Marti roundabout. The project was referred to as Twickenham Park, but was to be renamed closer to marketing.

These developments discussed above are relatively large, and will contribute significantly to overall water demand.

In the other communities within the cluster, construction development was mainly individual home construction or improvements. Commercial developments were mainly additions to existing buildings. At the entrance to Mewton Park/Ensom Acres, excavation was taking place for what would become a large church, and in Twickenham, some respondents pointed to an expansion of the Life of Jamaica Industrial Park recently divested by FINSAC, but the identity and plans of the new owners had not yet been ascertained.

White Marl, just bordering Central Village, contains an industrial estate that has about 5 important manufacturing plants. Based on interviews with representatives of three of the largest plants, they reported that no immediate plans for additional expansions were envisaged, and those that were envisaged, would not seriously impact water demand.

5.5.4.5 Water Consumption, Supply Conditions and Quality

In Green Acres and Johnson Pen water pressure was reportedly favourable except during peak demand periods. The problem of broken mains was a concern.

Observation suggested that non-metered water was an important source of water for this community. Poor drainage and flooding was also a problem. Members of the Royal Place Estate housing development reported a good supply of water, but considered the quality of the water to be very poor. Their complaint was that the piped water was discoloured and often actually contained green sediments.

At Ebony Vale, the water pressure was reported as being adequate. This was perhaps due to the presence of Friendship pumping station at the edge of this community. However,

serious flooding was reported to occur in certain sections of the scheme due to inadequate drainage.

In the three older Sydenham housing schemes, (Villas, Gardens, and Cottages) respondents complained about the very poor water pressure, but had no complaints about its quality. Nether did a problem with broken mains seem to exist.

Ensom City, to the North East of Spanish Town, is a large residential community. Some respondents characterised their water supply as very poor, including complaints of sediment occurring frequently. Water pressure was reportedly variable, but usually being non-existent in the afternoon.

In nearby Mewton Pen (Ensom Acres) respondents described both their water pressure and quality as adequate. Thompson Pen residents, pointed to a significant loss of water pressure during peak use periods only. One respondent felt that water was being delivered too heavily chlorinated. Flooding was considered to be a problem but mainly when the Rio Cobre was in spate. Some structures were threatened when this happened. Twickenham Park residents and business places, both complained about their poor water supply. The Director of Brown's Prep School, in Greendale and Twickenham Gardens reported that the school's water supply was so poor that they had just secured two large water containers to augment supplies. Along the main road, most of the business places reported very low water pressure, and a few commented of its poor quality.

In Central Village, the water supply along the main road was reported as being adequate. In one of its two planned communities, Spaulding Gardens, this was also the case, although, water pressure was said to fall noticeably during peak use periods. The perception of the quality of the water in both areas was that it was good.

In the housing scheme refereed to as Twickenham Park, the President of The Citizen's Association reported that the water supply was adequate but that its quality was questionable. Flooding was also reported whenever it rained heavily to the point where some residents were flooded out.

Two major unplanned communities exist in Central Village; only one, Big Lane, was toured. Big Lane is a sprawling squatter community whose residents complain that water

supply is very poor, especially on weekends. There is an NWC pumping station close to the community, but the problem is that only some residents are connected to a newer four-inch supply main, while others remain connected to a much older pipe. Flooding and broken mains were a problem. Some members of the community remained unconnected to the mains. Sufferers (Windsor) Heights, on the northern side of the main road, was not visited.

5.5.4.6 Public Health, Safety and Conservation

In the larger housing schemes that were a characteristic of this cluster, few health issues arose, and when isolated instances did occur, the existing Citizens Associations represented these communities. In several other communities in proximity to these housing schemes, very important health issues arose, pertaining mainly to sewage and solid waste disposal.

Johnson Pen had a squatter community in which several drains were choked with garbage; the percentage of this squatter community using pit latrines was not ascertained. Johnson Pen's distance from the nearby housing schemes is probably the main reason why this has not become a source of complaint. Further to the North East, in Ensom City, sewage was being discharged into a gully from adjoining areas apparently not connected to the treatment plant. This gully flowed to and eventually entered the Rio Cobre near the 'hospital' bridge by Sufferers Rock at the entrance to Spanish Town. Solid waste also found its way into the Rio Cobre, which flows to the South East of the community.

On the outskirts of Ensom City, on the banks of the Rio Cobre, is a very large road side sand mining operation, where river sand was being bagged and sold to the passing public. Judging from stacked bags and the general level of activity and secondary occupations it had generated, this must represent one of the more flagrant examples of uncontrolled and presumably, unregulated sand mining operations along the Rio Cobre.

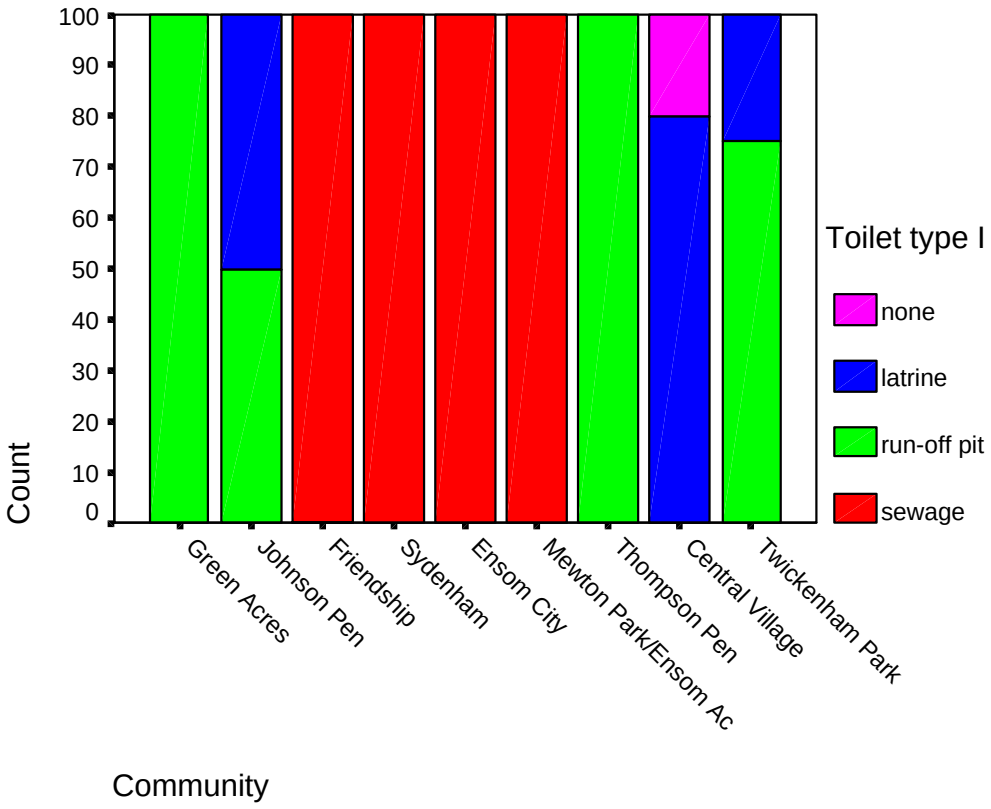
Thompson Pen lies east of Ensom, and closer to Twickenham Park most of the community is connected to a sewage treatment plant. Respondents confirmed that sewage and garbage were entering the Rio Cobre from squatter elements along the riverbank where it curved West of Lauriston, before passing under the main road bridge near Sufferers Rock.

In Central Village, the communities at the Southern tip of Big Lane are situated close to the Rio Cobre. Sewage is reported to be entering the river at Denshire, and a small garbage dump was observed between this community and the Rio Cobre. Areas such as Nazir and Dirt Lane were reported to have a very high percentage use of pit latrines. This was also considered to be true for Sufferers Heights, although no first hand information was gathered at that location.

In nearly all of the communities situated close to the Rio Cobre or large canals, river bathing and clothes washing takes place. Nearly all of the communities in Suburban Spanish Town reported reasonably efficient garbage collection.

Figure 5.5.4.6 illustrates the prevalence of various sanitary facilities within the sub-region.

Figure 5.5.4.6 Sanitary Facilities in Greater Spanish Town



5.5.4.7 Summary of Main Issues

- **Depressed Conditions**: As a general observation, and in terms of sheer densities, a significant proportion, if not the majority, of the population within Suburban Spanish Town live in unplanned communities, which invariably include squatter elements, with low-income occupations and their associated social and economic activities. This, while not impacting the Project's capital works directly, undermines the sustainability of its intended benefits.
- **Unsatisfied water needs**: Poor potable water supplies appear to be a problem and this is ascribed due to a combination of factors such as: closure of the treatment plant due to high turbidity of the raw water, broken water main, defective pumps, or electrical outages and pilferage.
- **Water affecting housing market**: Most houses in Ensom City were observed with plastic water tanks on their roofs, indicating that increasingly, water has become a marketing issue to developers.
- **Health Issues**: In nearly all of the communities that have settlements close to the Rio Cobre, or large canals serving them, river bathing and clothes washing takes place. However, nearly all of the communities in Suburban Spanish Town reported reasonably efficient garbage collection.

5.5.5 South - East St. Catherine

5.5.5.1 General Profile & Demographics

South-Eastern St. Catherine comprises the communities of Portmore, the Hellshire Hills and the sugar workers' settlements of the Bernard Lodge estate (Figure 5.5.5.1).

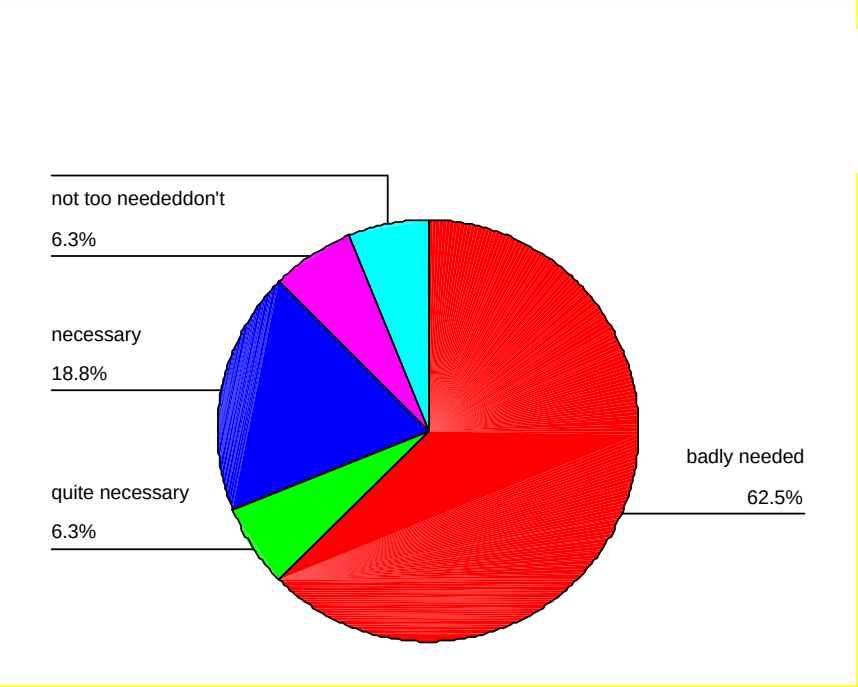
The communities investigated were:

- Lime Tree
- Independence City
- Port Henderson
- March Pen

- Salt Pond
- Phoenix Park
- Dunbeholden
- Goshen and
- Hill Run

Figure 5.5.5.1 shows the perceptions of respondents to the importance of the project. In most communities it is seen as badly needed.

Figure 5.5.5.1 Perception of Importance of Proposed Works to Residents of SE St. Catherine



5.5.5.2 Existing Land Use and Livelihoods

The land use throughout SESC is essentially residential and commercial agricultural. Portmore (including Greater Portmore) and Hellshire are dormitory communities for Kingston, with growing localised economic activity. A few commercial nodes have developed and the Portmore Town Centre is the largest of these.

Commercial agricultural activity takes place on the Bernard Lodge sugar estate and on lands divested by that estate to private farmers.

Existing and planned housing developments were increasingly encroaching on former agricultural tracts.

The older housing schemes, such as Independence City, Edgewater, Bridgeport and Garveymeade and the private developments in the Hellshire hills tend to be occupied by professionals and white collar workers; while the more recent and the larger schemes, constructed by the Government's National Housing Trust (Waterford, Southboro, Cumberland, Braeton, Greater Portmore, etc.) are mainly occupied by blue collar workers and public service employees. Independence City now has a significant population of pensioners.

The working age population of Port Henderson is absorbed within the hotel and restaurant trade and the fishing industry, in that order. Similarly, in Hill Run, at the other (western) extremity of the project area, the population is absorbed in farming the divested cane lands on a commercial basis – mainly inland fishing and chicken. Most of these properties are on five-acre lots. Lands divested at Grange and Goshen are used as stud farms for the horseracing industry centred around the nearby Caymanas Park (bordering Independence City). These areas fall into irrigation Blocks A and E.

There are a few estate barracks remaining for employees of Bernard Lodge, such as those at Phoenix Park. The estate now facilitates the construction of housing, primarily for their more permanent factory workers – at Lime Tree Grove and Salt Pond – and the Government is attempting to do the same for field workers at Dunbeholden, which is the site of a brownfield development under the Operation PRIDE programme.

With the contraction of the estate and factory operations at Bernard Lodge, including the closure of the ethanol plant, unemployment is an increasing reality in rural SESC. It is also a serious problem among the adult children of the householders in the blue-collar schemes.

