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REGIONAL GUIDELINES FOR DEVELOPING, REVIEWING AND/OR UPDATING NATIONAL WASTEWATER MANAGEMENT PLANS

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GEF Caribbean Regional Fund for Wastewater Management Project
(GEF CReW)

Regional Guidelines for Developing, Reviewing and/or Updating National Wastewater Management Plans

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LIST OF ACRONYMS

CEHI	Caribbean Environmental Health Institute
CReW	Caribbean Regional Fund for Wastewater Management
DWM	Decentralized Wastewater Management
EIA	Environmental Impact Assessment
FOG	Fats, Oils and Grease
GEF	Global Environmental Facility
GPA	Global Programme of Action
IWRM	Integrated Water Resources Management
LBS	Land-Based Sources
MDG	Millennium Development Goal
MN	Million
O&M	Operation and Maintenance
UNEP	United Nations Environment Programme
WCR	Wider Caribbean Region
WWMP	Wastewater Management Plan

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COMMON WASTEWATER TERMS USED IN THIS DOCUMENT

Advanced treatment: Advanced treatment processes are used to remove nutrients, additional solids and/or biochemical oxygen demand. Advanced treatment provides a very high level of treatment that goes beyond secondary treatment. In the case of nitrogen removal, the processes are biological. For phosphorus removal, chemical additives are normally required. Specific processes are used to remove other nutrients, additional solids and biochemical oxygen demand.

Agricultural non-point sources of pollution: Non-point sources of pollution originating from the cultivation of crops and rearing of domesticated animals, excluding intensive animal rearing operations that would otherwise be defined as point sources

Biochemical Oxygen Demand (BOD_5): A measure of the organic strength of a sample of wastewater. It provides information on the organic load or how much "food" there will be for organisms. The load can be either to a treatment plant unit or to a receiving water body.

Capital costs: Costs of construction of wastewater management facilities (including sludge and septage management) and any costs associated with lease, easement or acquisition of rights-of-way.

Chemical Oxygen Demand (COD): A quantitative measure of the amount of oxygen required to chemically oxidize all organic compounds in a unit volume of wastewater. The COD level can be determined more readily than BOD, but this measurement does not indicate how much of the waste can be decomposed by biological oxidation.

Chlorination: The application of chlorine to water, sewage or industrial wastes, generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical waste water treatment results.

Coliform organisms: A group of bacteria recognized as indicators of faecal pollution (see also escherichia coliform).

***Disinfection*:** Disinfection is a process where a significant percentage of pathogenic organisms are killed or controlled. In many plants the disinfection process comes after secondary treatment. In disinfection, the wastewater following secondary treatment is usually treated in one of two ways: (1) chlorination or (2) ultra-violet radiation.

Dissolved solids: Solids physically suspended in sewage that cannot be removed by proper laboratory filtering.

Effluent: Wastewater or other liquid, partially or completely treated, flowing from a reservoir, basin, treatment process or treatment plant.

Existing costs: Costs for wastewater treatment plants, which include:

- original construction costs
- annual operating and maintenance costs, including depreciation
- past repairs and upgrades

Financing mechanisms: Mechanisms for funding wastewater treatment facilities, which can include borrowing, grants from Government, reserve funds, capital levies, property taxes, user fees and utility rates.

Industrial wastewater: The liquid discharge from manufacturing processes, for example, soft drink and beer manufacturing, sugar processing, metal processing and photo finishing.

Operation and Maintenance Costs: Costs that include costs for labour, utilities, materials, contractual services, expenses and replacement of equipment and parts to ensure effective and dependable operation during the planning period.

Organic matter: Waste from homes or industry of plant or animal origin. Organic matter forms the volatile fraction of solids in wastewater, activated sludge and industrial wastes.

Package treatment plant: A wastewater treatment plant ranging in capacity from 600 gallons per day (gpd) to 140,000 gpd that utilizes long-term aeration final sedimentation and chlorination and which is designed to serve hotel complexes, shopping centres, apartment buildings, factories, small subdivisions and even private homes

Potable water: Water fit for human consumption.

***Preliminary treatment*:** The first processes that the wastewater encounters in which monitoring is commonly followed by screening. The next process in preliminary treatment is grit removal. Screening and grit removal are important to the proper operation of the raw sewage pumps. Materials in raw sewage will cause clogging and wear on the internal parts. These raw sewage pumps deliver the flow to the next phase of treatment: Primary Treatment.

Primary treatment*:* Primary treatment is a physical settling process that removes solids. Not all plants have primary treatment. Primary treatment generates primary sludge. The sludge is removed and pumped to the solids treatment process for ultimate removal. The wastewater still has solids remaining after primary treatment. These solids are either dissolved or suspended. These dissolved and suspended solids are removed through the next phase of treatment: Secondary Treatment.

