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TECHNICAL REVIEW OF THE GRENADA GRAND ANSE SEWER PROJECT

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WATER AND SANITATION for HEALTH PROJECT

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TECHNICAL REVIEW OF THE GRENADA GRAND ANSE SEWER PROJECT

Prepared for the Regional Development Office for the Caribbean,
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By

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and
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ACRONYMS

A.I.D.	United States Agency for International Development (Washington)
CIDA	Canadian International Development Agency
GIDC	Grenada Industrial Development Corporation
HPE	Office of Health, Population, and Education (RDO/C)
MGD	Million Gallons per Day
NAWASA	National Water and Sewerage Authority
O&M	Operations and Maintenance
PAHO	Pan American Health Organization
RDO/C	U.S. Agency for International Development, Regional Development Office for the Caribbean
TVA	Tennessee Valley Authority
USAID	United States Agency for International Development (overseas mission)

EXECUTIVE SUMMARY

Background

To improve sanitary conditi ...r a significant percentage of the population of Grenada and to improve the infrastructu... uired for its tourism industry, the Government of Grenada approved the design for the ...d Anse Sewer Project (hereafter "the Project"). The United States Agency for Internation... ...velopment (USAID) has provided funding. Construction commenced in September 19... and the anticipated completion date for the project as designed is October 1992.

The Project provides for collection of domestic and commercial sewage in the Grand Anse area and transfer of wastewater to an ocean outfall which extends 1,100 ft. (335 m) into the ocean at Point Salines. The design provides for screening for large debris with no further treatment.

An area containing an equivalent population of approximately 10,000 people (residents, hotels, and industry) is presently serviced by septic tanks and pit latrines. Sullage (grey water) is typically disposed of in surface drains. Drainage from this area is collected in two drainage ditches and is discharged to the near shore area on Grand Anse beach. Coliform contamination and increased concentrations of nutrients have been found in the bay in previous studies. Near the discharges, odors are unpleasant and the drainage plume is apparent. Both residents of Grenada and tourists take advantage of the recreational opportunities provided by Grand Anse beach.

Because cholera is spreading throughout the region, public awareness and interest in this disease has increased. Indeed, cholera represents a significant threat to the population of islands in the Caribbean. The pending threat of cholera has prompted this re-evaluation of the design rationale for the Project.

The objectives of this study were to: (1) assess the potential risk of the spread of cholera associated with the Grand Anse Sewer Project design; (2) provide recommendations for reducing or eliminating such threat if appropriate; and (3) suggest broad communication strategies for local authorities to inform the Grenadian public about the Grand Anse Sewer Project.

Findings

The team conducted a detailed review of the Project with particular reference to the transmission of cholera should an outbreak occur. Sources of information were documentation, interviews, and on-site visits. The following conclusions and recommendations were reached:

- Cholera is a real and significant threat to the population of Grenada and other Caribbean countries.

- The current situation in Grand Anse in which untreated sewage from pit latrines and septic tank overflows is being discharged near the shore is a threat to the health of the citizens and tourists.

- The Grand Anse Sewer Project as designed will help to alleviate the potential threats to public health and the near-shore environment posed by current wastewater management practices in the Grand Anse Bay drainage. Therefore, it is recommended that the project be completed and started up as soon as possible with the understanding that the Project should be treated as a first step in dealing with wastewater in the Grand Anse area.

- The ability of the Project to control the spread of cholera on the island of Grenada may be minimal considering the many point and non-point sources of sewage-related pollution that exist throughout the country and, in particular, at the sewage outfall that is operated for neighboring St. George's.

- An environmental monitoring program should be implemented before the start-up of the Project and continued thereafter so that the effects on the near-shore environment can be determined.

- A public information/education campaign should be initiated by the National Water and Sewerage Authority (NAWASA) and the Ministry of Health to make the public more aware of the need for the Project, the need for connecting to the system, and the threat of water-borne diseases and methods for their control.

- A review was carried out on the technical expertise needed to operate and maintain a sewage handling system in Grenada. It was found that the NAWASA has a well-developed engineering capability as well as adequate laboratory expertise. The operation and maintenance of the new collection and disposal system should not be a problem for NAWASA. However, some institutional strengthening is needed in fee collection, procurement and supply, and public relations along with additional operation and maintenance training.

- Potential impact on the marine environment from the outfall of the Project should be considered in a global context rather than simply with respect to the immediate coastal area. The discharge of contaminants of this type into the ocean is not without adverse effects on the Caribbean environment as a whole. Therefore, the Government of Grenada should undertake development of a comprehensive excreta and wastewater management strategy to service the entire population of the country and to protect public health and the environment. The Grand Anse Sewerage Project is only one of several wastewater management methods on the island. Much of the rural areas of Grenada and parts of the urban areas of St. George's and other towns are served by septic tanks and other on-site disposal methods. The St. George's sewage collection system has no treatment process and discharges through an ocean outfall. All of these components of excreta and wastewater management should be evaluated so that an effective and financially efficient wastewater facilities master plan can be developed for the island. This plan should include institutional, financial, and engineering considerations.

- Within the framework of the master plan, a mechanism should be developed so that the Project can be upgraded to include sustainable wastewater treatment as a means of reducing the load of contaminants, nutrients, and pathogens entering waters of the region.

