January 30, 2007

Environmental Assessment
Guyana National Engineering Solutions to Climate Change Project

1. Introduction

Over 90% of the Guyanese population lives within 30 kilometers of the Atlantic coast. This is an area of reclaimed lands, much of which lies below the regional mean sea level. Protected by a seawall complex, the coastal zone is heavily intervened with a network of drainage and irrigation canals. These link the EDWC water storage systems to regional agriculture and provide for regional drainage and flood control.

Present rates of sea level rise and projected environmental impacts associated with global climate change pose a significant threat to the country and its economy. While recent projects conducted under Climate Change Adaptation have served to define needs and highlight policy deficiencies, recent flooding demonstrates the immediate vulnerabilities of Guyana to climate driven events and weaknesses in the current infrastructure. This project is designed to provide some immediate infrastructure improvements to cope with the local effects of sea level rise and provide a technical baseline for the continued management and adaptation of the local drainage and flood control network.

2. Description of Project Area

Guyana's coastal zone consists (figure 1) of a low-lying system of marine and riverine deposits which formerly comprised an extensive network of tidal deltas. The origin of the coastal sediments includes discharges from local river systems and a large sediment load that is transported from the Amazon River northward along the northern coast of South America by the Guiana current.

Much of the land now in use in northern Guyana lies in the coastal zone below the mean high tide level which is around 54 ft Guyana Datum (GD). This land was reclaimed from tidal areas and is protected by an intricate network of seawalls, dykes, polders and drainage structures. Guyana's agrarian economy, which contributes over 35 percent to the GDP, is highly dependent on this coastal drainage and irrigation system as are the homes and businesses of the region.

Human settlement and infrastructure is concentrated in the reclaimed coastal plain where approximately 75 percent of the nations population resides. The population is distributed in locations determined by the availability of suitable land for housing and services. The areas of the Essequibo Islands – West Demerara (Region 3), Demerara – Mahaica (Region 4) and the Mahaica – Berbice (Region 5) are the most densely populated areas, with the majority of Guyana's citizens located in Region 4. The highest population densities are found in the vicinity of the capital, Georgetown, and adjoining areas due to its proximity to the agricultural zone and access to port facilities.

Figure 1
Guyana Political Boundaries

Guyana's drainage and irrigation system has its origins during the Dutch colonial period beginning in the late 1600's. Land reclamation began under their tender and continued through the British colonial period until Guyana gained independence on May 26, 1966. Over the 200 years of operation, the drainage and irrigation system has been modified and amplified to increase the quantity of tillable land. Drainage has been managed through the use of gravity based systems augmented with pumps but the system has suffered from the impacts of sea level rise over the past century. A series of severe storms have further stressed the drainage and water storage system and at the present time, the reclaimed coastal areas are highly susceptible to flooding. Given the forecasted impacts associated with global climate change and sea level rise, the risk of future flooding, even during normal weather events, is increasing significantly.

3. Description of Project

The Guyana Conservancy Adaptation Project (CAP) is designed to assist the Government of Guyana (GoG) with their efforts to design rehabilitation and long term plans for the management of flooding in the coastal inhabited areas (figure 2). Additionally, in region 4, the East Demerera Water Conservancy (EDWC) is the principal source of irrigation water and a major source of potable water for the region. A field review of the EDWC infrastructure after the floods experienced in 2005 and 2006 identified some significant issues relating to protection of the dam and its infrastructure. As a result, the project will finance specific rehabilitation works and operational improvements aimed at enhancing the capacity to manage water levels within the EDWC to compensate for losses of drainage capability due to sea level rise.