The perception of SESC as one vast housing estate has attracted a fair share of squatters, who have settled in new settlements, such as Little Portmore, or ensconced themselves in older, unplanned settlements such as March Pen Rd., especially its Ghetto settlement.

With the exception of the older schemes or settlements, such as Independence City and Port Henderson, the communities of SESC have overwhelmingly youthful populations – both in the planned and unplanned settlements. This is manifested in the introduction of significant levels of unemployment in this once dormitory community.

5.5.5.3 Compatibility of Developments Underway and Planned

The ongoing developments of which the team was aware are:

1) The Operation PRIDE project at Dunbeholden;
2) The house lots at Hill Run, and
3) Highway 2000, which passes through the project area.

The Operation PRIDE Dunbeholden project is not considered to be incompatible with current water supply. On the contrary, it could prove to be beneficial to it, as it could reduce the number of pit latrines with potential for seepage of sewage into the groundwater. The Hill Run development, on the other hand, could signal the construction of houses all over the St. Catherine Plains, leaving no room for the aquifer to renew itself naturally. This could effectively put paid to the plans of the project to increase the water supply to adequate levels.

The Highway 2000 corridor is currently the subject of a development plan as predecessor to promulgation of a Development Order. A moratorium on development approval for the corridor has been declared in the interim.

5.5.5.4 Water Consumption, Supply Conditions and Quality

The communities of S.E. St. Catherine are said to experience generally inadequate water supply and questionable water quality. Except for Lime Tree Grove, located near to the Clifton pumping station, and March Pen Rd., which gets its supply from Spanish Town, residents report poor water pressure and extended water lock-offs. All those who receive their supply from the SESC pumping stations and reservoir at Clifton and Marley Hill, speak of the water being “too heavy”, “too salty” or too chlorinated.

The hotels and guesthouses in Port Henderson regulate their water supply with storage tanks from which they pump water to the rooms and encourage their guests to drink bottled water. The Independence City Primary School also uses a storage tank and a

pump to help it through periods of water lock-off. Residents also express distrust of the quality of the water and resort to using bottled water.

In the Bernard Lodge communities, March Pen is mainly dependent on two stand-pipes for potable water and on the canal for other purposes; Salt Pond Gardens and Dunbeholden had metered water supply but little actual water; the Phoenix Park residents reported being supplied via a standpipe from the estate (probably from a well at Dunbeholden) and the farmers and horse-breeders at Hill Run and Goshen respectively reported reduced economic activity on account of insufficient and unreliable water supply.

In Hill Run, residents of the scheme and the farmers tell two somewhat different stories. The residents claim to receive a fairly regular supply of potable water from Spanish Town. This might have been achieved by special arrangement with the developer, because the farmers claim that water never flows through the mains. They both report that the mains, which happen to be asbestos (this was confirmed by the team) were constantly leaking and contributing to the flooding of the roadway. Residents have attempted to stem the leaking with wood. The farmers catch rainwater, truck in water and wash in the canal.

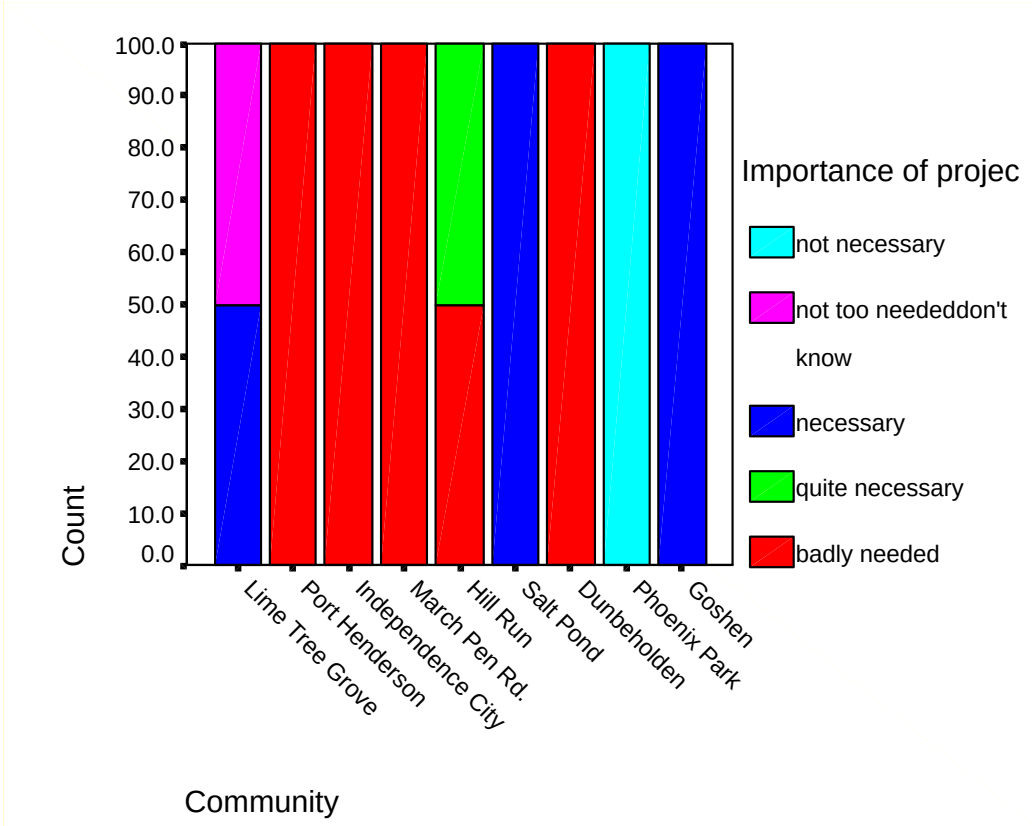
As regards water for agricultural use, the Rural Agricultural Development Agency (RADA) has an arrangement with the National Irrigation Commission (NIC) to supply the farmers with water. This comes via a sluice gate on the Bernard Lodge estate, however, and the farmers claim that they have not been receiving any water from this source as the estate traps all the water supplied for their own use. Most have stopped paying the NIC for water that they had not been receiving. Of approximately 300 five-acre lots, an estimated 25 farms were put in operation. Only between 18 and 20 were currently functioning. Most poultry and pig farms had gone out of business while mainly fish farmers persevered, thanks to the bountiful rainfall.

The team was unable to locate anyone in Goshen Pen, but noted horse-breeder and trainer, Jaghai, of the Bombay Stud Farm in neighbouring Grange, explained that most of the lots at Goshen Pen, normally leased as stud farms to Bernard Lodge, were not in operation because of inadequate water supplies. He reported that the Grange horse-

breeders have two wells exclusively for their own use and have no water problems. Those "on the Bernard Lodge side", however, did experience severe water problems, especially during periods of drought.

Figure 5.5.5.4 shows the perceptions of respondents to the importance of the project. In most communities it is seen as badly needed.

Figure 5.5.5.4: Perception of the Importance of the Project to Communities in SE St Catherine

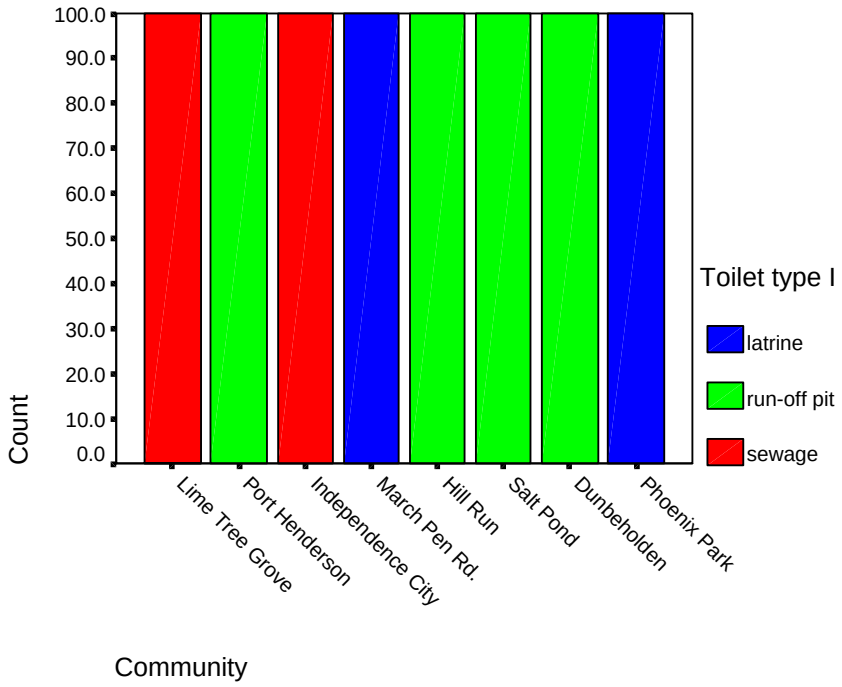


5.5.5.5 Public Health, Safety and Conservation

Salt Pond and Independence City both have central sewage systems and regular garbage collection and residents report no significant public health problems. There are no squatters living on the Lime Tree side of the canal that separates that community from Lakes Pen. Port Henderson has only soak-away pits (Figure 5.5.5.5a) and an irregular

garbage collection system; hotels resort to burning their garbage or trucking it away. No form of sanitary convenience was observed at the squatter settlement that had sprung up by the fishing beach.

Figure 5.5.5.5a: Sanitary Facilities in Communities in SE St Catherine

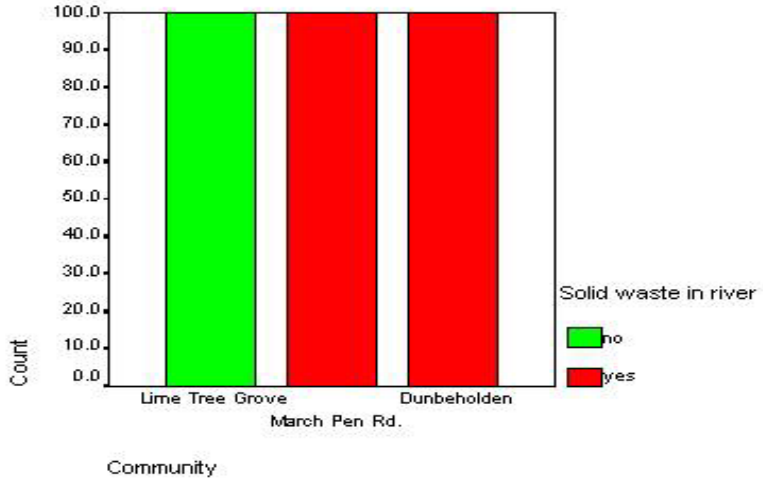


On March Pen Road, nearly all the residences had pit latrines. A small percentage had water closets, which they flushed with canal water. Washing and bathing in the canal was reported as common. Garbage was often dumped in the canal and even baby diapers had been found in it. Conditions at the other sugar workers' settlements, Salt Pond, Dunbeholden and Phoenix Park were similar. They all used mainly pit latrines ('though respondents in Dunbeholden and Salt Pond claimed otherwise), received a visit by the garbage truck only once per fortnight and had resorted to burning their garbage or dumping it in the canal, and using the canal for some domestic purposes. Hill Run residents also had to burn their garbage to dispose of it.

Large sections of the riverbed between Lakes Pen and Central Village were observed to be mined out.

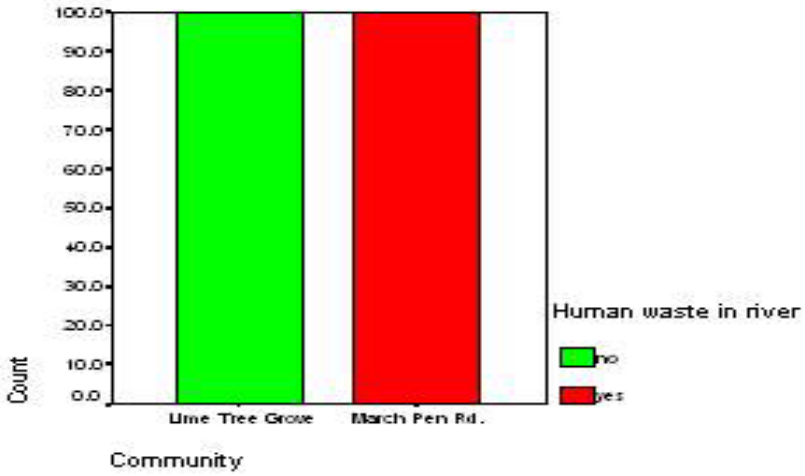
Figure 5.5.5.5b illustrates the community perception of solid waste pollution.

Figure 5.5.5.5b: Community Perception of Solid Waste Pollution



100% of respondents interviewed said that residents in March Pen disposed of human waste in the river. However, no one interviewed from Lime Tree confirmed that allegation.

Figure 5.5.5.5c: Community Perception of Human Waste Pollution



5.5.5.6 Flooding Issues

Most of the SESC region is flood prone. In Lime Tree Grove, the water floods the roads but not the houses. Independence City experiences this problem only when the drains along the main road are blocked. Occupants of the sugar workers' schemes claim that the roads were flooded with every shower of rain but that the water quickly drained off.

Hill Run had the worst flooding problem. Roads and fields appeared to be almost constantly flooded. Residents attributed this to the overflowing of the canal, which they claimed was never maintained. Residents of the housing scheme claimed that this was the main impediment to lot holders' erecting structures on their lots, as they were waiting for the flooding problems to be resolved.