Chapter 1

INTRODUCTION

1.1 General Background on Grenada

Grenada is an island nation of approximately 91,000 people, with a land area of 344 km^2 located in the southern Caribbean. The island has a mountainous interior surrounded by narrow coastal plains. The economy is based on agriculture, light industry, and tourism. The gross national product per capita was $1,720 in 1988 (Mendez, 1991).

1.2 History of the Grand Anse Sewer Project

The Grand Anse Sewer Project (hereafter referred to as "the Project") was designed to improve sanitary conditions for approximately 10 percent of the population of Grenada and, at the same time, to improve the infrastructure required for the country to develop its tourism industry. The design for the Project was approved by the Government of Grenada and funding for the project was provided by the U.S. Agency for International Development (USAID). Construction commenced in September 1990, and the anticipated completion date is October 1992.

The Project provides for collection of domestic and commercial sewage in the Grand Anse area and transfer of wastewater to an ocean outfall that extends 1,100 ft. (335 m) into the ocean at Point Salines. This design calls for screening for large debris with no additional treatment. The Grand Anse area contains private residences (both formal and informal or squatter structures) hotels, and industry.

1.2.1 Previous Studies

Several studies have investigated the wastewater management practices in the Grand Anse Bay drainage area. A 1975 study by PAHO recommended a wastewater collection system with a lagoon treatment system, and disposal through a near-shore discharge into Prickly Bay on the south coast. In 1985 a study by TVA looked at the St. George's system as well as the Grand Anse area. This study recommended that a stop-gap outfall be installed on the St. George's discharge to eliminate near-shore discharge of untreated sewage; an oxidation ditch treatment system was to be constructed at a later date. The outfall was built in 1988 with CIDA funds, but the treatment system was never built. The TVA study proposed a collection system and an artificial wetland treatment system for Grand Anse. Discharge was to be into Prickly Bay.

Louis Berger International carried out a study in 1988 recommending a collection system for Grand Anse and an activated sludge treatment plant with chlorination and an ocean outfall.

This study evaluated the feasibility of several treatment options. However, it did not evaluate ocean currents or identify an optimum ocean outfall site.

The latest study was conducted in 1989 by the Bellairs Research Institute. A water quality sampling program in Grand Anse Bay showed elevated levels of coliforms and nutrient contamination. This study concluded that an ocean outfall with only coarse screening and grease removal was the most appropriate disposal option, based on capital costs, operating costs, and operator skill required. Strong offshore ocean currents were measured off the southwestern tip of the island (Point Salines) where the outfall was proposed. It was noted that secondary treatment options do not remove nutrients, which would result in adverse effects to fringing reefs if effluents were discharged into near-shore waters; therefore, an offshore outfall would be required even if secondary treatment was used. The Point Salines outfall was recommended to transport untreated sewage away from coastal waters and minimize the effect on the near-shore environment and public health. It was also determined that discharges on the south side of the island, such as Prickly Bay, would circulate among the fishing areas near the coast, posing a threat to public health and the costal environment.

1.2.2 Design of the Grand Anse Sewer Project

Based on the Bellairs study, the Grand Anse Sewer Project was designed to collect sewage from the major population and tourist areas that drain into Grand Anse Bay. The design includes a collection system with four pump stations and an outfall of 1,100 ft. (335 m) into water 45 ft. (14 m) deep off Point Salines. Coarse screening is the only treatment provided. Collection of wastewater from squatter houses was not included in the design.

1.2.3 Wastewater Management Institutions in Grenada

The National Water and Sewerage Authority (NAWASA) is responsible for operation, maintenance, and monitoring the performance of the new Grand Anse Sewer system as well as the sewage system in St. George's and the distribution of potable water in Grenada. NAWASA has personnel in engineering, laboratory analysis, operation, and maintenance. The Authority is responsible to the Ministry of Communications, Works and Public Utilities and must rely on government approval and subsidies for partial funding of its operating budget.

1.3 Objectives of the Study

This study was undertaken by the United States Agency for International Development/Regional Development Office/Caribbean (USAID/RDO/C) in response to concerns expressed by the Grenada Ministry of Health officials over the design of the Project in light of the presence of cholera in the Latin American and Caribbean region. The objectives of this study are detailed in the scope of work (see Appendix A) as follows: (1) to assess the potential risk of the spread of cholera associated with the Project design; (2) to provide recommendations for reducing or eliminating such threat if appropriate; and (3) to suggest

broad communication strategies for local authorities to inform the Grenadian public about the Grand Anse Sewer Project.

1.4 Methodology of the Study

To determine the concerns of the Grenadian government, interviews were conducted with officials in the Ministry of Health and the Fisheries Division of the Ministry of Agriculture. NAWASA staff were interviewed and inspections were made of the analytical laboratory and maintenance facilities. The authors of the Bellairs study were interviewed as were the designers and construction managers of the Project. Some of the construction activities, the outfall site, and the Grand Anse beach were inspected. The design documents as well as the previous studies were reviewed. A list of persons contacted is given in Appendix B.

1.5 Background on Cholera

Cholera, a gastrointestinal disease caused by *Vibrio cholerae*, has afflicted humans for centuries and recently has spread to South and Central America. Because cholera is spreading throughout the region, public awareness and interest in this disease has increased. Indeed, cholera represents a significant threat to the inhabitants of islands in the Caribbean.