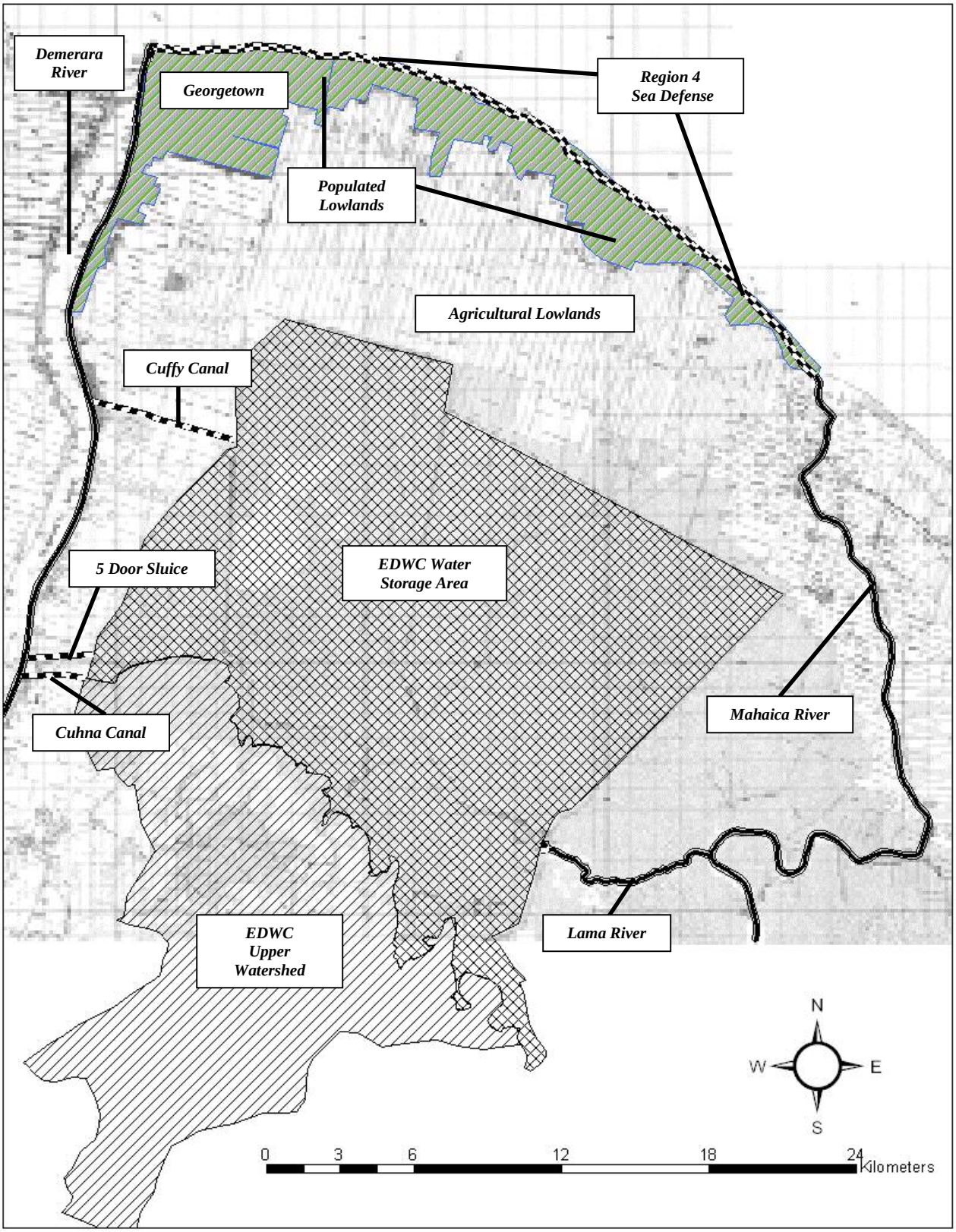
For the coastal lowlands, the project will develop a comprehensive engineering baseline and analytical tools for use in planning future interventions within the lowland drainage system. The tools developed under the analytical component of the project will be used by the IDB to design and develop a comprehensive US$25 million flood management project.

The project is divided into 3 basic components. These are:

- *Component 1 – Infrastructure civil works and operational improvements*- Comprising minor maintenance works to existing water control structures in the EDWC, clearing internal flow blockages in the system, and the reopening of 1 or 2 discharges to the Demerara River to improve relief drainage capacity.

- *Component 2 – System Analysis and Hydrologic baseline studies* – A detailed collection of engineering and analytical studies to designed to characterize both the characteristics of the EDWC from a flow and safety perspective and the flood control and drainage behavior of the inhabited coastal lowlands. Outputs will include both critical engineering data and a digital elevation model of the region for use in flood management and land use planning.