Receiving waters: Rivers, lakes or other water sources that receive treated or untreated wastewater

Relevant actors: Wastewater utility managers, officials from entities responsible for public health, water resources, environment and civil society stakeholders

Secondary treatment*:* Secondary treatment is a biological treatment process used to stabilize the dissolved solids. There are many different kinds of secondary processes that can be employed. A very common secondary process is known as activated sludge. In activated sludge treatment, the wastewater is mixed with organisms that are returned from the secondary clarifiers. Lagoon systems are also a form of biological or secondary treatment. These lagoon systems are used where there is a lot of land available and/or the wastewater flows (quantities) are low. Another type of secondary treatment is known as fixed film processes. Intermittent sand filters are employed in some smaller applications. All of the secondary treatment processes produce biosolids. These biosolids are pumped to the solids treatment system for further processing.

Sewage: Largely the water supply of a community after it has been fouled by various uses. It may be a combination of the liquid or water-carried wastes from residences, business buildings and institutions, together with those from industrial establishments and with such groundwater, surface water and storm water as may be present.

Sludge*:* The residual organic matter and dead bacteria used in the treatment process
or biosolids removed from the wastewater being treated.

Total Suspended Solids (TSS)**:** Particulate material contained in wastewater. A test for TSS filters the wastewater sample through a special fiberglass filter and measures the solids that can be seen in a beaker.

Wastewater: Liquid or water-carried waste removed from residences, institutions, commercial and industrial establishments, together with groundwater, surface water and storm water.

Wastewater treatment plant: A series of tanks, screens, filters and other processes by which most pollutants are removed from water.

Water pollution: A general term signifying the introduction into water of micro-organisms, chemicals, wastes or sewage which renders the water unfit for its intended use.

Water reuse: The use of reclaimed water.

EXECUTIVE SUMMARY

The waters surrounding Caribbean countries are continually polluted by wastewater discharges due to inadequate and poorly functioning wastewater treatment plants. A study in 1991 revealed that as many as 75 per cent of wastewater treatment plants in the Caribbean produced unacceptable effluent and that in 60 per cent of cases, effluent is disposed of in aquatic environments (either salt water or fresh water). Besides the health risk that is associated with this poor water quality, improperly treated wastewater has caused damage to coral reefs throughout the region. Because of the far-reaching impacts of inaction, it is essential that Governments in the Caribbean region establish a framework to manage and monitor wastewater discharges that find their way into surrounding waters and promote proper environmental management and ensure long-term sustainability.

The majority of GEF-CReW countries are parties to the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region, also known as the Cartagena Convention, adopted in Cartagena, Colombia on 24 March 1983, and have ratified one of its protocols – the Protocol on Land-based Sources of Marine Pollution (LBS Protocol), which governs the standards for domestic sewage discharges into the waters of the Wider Caribbean. The existing infrastructure for wastewater in GEF-CReW countries is generally in disrepair making it an urgent need for these countries to make improvements in the wastewater sector by building suitable facilities and infrastructure for assimilating wastewater reuse within the wastewater management design and operation and meet LBS standards and obligations. To translate this need into rational and cost-effective services as well as control the discharges and pollution of its surrounding waters will require a wastewater management framework to be established within Caribbean jurisdictions. A wastewater management framework comprises several elements one of which is the wastewater management plan (WWMP).

As a first task, the process to develop a WWMP involves an evaluation of current and future wastewater needs, developing wastewater management alternatives to meet those needs and selecting the most cost-effective, environmentally sound wastewater management plan through careful comparison and evaluation of alternatives. The initial impetus for wastewater planning may arise from concerns by a local community or as the result of a public health breach. In either case, the final recommended Plan must comply with regulatory requirements and provide for sound wastewater management over the specified planning period.

These Guidelines provide the steps required to develop a WWMP. They specify the factors that should be taken into consideration in developing the Plan and identify the actors and stakeholders that are responsible for implementing it. The Guidelines conclude with a Sample Table of Contents for a WWMP[1]. Suggested technologies that may be used in the management of wastewater are also summarized for consideration[2]. It is important to note that these Guidelines are not supported by legislation and it is not mandatory that they be adopted. They are recommendations of the widely accepted and prevailing standards in the sector. GEF CReW countries are encouraged to adopt them as being of persuasive authority on how to develop, review and update a WWMP.

The primary audience for the Guidelines is the water utility manager and any official that has responsibility for wastewater management planning in CReW participating countries. The Guidelines may also be useful to policy makers and operators in related sectors. They apply to countries of all sizes with wastewater systems of varying complexities and should be used only as a basis for putting together a WWMP that meets the country's unique needs.