In some regions of the world, especially developing countries, cholera is endemic and outbreaks of the disease are seasonal. The typical mode of transmission of cholera is contaminated water and food products. Although cholera is usually associated with fecal contamination, studies carried out in a number of research laboratories have demonstrated that *V. cholerae* is a member of the natural bacterial flora of aquatic environments, especially saline waters. Thus, outbreaks of cholera can occur in isolated cases as a result of improper handling and storage of seafood products.

Cholera is characterized by a sudden and violent onset of diarrhea, with infected individuals losing significant quantities of fluids as a result of the mode of action of cholera toxin. The toxin stimulates translocation of water and electrolytes from host tissues into the intestinal track; the resulting diarrhea is typically severe and the dramatic loss of electrolytes can result in shock and death of patients.

Several investigators have reported results of studies on *V. cholerae* which document that the natural habitat of this species is saline waters of coastal regions. The range of salinities in which *V. cholerae* can survive and grow has been reported to be similar to that of marine and estuarine waters. *V. cholerae* requires an adequate supply of sodium (Na^+) ions as do other marine and estuarine bacteria. Once the minimal requirement for Na^+ has been met, the amount of available organic nutrients is more important to growth and survival of the organism than is the total salinity. Thus, *V. cholerae* can easily survive and grow in inland waters as well as in coastal marine waters.

Genetic studies on *V. cholerae* have also provided conclusive evidence that this species is a component of the bacterial community of marine waters. For example, approximately 10 percent of *V. cholerae* is bioluminescent, a trait typically associated with marine species. *V. cholerae* can selectively attach to zooplankton and phytoplankton as well as to some types of aquatic vegetation. An association with aquatic organisms of other trophic levels has an effect on growth, survival, and mobility of this species.

It is possible for *V. cholerae* to be widely distributed in coastal waters, while no clinical cases occur in the population. However, when a clinical case does occur, depending on the virulence factors which characterize the causative organism, the disease may spread rapidly, as with the current epidemic in countries in South and Central America. Studies on the molecular genetics of isolates of *V. cholerae* from natural habitats and from clinical cases are beginning to elucidate the apparent paradox of this species. It has been recognized for decades that not all strains of *V. cholerae* produce the toxin responsible for the clinical symptoms of the disease. Recent comparisons on the genetic diversity of toxin-producing and non-toxin-producing strains of *V. cholerae* have documented that non-toxigenic strains are genetically diverse, whereas toxigenic strains are not. Thus, in the absence of a virulent, toxigenic strain of *V. cholerae*, there is a low probability of an outbreak of epidemic cholera occurring. When a highly virulent, toxigenic strain of *V. cholerae* is imported into a locality, the chances of epidemic cholera occurring are greatly increased, as has probably occurred in Central and South America. Because *V. cholerae* is indigenous to many aquatic environments, the threat is ever present for clinical manifestations of cholera.

Chapter 2

FINDINGS OF THE EVALUATION

2.1 Risk Factors Associated with Cholera

To assume that cholera will never appear in Grenada is unrealistic. Based on the current cholera epidemic in Central and South America and the number of tourists entering Grenada via air travel, ocean liner, and private sailboats from other countries, it is reasonable to assume that the disease will appear. Also, considering the seemingly ubiquitous distribution of *V. cholerae* in coastal marine waters, it is likely that this species is indigenous to Grenada as with coastal waters of other countries. However, to date, no clinical cases of cholera caused by a toxigenic strain of *V. cholerae* have been reported.

Asymptomatic carriage of *V. cholerae* (non-01 strains) has been documented for persons involved in high-risk activities (i.e., consumption of raw shellfish harvested from coastal waters of some regions of the United States). In some studies, up to 4 percent of such persons may be asymptomatic carriers of *V. cholerae*.

Assuming cholera does appear in Grenada, the Project can be evaluated in regard to cholera transmission only if the infected persons reside in a hotel or residence connected to the sewage system. Furthermore, the role of the Project in minimizing or enhancing the spread of cholera is directly related to the amount of contaminated waste products entering the system. If an infected individual is transported to the hospital in St. George's, the sewage system servicing the hospital may have a greater impact on the transmission of cholera than the Project itself simply because more contaminated waste materials would enter that system. However, under this circumstance, some *V. cholerae*-contaminated sewage would be produced in the Grand Anse area.

An important concern related to the spread of cholera is the potential role of seafood products. As previously described, *V. cholerae* is a member of the indigenous bacterial community of many coastal ocean waters. Thus, if this is true for Grenada, there is a constant threat to the population, especially if improperly prepared (i.e., uncooked or undercooked) seafood is consumed. Many studies have documented cases of cholera resulting from ingestion of contaminated and improperly handled seafood products. However, this threat can be minimized by proper preparation and handling of seafood products.

Cruise ships and private sailboats represent an important mechanism by which cholera can be brought into Grenada. The close proximity of other ports-of-call and the frequency with which sailboats and cruise ships arrive may prove to be the most difficult obstacle to overcome to keep infectious *V. cholerae* out of the country; a person may become infected while visiting another port and not have symptoms until after arriving in Grenada, thereby introducing the organism to the sewage system in St. George's, Grand Anse, or any other location that may not be serviced by any sewage collection system.