Figure 2 - Map of Project Area



- *Component 3 - Project Management and Donor Coordination* – An administrative component designed to assist with institutionalizing long-term flood water management and assistance in coordinating objectives with the donor community.

3.1. Component 1 – Infrastructure civil works and operational improvements

The project will finance key interventions to the EDWC. Works to be financed by the GEF will focus on improving the ability of the Government to manage water levels behind the EDWC Dam during heavy rains by improving internal water flows in the conservancy and increasing EDWC drainage relief capacity to the Demerara River. Improvements to the conservancy dam are not contemplated under this grant because the scope of such works is beyond the capacity of this project to execute. These works will be deferred to the larger IDB initiative. To advance that activity, the GEF project will fund the engineering safety assessment and analysis of the dam structure to prioritize future intervention works. Interventions envisioned include inter alia:

- *Rehabilitation of key drainage relief canals:* The Cuffy Canal, which currently operates at reduced capacity due to certain restrictions, will be rehabilitated to its original design in order to improve its discharge capacity by 30 percent. Rehabilitation of the Cuhna canal may also be considered based on feasibility and availability of funds. Both canals pass under the main road from the airport to the capital Georgetown and the length of canal to be rehabilitated in both cases is roughly 1,000 meters.

- *Improvement of water flow system within EDWC:* Due to overgrowth of internal waterways behind the EDWC Dam, water is backed up in the north eastern part of the conservancy. As internal creeks are choked with vegetation, water does not efficiently flow westward to the Demerera drainage structures, as originally designed. Therefore, a rationalization plan will be developed and the government will carry out the necessary work within the conservancy to level the hydraulic gradient and improve the drainage relief capacity to Demerara River. The effect of these improvements will significantly increase the western discharge capacity of the system. For example, a principal water control structure, the five-door sluice is presently operating at 70 percent efficiency. It is anticipated that improving internal conservancy flows will increase discharge efficiencies at this structure to near 100 percent.

- *Repair of water control structures*: Various sluice gates behind the EDWC do not operate as originally designed, and in many cases leak water from behind the conservancy dam. These structures will be repaired to their original designs.

3.2. Component 2 – System Analysis and Hydrologic Baseline

Analytical work to be financed under the project aims to provide the hydrologic baseline necessary for contemplating rational interventions to the flood control system. Without the knowledge of how drainage regimes in the populated areas of the coastal lowlands behave, authorities are unable to identify where flood waters originate or where interventions are going to be effective. Additionally, future growth in the region cannot be adequately managed as its impact on the flood control network cannot be accurately evaluated. Emergency interventions are undertaken without an understanding of how the current flood control regime functions. Years of neglect coupled with unregulated land-use change has greatly perturbed the original network. The impact of these changes, in some areas, has lead to increased flooding or has impeded the ability to remove water. The results from this component will provide the hydrologic baseline critical for flood zone management and the design of effective interventions. Analysis will include, inter-alia:

- *Detailed Topographic and Landuse Mapping*: Existing conservancy and coastal drainage, irrigation systems, and landuse will be plotted and large-scale digital elevation maps (DEMs) using a combination of aerial photography coupled with LIDAR (light detection and ranging) technology will be produced. Where necessary, conventional land survey techniques will also be used to augment data production. Survey work will be tied to the national geodetic grid and vertical datum. Target contour intervals are in the range of 1 foot or less.

- *Hydrologic Modeling of Coastal Lowlands* – Using the LIDAR derived topographic baseline, hydrologic models will be applied to the regional topography to identify and assess water flows in the region. These models will be used to identify flood risks and optimum drainage options for flood management. Additionally, the models coupled with the DEM and landuse mapping will be used to assess the impact of current constructions on the drainage network and provide a basis for evaluating the impact of future landuse changes on the drainage and flood control system.

- *Assessment of* EDWC *System Integrity*: An engineering evaluation of all EDWC structures (including dams, canals, levies, sluices and sluice gates) will be conducted to determine which parts of the system are not operational, which need repairs and what needs replacement, to allow the system to operate at maximum capacity.