5.5.5.7 Summary of Main Issues

- **Squatter influx:** The perception of SESC as one vast housing estate has attracted a fair share of squatters, who have created new settlements, such as Little Portmore, or ensconced themselves in older, unplanned settlements such as March Pen Rd., especially its Ghetto settlement.
- **Indiscriminate construction*:*** The Hill Run real estate development could signal the construction of houses all over the St. Catherine Plains, thus compromising the alluvium aquifer recharge and ultimately groundwater resource. This would effectively destroy the basis of a part of the KMA water supply upgrading project.
- **Highway 2000***:* The Highway 2000 asphaltic carriageway will reduce percolation in this section of the right-of-way. All crossings over irrigation pipelines have been kept open.
- **Water deficiencies*:*** The communities of S.E. St. Catherine report generally inadequate water supply and questionable quality. All who receive their supply from the SESC pumping stations and reservoir at Clifton and Marley Hill, speak of the water being "too heavy", "too salty" or too chlorinated.
- **Economic impacts*:*** The hotels and guesthouses in Port Henderson supplement their water supply with tanks and pump it to the rooms. They encourage their guests to drink bottled water. The farmers and horse-breeders at Hill Run and Goshen respectively tell a story of reduced economic activity on account of insufficient and unreliable water supply. Some Hill Run farmers have stopped paying the NIC for water that they are not receiving. Of some 300 five-acre lots, only an estimated 25 farms had been put into operation. Only between 18 and 20

were currently functioning. Most poultry and pig farms have gone out of business but fish farms remain.

- **Asbestos mains*:*** Hill Run residents claim that the mains were constantly leaking and contributing to the flooding of the roadway. The mains are made from asbestos-cement.
- **Port Henderson health hazard*:*** Port Henderson had only soak-away pits and an irregular garbage collection system; hotels resort to burning their garbage or trucking it away. No form of sanitary convenience was observed at the seaside squatter settlement that had sprung up by the fishing beach.
- **On March Pen Rd**., nearly all the residences had pit latrines. A small percentage had water closets, which were flushed with canal water. Washing and bathing in the canal was reported as a common practice. Conditions at the other sugar workers' settlements, in Salt Pond, Dunbeholden and Phoenix Park were similar. They all use mainly pit latrines, received a visit by the garbage truck only once per fortnight and had resorted to burning their garbage or dumping it in the canal and using the canal for some domestic purposes.
- **Sand mining*:*** Large sections of the riverbed between Lakes Pen and Central Village were observed to be mined out.
- **Flooding impediment*:*** Most of the SESC region is flood prone. Hill Run has the worst flooding problem. Roads and fields appeared to be almost constantly flooded. Residents attributed this to the overflowing of the canal, which they claimed was never maintained. Residents of the housing scheme claimed that this was the main impediment to lot holders' erecting structures on their purchased lots, as they waited for the flooding problems to be resolved.

5.5.6 Summary of Key Issues

The following is a summary of the Community Analysis, outlining the main issues affecting the project.

5.5.6.1 Project not addressing perceived needs in some communities

If the project is implemented as designed then some communities within the project area, where an inadequate water supply is attributed largely to mains breaking frequently, will supposedly not have this problem addressed as not all mains in the project area are to be replaced.

5.5.6.2 Inadequate infrastructure

Residents of Kent Village perceive little benefit from the project unless the size of the service pipe into the community is increased and non-revenue water supply is addressed.

5.5.6.3 Developments and water

Planned developments by a number of real estate developers were identified in the Western section of Greater Spanish Town. These will have important implications for potable water demand in the area. The perception by developers was that water is a major constraint to future development of the western section.

5.5.6.4 Suburban Spanish Town's unsatisfied water needs

This problem, as it manifested itself to most residents, appeared to be mainly one of poor distribution resulting from either water mains that were broken, NWC's pumps that were defective or the effect of JPS power outages on NWC's pumps.

5.5.6.5 SESC water deficiencies

The respondents of communities in S.E. St. Catherine tell a story of generally inadequate water supply and questionable quality. All who receive their supply from the SESC alluvial aquifer and reservoir at Marley Hill speak of the water being "too heavy", "too salty" or too chlorinated. It is the opinion of the community that water quality must be improved.

5.5.6.6 Economic impacts

The hotels and guesthouses in Port Henderson regulate their water supply with tanks and pump it to the rooms. They encourage their guests to drink bottled water.

The farmers and horse-breeders at Hill Run and Goshen respectively tell a story of reduced economic activity on account of insufficient and unreliable water supply.

Some Hill Run farmers have stopped paying the NIC for water that they are not receiving. Of some 300 five-acre lots, an estimated 25 farms were in some form of operation. While this may not be solely because of inadequate water supply, respondents attributed an important role to the problem. Most poultry and pig farms had gone out of business and mainly fish farms had persevered, thanks to the bountiful rainfall.

5.5.6.7 Asbestos Mains

Hill Run residents claimed that the mains, which happen to be asbestos-cement, were constantly leaking and contributing to flooding of the roadway.

5.5.6.8 Squatter influx

The perception of SESC as one vast housing estate has attracted a fair share of squatters, who have created new settlements, such as Little Portmore, or ensconced themselves in older, unplanned settlements such as March Pen Rd., especially its ghetto settlement.

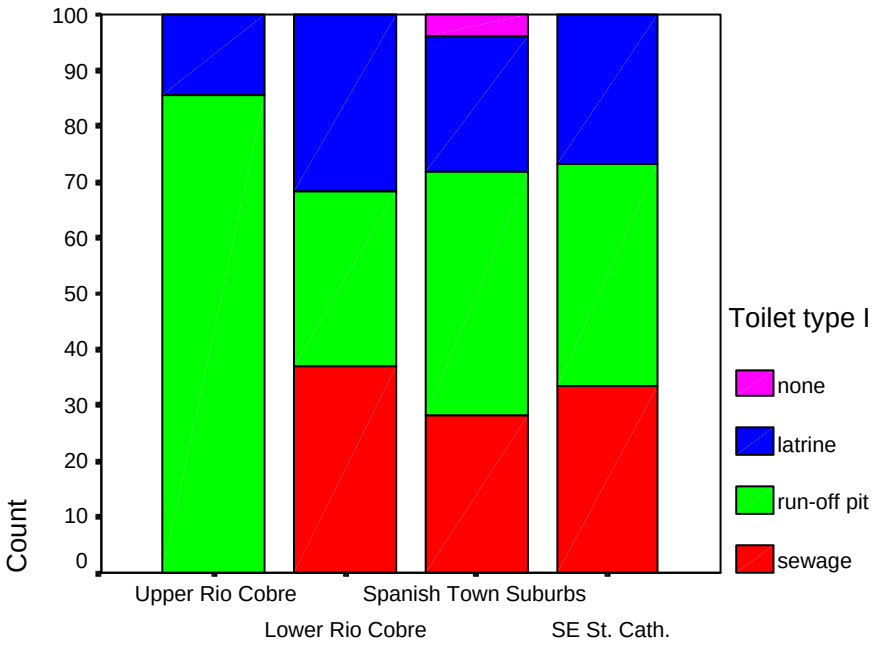
5.5.6.9 Informal settlements and public health & conservation

The informal settlements presented the most visible challenges to public health and safety. The public health and safety threats included waste disposal, both liquid and solid, river bathing and washing, and sand mining along the banks of the Rio Cobre.

The relatively low coverage of central sewage collection and disposal systems exacerbates the problem.

Figure 5.5.6.9 overleaf illustrates this.

Figure 5.9.6.9: Sanitary Facilities in Communities in Upper Rio Cobre & Spanish Town Suburbs.



5.5.6.10 Indiscriminate construction

The Hill Run real estate development and The Palace on the Bernard Lodge estate could attract the construction of houses all over the St. Catherine Plains creating additional potable water demands potentially not serviceable by the project.

5.5.6.11 Highway 2000

Highway 2000 traverses the aquifer. Apart from the damage that it can potentially cause is pollution of existing water resources, there is the possibility that it could attract further development of the built environment adjacent to it, especially of the more undesirable type, such as the spawning of squatter settlements.

5.5.6.12 Flooding impediment

Most of the SESC region is flood prone. Hill Run experiences the worst flooding problem. Roads and fields appear to be almost constantly flooded. Residents attribute this to the overflowing of the irrigation canal, which they claim is never maintained.

Residents of the housing scheme claim that this is the main impediment to lot holders' erecting structures on their purchased lots, as they wait for the flooding problems to be resolved.

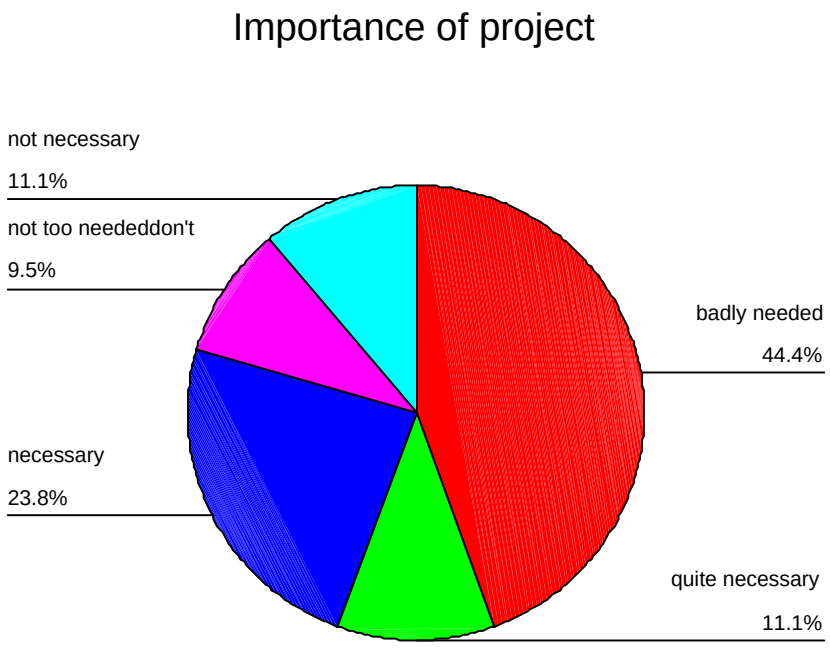
5.5.6.13 Impact of Project

Respondents generally thought that the road excavation and pipe laying would have a very negative impact on their lives and livelihood but nevertheless had a positive attitude to the project and a high level of tolerance to the necessary disruption.

Health issues from dust or ponding of water were each named by just over 60% of respondents as one of their three main concerns. The first named concerns, however, were, in the following order, health issues, dust nuisance and road congestion - together accounting for 82% of all responses.

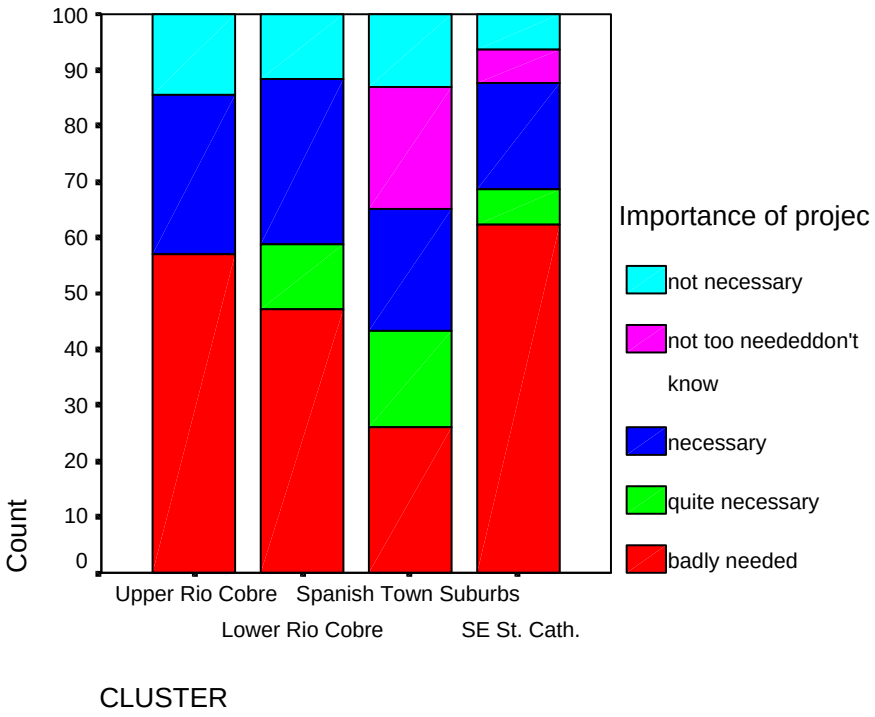
The concerns notwithstanding, there was tremendous support for the project throughout the project area (Figure 5.5.6.13a), none more so than in Spanish Town, where it was likely to cause the greatest dislocation.

Figure 5.5.6.13a: Perception of Importance of Project to Residents in the Project Area



A majority (55.5%) of residents expressed the belief that the project was badly needed or quite necessary; a further 24% believed it was necessary, bringing the level of support for the project to just under 80%. Less than 21% failed to voice positive support for its implementation, with those believing it to be unnecessary amounting to a mere 11%. This support was common to all segments of the project area ((Figure 5.5.6.13b))

Figure 5.5.6.13b Support for Project



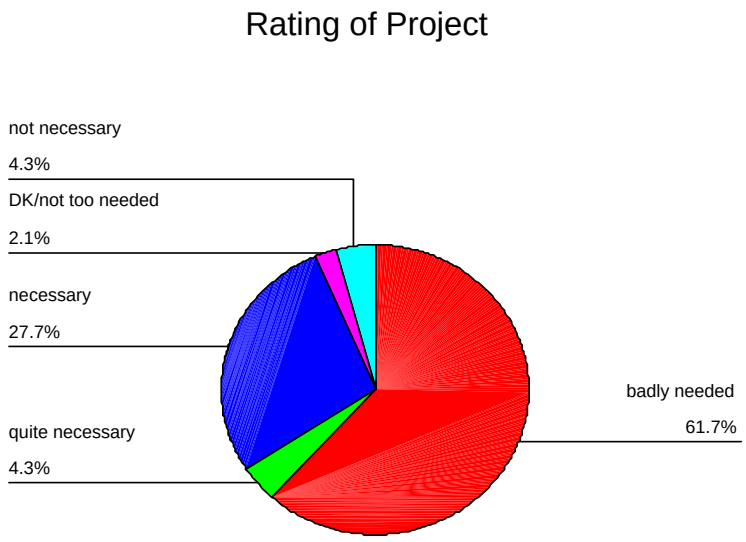
The graphics show that support for the project exceeds 85% within the overall project area.