2.2 The Present Situation in Grand Anse

Field observation of the excreta and wastewater management practices within the Grand Anse Bay drainage basin and discussions with NAWASA staff confirmed previous reports. A variety of different disposal systems are currently in use: septic tanks, self-contained treatment systems, pit latrines, and sullage disposal into surface drains. The ultimate fate of much of the wastewater, even in the dry season, is collection in two ditches that lead directly into the surface waters of Grand Anse beach. The discharge from the drainage ditches forms a small but obvious effluent plume and has a very noticeable and offensive odor. During repeated visual inspections, several children, both local residents and tourists, were observed playing very near the outfalls.

Because the surface waters are frequently used for swimming, sailing, snorkeling, and other recreational purposes, it is not surprising that there are reports of gastroenteritis and other maladies resulting from contact with sewage-contaminated waters. The current situation in Grand Anse is unacceptable in the context of public health and esthetics. Drainage ditches represent an immediate threat to anyone using waters in Grand Anse Bay for recreational purposes. In addition to cholera, other diseases (i.e., hepatitis and other gastrointestinal disease-causing organisms, *Salmonella*, *Shigella*, enteropathogenic *Escherichia coli*) should be of concern to public health officials.

2.3 Concerns of Grenadian Government Organizations

Several concerns about the Project were expressed in the course of interviews with officials of the government. These concerns are summarized below:

NAWASA

- People may be reluctant to pay connection fees required to use the new system. It has been proposed that the costs associated with the connection of new customers be subsidized by the government for low- and middle-income users. A final decision has yet to be made on how the program will be implemented or the regulatory mechanisms by which people will be required to connect to the system.
- The pumps in the new system will use a considerable amount of electricity for which NAWASA must pay. Thus, a higher monthly fee will be needed to pay for the operating costs of the new system.
- The coastal monitoring program recommended in the Bellairs study has not been implemented. A proposal for the monitoring program was developed by NAWASA and the Fisheries Division, but, to date, no funding mechanism has been identified.
- The public relations effort by NAWASA has been hampered by lack of funds, caused by delay in approval of the water rate increases.

Grenada Industrial Development Corporation (GIDC)

- If the system is run without treatment and adverse environmental and health effects result, it could be very costly in terms of lost tourism and trade, in addition to the costs associated with illness.
- Having a sewage treatment facility could be "sold" to outside investors (tourism and industry) as an indication of Grenada's environmental concerns.

Fisheries Division of the Ministry of Agriculture

- The sea moss beds to the south of the island are extensively used by Grenadians. Staff members consider the beds close enough to the outfall to be affected by contamination.
- Input from the local fishing community was not included in the Bellairs report.

Ministry of Health

- Concerns were expressed over adverse effects of the outfall on shellfish beds to the south and general environmental effects.

2.4 The Grand Anse Sewer Project

As mentioned in Section 1.2.2., the Project is designed to improve sanitary conditions for a significant percentage of the population of the country and, at the same time, to improve the infrastructure required for Grenada to continue its overall development and to enhance the tourism industry. The Project, as approved by the Government of Grenada and USAID, provides for collection of domestic and commercial sewage in the Grand Anse area and transfer of wastewater to an ocean outfall that extends 1,100 ft (335 m) into the ocean at Point Salines. Only screening for debris, with no additional treatment, is provided in the design. The construction contract for the Project includes operation and maintenance training for NAWASA personnel and includes a two-year spare parts inventory.

2.4.1 Basis of Design

The environmental assessment study prepared by the Bellairs Research Institute described in detail the expected movement of waters at and near the outfall site. Briefly, the major ocean currents tend to envelop the island, sweeping along the coastline in a southern flow and merging in the general location of Point Salines. As the waters continue to move to the south, they encounter the Antilles current that sweeps along the northeastern coast of South America. This current is reported to extend through the Caribbean and ultimately flows into the Gulf of Mexico.

The sewage outfall site was inspected above and below water. On the basis of its physical characteristics, the prevailing environmental conditions, and previous studies, it was concluded

that the site is more than adequate for rapid dilution of an effluent stream with subsequent transport from shore.

An important concern over the location of the outfall is the potential impact on the fertile fishing grounds along the southern side of the island. All available information, both published characteristics of current patterns and local knowledge of fishermen and tour guides, indicates that the outfall site is subject to strong current flows, except for 2 to 3 hours per day during slack tide when the currents can slow to a standstill. At other times, the currents at the site of the outfall are extremely strong (i.e., 2 knots). Also, objects placed into near-shore waters were observed to move swiftly from land to open waters. However, it is difficult or impossible to predict the effects of unusual events, such as storms or breaks in the outfall pipe.

Attributing an impact on the fishing grounds to the sewage outfall will be made even more difficult because of the demographic patterns of Grenada. Approximately 15 to 20 percent of the population of Grenada resides in the coastal area along the southern and southeastern coast. None of this area is serviced by a centralized sewage collection and disposal system. As a result, a large number of point and non-point sources of fecal contamination of near-shore ocean waters exist. A similar situation exists for the residents living along the northeastern coast of Grenada. Thus, point discharges and surface runoff along the entire eastern side of Grenada will enter near-shore waters and be carried south by the prevailing ocean currents. Because of the population size along the eastern side of Grenada, the net impact on near-shore waters arising from point and non-point sources may be significantly larger than that entering from the Project.

2.4.2 Design

The design calculations for the collection system and the ocean outfall (Louis Berger International, 1989) were found to comply with accepted engineering practice. The assumptions necessary for flow estimation were reasonable and the system sizing should be adequate for the population served. The flow in the system will be limited to a maximum of approximately 2 million gallons per day (MGD) by the pressure drop associated with the size and number of the diffusers on the outfall. The structural design of the outfall was based on withstanding a 50-year storm event.