- *EDWC Hydraulic Modeling*: Within the EDWC, data will be collected to produce a system flow model. This model will serve as a foundation to develop improved management procedures using defined operational parameters and to identify the improvements in drainage infrastructure needed to protect the system from failure. These flow models will help identify key bottlenecks for effective drainage and purging. The hydraulic model of the conservancy system will be

developed to evaluate the most effective measures that can be taken to increase the drainage relief capacity of the EDWC.

- *Pre-feasibility studies for coastal lowland interventions:* Based on the results of the hydrologic modeling, and scenario analysis, 10 – 20 key interventions will be prioritized and presented to the Government and the donor community to further improve coastal flood controls.

- O*perational Capacity Building:* Development of an extensive training program that will allow the government's responsible agencies to better understand, operate and maintain the EDWC and coastal lowland drainage relief systems.

3.3. Component 3 - Institutional Strengthening and Project Management

The objective of this component is to strengthen the institutional framework for flood control within the context of the national emergency management sector headed by the Civil Defense Commission. The project will finance activities to better assess the current needs of the actors involved in the flood control and emergency management and will work together with the concerned parties to develop a national framework for a more streamlined approach to hazard and risk management in the country. The project will also support consultations with civil society and the donor community to create consensus around a medium and long term intervention strategy to help the country adapt to sea level rise. The key outcome of the analysis and project management component will be improved Government effectiveness in managing floods and other emergencies. With clear lines of responsibility in times of urgent need as well as times of calm, the GoG will be better equipped to manage flood control policy.

4. World Bank Safeguards Triggered

Based on the recommendations from the Bank Quality Assurance Team, several safeguards were triggered for consideration, including:

- Environmental Assessment (OP/BP 4.01)
- Natural Habitats (OP/BP 4.04)
- Forests (OP/BP 4.36)
- Physical Cultural Resources (OP/BP 4.11)
- Safety of Dams (OP/BP 4.37)

A description of safeguard issues and impacts associated with the project can be found below:

Environmental Assessment (EA) (OP/BP4.01):

Civil works funded under this project may include the widening of the Cuffy and/or Cuhna outlet structures. These activities will require the construction of a bridge along a major north-south thoroughfare. Environmental impacts will be limited to the construction sites and will result in a temporary impact to local traffic. An

Environmental Assessment will be conducted during the engineering design stage of the project component to address these issues. These two structures lead directly to the Demerara River. The only function of these canals is to provide relief capacity to the EDWC system to protect the EDWC dam during the two rainy annual seasons. These canals are not associated with the irrigation or potable water supply functions of the EDWC system. While not expected to have an adverse impact on conservancy, an additional site-specific EA will be completed for the improvement of water flow systems within the EDWC. Remaining civil works are limited to repairs to existing structures and are classified as category C. These works will be contracted using appropriate environmental management clauses to assure contactor compliance with accepted environmental practices.

A key output of the analytical work will be an engineering tool that is to be used to as a foundation for determining the environmental impacts of follow-on interventions. With the development and use of a detailed digital elevation model, local watershed characteristics and drainage regimes will be mapped and modeled, creating the basis for future engineering interventions. A separate report will be developed, based on the analytical work undertaken in the project, which will specifically addresses the likely environmental impacts of future interventions. Expected hydraulic impacts, as well as changes in water quality, natural habitats, land use, livelihoods and analysis of alternative strategies will be considered. Based on this information, an intervention strategy will be developed.

Natural Habitats (OP/BP 4.04)

A portion of the project takes place within the East Demerara Water Conservancy. This is a man made structure that is considered a natural habitat. No adverse impacts to the conservancy are envisioned under the project. At the same time, by improving the drainage capacity of the EDWC and assessing the weak portion of the EDWC Dam, the project aims to ensure that this natural habitat remains in tact.

Physical Cultural Resources (OP/BP 4.11)

While activities to be carried out under the project are not expected to impact any known cultural heritage sites, technical specifications for works in the Operation Manual will include "chance find procedures" to be followed in the event that culturally significant materials are discovered during the execution of civil works.