The greatest portion of persons thinking the project unnecessary was 15% in the Upper Rio Cobre, whom the project was not intended to benefit.

In Spanish Town and S.E. St. Catherine, two-thirds of residents enthusiastically supported the project, with total positive ratings amounting to 88% in SESC and 94% in Central Spanish Town. There were only 4% of naysayers in Spanish Town and 6% in SESC.

The support of the residents of Spanish Town is, once again, illustrated by the following graphic (Figure 5.5.6.13c).

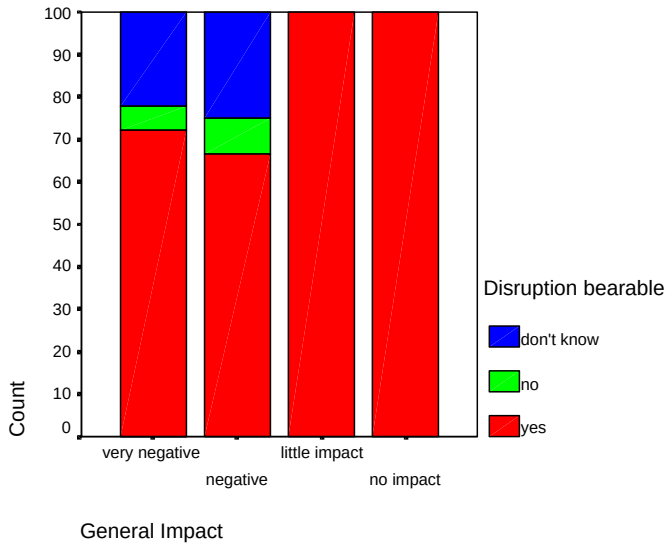
Figure 5.5.6.13 c Perception of Importance of Proposed Works to Residents of Central Spanish Town



The support in Spanish Town was remarkable when one considers the residents' perception of the negative impact that the works would have on their lives and livelihood.

Even among those who thought that the project would have a very negative impact on their economic welfare, over 70% were positive that they were prepared to put up with the disruption, 22% were not sure and only 6% were opposed (Figure 5.8.9.14 d)

Figure 5.5.6.13d: Perceived Impact of Project in Spanish Town



6 CONSIDERATION OF ALTERNATIVES

The Tibbets Abbott McCarthy Stratton (TAMS) report of 1976 comprehensively evaluated all water resource development proposals previously postulated targeting the potable water supply of the overall KMA and recommended the implementation of a Phase I Blue Mountain Water Supply Scheme providing for the construction of a major dam on the Yallahs River at Mahogany Vale and ultimately a trans Blue Mountain supply derived from the northern flowing streams of the Blue Mountains in Portland (at very considerable costs even at that time).

Economic and financial constraints resulted in the construction between 1983 and 1986 of the Yallahs Pipeline Project as an initial phase of a "Blue Mountain Scheme" - for the supply of water into the Kingston and St. Andrew section of the overall KMA - and no further development of a more comprehensive overall scheme has subsequently occurred.

In 1990 the Government of Jamaica concluded that the water resources of the Rio Cobre Basin represented the only viable (technical and economic) option for potable water supply development to meet the needs of the Greater Spanish Town and SE. St. Catherine sections of the KMA and commissioned a feasibility study which concluded that the available water resources of the Lower Rio Cobre Basin were effectively already over-committed (particularly with their extensive use for irrigation water supplies to support agricultural activities on the St. Catherine Plains) and proposed various works to augment potable water supplies for the study area by ceding certain ground and surface water rights from the irrigation sector to the potable water sector.

Arising from this feasibility study and following further project reviews, the original concept of the present project for the Greater Spanish Town and SE. St. Catherine sections of the KMA was defined in 1996 (and refined in November 1998) – whereby artificial recharge of the limestone and alluvial aquifers of the Lower Rio Cobre Basin and a return to the use of surface water for irrigation of those sections of the St. Catherine Plains that had been converted to well fed pressurized systems would enable additional groundwater abstractions to be allocated to the potable water sector in those sections of the overall KMA (without unduly compromising the irrigation sector) while

Unaccounted-for-Water initiatives would reduce the effective total potable water demand in the particular service area.

At the same time, the potential development of desalination of the brackish water of the Ferry Springs was assigned as one possible strategy for augmenting future potable water supplies for the Kingston and St. Andrew section of the KMA.

Given the foregoing and that the current costs of Phase 2 of a "Blue Mountain" Scheme of the style and extent conceived of in the TAMS Report of 1976, with extensive tunneling through the Blue Mountains, have undoubtedly escalated to in excess of one half billion US dollars, there are no technically and economically viable alternatives to the present project to meet current and projected medium term future water supply needs of the Greater Spanish Town and SE St. Catherine sections of the KMA other than the wholesale reduction of irrigated agriculture on the St. Catherine Plains and the reallocation of significant water abstraction rights to the potable water sector. This is not acceptable within the declared policy of the Government of Jamaica.

The "No Action" alternative is not viable as current levels of public water supply within the project area are not acceptable, existing facilities - already inadequate for the supply of potable water to existing communities on a reliable 24 hours per day basis - would deteriorate further and exacerbate the problem, with serious implications for the quality of life and for public health and, generally, for the future development of the project area.

Therefore, through:

- the rehabilitation of existing water supply facilities and restoration to design levels
- the reduction of Unaccounted for Water (UFW)
- the development of additional ground water sources supported by appropriate technically and economically feasible artificial aquifer recharge,

the present KMA Water Supply Project represents the only current alternative.

7 POTENTIAL IMPACTS AND MITIGATION MEASURES

This section identifies the potential impacts and suggested mitigation measures related to the implementation of the Kingston Metropolitan Area Water Supply Project. Findings of the assessment are presented according to site preparation, construction and operation phases. The impacts have been determined as being significantly positive or negative, direct or indirect, long term or short term.

Some impacts pertain to all aspects of the project while others relate to a specific Lot or an aspect within a Lot. The major components of the project are:

Lot 1 - Rehabilitation of existing production and certain distribution pumping and service storage facilities - on the Rio Cobre System, in Greater Spanish Town (including the Spanish Town Water Treatment Plant) and in SE St. Catherine together with the installation of bulk flow meters at all production sites and the replacement of distribution mains in two sections of Spanish Town.

Lot 2 (to be implemented as Lot 2A, GST and Lot 2B, SESC) - Development of Groundwater Sources from the Lower Rio Cobre limestone aquifer in the northern section of Spanish Town and the construction of new trunk transmission and distribution pipelines in both Greater Spanish Town and SE St. Catherine, together with the construction of new distribution pumping stations and new service storage reservoirs in Greater Spanish Town.

Lot 3 (to be implemented as Lot 3B) - Artificial Recharge - artificial recharge of the Lower Rio Cobre limestone aquifer, and the supply and installation of groundwater level and key climate parameter recording equipment at strategic locations covering both the Lower Rio Cobre Limestone and Alluvial aquifers;

and

Under separate, direct arrangements, the procurement and installation of certain bulk flow meters throughout the Project Area to monitor flow into discrete District Metered Areas (DMAs)

7.1 MAIN ISSUES IDENTIFIED

The main environmental issues (other than temporary impacts of construction activities) identified for this project are:

7.1.1 Physical Aspects

Hydrology

Construction of new wells can have a negative impact on the hydrological regime if abstraction rates are not monitored and controlled, particularly as over-abstraction can result in saline intrusion (an issue primarily for the Water Resources Authority).

In the event of improper operation of the proposed water treatment facilities of the Aquifer Recharge component, there is a potential for contamination of the Lower Rio Cobre Limestone aquifer through the input of surface waters contaminated with faecal coliforms, petroleum products, pesticides, detergents or other substances.

Contamination of Water Resources by Inappropriate Sewage and Other Waste Disposal

Significant contamination of the existing surface and groundwater resources has already occurred within the project area through the inappropriate disposal of sewage and other wastes. Unless strong and appropriate actions are brought to bear on this matter the sustainability of the proposed project in the medium to long term could be severely compromised.

Hazard Vulnerability

Impacts during construction relate to the effect of seismic activity, flood events and stormwater run-off in the project area. Flooding is a major natural hazard to be considered in the planning of construction operations and such operations must not compromise existing drainage routes.

Man-made hazards are also possible during the construction and operation phase, through the operations of the facilities and the deployment and use of chlorination facilities.

With respect to man-made/technological hazards during construction, accidents can occur on-site and as a result of activities both on and off-site, such as transportation of equipment and materials, well drilling, subterranean work, handling of hazardous materials and general construction activities.

Health and safety aspects must be considered with respect to workers, neighbouring communities, the motoring public and pedestrians.

Air Quality

Movement of trucks and heavy-duty equipment to and from the project area, as well as construction work, drilling, excavation and stockpiling of earth material, will contribute to fugitive dust. Construction activities will also result in the removal of some amount of vegetation that will expose and loosen soil which can become airborne with medium to strong winds. This would add fugitive dust to the area. Some sites sampled reported high levels of ambient particulates, mostly along the main thoroughfares. The transport of aggregate for construction will also contribute to the fugitive dust levels. Construction vehicles will emit air contaminants such as nitrogen and sulphur oxides as well as particulates. No major impacts are expected during the operational phase.

Noise

Noise levels are expected to increase during the construction phase for all three lots. This is due to the use of heavy machinery, pneumatic drills, earth moving equipment, and the use of construction and transportation vehicles. No major impacts are expected during the operational phase.

7.1.2 Biological Aspects

Loss of Vegetation

Construction activities for Lots 2 and 3 will require the removal of several hectares of vegetation, establishment of new pump stations. The removal of vegetation may result in the loss of some existing airshed purification functions. During construction, the removal of vegetation may also increase surface run-off and result in sheet flow after heavy rainfall events which could also increase the potential for soil erosion.

Birds

Vegetation clearance will result in loss of habitat for both endemic and migratory bird species. The habitat within the project area includes small scale agricultural lands, sugar cane plantations, ruinate vegetation and scrub. Removal of vegetation is not expected to have a major negative impact on existing habitats for birds due to the diversity of habitats within the project area. Any birds dislocated during construction are likely to relocate to adjacent habitats.

Crocodiles

The project areas within Spanish Town and south east St. Catherine, particularly those under Lot 2 (Spanish Town Water Treatment Plant and neighbouring irrigation canals) and Lot 3B (Aquifer Recharge) are known habitat areas for the endangered American Crocodile. Both crocodiles and humans are at risk from the potential interactions. The American Crocodile (*Crocodylus acutus*) native to Jamaica is an endangered species, protected under national and international law, and may be a potential threat to unsuspecting humans in their habitat.

7.1.3 Social Aspects

Disruption of Potable Water Supplies

Various work required under the project will unavoidably result in the temporary disruption of potable water service to existing NWC customers and appropriate planning coupled with comprehensive prior notification to particular consumers affected from time to time and the general public of inevitable interruptions in supply of an essential service (in accordance with NWC service standards established by the Office of Utilities Regulation and the NWC itself) is of critical importance in the context of public health.

Traffic, Transportation and Access Roads

Construction activities will see an increase in the movement of heavy vehicles and construction equipment. In particular Lot 1 which includes mains replacement in two sections of Spanish Town itself, will directly impact the transportation network and will require the alteration of traffic patters, creation of detours and restricted flow of traffic.

Disruption to Business Enterprises

Business enterprises will be disrupted, particularly in central Spanish Town in Lot 1 where extensive road closures and detours will occur.

Solid Waste Management

Solid waste generated from the construction activities will include construction debris, vegetation, solid waste generated from the construction camps, and decommissioned structures.

Public Health and Safety

Construction activities will result in the generation of solid waste and require transportation and storage of significant volumes of construction material. The proper disposal of construction spoil, decommissioned structures and hazardous waste is critical.

Increased levels of fugitive dust and construction noise (and water supply disruption, as noted above) are also public health issues.

The operation of chlorination facilities requires trained personnel and certified equipment. Workers responsible for maintaining and operating chlorination facilities must be appropriately trained and experienced and must utilize appropriate protective gear.

The NWC's Emergency Response Plan for chlorine emergencies should be adapted, if necessary, to include for all new chlorination facilities installed under the project.

Archaeological and Cultural Heritage

Spanish Town is a historical site with several buildings listed under the Jamaica National Heritage Trust Act. Construction could result in the unearthing and discovery of artifacts, and the use of earth moving and heavy machinery could impact existing structures.

Employment

Employment opportunities will be created during the site preparation, construction and operation phases. This will mostly be unskilled labour for the duration of the construction activities. Additionally, economic opportunities will involve the sourcing of

construction material and linkages created with local and regional suppliers and industries.

7.1.4 Tables of Impacts

Table 7.1 details the main activities of the project works, the potential negative impacts during the site preparation, construction and operation phases, and the proposed mitigation measures.