2.4.3 Construction

The construction methods employed at the time of the team's observation and apparent in previous work complied with construction specifications for the Project. A team of two NAWASA engineers and two construction inspectors provided adequate inspection of the work. The methods being followed should result in a reliable system, and participation of NAWASA engineers will provide valuable knowledge for the future.

2.5 Institutional Capabilities of the Government of Grenada

NAWASA has a well-developed engineering capability as well as laboratory expertise. Operation and maintenance of the new collection and disposal system should not be a problem for NAWASA from the standpoint of engineering and operator skill. However, some institutional improvements appear to be needed in the areas of operation and maintenance training, procurement and supply, collection of fees, and public relations.

Laboratory Capability—The existing laboratory and personnel within NAWASA are capable of performing bacteriological, chemical, and physical analysis of ocean and fresh waters. Laboratory supervisors stated that the existing personnel and equipment are fully utilized. Laboratory staff appeared to be well trained and competent, but several instruments were inoperative due to lack of spare parts. (Spare parts and supplies are difficult to obtain due to administrative delays.)

Engineering Capability—NAWASA has substantial engineering capability with seven trained engineers: the manager, chief engineer, senior engineer, and four others. Many of these engineers have post-graduate degrees. A civil and a mechanical engineer have been involved in the construction of the Project from the beginning, which will assure needed continuity when the Project becomes operational. Training is also a part of the construction contract. Additional training for the operators and maintenance personnel may be advantageous, however.

Public Relations—On the basis of discussions with representatives of a variety of different private and governmental concerns, and casual conversations with members of the public, it is evident that NAWASA has not been successful in informing the public of the benefits of the sewage system. Also, there has been little, if any, notice of pending disruption of traffic patterns due to Project construction. Fortunately, NAWASA has demonstrated a commitment to improving this problem with the establishment of a consumer relations department and the appointment of a public relations officer. However, NAWASA has had difficulty in funding the consumer relations department.

Annual fees are approximately $30 per year per household for water only. NAWASA has been able to improve the collection rate on user fees; collections are now at about 70 percent of billings. It appears that substantially higher fees and collection rates will be needed to support the operating and maintenance expenses of the Project. NAWASA staff expressed concern that people will be reluctant to pay the connection fee to be hooked up to the new sewer system.

Industrial Discharge Monitoring—There are several industries in the area served by the Project and more are likely to move in. The discharges from these industries could affect the equipment in the sewer system as well as the environment near the outfall. The effects of industrial discharges on the operation of a sewage treatment plant were observed by the team on a visit to a sewage treatment plant in Bridgetown, Barbados. This facility receives effluent from a variety of industries: ice cream manufacturing, tanning, meat processing, battery

manufacturing, and a slaughter house. The resulting wastewater is both difficult and expensive to treat.

2.6 Possible Modifications to the Project

A preliminary analysis of treatment alternatives was conducted so that a suggestion could be made concerning modifications to the Project. The following table demonstrates that a waste stabilization pond system has the advantages of low initial cost, very low operating costs, good pathogen removal (*V. cholerae* included), and minimal sludge production. The disadvantages of pond systems are the large land area required for adequate treatment and the occasional need to remove and dispose of accumulated sludge. Aerobic and facultative ponds rely on natural oxygen transfer from the air and oxygen production by algae to supply the aerobic microorganisms that do the work of treating sewage in these ponds. Adequate treatment requires shallow ponds that occupy large land areas and have long residence times. These long residence times lead to good removal of pathogens, including *V. cholerae*.

Mechanical systems provide oxygen for microorganisms in treatment works such as aerated ponds, oxidation ditches, trickling filters, rotating biological contactors, and activated sludge plants. Because oxygen transfer in these systems is more efficient, tanks can be deeper and occupy less land area. The ability to maintain higher concentrations of the working microorganisms in the treatment plants allows shorter residence times to achieve the same level of treatment. As a result, these mechanical plants produce larger quantities of sludge (excess microorganisms), are not as effective at removing pathogens, use large amounts of energy to operate mechanical equipment, have expensive replacement parts, and require skilled operator attention.

Approximately 30 acres would be required for a facultative pond system as compared to approximately 5 acres for an activated sludge plant. There is some land available south of the runway at the airport that may be large enough for a pond system; however, it is not clear if the topography is too restrictive or if the Airport Authority would allow its use. Another pump station would probably be needed to pump treated wastewater to the outfall if this site was utilized. If a pond system was located near the final pump station (Pump Station No.4) adjacent to Frequente Industrial Park, the installation of an additional pump station could be avoided. However, this area has been designated for industrial sites and the land is probably not available.