Forests (OP/BP 4.36)

The southern portion of the East Demerara Water Conservancy is bordered by a forest. No physical work is envisioned within 10 miles of this forest and no adverse impacts to the forest are envisioned under the project. Moreover, improvements in water flows within the EDWC are expected to have no impact on the bordering forest.

Safety of Dams (OP/BP 4.37)

The EDWC is bordered to the north by a 30 mile long earthen dam constructed some 150 years ago. The dam has been heavily stressed particularly during the past two flood events (2004-5, 2005-6). While no civil works are to be conducted on the dam, a detailed engineering assessment of the dam and its associated drainage structures is to be completed under the project. This will provide the engineering and safety guidance to the GoG for the design and development of any dam strengthening programs.

The engineering analysis developed under the present project will provide the technical basis for the Government to fulfill the requirements for an expert assessment of the weakened portion of the EDWC Dam provided under this safeguard. Upon receipt of the dam safety assessment, and as part of implementation of the project, the World Bank will contract independent experts to assess and to validate the quality of the report.

5. Environmental Impacts resulting from Project Activities

The environmental impacts resulting from the execution of project activities are limited to those activities contemplated under component 1, *Infrastructure civil works and operational improvements.* The remaining components pertain to scientific and engineering studies or administrative and institutional strengthening activities and will not result in physical impacts to the project area. Table 1 presents a summary of project components and environmental summary.

Table 1
Environmental Summary

Project Component	Component Task	Type of Activity	Description of Activity	Direct Environmental Impacts anticipated	Bank Environmental Classification	Environmental Management Requirements
Component 1 – Infrastructure civil works and operational improvements	*Rehabilitation of key drainage relief canals to be determined*	*Construction*	Rehabilitation of 1 or 2 drainage canals, to be determined.	Direct construction impacts, traffic and transportation impacts	Category B	Once actual works are identified, EA will be produced under the project during the design phase.
Component 1 – Infrastructure civil works and operational improvements	*Improvement of water flow system within EDWC*	*Engineering - Hydraulics Study and maintenance plan*	Maintenance planning, and internal hydraulics and flow optimization study.	None - Engineering Hydraulics study-data development.	Category C	None
Component 1 – Infrastructure civil works and operational improvements	*Repair of water control structures*	*Maintenance and repair*	Minor repair and maintenance of existing water control structures.	Minimal impacts associated with water control structure maintenance and repair activity	Category C	Environmental contract clauses to be applied (Annex 1)
Component 2 – System Analysis and Hydrologic Baseline	*Detailed Topographic and Land use Mapping*	*Engineering study and data development*	Baseline data development and analysis.	None - Engineering Hydraulics study-data development.	Category C	None, data developed to be used in future projects and forms the foundation for future environmental management programs.
Component 2 – System Analysis and Hydrologic Baseline	*Hydrologic Modeling of Coastal Lowlands*	*Engineering study and data development*	Baseline data development and analysis.	None - Engineering Hydraulics study-data development.	Category C	None

Project Component	Component Task	Type of Activity	Description of Activity	Direct Environmental Impacts anticipated	Bank Environmental Classification	Environmental Management Requirements
Component 2 – System Analysis and Hydrologic Baseline	*Assessment of* EDWC *System Integrity*	*Engineering study and data development*	Baseline data development and analysis.	None - Engineering Hydraulics study-data development.	Category C	None
Component 2 – System Analysis and Hydrologic Baseline	*EDWC Hydraulic Modeling*	*Engineering study and data development*	Baseline data development and analysis.	None - Engineering Hydraulics study-data development.	Category C	None
Component 2 – System Analysis and Hydrologic Baseline	*Pre-feasibility studies for coastal lowland interventions*	*Engineering analysis and design*	Pre-feasibility engineering design and tender document development.	Pre-feasibility designs will need to be evaluated for potential environmental Impacts	Category C	EA(S) will be produced under the Bank project for intervention activities identified as part of the pre-feasibility engineering design
Component 2 – System Analysis and Hydrologic Baseline	O*perational Capacity Building*	*Technical training and institutional strengthening*	Training program in the use of engineering analysis tools and use of data developed under the project.	None- Training and institutional activity	Category C	None
Component 3 –Institutional Strengthening and Project Management	Institutional Capacity Building	Institutional Development, Public Consultation and Policy development assistance	Meetings and consultations with government and non-government entities	None- Public consultation and institutional strengthening activities	Category C	None