WWMPs are valuable because they guide the development process and may be used as a checklist to assess whether the actions that have been agreed to are being pursued. A WWMP may later be established in policy and ultimately legislation. In this way WWMPs can become incorporated into the overall national development framework.

[1] Annex 1
[2] Appendix D

REGIONAL GUIDELINES FOR DEVELOPING, REVIEWING AND/OR UPDATING NATIONAL WASTEWATER MANAGEMENT PLANS

1.0 INTRODUCTION

The existing wastewater systems in Wider Caribbean countries face multiple problems that affect water quality and contribute to the growing problem of pollution of coastal and marine waters. The problems include growing populations, increased service demands, limited water supplies, a highly variable climate, aging infrastructure and limited funding. These countries depend on the marine environment for their livelihoods through fisheries and tourism as their main economic, social and recreational product. Therefore the degradation of these resources is of serious concern and impact to their well-being. UNEP-GPA's October 2006 report on the "State of the Marine Environment" singled out untreated wastewater (including domestic wastewater) entering the world's oceans and seas as the most serious problem contributing to marine pollution, putting at risk human health and wildlife and livelihoods. According to the report, in Latin American and the Caribbean, it is estimated that the percentage of wastewater from all sources entering the sea untreated is as high as 85 per cent.

The Latin America and Caribbean countries demonstrated their intention to address the pollution problem caused by domestic waste water by ratifying the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region, also known as the Cartagena Convention, adopted in Cartagena, Colombia on 24 March 1983, and ratifying the Protocol on Land-based Sources of Marine Pollution (LBS Protocol), which was adopted on October 6, 1999. Both of these legal instruments set ambitious goals to govern domestic sewage discharges into the waters of the Wider Caribbean Region. Accordingly, Annex III of the LBS Protocol was designed to meet these goals by providing sewage effluent quality guidelines, criteria for classification of receiving waters and timetables for countries to implement appropriate wastewater treatment services"[3].

In particular the Protocol obligates Parties to control wastewater discharges that contribute to the pollution of marine and coastal areas. It defines wastewater to refer to all discharges from

[3] LBS Protocol

households, commercial facilities, hotels, septage and any other entity whose discharge includes the following:

a) Toilet flushing (black water)
b) Discharges from showers, wash basins, kitchens and laundries (grey water)
c) Discharges from small industries, provided their composition and quantity are compatible with treatment in a domestic wastewater system.

The Protocol obligates Parties to also control non-point agricultural run-off. Caribbean jurisdictions have themselves recognized that implementing the LBS obligations will require not only an upgrade to wastewater infrastructure but also improvements in wastewater planning frameworks to ensure that the standards that govern wastewater discharges are effectively implemented.

Cost estimates of the developmental works to upgrade infrastructure within selected countries have been given to be: Barbados (US$40 MN), Jamaica (US$1,500 MN), Guyana (US$75 MN) and Trinidad and Tobago (US$545 MN) at a total value of US$2.16 Billion.[4] The existing national budgets of these countries evince that only a fraction of this estimate can be met, requiring that approaches to reducing the gap between what is needed and what funds are available must be adopted. International funding agencies will want assurance that the investments they make in Caribbean wastewater infrastructure will be adequately managed and maintained to ensure long-term sustainability and security[5]. This assurance may be met by Caribbean countries through the introduction of new administrative systems and management tools to allow them to adapt to the increased improvement in the regulatory requirements and the environmental complexities of wastewater systems they now face.

The majority of GEF CReW participating countries are parties to the LBS Protocol. This not only has the effect of satisfying the feasibility of obtaining international funding, it also signifies that these countries operate under the same umbrella of requirements and standards for wastewater management. This common framework is invaluable to implementation and

[4] http://www.caribbeanhotelandtourism.com/downloads/CHTAEF_Wastewater.pdf

[5] This assurance will require water and wastewater systems to present convincing evidence that they possess adequate financial, technical and managerial capacity to provide the service that their customers expect, to maintain the infrastructure necessary to provide that service and to manage the organization technically and financially throughout the life expectancy of the improvements being financed.

enforcement. As an implementation measure, the LBS Protocol requires Parties to "take all appropriate steps to prevent, reduce and control pollution of the Wider Caribbean Region (WCR) using the best practicable means at their disposal in accordance with their capabilities." (Article 4, LBS Protocol). To give effect to these provisions, countries must develop waste management plans and demonstration projects to reduce pollution of their coastal and marine environment.