Table 1

COMPARISON OF ALTERNATIVE TREATMENT TECHNOLOGIES

Process	*Capital Costs[1,2,3] (US$)*	*O&M Costs[1] (US$/yr)*	*V. cholerae Removal[4,5]*	*Operator Skill Required*	*Land Area Required*	*Sludge Production*
Stabilization Pond	600,000 - 1,500,000	60,000	+ + + +	low	large	small
Aerated Pond or Oxidation Ditch	1,000,000 to 1,500,000	140,000	+ + +	moderate	medium	medium
Trickling Filter or Rotating Biological Contactor	1,500,000 to 2,000,000	220,000	+	high	small	large
Activated Sludge	2,000,000 to 2,500,000	270,000	+ +	high	small	large

[1]Environmental Protection Agency, 1977
[2]Palange, R.C., and A. Zavala, 1987
[3]Reid, 1982
[4]Feacham, R. 1983
[5]+ + + + = very effective, + = least effective

Chapter 3

SUMMARY AND CONCLUSIONS

When looking at risk factors concerning the spread of cholera in a particular situation or project, it is critical to delineate the restrictions which define the overall objective. For example, it is inappropriate to consider the efficacy of a project only in the context of transmission of cholera. Certainly, other diseases pose as much if not more of a public health threat. Also, without considering other factors such as governmental infrastructure and environmental impact, a simple risk assessment for transmission of a single disease agent has limited importance.

The consultant team conducted a detailed review of the current situation in Grand Anse in particular and in Grenada in general as pertaining to the Project, with particular reference to the potential for transmission of cholera. The following conclusions were reached:

1. *Cholera*—Cholera is a real and significant threat to the population of Grenada and other Caribbean countries.

2. *Current Situation*—Excreta and sullage are currently being inadequately collected and treated in the Grand Anse Bay drainage area, resulting in bacterial and chemical contamination of the bay. This contamination is resulting in environmental degradation and poses a significant threat to the health of residents and tourists.

3. *Basis of Design*—The data and methodology used to develop the design of the Project were determined to be accurate; the effluent from the outfall should not impact the near-shore environment. The outfall will be sited so that strong ocean currents will carry the effluent away from the beaches and fishing grounds under normal conditions.

4. *Design and Construction*—The consultant team evaluated the Project for adequacy of design and construction methods. The team considers the Project capable of performing the required collection and disposal of sewage in the Grand Anse area in a reliable manner, if properly operated and maintained by NAWASA.

5. *Overall Effect of the Project*—The Project should have a positive effect by reducing the hazards to public health and nutrient loading that now exist in Grand Anse. The Project may have limited impact on control of cholera in Grenada considering the many point and non-point sources of sewage-related pollution that exist throughout the country and, in particular, at the sewage outfall that is operated for neighboring St. George's.

6. *Environmental Monitoring*—An environmental monitoring program is needed to confirm the predictions of the Bellairs study. This program should start immediately so that baseline data can be collected before the Project is started up. A proposal has been drafted by NAWASA and the Fisheries Division to implement such a program,

but funding is needed. The program should be designed to detect any changes in water quality and the marine ecosystem in the outfall area.

7. *Institutional*—It is not clear if the existing institutions are adequate to support the Project. NAWASA currently has the engineering and technical capability to operate and maintain the Project. However, capabilities to set and collect fees are lacking and a public relations program has yet to be implemented. An industrial monitoring program may be needed to mitigate the effects of industrial discharges into the system.

   Sustainability of the system depends on the ability to collect adequate user fees and to procure spare parts and supplies in an efficient manner. NAWASA has had a low rate of collections for services; staff members have expressed concern that customers will not pay the required fee to connect to the new system. They also complained of long delays in the processing of purchase requests for equipment and supplies.

   For maximum effectiveness of the Project, all sources of wastewater in the Grand Anse Bay drainage should be connected to the sewer system. Current plans call for a graduated connection fee based on ability to pay. This plan will require institutional support to implement and to ensure a maximum percentage of connection. Currently, there are no plans to connect the squatter population (approximately 10 percent of the houses) to the new system. This omission could seriously hinder the Project's effectiveness.

   Industrial influents could put extra stress on the system both from a mechanical standpoint and on the expected effects of the outfall. This concern can be addressed with an industrial monitoring program. The program would require institutions to evaluate, monitor, and control existing and future discharges into the system. Expertise is available in the region in the form of professional organizations that could be used to assess the industrial waste situation.

8. *Public Relations*—The public relations of NAWASA have been poor. The result is lack of public support for activities such as rate increases and possibly for future connections and facilities improvement. A public information/education campaign could be initiated by NAWASA and the Ministry of Health to make the public more aware of the need for the Project, the need for connecting to the system, and the risk of water-borne diseases and methods for their control. Media available include newspapers, radio, television, and word of mouth.

9. *Future Needs*—Potential impacts on the marine environment from the outfall of the Project should be considered in a global context rather than simply with respect to the immediate coastal area. Discharge of contaminants of this type into the ocean is not without adverse effects on the Caribbean environment as a whole. Therefore, it is the responsibility of the Government of Grenada to develop a comprehensive excreta and wastewater management strategy that will service the entire population of the country and protect public health and the environment. The Grand Anse Sewer Project is only one of several wastewater management methods on the island. Much of the rural

areas of Grenada and parts of the urban areas of St. George's and other towns are served by septic tanks and other on-site disposal methods. The St. George's sewage collection system does not have treatment and discharges through an ocean outfall. All of these components of excreta and wastewater management would be evaluated and included in an effective and financially efficient wastewater facilities master plan. This plan would include institutional, financial, and engineering considerations.

Within the framework of the master plan, consideration would be given to the upgrading of the Project to include sustainable wastewater treatment as a means of reducing the load of contaminants, nutrients, and pathogens entering waters of the region.