5.1. Impacts expected from Component 1

Two types of activities are contemplated under the *Infrastructure civil works and operational improvements* component. The first is largely in support of maintenance requirements associated with water control structures in the EDWC. Works of this nature will involve the repair of sluice gate doors, repairs to operating mechanisms, replacement of stairs and platforms associated with control structures and similar activities. Under no circumstances will any intervention be made to the dam and structures will be repaired as is without modification to their discharge characteristics. Impacts are restricted to those resulting from site activities and the disposal of waste materials from rehab operations.

The other category of works contemplated under this component is the increase to the drainage relief capacity of the EDWC system. This involves the rehabilitation of one or two relief canals on the western edge of the EDWC. These canals were used historically as relief structures. The canals are the Cuffy and the Cuhna.

Impacts anticipated from the rehabilitation of these canals are related to the need to construct bridges in the main road from the capital to the northern interior of the country and the impacts associated with excavation activities in the project area. The lands are otherwise vacant and no relocation activities will be required as a result of project. In both cases, the constriction activity will be limited to the existing ditch alignment. Ditches are for relief purposes only and will not impact the water use activities of the conservancy.

5.2. Impacts expected from Components 2 and 3

Components 2 and 3 do not produce direct impacts as they to not involve any construction activity. These activities relate to engineering data development studies and institutional strengthening activities. However, work contemplated under component 2, activities developed under *Pre-feasibility studies for coastal lowland interventions,* will result in the preparation of works bidding packages for future execution through the GoG as funding becomes available. This will, in all likelihood involve the participation of a donor agency.

Therefore, as an activity under this project, appropriate environmental planning and required environmental assessments will be completed for the works under policies established by the Bank for the engineering designs and bidding documentation developed under the key interventions

6. Project Environmental Management

Environmental management during the project life will include three basic activities: First, for the small maintenance related works, the environmental requirements presented in annex I will be applied in the form of contract clauses.

The second element is the infrastructure works under component 1, Rehabilitation of key drainage relief canals. This task will be defined as an activity under the project. During development, the actual site of works will be selected from among the two choices, the Cuhna and Cuffy canals. Once agreement is reached on the location of the rehabilitation, a complete engineering design and tender process will be developed and implemented to produce the works. An environmental assessment of the works under consideration will be produced as part of the engineering process and findings of the EA will be incorporated into the final designs. Both sites will require the construction of a bridge over the canal works which will require traffic management considerations as the roadway affected is the principal route from the capital to the airport and northern interior of the country.

Finally, as a result of the analysis of regional hydrologic conditions, the project will develop a series of engineering interventions which will be designed to optimize the drainage and flood control system of the coastal lowlands. The project will take these interventions through the pre-feasibility design phase for follow-up by the government or other donors under follow-on projects. During the development of these designs, the project will also produce an environmental assessment of the interventions identified.

Sample TORs for the environmental assessments are contained in Annex 2 of this document to be executed under both the canal rehabilitation and drainage intervention designs tasks of the program.

Annex 1
Environmental Contract Clauses for Small Works

1. Site Security

The contractor shall be responsible for maintaining security over the construction site including the protection of stored materials and equipment. In the event of severe weather, the contractor shall secure the construction site and associated equipment in such a manner as to protect the site and adjacent areas from consequential damages. This includes the management of onsite wastes, construction and sanitary, additional strengthening of erosion control and soil stabilization systems and other conditions resulting from contractor activities which may increase the potential for damages.

2. Discovery of Cultural – Historical Artifacts

If, during the execution of the activities contained in this contract, any material is discovered onsite which may be considered of historical or cultural interest, such as evidence of prior settlements, native or historical activities, evidence of any existence on a site which may be of cultural significance, all work shall stop and the supervising contracting officer shall be notified immediately. The area in which the material was discovered shall be marked and the evidence preserved for examination.

Work may resume, without penalty of prejudice to the contractor upon permission from the contracting officer with any restrictions offered to protect the site.