Various governments participating in the CReW project pointed to the need for a "how to" Guide on developing, reviewing and updating Wastewater Management Plans (WWMP). The need for these Guidelines was also acknowledged and documented most recently in the Integrated Water Resources Management (IWRM) Roadmaps that were developed with the technical assistance of the Caribbean Environmental Health Institute (CEHI). These Guidelines offer the basic knowledge and resources needed by wastewater entities, policy makers, wastewater operators and physical planners to meet that implementation measure, in particular, established in the LBS Protocol and expected under the Johannesburg Plan of Implementation and the Millennium Development Goals (MDGs) under which Caribbean countries committed to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation"[6]. The main focus of these Guidelines is on domestic discharges that find their way into wastewater treatment plants.

The Guidelines are divided into eight parts each with a number of sections. It proceeds by discussing who should be involved in developing a WWMP and subsequently elaborating the tools for developing it. The Appendices to these Guidelines include:

- Obligations under the LBS Protocol (Appendix A)
- Legislation Relevant to Wastewater Management (Appendix B)
- Overview of Wastewater Treatment (Appendix C)
- Optional Technologies for Wastewater Management (Appendix D)
- Mapping and Wastewater Management Plans (Appendix E)

Common wastewater terms are introduced at the beginning of the Guidelines document and a Sample Table of Contents for a WWMP is provided as a separate Annex 1.

[6] Goal 7C

Wastewater management is a key municipal service that can influence various aspects of development. It is inextricably linked to land use, protection of public health, protection of water resources and overall physical and socio-economic planning and development. Because of these significant implications, a wide range of actors besides the wastewater utility manager should be involved in the process to develop, update and review WWMPs. These actors include public health, water resources, environment and planning officials. To be comprehensive, the WWMP must also consider the views of civil society stakeholders in the development of their communities. The Guidelines therefore provide information and direction to these key groups in WWM plan development and also specify a planning approach that complies with the enforcement provisions of existing wastewater management legislation where they exist[7]. The development and implementation of effective WWMPs by GEF CReW participating countries will make them attractive to investment and financing agencies and will ultimately promote their own economic growth.

The Guidelines are not designed as a stand-alone document, which is structured as an action-oriented and practical guidebook to provide the technical support to the **Regional Wastewater Management Policy Template and Toolkit** also prepared under this project. The Guidelines and Policy Template Toolkit are intended to be used in conjunction with other industry documents, manuals of practice, project reports and case studies as integrated tools to enable the wastewater management system to meet future service demands and regulatory requirements and to provide for long-term sustainability. However, the Guidelines may be used independently, depending on the stage at which the wastewater entity finds itself, in relation to the system's most pressing needs or starting with the easiest success.

1.1 How to Use these Guidelines

The Guidelines propose the:

- parties that should be involved in the process
- contents of the WWMP including:

[7] For most GEF CReW participating countries the control of wastewater is executed through outdated Public Health Acts.

    - an inventory of the wastewater systems in the area concerned
    - current and future wastewater management needs of the area concerned
    - the options for addressing those needs and selecting an appropriate approach
- how the selected approach will be implemented and financed, including phasing and timelines
- process for evaluating and reviewing the WWMP when it is in place
- means by which a WWMP may be advanced to become Policy.

The level of detail and ultimate scope of the WWMP will depend to a large extent on the nature, scale and location of the wastewater needs that are being assessed. Planners are encouraged to recognize this and use these Guidelines as a basis for putting together a WWMP while taking account of unique needs. Stakeholders are also encouraged to keep their environment and planning entities involved throughout the process and to utilize all technical and financial resources that may be available.

2.0 WHO SHOULD BE INVOLVED IN PREPARING A WASTEWATER MANAGEMENT PLAN (WWMP)?

"Because a WWMP has significant implications for land use it is important to involve all stakeholder entities that will ultimately bear the economic, environmental and institutional consequences of the recommended plan as well as all stakeholder groups that will be affected by the recommended plan in the decision-making process to develop one. The planning process should therefore elicit participation by all "stakeholder" groups. The process includes many critical decision points which can become significant obstacles in achieving an implementable plan if stakeholders are not directly involved in the decision-making process. It is therefore important that the community in particular, be informed and educated on the myriad of technical, environmental and fiscal issues presented by the wastewater management alternatives that may be proposed. As such, the participation of and consultation with stakeholders such as elected officials, physical planning, health and environment entities and civil society groups or should be brought into the wastewater management planning effort as early as possible and these groups should be continually apprized of the development of the plan"[8]

Begin by setting up a small planning committee involving the entities mentioned below as committee members or for consultation as needed to ensure that various components of the WWMP are examined from a broad perspective. This will ensure a smooth planning process and result in a thorough WWMP. The wastewater utility manager should lead the wastewater management planning process and depending on the complexity of the wastewater issues and the amount of data already collected through various studies, a professional wastewater engineer may be hired to assist the committee. At a minimum, consultation with engineers, as well as planners and other professionals, is recommended in all cases.