Table 7.2 gives the expected positive impacts and Table 7.3 outlines potential negative impacts of certain existing environmental conditions on the sustainability of the project.

Table 7.1 Potential Negative Impacts and Proposed Mitigation Measures

GENERAL CONSTRUCTION ACTIVITIES

Potential Impacts – Construction Phase - Mitigation Measures

Hazard Vulnerability

1. Construction schedules should take account of the traditional rainy season between May and October and of the hurricane season from June to November as tropical weather systems may cause exceptionally heavy rainfall with attendant consequences.
2. Safety management issues should be taken into account during construction scheduling.

These mitigation measures are the **responsibility of the developer working with the relevant contractors.**

Disruption of Public Water Supply

1. Scheduling of construction activities should keep temporary disruptions of the public water supply to the minimum consistent with the work required and prior notification of all scheduled disruptions of the public water supply from time to time should be provided to affected customers (in accordance with service standards established by the Office of Utilities Regulation and the NWC itself).

This mitigation measure is the **responsibility of the developer working with the relevant contractors.**

Business Enterprises

1. Temporary pedestrian access should be provided to businesses adjacent to excavated trenches during contractor's normal working hours where possible and temporary vehicular access over trenches left open outside of contractor's working hours shall be provided to affected businesses at reasonable times agreed with the particular businesses.

These mitigation measures are the **responsibility of the developer working with the relevant contractors in consultation with appropriate interest groups and the appropriate statutory authorities**

GENERAL CONSTRUCTION ACTIVITIES: Potential Impacts – Construction Phase: Mitigation Measures - Continued

Dust

1. Un-vegetated areas and stripped road surfaces should be watered to the extent necessary to minimize fugitive dust.
2. Stockpiled earth materials should be covered or wetted on windy days to limit fugitive dust. Vehicles transporting earth materials should be covered en route.
3. A monitoring programme should assess the effectiveness of dust control measures against pre-construction ambient air quality.
4. As their assignment requires, construction workers should be provided with dust masks.

These mitigation measures are the **responsibility of the developer working with the relevant contractors.**

Noise

1. Where construction is in close proximity to residential areas, the impact of construction activity noise on the surrounding communities should be minimized by restricting major construction activities to the hours between 7 am and 6 pm.
2. Construction equipment should be properly maintained to keep emitted noise to the minimum consistent with original performance specifications under normal operation.
3. As their assignment requires, construction workers should be provided with hearing protection devices.

These mitigation measures are the **responsibility of the developer, working with the relevant contractors.**

Construction Labour Employment

1. Construction camps and work areas must be provided with adequate sanitary facilities.
2. Workers should be sensitized to traffic management, solid and liquid waste disposal, dust management, parking, idling of equipment issues and oil spill control.
3. The "politicization" of employment opportunities often poses some challenge to contractors, and the need for security and relevant dialogue should be factored into construction planning.

These mitigation measures are the **responsibility of the relevant contractors.**

GENERAL CONSTRUCTION ACTIVITIES: Potential Impacts – Construction Phase: Mitigation Measures - Continued

Solid Waste

1. Appropriate arrangements should be made to ensure the proper collection and disposal of solid waste from premises where access for existing collectors is impeded because of mains construction activities, to the approval of the National Solid Waste Management Authority (NSWMA)
2. Solid waste generated by trenching activities should be either promptly removed from site or appropriately stockpiled in designated areas.
3. Excavated material should be reused as far as possible.
4. Construction sites and associated construction camps and work areas generate considerable waste and provision must be made for the proper collection and disposal thereof.
5. The disposal of solid waste (including decommissioned structures and scrap metal) should be as approved by the National Solid Waste Management Authority.
6. Any hazardous waste should be separated and stored in areas clearly designated and labelled as such, for future disposal as directed by the National Solid Waste Management Authority.

These mitigation measures are the **responsibility of the developer working with the relevant contractors with approval from the National Solid Waste Management Authority.**

Protection of Artifacts

1. Excavations, particularly within historic "old" Spanish Town, may unearth artifacts and the Jamaica National Heritage Trust (JNHT) should be provided with a schedule of construction activities and be allowed to perform Watching Briefs, if required.

The mitigation measure is the **responsibility of the developer working with the relevant contractors in association with the JNHT.**

GENERAL CONSTRUCTION ACTIVITIES: Potential Impacts – Construction Phase: Mitigation Measures - Continued

Traffic Flow

1. The preparation of Traffic Management Plans shall be informed by consultations with all relevant stakeholders.
2. Scheduling of construction work should be done to minimize disruption to traffic flow along the main arteries while facilitating the movement of material and heavy equipment.
3. To the extent feasible for efficient construction operations, the activities of the Contractor should be generally organized so as to achieve minimal disruption to pedestrians and vehicular traffic.
4. Properly trained flag persons should be employed where construction activities, including the movement of heavy machinery and construction equipment, could affect traffic flow.
5. Proper signage should be installed on the approach to all work sites.
6. Alternative traffic routes should be identified with proper signage to facilitate the flow of traffic.
7. Alternative traffic routes, road closures and denied road access should be made public (in due prior time) through the print and electronic media and, where appropriate, through community meetings.

These mitigation measures are the **responsibility of the developer working with the relevant contractors in consultation with appropriate interest groups and the appropriate statutory authorities.**

Maintaining Drains

1. Drains should be kept free of debris from construction activities so as not to impair their normal functioning.

This mitigation measure is the **responsibility of the developer working with the relevant contractors.**

GENERAL CONSTRUCTION ACTIVITIES: Potential Impacts – Construction Phase: Mitigation Measures - Continued

Public Health and Safety

1. To minimize risk to the public, construction activities which will directly affect traffic and pedestrians should be properly scheduled and proper standard construction techniques for sign–posting and flagging should be adhered to.
2. Dust control by wetting is essential in areas where vegetation is stripped.
3. Unnecessary idling of construction related vehicles should be discouraged.
4. Speed limits and entrances and exits should be properly signed.
5. All open excavations should be appropriately cordoned off and marked as necessary with reflective warning signs

These mitigation measures are the **responsibility of the developer working with the relevant contractors.**

Loss of Vegetation

1. Where vegetation has to be cleared for the works, clearing of vegetative stands should be carried out on a phased basis, if appropriate, to reduce the area of exposed top soil at any one time.
2. Where, in any permit, specific guidance is given by NEPA for the clearance of vegetation, retention of trees or replanting such requirements shall govern.
3. Any large trees to be retained should be 'red-flagged' to alert contractors.
4. Replanting of vegetation shall be carried out where appropriate.

The establishment of Permit Conditions are **the responsibility of NEPA.** Other mitigation measures are ultimately **the responsibility of the developer working with relevant contractors or subcontractors.**

Birds

1. All reasonable efforts should be made to retain bird feeding, nesting and roosting sites.

This mitigation measure is the **responsibility of the developer working with the relevant contractors.**

REHABILITATION OF EXISTING WELLS, WATER TREATMENT PLANT, PUMPING STATIONS AND RESERVOIRS/TANKS

Main Activities: Drilling, including disposal of drilling spoil, Pump Testing of Wells including disposal of water, General Building Rehabilitation and minor extensions, Construction of Reinforced Concrete Structures, Movement of Heavy Machinery, Stockpiling and Disposal of Excavated Materials, Trenching, Transportation Storage and Installation of Pipes / Valves / Pumps / Switchgear and Chlorination Equipment etc., Preparation for and Painting of Steel Tankage, Concrete Repairs, Recovery of Replaced Pipes / Valves / Pumps / Switchgear etc., Generation of Waste

Potential Impacts – Construction Phase

General Construction Impacts comprising Generation of Dust, Generation of Noise, Generation of Vibrations, Maintenance of Drains, Construction Labour Employment, Disposal of Waste, Public Health and Safety, Well rehabilitation and replacement well construction

Mitigation Measures

General

1. All requirements within the General" section above are applicable - with responsibility as defined therein.

Well Rehabilitation and Replacement Well Construction

1. Appropriate permits shall be obtained from the Water Resources Authority and any conditions set out therein shall be adhered to.

This mitigation measure is the **responsibility of the developer in association with the WRA**

REHABILITATION OF EXISTING WELLS, WATER TREATMENT PLANT, PUMPING STATIONS AND RESERVOIRS/TANKS

Potential Impacts – Operation Phase

Mitigation Measures

Chlorine Emergencies

1. The NWC's Emergency Response Plan for chlorine emergencies should be adapted, if necessary, to include for all new chlorination facilities installed under Lot 1 of the project

Preventing Unauthorised Access

1. Given that existing facilities may pose hazards to unauthorized persons who may gain access to water production or treatment sites (open reservoirs, chlorination and electrical power facilities, mechanical equipment subject to automatic start-up), arrangements and project provisions relating to site and building security must be maintained at all times.

Disposal of Dried Sludge from the Spanish Town Water Treatment Plant

1. Dried sludge must be disposed of in accordance with disposal permits or licenses issued by NEPA at a site(s) approved by the National Solid Waste Management Authority.

The above mitigation measures are the **responsibility of the developer.**

MAINS REPLACEMENT

Main Activities: Trenching, Storage and Disposal of Excavated Materials, Transportation Storage and Laying of Pipes, Generation of Waste

Potential Impacts – Construction Phase

General Construction Impacts comprising Generation of Dust, Generation of Noise, Generation of Vibrations, Protection of Artifacts, Maintaining Drains, Disruption of Traffic Flow, Disruption of Pedestrian Flow, Disruption of Business Access, Construction Labour Employment, Disposal of Waste and Decommissioned Structures, Public Health and Safety

Mitigation Measures

General

1. All requirements within the General" section above are applicable - with responsibility as defined therein.

Traffic Flow

1. As per "General" section above, **and**
2. Based on the rank of vulnerability of streets to congestion (Table 5.5.3.3), no two roads Ranked #1 and or #2 should be closed at the same time.

These mitigation measures are the **responsibility of the developer working with the relevant contractors in consultation with appropriate interest groups and the appropriate statutory authorities.**

Vibration

1. Vibration caused by earth moving equipment and heavy machinery could impact archaeological and heritage buildings within old Spanish Town, and the Jamaica National Heritage Trust (JNHT) should be provided with a schedule of construction activities and be allowed to perform a Watching Brief, if required.

The mitigation measure is the **responsibility of the developer working with the relevant contractors** in association with the JNHT**.**

MAINS REPLACEMENT

Potential Impacts – Mains Replacement - Operation Phase

Mitigation Measures

Disruption of Traffic and Pedestrian Flow and of Water Service

1. Impacts anticipated during the operation phase of the mains replacement component will include disruption to vehicular and pedestrian traffic for maintenance and repairs. Where possible, notification of maintenance and repair activities impacting the public or third parties should be publicized in advance.
2. Mitigation measures as listed under the construction phase should, as may be appropriate, pertain during maintenance and repair works.

These mitigation measures are the **responsibility of the developer.**

NEW WELLS & ASSOCIATED WORKS

Main Activities: Drilling, including disposal of drilling spoil, Pump Testing of Wells including disposal of water, Construction of Buildings, Movement of Heavy Machinery, Stockpiling and Disposal of Excavated Materials, Transportation Storage and Installation of Pipes / Valves / Pumps / Switchgear , Chlorination and Standby Power Generating Equipment etc., Generation of Waste

Potential Impacts – Construction Phase

General Construction Impacts comprising Generation of Dust, Generation of Noise, Stockpiling and Disposal of Excavated Material, Transportation and Storage of Materials, Disposal of Waste, Construction Labour Employment, New Well Construction

Mitigation Measures

General

1. All requirements within the General" section above are applicable - with responsibility as defined therein.

New Well Construction

1. Well construction permits must be obtained from the Water Resources Authority and any conditions therein must be adhered to.

This mitigation measure is the **responsibility of the developer in association with the WRA.**

NEW WELLS & ASSOCIATED WORKS

Potential Impacts – Operation Phase

Mitigation Measures

Abstraction of Water

1. Water abstraction licences must be obtained from the Water Resources Authority and any conditions therein must be adhered to.

This mitigation measure is the **responsibility of the developer in association with the WRA**

Chlorine Emergencies

1. The NWC's Emergency Response Plan for chlorine emergencies should be adapted, if necessary, to include for all new chlorination facilities installed under Lots 2A and 2B of the project

Handling Fuel Oils

1. Fuel storage and transfer should be undertaken in accordance with established best practices.

Preventing Unauthorised Access

1. Given that certain new water production facilities may pose hazards to unauthorized persons who may gain access to water production or treatment sites (open reservoirs, chlorination and electrical power facilities, mechanical equipment subject to automatic start-up), arrangements and project provisions relating to site and building security must be maintained at all times.

The above mitigation measures are the **responsibility of the developer.**

NEW WATER PIPELINES

Main Activities: Trenching, Storage and Disposal of Excavated Materials, Transportation Storage and Laying of Pipes, Generation of Waste

Potential Impacts – Construction Phase

General Construction Impacts comprising Generation of Dust, Generation of Noise, Generation of Vibrations, Protection of Artifacts, Maintaining Drains, Disruption of Traffic Flow, Disruption of Pedestrian Access, Disruption of Business Access, Construction Labour Employment, Disposal of Waste, Public Health and Safety

Mitigation Measures

The impacts for new water main construction and the associated mitigation measures are generally as those identified for the Mains Replacement component above (excluding issues relating to decommissioned structures).

Responsibility for the associated mitigation measures are as identified for the Mains Replacement component above

NEW WATER PIPELINES

Potential Impacts – New Water Mains - Operation Phase

The operational impacts of new water mains and the associated mitigation measures are identical to those identified for the Mains Replacement component above.