3. Worker Sanitation

Sanitation facilities shall be provided to site workers. All sanitary wastes generated as a result of project activities shall be managed in a manner approved by the contracting officer. The contractor shall provide the contracting officer with a site sanitation plan for approval and implementation prior to the commencement of site activities.

4. Site stabilization and erosion control

Contractor shall implement measures at the site of operations to manage soil eroding through minimization of excavated area, preservation of existing ground cover to the extent possible, provision of approved ground cover.

Where excavations are made, contractor shall implement appropriate stabilizing techniques to prevent cave-in or landslide. Measures shall be approved by the contracting officer.

An erosion management plan will be required where the potential exists for significant sediment quantities to accumulate in wetlands, lakes, rivers and near-shore marine systems. This plan shall include a description of the potential threat, mitigation measures to be applied, and consideration for the effects of severe weather and an emergency response plan.

5. Use of preservatives, paint substances, and hazardous materials

All paints and preservatives shall only be used with the approval of the contracting officer. Information shall be provided to the contracting officer which describes the essential components of the materials to be used so that an informed determination can be made as to the potential for environmental effects and suitability can be made. Storage, use, and disposal of excess paints, preservatives, and hazardous materials shall be managed in conformance with the manufacturer's recommendations and as approved by the contracting officer. The contractor shall provide the contracting officer with a list of materials and estimated quantities to be used, storage, spill control and waste disposal plans to be observed during the execution of the contract. This plan is subject to the approval of the contracting officer.

6. Management of trash and debris

The contractor shall provide the contracting officer with a trash and debris management plan that conforms to the solid waste management policies and regulations of Guyana. Under no circumstances shall the contractor allow construction wastes to accumulate so as to cause a nuisance or health risk due to the propagation of pests and disease vectors. The site waste management plan shall include a description of how wastes will be stored, collected and disposed of in accordance with current law. Additionally the contractor shall provide for the regular removal and disposal of all site wastes and provide the contracting officer with a schedule for such removal.

7. Disturbance of wildlife

The contractor shall ensure that contractor employees shall refrain from engaging in any activity resulting in the molestation of wildlife. Hunting and fishing in the work area shall be strictly prohibited. Under no circumstances will employees rely on local wildlife resources for sustenance during the execution of construction works. Contractor personnel are strictly prohibited from hunting, fishing or gathering of plant life within the conservancy boundaries. The contractor shall ensure that contract employees are adequately prepared with provisions of food and water as needed at the work site during the execution of works.

Annex 2
Sample TOR for the Execution of
Environmental Assessments under CAP

Environmental Assessment for Civil Works

Once the civil works are identified and approved by the contracting officer, the contractor shall prepare an Environmental assessment of the works contemplated. This assessment shall conform to Guyana national and World Bank Guidelines and at a minimum include:

1. Executive Summary of not more than 2 pages

2. Description of the works and alternatives considered

3. Legal framework including environmental, land use, water management and other related laws and regulations

4. Description of the Existing Environment

    - Biological
    - Physical
    - Socioeconomic

5. Analysis of Impacts including selection of the preferred options

    - Biological
    - Physical
    - Socioeconomic

6. Mitigation Analysis of the preferred option

7. Mitigation plan

8. Environmental Management Plan

9. Record of Public consultations

10. Technical Annexes

This assessment shall be written in a concise manner in terms that can be readily understood by non-technical personnel and shall be organized to clearly present the positive and negative impacts of works identified. Technical supporting information shall be included in the technical annex of the report.

Public consultation

During the development of this assessment, the contractor shall conduct public meetings with the affected population, relevant government and non-government entities. A record of these meetings shall be summarized in the assessment and a written record of these meetings shall be contained in the annex section of the report.

Public Comment

This report shall be delivered to the Government of Guyana and the World Bank for review. Additionally, the report shall be made available for public comment for not less than 30 days. At the conclusion of the public comment period, comments shall be reviewed and incorporated in the final environmental assessment document.

Relocation Plan

In the unlikely event that works require involuntary relocation. A relocation plan shall be developed pertaining to the affected sites. This plan shall be produced consistent with the Guyana national legal framework and shall conform to World Bank requirements for involuntary relocation.