Table 1: Recommended Members of WWMP Planning Committee

- Wastewater utility manager to chair and lead the process
- Physical planning officer
- Environmental/public health inspector
- Professional consulting engineer (if no full-time engineering staff)
- Owners of larger private wastewater systems (lagoons or piped systems)
- Local community/civil society/ NGO representative
- Consultation with engineers, planners and other professionals (as appropriate)

At the first meeting of the planning committee, members should exchange information that may be relevant to plan development, including any available technical and financial resources which may assist in the WWM planning effort. This can include the following:

- facility plans
- water quality studies
- sewer system evaluation studies
- onsite system reports

If these documents are technically sound and reflect current conditions, they may be considered or reviewed and revised for inclusion in the WWMP that is being developed.

[8] "Guide to Wastewater Management Planning", Massachusetts Department of Environmental Planning,1996

3.0 CONTENTS OF A WASTEWATER MANAGEMENT PLAN

The sub-sections below walk through the next steps in the process of preparing a WWMP, focusing on what information to obtain and include. The specifics of each WWMP will vary according to the particular circumstances of each GEF CReW country including climate, geology, soils and topography. If carried out appropriately, the result will be a WWTP which, when put in place, will be cost effective and environmentally sound. This approach should be tailored to address the particular needs presented by the conditions in each planning area.

3.1 Assessment of the Current Situation

To complete this task, a summary description of the problems and the reasons why the wastewater treatment facility is necessary to address them should be provided. The description should include the information identified. Sources of information used to compile the information must be included. This information should be presented according to the parameters described below.

3.1.1 Describe the sources of wastewater and how much wastewater is being produced annually

This will use the information set out in Table 2 below.

Table 2: Parameters for Assessing Current Information

- On a map[9], show planning area, current population, major centres of population, adjacent cities and towns, prominent surface waters, service areas of existing sewers and locations of treatment facilities. Also, locate commercial, institutional and industrial developments, particularly those with high wastewater production rates or those requiring special wastewater treatment.
- List the role and function of all entities involved in planning, financing and operating any existing wastewater facilities, including collection, treatment and disposal facilities as well as onsite treatment and disposal systems.
- Describe existing environmental conditions.
- Describe the annual wastewater volume produced by the sources listed above. Use existing wastewater system annual volume data, if available, and projected growth

[9] Annex E describes the importance of mapping to the process to develop WWMPs.

rates to calculate future needs. If existing volume data is not available, annual volume can be estimated with information such as:

- current population and past growth rates
- number of residential units and average number of people per household
- estimated average volumes of wastewater produced per person or per residence
- estimated organic loading per person or per residence
- estimated amount of truck hauled wastewater being produced from onsite systems, including septic tanks and holding tanks

- For private treatment facilities, contact the business or institution that owns the facility for volumes.
- Describe any water demand management programmes currently in place that may reduce the volume produced including flows and loads. Examples include low-flow toilets, composting toilets, low-flow shower heads, infiltration/inflow, collection systems, sewer use or related regulations.

3.1.2 Describe the type(s) of wastewater management systems currently used to manage/treat wastewater

The wastewater utility manager should describe the existing types of wastewater treatment systems and flows as stated below. A map delineating the location of these treatment systems and the overall sewer system could be added.

Table 3: Types of wastewater management system in current use

- Conduct an inventory of existing wastewater facilities. The inventory should:
  - Describe the wastewater management systems used, including any wastewater treatment plants and lagoons (public and private) and associated collection lines, lift stations, discharge routes and receiving waters and onsite systems (holding tanks, septic tanks and fields, ejectors). On a map, indicate the general location or service area of the existing system(s) in the planning area and any associated components.
  - Provide the annual volume treated, treatment type and remaining capacity

available for each wastewater management system

  - Identify how and where septage from onsite systems are treated and any impact it has on the system that treats it

- Identify areas that have wastewater servicing limitations or problem areas (high water table, poor soil quality, topographical issues, etc.).
- Identify any sources of wastewater from outside the planning area boundary that is managed at a facility within the planning area and describe any service arrangements that have been established (ex: capacity allotted to external sources, amount that external sources contribute to the system, amount charged to manage, etc.).
- If any wastewater produced in the planning area is managed at a facility outside the boundary of the planning area, identify the facility and any service arrangements with the operator.
- Identify any service agreements for wastewater management within the planning area (e.g. industrial service agreements).
- Provide a history of how the current wastewater management system came to be, explaining why the existing systems were adopted.