Chapter 4

RECOMMENDATIONS

4.1 Project Start-up

The Grand Anse Sewer Project as designed will help to alleviate potential threats to public health and the near-shore environment posed by current wastewater management practices in the Grand Anse Bay drainage. Therefore, it is recommended that the Project be completed and started up as soon as possible with the understanding that the Project be treated as one step in the process of managing wastewater in Grenada. The following recommendations are intended to minimize the environmental impact of the Project, assure its sustainability, and determine its place in the overall wastewater management strategy for Grenada.

4.2 Monitoring Program

A monitoring program is essential to assessing the environmental impact of the Project and determining if modifications are necessary to reduce these impacts. Monitoring water quality in the receiving waters at the outfall site is needed to establish a base line so that comparisons can be made to detect changes in the microbial community of the water column. Previous studies have demonstrated that the bacterial community of receiving waters is often the first component to respond to changes in water quality.

In conjunction with independent scientists a proper monitoring program should be designed and implemented so that it includes traditional measures of water quality (e.g., numbers of total and fecal coliforms, concentrations of nitrogen, phosphates, etc.) as well as an index of the indigenous bacterial community (e.g., species composition, etc.). In addition, the ongoing program being carried out by the Fisheries Division of the Ministry of Agriculture to monitor biological effects of the effluent from the St. George's sewage outfall should be expanded to include sites at the Point Salines outfall.

4.3 Institutional Capabilities

The institutional capabilities of NAWASA and the Grenadian government in general appear to need improvement in the areas of user tariff management and public relations. Therefore, an analysis of the existing institutions necessary to support the sewer project is needed to determine what institutional changes and additions should be made. This analysis should be directed at the capabilities needed to manage the assessment and collection of user and connection fees. Public relation efforts should be directed at assuring high connection rates to the new system and high collection rates of user fees. Public relations should also play a role in increasing public acceptance of laws and regulations that create realistic charges for water and sewer users. The need for an industrial discharge monitoring plan should be evaluated based on the characteristics of existing and future industries.

4.4 Wastewater Facilities Master Plan

A wastewater facilities master plan should be undertaken to evaluate the needs and appropriate alternatives for managing wastewater in Grenada. All of the components of excreta and wastewater management described in Chapter 3, Item 9 should be evaluated so that an effective and financially efficient wastewater facilities master plan can be developed. The master plan will identify the most urgent needs and the most efficient strategy for the use of available funds. This plan should include institutional, financial, and engineering considerations. The Project, as well as any other wastewater management practice in the island, will effect public health and the environment in both positive and negative ways. Therefore, the addition of treatment facilities to the Grand Anse Sewer Project should be considered in the context of a wastewater facilities master plan for the entire island and the results of the monitoring program.

Appendix A

SCOPE OF WORK

TECHNICAL REVIEW OF GRENADA GRAND ANSE SEWER PROJECT SCOPE OF WORK

Background: The Grand Anse Sewer Project is funded by USAID/RDO/C under the Grenada Infrastructure Revitalization III Project. The project, authorized in September 1988 started field construction activity in September 1990. The entire Revitalization III Project is estimated to cost approximately $8.4 million of which $4.4 million will be spent for the Grand Anse Sewer Project. The sewer design was completed by Louis Berger International in November 1989 and the project is expected to be completed in October 1992.

The rationale for design of this project is that a planned sewerage system such as this one would considerably reduce the threat to health and the damage to the tourism potential of the island by reducing the existing pollution problem in the Grand Anse area, a prime tourist spot with its scenic backdrop and outstanding beach. The parameters of the pollution problem are indicated in the following description of the sewerage/wastewater situation:

> In Grenada, grey water from sinks and showers is separated from toilet water and allowed to discharge directly into surface drains. Septic tanks, the major form of sewage treatment in the Caribbean, may not be sized or constructed properly and when not maintained, the soak-aways or leach fields overflow or seep into the surface drainage. In addition, hotels and restaurants do not normally use grease traps, squatters are prevalent in the area and use privies for liquid waste disposal, and loose cows, goats and other animals create waste that finds its way to the surface drains. The surface drainage system in the Grand Anse area is channeled into two concrete outfalls both of which discharge about 20 feet off the Grand Anse beach. This pollution has caused medical problems such as ear and eye infections, and skin rashes. Algae washed to shore is unsightly and odorous and the Grand Anse reefs are consequently virtually dead.

The USAID-funded sewerage project has been designed so that the raw sewage will now be discharged in 45 feet of water some eleven hundred feet offshore of Point Salines.

Recently the Grenada Chief Medical Officer has expressed his concerns to USAID and local authorities about the appropriateness of the planned sewer project vis a vis the presence of cholera in the Latin America and Caribbean region. His concerns include the possibilities of cholera outbreaks due to the discharge of raw sewage and the spread of cholera through contaminated seafood consumption given the proximity of fish breeding areas off the Grenada south coast. The local National Water and Sewerage Authority (NAWASA) has responded that

the risk of cholera spread is minimal; the direction of strong currents at the end of the sewer outfall will sweep away cholera bacteria from fishing and fish breeding areas; the dilution factor given the small volume of sewage involved and the large extent of the water column in a 45 feet water depth. In addition, the sewerage project represents an improvement over the current situation as it removes potentially cholera infested sewage from a populated to an unpopulated area; the outfall area is not a fish breeding ground; the area has restricted access; and there is not fishing conducted in the area. Given the serious concerns about the potential introduction of cholera to Grenada, USAID in consultation with Grenada local authorities has determined that a technical review of the sewerage project is required to determine if the project design is appropriate given the potential spread of cholera to the Caribbean region. The need for modifications to the design of the project with regard to treatment of the sewage prior to discharge is to be assessed.