NEW PUMPING STATIONS AND SERVICE STORAGE RESERVOIRS

Main Activities: Construction of Buildings and Water Retaining Structures, Movement of Heavy Machinery, Stockpiling and Disposal of Excavated Materials, Trenching, Transportation Storage and Installation of Pipes / Valves etc., Generation of Waste

Potential Impacts – Construction Phase

General Construction Impacts comprising Generation of Dust, Generation of Noise, Generation of Vibrations, Protection of Artifacts, Maintaining Drains, Disruption of Traffic Flow, Disruption of Pedestrian Access, Construction Labour Employment, Disposal of Waste

Mitigation Measures

General

1. All requirements within the General" section above are applicable - with responsibility as defined therein.

NEW PUMPING STATIONS AND SERVICE STORAGE RESERVOIRS

Potential Impacts – Operation Phase

Mitigation Measures

Preventing Unauthorised Access

1. Given that certain new water production facilities may pose hazards to unauthorized persons who may gain access to water production or treatment sites (open reservoirs, chlorination and electrical power facilities, mechanical equipment subject to automatic start-up), arrangements and project provisions relating to site and building security must be maintained at all times.

This mitigation measure is the **responsibility of the developer.**

AQUIFER RECHARGE

Main Activities: Construction of Canal Intake Works, Construction of Lined Earth Embankment Reservoirs and Wetland Beds, Construction of Building, Movement of Heavy Machinery, Stockpiling and Disposal of Excavated Materials, Trenching, Transportation Storage and Installation of Pipes / Valves etc., Generation of Waste

Potential Impacts – Construction Phase

Generation of Dust and Noise, Loss of Vegetation, Storage and Disposal of Excavated Materials, Transportation and Storage of Pipes, Disposal of Waste, Human Interaction with Crocodiles,

Mitigation Measures

General

1. All requirements within the "General" section above are applicable - with responsibility as defined therein.

Crocodiles

1. Sensitization sessions for the project team and sub-contractors should be conducted, in association with NEPA, to raise the awareness of: International and national legislation for the protection of the species; potential means of interaction; crocodile behaviour, breeding patterns and nesting areas
2. Increased diligence should be applied during the breeding season (March to August) when females can become more aggressive.
3. Proper solid waste disposal practices must prevail as adult crocodiles scavenge through garbage dumped along river banks and canals.
4. Immediate reporting to NEPA is recommended on the sighting of a crocodile.
5. No attempts should be made to restrain or tie crocodiles.

Note: A Management Plan for the Potential Interactions between Humans and Crocodiles has been prepared for the project

These mitigation measures are the **responsibility of the developer working with the relevant contractors in consultation with NEPA.**

AQUIFER RECHARGE

Potential Impacts – Operation Phase

Mitigation Measures

Contamination of Aquifer

1. The quality of raw and treated recharge water should be regularly monitored to ensure that water of inappropriate quality is not recharged into the aquifer.

Preventing Unauthorised Access

1. Given that certain new water production facilities may pose hazards to unauthorized persons who may gain access to water production or treatment sites (open reservoirs), arrangements and project provisions relating to site security must be maintained at all times.

Crocodiles

1. All requirements re Crocodiles set out for the Construction Phase are applicable to the Operations Phase.

Disposal of Settled Solids from Sedimentation Basins and Storage/Disposal of Cut Vegetation from Constructed Wetlands

1. Settled solids must be disposed of in accordance with disposal permits or licenses issued by NEPA at a site(s) approved by the National Solid Waste Management Authority. Cut vegetation from the constructed wetlands should be appropriately stored until disposal in accordance with disposal permits or licenses issued by NEPA at a site(s) approved by the National Solid Waste Management Authority.

The above mitigation measures are the **responsibility of the developer.**

Table 7.2: Potential Positive Impacts
1. An increase in water production for the provision of potable water to the KMA is a major positive impact and the main objective of the project The currently inadequate levels of service and unreliability of the existing potable water supply in the project area will be improved to provide **reliable 24 hour service of potable water at adequate pressure at NWC customer connections having a significant positive impact on the quality of life, sanitation and public health in the project area**
2. Reduction in the amount of Unaccounted-for-Water (UfW) is one of the main positive impacts expected. Water is currently lost through leaks, theft and poorly maintained supply network resulting in wasted water and reduced revenue. Replacement of mains and associated upgrading of facilities will result in a reduction of UfW. The replacement of old mains will reduce future disruptions for repair.
3. The surface water treatment facility (Spanish Town Water Treatment Plant) will be upgraded resulting in positive socio-economic benefits through a sustained water supply even during periods of high raw water turbidity.
4. Aquifer recharge will result in the minimisation of saline intrusion currently experienced in some wells.
5. Employment opportunities will be created during the construction and operation phases. This will mostly benefit artisans and unskilled labour for the duration of the construction activities. Additionally, economic opportunities will involve the sourcing and transportation of construction material and linkages created with local and regional suppliers and industries.

Table 7.3 Impacts of Existing and Proposed Activities on the Project

Project/Development	*Potential Impacts*	*Mitigation Measures*
Sand Mining	Illegal sand mining is on going in many areas of St. Catherine, and specifically within the project area in south east St. Catherine. The effects of continued sand mining will destroy the aquifer that is the source of water for the area.	1. Discussion must be held with the relevant Government agencies and the project developers. Agencies must be made aware of the importance of maintaining the integrity of the aquifer, and the necessity for enforcement to end illegal sand mining activities. Legislation of sand mining was under consideration but has not been put forward for approval (Appendix III). **Inter-agency discussions should involve the Ministry of Land and Environment, Mines and Geology Division, and the National Environment and Planning Agency and the Ministry of Housing and Water. Responsibility for enforcement of illegal sand mining lies with the Mines and Geology Division and NEPA.**

Table 7.3 Impacts of Existing and Proposed Activities on the Project

Project/Development	*Potential Impacts*	*Mitigation Measures*
Housing Developments	Several housing developments have been proposed and some have already been approved in the project area. These include the New Era Development and Morris Park in South East St. Catherine. These new developments will impact the project in several ways including increased and unprojected water demand; and improper disposal of sewage and solid waste with potential for aquifer contamination.	The approval of housing developments must be done in an integrated way. **Discussions should be held with the project developer NWC and NEPA, as well as the Ministry of Water and Housing, as responsibility for approval of housing sub-divisions lies with NEPA.**
Bus /Car Pound	An existing and growing bus/car pound in south east St. Catherine also has the potential for aquifer contamination through release of petroleum and petroleum products, lubricants and oils and improper disposal of batteries.	Discussions should be held with the relevant regulatory body and government agencies to determine the expansion scope of the existing facility and the process operations. **Discussions should be held with the project developer NWC and NEPA, as responsibility for enforcement of environmental infringements lies with NEPA**

Table 7.3 Impacts of Existing and Proposed Activities on the Project

Project/Development	*Potential Impacts*	*Mitigation Measures*
Improper Solid Waste Disposal	Several pits from illegal mining activities are currently being used for disposal of solid waste by local communities. This also has the potential for contamination of the aquifer.	Discussions should be held with the relevant regulatory body and government agencies to determine all sites of illegal dumping within the project area, to establish a time frame for clean up and remediation of these sites, and the implementation of appropriate solid waste collection and disposal strategies for the local communities. **Discussions should be held with the project developer NWC, NEPA, and NSWMA as responsibility for enforcement of environmental infringements lies with NEPA and solid waste disposal lies with the NSWMA.**
Surface Water Contamination / **Ground Water Contamination**	The integrity of the water supply to provide potable water for the expanding KMA is a national priority. In August 2004 the NWC was forced to temporarily discontinue operations at the Spanish Town Treatment Plant as a result of a spill of diluted caustic soda into the Rio Cobre.	1. Vigilant monitoring, enforcement and application of penalties are required to reduce incidents that can potentially contaminate the water supply and adversely impact the project. 2. Alternative water supply should be supplied to all members of the community to minimize and

Table 7.3 Impacts of Existing and Proposed Activities on the Project

Project/Development	*Potential Impacts*	*Mitigation Measures*
	The continued use of pesticides in the agricultural sector has resulted in the contamination of several rivers. Endosulfan has been used to treat the coffee berry borer and has resulted in detectable residues in the Rio Cobre basin (Witter, *et al*, 1999). The current of use of irrigation canals by the local communities for domestic purposes including bathing, washing laundry, washing of cars and disposal of waste, has the potential to contaminate the aquifer through the inputs of faecal coliforms biological waste, detergents and petroleum products. Disposal of effluent from existing sewage treatment plants downstream of the Headworks will result in continued contamination of the limestone aquifer. Proper treatment of sewage before disposal or re-siting of outfalls must now be considered.	eventually eliminate use of the irrigation canals for domestic purposes. **Discussions should be held with the project developer and relevant government agencies such as the WRA, NEPA, JBI, PCA and NSWMA as responsibility for enforcement of environmental infringements lies with NEPA and regulatory aspects of other sectors with various agencies.**

8 CLIMATE CHANGE CONSIDERATIONS

No country should at this time be unaware of the potential onset of global warming as a world-wide phenomenon. Increasing research generated by the scientific community indicates that changes in climatic patterns have been occurring and these affect several variables including ambient temperatures, rainfall patterns, changes in the frequency and intensity of tropical storms, and flood events. If the increasing number and intensity of hurricanes in the 2005 hurricane season are linked to climate change then one should accept that it is a reality.

Regarding the proposed KMA Water Supply Project the following climate change impacts should be considered:

1. Changes in rainfall patterns, affecting hydrological projections, water quality, water flow and sustainable yield
2. Increased hurricane events also result in the additional potential for flood events
3. Increase in ambient temperatures, affecting water temperature and other water quality parameters

In order to address these issues, the KMA Water Supply Project and the National Water Commission need to take precautionary mitigative measures as follows:

1. Be informed about the nature and implication of climate change through training and information dissemination to project staff
2. Develop capabilities for and participate in climate monitoring networks, including the generation and use of meteorological data and hydrological data, especially for the Upper and Lower Rio Cobre basins.
3. Design all engineering structures for the KMA Water Supply Project to allow for climate change possibilities over the next 100 years at least.
4. Train for and participate in hazard management networks (with ODPEM, NWC, NIC) as appropriate
5. Develop and maintain an Early Warning System to enable adequate response within and outside the project management team

9 PROJECT IMPLEMENTATION, ENVIRONMENTAL MONITORING & COSTS

9.1 PROJECT IMPLEMENTATION

9.1.1 Provisions of the Contracts for Implementation

The project will be implemented under four major contracts (Lots 1, 2A, 2B and 3B) with all being tendered following detailed prequalification exercises to identify potential contractors who are appropriately experienced and competent to undertake the scope and scale of individual contract works. Under all contracts the NWC will be the Employer with the Engineer designated as Nippon Koei Co. Ltd., / MWH UK Ltd. (who will provide experienced and appropriate resident engineering supervision on site).

All contracts will include provisions for the various Contractors to be responsible for those mitigation measures noted in Table 7.1 that are partially their responsibility.

The following abstracts from contract documentation are not exhaustive but are intended to illustrate the approach taken for the project.

9.1.1.1 Flooding

In the General Specification

> *The Contractor shall make all necessary arrangements to control any floodwaters that may arise during construction activities. The Contractor shall be deemed to have taken inclement weather and the associated precautionary measures into account when preparing his work programme and resource allocations.*

9.1.1.2 Maintaining Water Supplies and Scheduled Events (including Notifications)

In the General Specification

> ***Plants Deemed to be in Full Operation***
> *All existing water supply facilities at which work is to be executed under this Contract shall be deemed to be IN FULL OPERATION AT THEIR RATED CAPACITY and the Employer's workforce may be on site daily for operation and maintenance.*
> …..
> *Except as is occasioned by circumstances not related to this Contract, and except as is unavoidably essential to execute particular work required under this contract, the Contractor shall execute the Works such that all existing works shall be kept in*

operation or kept in full readiness for operation 24 hours per day throughout the Contract Period.

Where the status of a particular facility cannot be so maintained, due to the Contractor's execution of the Works, the Contractor shall organise his works to minimise downtime of the existing facility and to comply with the specific requirements set out herein. For the administration of this clause the term "operation" shall be interpreted, as appropriate, as the production of potable water (including such treatment normally afforded raw water at a particular site for potability inclusive of continuous application of chlorine), its storage and/or the distribution of potable water.

Scheduled Events

The taking out of operation of any NWC facility or any part thereof that will or may affect the level of service to existing water consumers shall be a Scheduled Event and shall be kept to an absolute minimum. Under arrangements for which the Contractor shall be fully responsible, appropriate Advisory Notices shall be published in the Jamaican Daily Press and broadcast on local radio and television stations in advance of each Scheduled Event in the format and to the extent reasonably required by the Employer and approved by the Engineer. Any failure by the Contractor to arrange for such Advisory Notices to be published or broadcast on a timely basis in relation to any particular Scheduled Event shall result in the withdrawal of approval for that Scheduled Event and the procedures set out above shall apply anew.

9.1.1.3 Noise

In the General Specification

Nuisance caused by noise shall be kept to a minimum with consideration given to the use of the quietest Contractor's Equipment available. For sites located in residential areas or in close proximity thereto, the Contractor is obliged to make use of Contractor's Equipment with minimum inconvenience to the public. Contractor's Equipment shall not be used between the hours of 8.00 p.m. and 7.00 a.m. Monday to Saturday, Sundays or Public Holidays without due authorisation from the Engineer.

All pneumatic breakers shall be fitted with mufflers.