3.1.3 Outline the costs associated with the current system(s) and the mix of financing mechanisms

The funding and budgetary support for operating the wastewater management system is the foundation of the entire wastewater utility. The outline will set out the costs in relation to the existing financing mechanisms. It will make a general assessment as to whether current financing mechanisms cover the costs associated with current systems (e.g. borrowing costs, operations and maintenance, depreciation). Any shortfalls with the current financing mechanisms should be described to determine whether the current financing mechanisms cover the costs.

3.1.4 Describe how well current systems address current needs

The WWMP should move on to actually demonstrate that the resources are adequate for an acceptable delivery of the utility's services to the public. This activity will include the factors set out in Table 4 below.

Table 4: Assessment of current systems to current needs

- Compare the current functioning of the system to its design capacity (for treatment and storage). How well does the current system meet the demand?
- Describe how the current system meets regulatory standards (Public Health Act, Environment Act, Water Pollution Rules, any licence conditions) for effluent quality. The specific laws and regulations applicable to wastewater management should be described in this section of the WWMP, with citations of names of laws and regulations. Include effluent concentrations of phosphorous and nitrogen if applicable and available. Appendix B sets out the regulatory standards that must be complied with in each GEF CReW participating country.
- Identify any organic or hydraulic overloading problems. List any emergency discharges that have occurred in the last ten years.
- Describe how the current system can accommodate excess rainfall or other external influences.
- Describe the condition of the current system, including any limitations such as:
  - age and condition of existing stabilization ponds, lagoons and treatment plants (continuous discharge or storage)
  - damage or outstanding repairs
  - leakage or seepage, extraneous flows into the collection system
  - operational issues of concern
  - obsolete technology or inadequate chemical facilities
  - combined sewer and storm lines
  - condition of truck dump
  - condition of onsite systems
  - number of discharges annually
- Describe any real or potential public health or environmental concerns related to current wastewater systems.

4.0 ASSESSMENT OF FUTURE WASTEWATER MANAGEMENT NEEDS

This section of the WWMP provides estimates of the planning area's wastewater needs over the next 25 years, identifying short- and long-term needs.

4.1 Describe the anticipated growth rate and pattern of land use in the planning area

To do this the information contained in Table 5 must be obtained.

Table 5: Anticipated growth pattern

- Estimate populations and provide demographic projections for the planning area over the next 25 years (using background studies on supply and demand
- Based on these estimates and trends, describe the anticipated rate of residential development that will take place over the short (next 5 to 10 years), medium (11 to 20 years) and long (20 plus years) terms.
- Identify any anticipated commercial, industrial and institutional developments expected to have significant wastewater management needs in the next 25 years.
- Identify areas that are currently using onsite services, but expected to connect to a wastewater treatment facility within 25 years and what the timing is expected to be.
- Together with the planning entity, prepare an estimate of future land use patterns and densities. This is critical to determining future land use and development and in defining the need for wastewater management.

4.1.1 Based on the current amount of wastewater produced in the planning area and the anticipated growth rate and pattern of land use, describe how much wastewater is anticipated and how it will affect the current system used

To fulfil this narrative the information in Table 6 must be provided.

Table 6: Anticipated wastewater and impact on current system

- Estimate the volume of wastewater to be produced by anticipated development as designated in the development plan.
- Estimate future treatment and storage capacity needed to accommodate wastewater produced by all potential development, divided between serviced areas and areas with onsite systems (identify and include the capacity needed to handle wastewater and septage from existing and anticipated development with onsite systems).
- Describe the ability of the current system to accommodate new or expanded

residential, institutional, commercial, industrial or other developments over the short, medium and long terms.

- Identify the impact of any anticipated changes in the density of development on the current system. This should fully describe the wastewater problems that require the WWMP and should describe the nature and severity of the problem and to establish priorities.

5.0 WASTEWATER TREATMENT OPTIONS AND COSTS

This section of the WWMP identifies the wastewater treatment options, system requirements and costs associated with managing the planning area's wastewater over the long term. It is important to consider a variety of alternatives before selecting a suitable approach. The information below must be obtained at this stage of the process.

5.1 Describe the available option(s) and the approach that is best suited to meet current and future needs

The evaluation of options should include, at a minimum, an analysis of the baseline and other wastewater alternatives set out in Table 7[10]. The implications of the baseline alternative should be set forth with respect to potential effects on: surface water quality, groundwater quality (if applicable), land use limitations and socio-economic factors (e.g. residential, industrial development and health hazards). Table 7 identifies the information that must be considered in deciding on a suitable approach to wastewater management.

Table 7: Wastewater treatment alternatives

- Explore the different types of systems available to manage wastewater, such as wastewater treatment plants, stabilizing ponds, sewage lagoons, engineered wetlands and onsite systems. Researching best practices and consulting with qualified professionals is recommended.