Objective: The objective of the scope of work is to assess the potential risk of the spread of cholera in the Grand Anse Sewer project design; provide recommendations for reducing or eliminating such threat if appropriate; and suggest broad communication strategies for local authorities and communities to allay concerns that the sewerage project will increase the cholera threat in Grenada.

Tasks: The consultants will review background material on the project which will be provided to them in advance of the assignment and develop an overall work plan for their assignment. During their consultancy they will conduct briefings with relevant RDO/C, U.S. Embassy Grenada, and Grenadian authorities as needed. A draft report will be left with RDO/C prior to the team's departure.

The team's report will address the following:

1. Discussion of the design rationale for the Grand Anse Sewer Project.
2. Assessment of the risk of the spread of the cholera pathogen under the current design.
3. Determination as to the adequacy of the current design and the risk of the spread of cholera.
4. Recommendations on modification options to the current design (if appropriate) to minimize the risk of cholera. Cost estimates should be provided for each option, and the relative efficiency of each should be discussed.
5. If necessary, rank order design options considered according to cost effectiveness analysis taking into account the following:
    a. Risk to health
    b. Capital cost of implementing each option
    c. Recurrent cost of maintenance and operation of each option

d. Grenada's institutional and historical capability to adequately maintain and efficiently operate sanitary engineering facilities such as the sewerage project

6. Broad recommendations on an appropriate public relations campaign to "launch" the new sewer project in Grenada.

Personnel: The personnel required to carry out this scope of work include a Sanitary Engineer and a Microbiologist specialized in enteric diseases with expertise in the prevention and control of cholera, previous experience working in a developing country, and great familiarity with the development and progress of the epidemic in LAC since 1991. A Facilitator is required for the Team Planning Meeting.

Schedule:

Activity	*Dates*
BACKGROUND READING:	February 26, 1992
TEAM PLANNING MEETING:	February 27,-28, 1992
BRIEFING:	February 28 2 p.m.
FIELD TRIP:	March 8-17, 1992
DEBRIEFING and	
FINALIZE REPORT:	March 20, 1992

LEVEL OF EFFORT

Technical Consultants, 13 days each

Facilitator, 2 days

Appendix B

PERSONS CONTACTED

Hon. Michael Andrews	Minister of Health
Mr. Arthur Archer	Sanitary Engineer, Bellairs Research Institute
Mr. Craig Archer	USAID/RDO/C Engineer, Infrastructure
Mr. Larry Armstrong	USAID/RDO/C Deputy Director
Mr. Russell Bubb	Production Quality Supervisor, NAWASA Water Quality Laboratory
Mr. Gerald Cashion	USAID/RDO/C Office Chief, Project Development
Ms. Rebecca Cohn	USAID/RDO/C Office Chief, HPE
Mr. Winfield Collins	USAID/RDO/C Office Chief, Infrastructure
Mr. Selby Dabreo	Senior Environmental Health Officer, Ministry of Health
Mr. Alphonsus Daniel	Mechanical Engineer, NAWASA
Mr. T. C. DeAllie	General Manager Grenada Industrial Development Corporation
Mr. Sam Dowding	USAID/RDO/C Senior Health Advisor HPE
Mr. Curtis Edwards	Chief Environmental Health Officer, Ministry of Health
Mr. James Finlay	Chief Fisheries Officer, Fisheries Division, Ministry of Agriculture
Ms. C. Horsford	Permanent Secretary, Ministry of Health
Mr. Blair Humphrey	Oceanographer, Bellairs Research Institute
Dr. Wayne Hunte	Marine Biologist, Bellairs Research Institute
Mr. Christopher Husbands	Civil Engineer, NAWASA
Mr. Ralph Imbriano	Manager, Maitland Brothers Company
Mr. Crofton Issac	Assistant Biologist, Fisheries Division, Ministry of Agriculture
Ms. Mosina Jordan	USAID/RDO/C Director
Dr. Eugene Laurent	Chief Medical Officer, Ministry of Health
Mr. David Lewis	Senior Engineer, NAWASA

Mr. Stephen Lindo	Engineer, Bridgetown Sewage Treatment Plant, Barbados
Mr. Drew Luten	USAID/RDO/C Regional Legal Advisor
Dr. Ted Mathison	Microbiologist, University of the West Indies
Dr. Doreen Murray	Acting Chief Medical Officer/Medical Officer of Health, Ministry of Health
Mr. Ivan Noel	Environmental Engineer, NAWASA
Mr. Raymond Noel	Manager, NAWASA
Mr. Paul Philip	Biologist, Fisheries Division, Ministry of Agriculture
Ms. Phillips	Project Officer, GIDC
Mr. Bob Posner	USAID/RDO/C Project Development
Mr. Mike Quinn	Engineer, Louis Berger International
Mr. Kennedy Roberts	Ministry of Health
Mr. Joseph Scott	Lab Tech, Bridgetown Sewage Treatment Plant
Mr. Brinley Selliah	USAID/RDO/C Engineer, Infrastructure
Mr. Julio Sinogba	Engineer, Louis Berger International
Ms. Rosalie Thomas	Laboratory Supervisor, NAWASA Water Quality Laboratory
Ms. Annette Veler	Chargé, US Embassy, Grenada

Appendix C

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