9.1.1.4 Working Hours

In the General Specification

The Contractor shall allow for completing the Contract whilst restricting his working hours to between 8.00 a.m. and 5.00 p.m., on Mondays to Fridays. Other hours of working may be required by the Employer for connections to existing plant.

Any request for working at weekends and public holidays shall be made to the Engineer. Any permission for weekend working granted may be withdrawn if necessary. Any work requested for weekend working shall be such as will not require supervision by the Engineer or attendance by the Employer's Operational Staff.

If, in the opinion of the Engineer, it is necessary for the safety of the Works or for any other reason the Works, or portion thereof, shall be carried out continuously by day and night.

9.1.1.5 Site Cleanliness and Environmental Protection

In the General Specification

The Site shall be maintained by the Contractor in a clean and orderly manner and particular attention shall be paid to the protection and conservation of local environmental features and local habitats.

The Contractor shall be responsible for the proper upkeep and maintenance of the Site and Works.

The Contractor's refuse shall not be deposited indiscriminately and arrangements shall be made for all waste materials, including such things as bags, packing cases, surplus concrete, waste timber and tins to be promptly removed from site and transported to an authorised tip. No refuse shall be deposited into excavations before backfilling. The Contractor shall provide the Engineer with a copy of all tipping records. Local facilities for recycling of wastes shall be investigated and adopted wherever possible.

Materials, plant and equipment shall be positioned, stored and stacked in an orderly manner.

The public and private highways, including footpaths and verges, leading to any particular Site which are used for access shall be kept clean and free from mud, debris and other deleterious matter occasioned by the Contractor's operations. The highways adjacent to or forming part of the site shall be protected against damage resulting from the Contractor's operations.

Site personnel shall be prohibited from urinating or defecating on Site except in properly constructed toilets provided by the Contractor or, subject to any conditions reasonably imposed by the Employer and with the approval of the Employer and Engineer, working permanent sanitary facilities of the Employer at any particular site.

Fuel and oil spillages shall be dealt with by the Contractor immediately in a manner approved by the Engineer. Contaminated material shall be immediately removed from site, including contaminated soils. Contaminated and toxic waste must be disposed of to a suitable authorised tip and written evidence of receipt provided to the Engineer.

9.1.1.6 Disposal of Excavated Material

In the General Specification

The Contractor shall transport and dispose of all excavated material surplus to that required for the works. The all excavated material shall first be transported to a temporary disposal area with haul distance not exceeding 5 km. The locations proposed by the Contractor for disposing or storing excavated materials, whether temporarily or permanently, shall be subject to the approval of the Engineer. When construction commence in each site, the Contractor shall indicate the location of temporary and permanent designated disposal areas giving haul distances from the excavation sites.

> *The excavated material shall not be allowed to stagnate along the excavated trench area and by the side of the road sides causing nuisance to the public. All usable excavated material shall be used as backfill material and the balance material shall be disposed to a permanent disposal area. The following requirements shall be observed by the Contractor in disposing the excavated material.*
>
> - *The routes for transport shall be subject to agreement with the appropriate Local Authorities.*
> - *Transport, loading and unloading of materials shall be carried out in such a way as not to cause nuisance to the people by way of noise or dust.*
> - *Transport of material shall be done in covered vehicles in order to prevent any material dropping on the road and fine dust flowing out.*
> - *Transport of material shall not be carried out in wet condition to prevent spill over of mud and silt along the transport route.*
> - *During loading and disposing times the exposed areas and the access roads shall be damped at regular intervals to prevent nuisance caused due to dust.*
> - *No surplus material of any description shall be disposed of in such a manner as to obstruct or pollute any water course or drainage channel.*
> - *Unless otherwise approved, dumps of surplus material shall on completion, be graded to slight cross falls and even side slopes; the maximum height of such dumps shall be 2 m.*

9.1.1.7 Protection of Artifacts

Although the issue is generally covered within the Conditions of Contract (which are based on FIDIC standard conditions appropriately modified), the Particular Specification includes:

> *The Contractor's particular attention is drawn to the historical significance of the central section of Spanish Town, the potential for the discovery of historical artifacts during excavations for mains replacement in the area and the requirements of Clause 27.1 of the Conditions of Contract. The Contractor shall further note that pursuant to the laws of Jamaica the Engineer's instructions under the said condition of the Contract will be guided by directions issued by the National Heritage Trust.*

9.1.1.8 Traffic Management

In the General Specification

> *The Contractor shall comply with the relevant provisions of the appropriate Highway Authority in relation to traffic safety measures and traffic management requirements. Before any work affecting the use of any highway or road commences the Contractor's method of working shall be agreed with and confirmed in writing to the Engineer, Highway and Police Authorities. The proposed method of working shall include all traffic safety measures and traffic management requirements. Throughout the Contract the Contractor shall co-operate with the Highway and Police Authorities with regard to works affecting highways. The Contractor shall inform the Engineer of any arrangements made with such authorities.*

> *The Contractor shall be responsible for arranging any highway and footpath diversions or closures required and for determining and providing any traffic control measures with the relevant Highway Authority. Where the temporary diversions or closures are required by the Works the Contractor shall provide and maintain an alternative. This alternative shall be in place prior to commencing works affecting the existing route. The Contractor shall allow adequate time so that all statutory requirements and procedures are followed and approvals obtained without delay to the Works. The Contractor shall be responsible for all temporary traffic control measures and signing, at his own cost. The Contractor shall be responsible for meeting all his and the Highway Authority's costs.*
>
> *The Contractor shall provide an information board at each roadworks location that may be left unattended at any time. The board shall give information on the Employer, the Contractor and emergency telephone contacts as agreed.*

In the Particular Specification (for the mains replacement works under Lot1, similar provisions being included in other contract documents where construction activities will affect traffic and access):

> *The works in each defined mains replacement area must be carefully and methodically planned and executed in an efficient and timely manner minimizing disruptions to the normal daily life of the community, both local and at large.*
>
> *It is the responsibility of the Contractor to coordinate his work with all agencies/persons/organizations affected by the works to minimize such disruptions and to undertake all work with due concern for persons, businesses and services affected thereby.*
>
> *Prior to the commencement of construction at site the Contractor shall prepare, and obtain the Engineer's approval of, a comprehensive Work Plan and Methodology Statement for each of the two areas for mains replacement.*
>
> *Specifically for this purpose, the Contractor shall consult with all such agencies/persons/organizations which will include but not necessarily be limited to: -*
>
> - *The Parish Council*
> - *The local Chamber of Commerce*
> - *Recognizable organized groupings of commercial operators within particular fields of endeavour Note that commercial activities occupy the road around the southern end section of Cumberland Road while in the vicinity of Manchester Street and French Street the roads can be totally occupied by open markets. The possibility of temporary restriction of these activities or there relocation with the approval of the relevant authorities should be assessed accordingly – with both the commercial operators and the relevant authorities*
> - *The National Works Agency (NWA)*
> - *The relevant Solid Waste Management Agency*
> - *Police and Emergency Services including the Fire Brigade and Health Services and the Judiciary*
> - *Utility and similar service providers including the National Water Commission (NWC) – water mains; Jamaica Public Service Company (JPSCo.) – overhead*

power cabling; CWJL - underground and overhead telecommunications cabling; Roads and Works Department of the Parish Council / National Works Agency – drainage; Cable Entertainment providers - with overhead cabling

- *National Heritage Trust*
- *Public transport operators*
- *The Engineer*

In particular the Contractor shall identify individuals or organizations within each mains replacement area with special needs or concerns and ascertain the nature of such special needs or concerns.

Following initial consultations, the Contractor shall prepare a comprehensive draft Work Plan and Methodology Statement for each of the two areas for mains replacement. These shall clearly identify the Contractor's proposals with respect to (but not limited to): -

- *ongoing consultation/coordination activities with affected agencies/persons/organizations and the public at large and an ongoing information dissemination programme (keeping the public and those affected informed of progress problems and timetables)*
- *individuals or organizations with special needs and mitigation measures therefor*
- *the establishment of a special needs / emergency hot-line*
- *working hours and overall work programme and timetable*
- *working methodology (taking into account the provisions of the General Specification) covering all work activities including, but not limited to:-*
  - *public safety (barriers, access restrictions and lighting and watching)*
  - *temporary diversions of existing utilities*
  - *the lengths/locations of trench openings at any time*
  - *night or week-end working*
  - *storage / removal / replacement of material excavated from pipe trenches*
  - *protection of day and overnight excavations (if any)*
  - *approach and timing for pressure testing, service connection replacement and new works sterilization*
  - *the collection and collation of "as-built" data covering the new mains and services constructed and other existing services encountered during construction (and any modifications thereto), etc.*
  - *measures and methodologies to be adopted to minimize noise, vibration, dust and other nuisance*
- *traffic and access control plan including plans for the maintenance of pedestrian access to all properties at all times; proposed restrictions on vehicular access; signage - both local and remote (the latter to direct through traffic to alternative routes); parking restrictions; procedures, notice time and timetables for notifications regarding access restrictions/detours etc., (procedures shall include both advanced written notifications delivered to individual premises and the use of the print and radio/television media); etc.*
- *emergency access response plan (to deal with fire, health or public safety emergencies)*
- *emergency repair plan for utility and similar service providers*

- *notifications to NWC customers of water lock-offs – procedures, notice time and timetables (procedures shall include both advanced written notifications delivered to individual premises and the use of the print and radio/television media)*

9.1.1.9 Interference with Access to Properties

In the General Specification

Existing access to properties and land adjacent to the works must be maintained by the Contractor at all times.

Where existing access cannot be maintained, prior to obstructing the access to any property, satisfactory alternative arrangements must be provided by the Contractor. The Contractor shall notify the Engineer and the relevant occupiers in writing 14 days in advance of any such interference and shall confirm to the Engineer that alternative arrangements have been agreed with the relevant occupiers.

The Contractor shall inform owners and occupiers at least 48 hours in advance of any operations that may restrict access to properties and land adjacent to the works.

The Contractor shall not leave any spoil or such other matters related to his works that either obstructs or in any way creates a nuisance.

The Contractor shall maintain emergency vehicle access to all properties at all times.

9.1.1.10 Trees

In the General Specification

Measures to protect existing trees, tree surgery, repair work, bracing and feeding, and tree removal shall be carried out in a manner approved by the Engineer. ……..…

The Contractor shall only cut down and remove from the site such trees as the Engineer shall direct. …..

If the Contractor shall damage, in any way, trees not designated for removal, then he shall replace them at his own cost with plants of a similar size and variety.

9.1.1.11 Clearing and Reinstatement of Ditches

In the General Specification

Where required by the Engineer, existing ditches shall be cleared by removing vegetation and deposits. The sides shall be trimmed, the bottom uniformly graded and the ditches kept clean and maintained for the period of the Works. Material removed from existing ditches shall be disposed of in tips provided by the Contractor off the site.

Where ditches or open drains are crossed they shall be kept open for as long as directed and as may be necessary to allow for the normal seasonal passage of water. On completion of the Works, the ditch or drain shall be restored over the working width to at least its original condition and to the approval of the Engineer.

9.1.1.12 Surface and Ground water Discharge

In the General Specification

Adequate provision shall be made and approvals sought from the Engineer for discharge of any ground or surface water into local water courses, surface water drains and ditches where such water courses, surface drains and ditches extend beyond and into property not owned by the Employer. The Contractor shall take all practicable measures to prevent the deposition of silt or other material in, pollution of, or damage to water courses arising from his operations or acts of vandalism.

Silt traps shall be provided as required on any permanent or temporary drains which may be required for the removal of water during the construction period. All drains shall be maintained clear of silt until completion of the Contract. Any silting of watercourses, whether within the Site or not, which arises from the failure to observe this clause shall be removed.

9.1.1.13 Existing Utilities

In the General Specification

The Contractor will be held responsible for determining the precise location, depth and other relevant information about existing utility apparatus.

Local officials of each of the Utility Companies or Statutory Authorities responsible for buried services shall be contacted and close liaison maintained with them throughout the construction of the works. Under the co-ordination of the Engineer the positions of all main services liable to interference by the construction shall be established in advance, trial holes being excavated where the information cannot be derived from records or surface indications. Apart from verifying positions to avoid damage, scrutiny is needed to clarify those main services which might conflict with the Permanent Works where this is not indicated on the drawings. Where conflicts arise the Engineer will consider if an amendment to the design can be made or if a diversion of the existing main service is needed.

Early scrutiny of these services is essential to enable any such diversions to be made in advance of the construction.

Any utilities marked on the Engineer's drawings are only there for assistance and should not be regarded as complete or accurate information.

Where existing services conflict with the Permanent Works, their diversions will be agreed in detail when they are encountered. Drain diversions shall be made by the Contractor and other diversions by the relevant Utility Company or Statutory Authority unless agreement is obtained from them for such work to be done by the Contractor. The Engineer will co-ordinate this work and will issue detailed instructions for each diversion.

All reasonable precautions shall be taken by the Contractor to prevent damage to existing buried main services and connections to buildings.

Adequate temporary support shall be provided by the Contractor to all existing services and connections that are exposed or partially exposed or otherwise weakened by the excavation. Should any damage occur every facility for the prompt repair of the affected service shall be made available to the Utility Company or Statutory Authority.

Where works are required to be carried out or access taken adjacent to above ground pipelines or pipe supports or any overhead electricity or telephone cables precautions shall be taken by the Contractor to prevent plant and equipment from causing damaging. The Contractor shall consult with the relevant Utility Company or Statutory Authority, in conjunction with the Engineer, to ensure all necessary precautions and a safe system of work is implemented for working adjacent to or under overhead high tension cables and other overhead cables.