[10] Some examples of these options are described at Appendix C.

- Compare the feasibility of different options based on the geography, size, rate of growth and development and financial capacity of the planning area including the use of alternative technologies[11].
- Other considerations to help decide on an approach include:
  - service sharing and other agreements
  - coordination of municipal or district-wide inspection schedules and pump-out of onsite systems
  - current water rates and possible rate adjustments
  - existing land use patterns, development direction and densities and possible changes to these to accommodate different wastewater management systems
- Describe the selected approach and any limitations it may have
- Describe how the community was consulted on the selected approach and alternatives.
- Appendix C provides more details about wastewater treatment alternatives.

GEF CReW countries have admitted that due to limited financial resources they have been unable to introduce improvements to their wastewater treatment infrastructure. The alternatives mentioned in Table 7 above may therefore be too costly for these countries. In addition to the baseline alternatives outlined above they could also consider the use of decentralized facilities for treatment and disposal of wastewater, such as onsite systems, package plants, cluster systems, wastewater reuse or other systems which may preclude the need for costly centralized facilities.

5.1.1 Initial screening and evaluating alternatives

An initial screening of the wastewater management alternatives should be conducted. Those that do not meet physical constraints of the planning area, such as climate, soils or topography, or are incompatible with environmental requirements should be rejected.

A cost effectiveness analysis on all alternatives advanced for detailed evaluation should then follow[12]. The analysis should include:

[11] Specifically, alternative technology includes land application of effluent and sludge; aquifer recharge; containment ponds; sludge composting and drying prior to land application; self-sustaining incineration; methane recovery; co-disposal of sludge and solid waste; and innovative, alternative onsite systems.

- a calculation of the direct monetary costs of each alternative using present worth or equivalent uniform annual cost as a basis
- all costs associated with construction of and operation of wastewater management facilities and other appropriate monetary factors including capital costs and operation and maintenance costs
- a comparison of existing institutional arrangements and authorities with those necessary to implement each option.

5.1.2 Based on the option selected, describe the improvements necessary and the associated costs

Based on the option selected, describe the improvements necessary and the associated costs the items mentioned in Table 8.

Table 8: Improvements and associated costs

○ Repairs to fix leaks and other damage ○ Upgraded technology or facilities to meet standards for treatment and storage operational enhancements ○ Elimination of combined sewers, where applicable ○ Demand management strategies to reduce wastewater production and need for expansion ○ Decommissioning failing onsite systems and associated remediation

6.0 IMPLEMENTATION AND FINANCING

Wastewater infrastructure is a huge capital investment which must be protected and maintained. It is the responsibility of the wastewater utility to effectively carry out the associated financial and administrative responsibilities for positive, long-term stewardship of this capital asset. Wastewater infrastructure systems are comprised of many components including the collection system, pumping stations, treatment plant and personnel. Problems with any one component can have an adverse impact on the rest of the system, often with costly consequences. In addition to the costs incurred to design and build infrastructure systems, both capital and operations

[12] This analysis should be done in accordance with accepted engineering economic principles

expenses are affected by current events. To ensure proper long-term stewardship, wastewater utility officials should be familiar with the bottom line.

This section of the WWMP should identify where and when wastewater management systems are expected in the planning area and how they will be financed. Information in this section will support future land development as designated in the development plan[13]. The required actions are described below.

6.1 Describe how wastewater management will be introduced

Table 9: Introduction of wastewater management

○ If a wastewater treatment facility will be built in the future, indicate on a map where the facility and associated components such as lift stations or line upgrades, if required, will be located and explain the reasons for the site choice. ○ Describe where future expansion of facilities will occur and outline any phasing. ○ Given existing regulatory processes (see Appendix B), estimate the length of time required to implement the plan. ○ Describe anticipated stages of construction and estimate timing. Identify factors that may influence timing. ○ Summarize this information in a table.

6.1.1 Describe the short- and long-term projected costs of the selected approach, including maintenance, repair and renewal and how these costs will be recovered

Table 10: Projects costs of selected approach etc.

○ Estimate the capital and operating financing needed to construct, operate and maintain systems, from a life-cycle costing perspective. ○ Estimate the costs of any planned upgrades or phasing. ○ Identify methods of financing (.g. property tax increase, capital borrowing, capital lot levies, special levies, gas tax rebate funds, septic dumping fees, utility rates, building

[13] New development that requires wastewater treatment services should ensure that the capital costs associated with the development and related servicing requirements are built in to a system of levies and charges.

permit costs).