Should any leakages or damage to existing services, highways or roads be discovered, the Contractor shall at once notify the Engineer and the Utility Company or Statutory Authority or owner concerned as appropriate, and the Contractor shall afford every facility for the repair or replacement of the apparatus affected.

Records of existing and diverted services shall be maintained to the satisfaction of the relevant Utility Company or Statutory Authorities.

9.1.1.14 Safety, Health and Welfare

In the General Specification

The Contractor shall take full responsibility for the accuracy, stability and safety of all operations and methods of construction. Every precaution shall be taken for the safety of workmen while they are employed on the Works.

Any legislation in operation at the time of Tender or enacted during the Contract Period that affects the working conditions, safety, health or welfare of the Contractor, the Engineer or the Employer and their staff shall be complied with.

Recognised procedures shall be adopted for the safety of workmen, adjacent bystanders and traffic. Attention to be drawn to any guidance manuals referred to in the Schedule of Approved Standards and Guidance publications.

Method statements for all the Contractor's activities, including safety proposals, shall be submitted in advance of the commencement of work. Work activities shall not commence without written confirmation from the Engineer.

The Contractor will be solely responsible for the sufficiency, stability and safety of all temporary works and will supply details, drawings and calculations of such temporary works to the Engineer before construction of the said temporary works.

The Engineer or Engineer's Representative shall be entitled to inspect all Registers, Reports and Certificates which the Contractor is required to keep or issue in respect of safety matters and accidents.

9.1.1.15 Contractor's Equipment *(incl. protection of workers from dust and safety systems)*

In the General Specification

All manufacturer's instructions and recommendations for the use, application, erection, or construction of any material or item of Contractor's Equipment or Plant shall be followed precisely.

Care shall be taken by the Contractor to protect all employees when using power tools or materials which will produce a fine dust and in particular when working on all asbestos based products.

The Contractor shall implement safe systems of work for all construction activities and ensure that method statements are prepared and adhered to. These shall recognise the appropriate approved standards, current guidelines and any regulatory requirements.

9.1.1.16 Dangers of Working in Confined Spaces

In the General Specification

The Contractor's attention is drawn to the dangers of working in confined spaces and in areas of the existing works utilising chemicals for water treatment, including chlorine or its derivatives and fuel oil. Any confined space with limited ventilation which is also connected with water in or from a closed conduit or borehole, or is below ground level, should be treated as a potentially hazardous location where dangerous gases may be present and prior to entry adequate safety precautions must be taken in accordance with current good practice. Due care and diligence shall be taken when working in such locations.

Reference shall be made to the relevant guidance publications listed in the Schedule of Recognised National and International Standards Bodies and Authorities in these documents e.g.:

(1) Health and Safety guideline Nos. 2 and 3 published by the National Joint Health and Safety Committee for the Water Service.

(2) Safety in wells and boreholes - published by ICE.

(3) HSE Guidance note GS5 - Entry into confined spaces.

(4) The section on working in confined spaces in Construction Safety published by the Building Employers Confederation.

(5) BS 6164 Code of Practice for Safety in Tunnelling in the Construction Industry.

(6) Any other appropriate local safety ordinances and regulations.

9.1.1.17 Emergency Arrangements

In the General Specification

The Contractor shall maintain arrangements whereby he can quickly call out labour, materials and equipment outside normal working hours to carry out any emergency work associated with the Works.

A current list of names, addresses and telephone numbers of the Contractor's staff responsible for organising such emergency work shall be provided to the Engineer and maintained current.

The Contractor shall acquaint himself, his employees and any sub-contractors with any relevant arrangements, including those of the Employer, which are in existence for dealing with emergencies.

9.1.1.18 Contamination of Water Supplies

In the General Specification

The Contractor's attention is drawn to the need for all personnel involved directly on the Works to take due precaution against contamination of the water supply

(both raw and treated). The Contractor shall take steps to ensure the following safe practices are adopted:

(i) No person shall be employed on the Contract to work on Site who is suffering from an enteric infection or who is a carrier of typhoid or other waterborne disease.

(ii) All staff engaged in work on Site shall be tested to ensure that they are not carriers of typhoid, other waterborne disease or any other potential pathogenic organisms, or who are otherwise unsuited on medical grounds to be employed in or around water supply installations.

(iii) Before any person commences any activities associated with the Works they shall be notified of the need for personal hygiene and the dangers of contamination and pollution. The Contractor shall remove immediately from the Site any employee who has been polluting or fouling the Site.

(iv) A register shall be kept on Site showing the name, address and date of test of each member of staff so tested.

(v) Should any person on the Works be affected by an illness associated with looseness of the bowels, this shall be promptly reported to the Engineer. The Engineer may then instruct that the person affected be suspended temporarily or permanently from the Contract, or be employed only on certain parts of the Works until the Employer's medical officer is satisfied that it is safe for him to be employed on other areas of the Works.

(vi) The Employer's medical officer may at any time examine any or all of the Contractor's personnel to confirm that they are not suffering from, or are carriers of enteric infections, typhoid or other waterborne disease.

(vii) Adequate sanitary accommodation and washing facilities shall be provided by the Contractor at Site.

(viii) The Contractor shall ensure that any equipment that comes into contact with potable water processes shall be reserved solely for such use. Such equipment shall be disinfected prior to use.

9.1.1.19 Pollution of Watercourses

In the General Specification

The Contractor shall notify the Engineer in writing 14 days in advance of his intention to commence any part of the Works affecting a watercourse, canal, lake, reservoir, borehole, aquifer or catchment area.

The Contractor shall be responsible for maintaining watercourses, including land and road drainage within the Site, in effective working order at all times.

All necessary precautions shall be taken to prevent the pollution or siltation of rivers, streams, watercourses, reservoir, catchment areas, surface water drains and ground surface by poisonous, noxious or polluting matter arising from the Contractor's operations.

The Contractor shall obtain approval for all temporary discharges, crossings or diversions to watercourses from all appropriate bodies and shall comply in all respects with their requirements.

The Contractor is required to provide the Engineer with a Method Statement for implementing his preventative measures.

Any construction vehicles and equipment which, in the opinion of the Engineer, presents a risk of affecting a watercourse shall be removed from site.

9.1.1.20 Hazardous Substances

In the General Specification

The Contractor shall not bring to the Site, or use for any purpose, any hazardous substances unless written approval has been given by the Engineer and any necessary licences have been obtained.

All locations and methods of storage for hazardous materials shall be approved in writing by the Engineer.

9.1.1.21 Trenches Not To Be Left Open

In the General Specification

Trench excavation shall be carried out expeditiously and, subject to any specific requirements of the Contract, the refilling and surface reinstatement of trench excavations shall be commenced and completed as soon as reasonably practicable after the pipes have been laid and jointed. Pipelaying shall follow closely upon the progress of trench excavation and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline. The Contractor shall be responsible for preventing and taking precautions against floatation of pipes in locations where open trench excavations may become flooded, and these precautions may include the partial filling of the trench leaving pipe joints exposed for water tightness testing of the joints.

Each trench excavated for restitution of an individual service connection shall be backfilled within 10 days of the initial excavation. If it is impossible to complete the work at an individual service connection for any reason, then the trench shall not be backfilled until the required work can be performed.

If the Engineer considers that the Contractor is not complying with any of the foregoing requirements he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trench excavation. The Contractor will not be permitted to excavate trenches in more than one location in any one road at a given time without the Engineer's written permission.

9.1.1.22 Protection of Structures

In the General Specification

The Contractor shall be responsible for the care and protection of all existing service utilities or other facilities and structures which may be encountered in or near the area of his work.

The services drawings, prepared by the Engineer indicate the approximate locations of all identified services determined by the Engineer. The individual house connections of utilities are not shown in these drawings. The Contractor shall carry out his own searches by excavating trial pits or by other methods as may be appropriate. During the excavation, the Contractor shall take action either to temporally divert or support across the trench all services mainly crossing the

trench in consultation with the respective Utility Agencies. If any of the service connections are to be supported across the trench, the Contractor shall provide adequate support and cover to prevent any damages to the services during construction. When a main utility service crosses the trench the Contractor shall provide a reasonable space for the crossing of such services in trench support at such locations as may be required.

As most of the services are located within about one meter depth from the road surface the Contractor shall take extra precautions in excavating initial one meter depth. The Contractor shall carry out excavation of first one meter depth with light equipment such as pavement breakers combined with manual excavation to avoid damages to any services which have not been relocated. If any utility service gets damaged during excavation, the Contractor shall take prompt action to restore the same in consultation with the respective Utility Agency.

9.1.2 Enforcement by the Resident Engineering Staff

While the Contractor is responsible for particular contractual obligations, as illustrated in the foregoing section, the resident engineering staff on site will carefully monitor Contractor performance and will be charged with the day-to-day task of ensuring that contract provisions are properly applied and followed.

All resident engineering (RE) staff will be fully briefed on and sensitized to the contractual provisions as they relate to protection of the environment and their importance.

In addition both RE staff and the Contractor will be provided with the Management Plan for the Potential Interactions between Humans and Crocodiles prepared for the project

9.2 ENVIRONMENTAL MONITORING DURING IMPLEMENTATION

9.2.1 Environmental Standards

NEPA and other Jamaican Standards have been adopted as the primary reference in developing the requirements for environmental monitoring during project implementation. Where standards are in draft form it is assumed that they will receive legislative backing during the project's implementation and these will be implemented as would have been otherwise intended.

9.2.2 Scope of Environmental Monitoring

The environmental monitoring programme will:

- Monitor any changes in the biophysical and social characteristics of the environment within the specific areas impacted by work under the project;
- Determine if these changes result form project causes;
- Identify the impact of non-compliance by the Contractor with contractual requirements that are designed to protect the environment and mitigate potential negative impacts;
- Assess the effectiveness of potential negative impacts, and
- Identify any concerns not foreseen and recommend additional mitigation measures.

Complaints received from the general public will be monitored by the Resident Engineer for each lot who will initiate appropriate action.

All authorized personnel from NEPA, the NWC, the RE staff, the Environmental Managers (ESL) and other relevant agencies will be guaranteed access to all project sites at all times throughout implementation and the Senior Resident Engineer, through his staff of Resident Engineers for each lot, will liaise between all involved parties.

RE staff will undertake regular monitoring of construction activities and inspections will be carried out regularly and reported upon, but not necessarily in a pre-defined structural approach.

ESL as the environmental managers for the project will undertake regular inspections and as deemed necessary based on project generated reports.

9.2.3 Reporting

Reporting will primarily comprise:

- Individual RE staff Inspection reports presented at Monthly Contract Progress meetings;
- Individual site visit reports by the environmental managers, ESL;
- Individual site visit reports by NEPA;
- Bi-annual (6 monthly) Compliance Reports

9.3 COSTS OF ENVIRONMENTAL MONITORING & MITIGATION MEASURES

The costs of environmental monitoring to be undertaken by the RE staff and by the environmental managers, ESL, will be borne by the NWC and are included within the overall project budget.

Monitoring and mitigation measures required of Contractors have been included in tender documents for the project and thus will be included in contract costs.

The costs of monitoring of future operations will be borne directly by the NWC.

10 SUMMARY AND CONCLUSIONS

The KMA Water Supply Project as designed will see the implementation of several project works including the rehabilitation of existing facilities, replacement of obsolete parts and equipment, development of groundwater resources and recharge of a major aquifer. These project works will result in several positive impacts including an increase in the water supply for the provision of potable water to the Kingston Metropolitan Area, a reduction in unaccounted for water and a greater efficiency of operations.

Several environmental issues have been identified as being relevant to the project. In the physical environment the construction of new wells with the potential for over abstraction and the aquifer recharge programme will impact the existing hydrological regime. The potential for increased fugitive dust, noise and vibration during construction processes can affect air quality and human health. The mitigation measures detailed herein should be implemented.

In the biological environment loss of some vegetation is expected and along with it some potential dislocation of birds, reptiles and amphibians. No rare, threatened or endangered birds are expected to be impacted in the project area. The endangered American Crocodile, protected by law, may be impacted by the project works, as the project area is within known crocodile habitat that encompasses the lower reaches of the Rio Cobre and the irrigation network. Impacts are expected through the increase in human activity, noise and earth moving equipment. More significant is the potential risk to humans from interaction with the crocodiles and the mitigation measures as detailed should be implemented, to minimize human/crocodile interaction and safe guard public safety in the event of interactions.

Within the social environment traffic and transportation routes are expected to be significantly impacted. Mitigation measures as detailed should be implemented to minimize disruption to businesses, reduce risks to public safety and to facilitate the smooth flow of traffic.

In addition to the potential impacts of the proposed project on the existing environment, a critical issue identified is the impact on the project due to the existing environmental context in which the project is placed. The success and sustainability of the project are

dependent on the quantity and quality of the raw water supply. Several aspects of the existing conditions have been identified which if not curtailed, will negatively impact the project. These include illegal sand mining, approved housing developments, improper solid waste disposal, sewage effluent discharge, pesticide use, security and community use of irrigation network and associated facilities.

These issues and their expected impacts have been outlined. The main mitigation measures proposed will require a co-ordinated effort and the cooperation of several government agencies to ensure that the quality and quantity of water for the Kingston Metropolitan Area is not compromised. These are:

- ✓ Upgrading of sanitation systems
- ✓ Installation of adequate solid waste disposal systems
- ✓ Re-siting of sewage effluent disposal outfalls
- ✓ Re-siting of planned housing developments
- ✓ Enforcement for illegal sand mining activities
- ✓ Inter-agency co-ordination

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