- Explain how costs to expand or construct new infrastructure will be recovered by the developer (e.g. levies).
- Explain the cost-sharing formulas of any approach that could be applied at the regional level.
- Consider any recently updated regulatory requirements and their long-term cost implications.

6.1.2 Describe the financing mechanisms which may be used

Whatever the system, be it public or private, it will have to be paid for somehow. Wastewater treatment, the ongoing maintenance of wastewater treatment plants and other sewerage infrastructure and improvements to treatment require significant capital construction and ongoing operational costs. The following sections describe the types of investments for treatment, enhancements and sewerage infrastructure construction, maintenance and improvements. They include:

- capital cost – the cost of building a new system, or of upgrading or extending an existing system
- operating and maintenance costs of operating and maintaining the system including monitoring technologies
- cost of making provision for future replacement (depreciation).

Capital cost

The capital cost of providing a proposed new system is of course very important – but it is not as important as the cost that is going to have to be paid annually over subsequent years. It may sometimes be better to select a system that is more expensive to build but cheaper to operate and maintain, than one that is cheaper initially but expensive to operate. However, the cost of loan servicing and the amount that is going to have to be put aside for depreciation are other important matters that will influence this decision.

Operational and maintenance costs

'Operations' usually applies to the day-to-day actions that need to take place to run a system. For example, to run a central wastewater treatment system, electricity is needed, as well as someone to monitor and oversee the system. These are operating costs.

In choosing an option the costs of operating any system need to be factored in. Interestingly, the operating costs of onsite systems tend not to be factored into decisions. Costs are generally absorbed directly by the homeowner or businessperson – in terms of time and effort to monitor and look after the system. This is very misleading because it is the willingness of the owner to operate and maintain the system that is such a big factor in its long-term success. For onsite systems, the operational issues are probably relatively small but will include monitoring and inspections.

Budgeting for maintenance will require that sufficient funding is available for the following:

- Preventive maintenance (operating budget)
- Emergency maintenance (emergency reserve fund)
- Equipment replacement (capital reserve account)

Maintenance is essential to the sustainability of any wastewater management system. It includes all the activities needed to keep the physical system at a high quality. A preventive management programme combined with good operational practices will reduce the need for much of the corrective or emergency maintenance. Time and money spent on maintenance will therefore extend the 'design life' of the asset and will mean that it will not be necessary to replace the system earlier than is needed. Maintenance can include routine cleaning of any pipes and screens, pump-outs of septic tanks and associated testing. Monitoring of the physical state of a system will also be necessary.

Future replacement

Any system will have a life, beyond which it will be 'worn out'. It will need replacing at some stage and an important management concern will be to ensure that it is replaced at the best possible time. As much as possible, this needs to be right at the point where the system is still functioning well (so service levels are maintained) but just before it might fail. This involves expert judgment and puts an onus on the water utility to make that judgment, or to know when to seek external expert advice. More often than not that advice is sought when the system fails. Commissioned management assistance may avoid this problem.

Monitoring technologies

The development of new technologies for monitoring of wastewater treatment systems now provides high-level, economical support to inspection programmes. Remote monitoring of a large number of systems on individual properties can be accommodated by computer data processing, with fault detection and alarm call-out procedures initiating maintenance responses to deal with emergency situations. Such monitoring technologies enable labour cost savings associated with operation and maintenance inspections.

6.1.3 Examples of possible guiding policies that could be included in a development plan

Table 11 provides examples of possible guiding policies that could be included in a development plan, as appropriate

Table 11: Examples of policies for inclusion in WWMP

- New development must be connected to wastewater systems either where they exist now or where they are planned to be implemented.
- Unless physically impractical, existing non-serviced development eventually must be connected to wastewater systems through a phased approach (identify the amount of time until existing development will connect).
- Extension of piped wastewater services beyond the boundaries of a settlement area must occur in a planning context that takes into consideration the broader region that may be affected by the extension.
- Piped wastewater infrastructure will not be extended beyond the boundaries of an urban centre in a way that supports the expansion of new development on the periphery of the urban centre.

7.0 WWMP SUMMARY AND CONCLUSION

The concluding section should summarize the information and the approach endorsed by the WWMP. It should also highlight next steps for the planning area regarding land use, wastewater infrastructure and servicing and financial planning.

If increased capacity will be required, the WWMP must estimate and plan for the infrastructure investments necessary to accommodate the projected development. The Plan ensures that proposed infrastructure investments will be environmentally and economically sustainable, with implementation timelines that match population projections.

The WWMP must also demonstrate that the responsible local authority (where applicable, e.g. the Barbuda Council) will address any existing or anticipated environmental or public health issues, such as a boil water advisory.

Finally, the WWMP must indicate how new development will strive to pay for itself. The WWMP makes the link between planned development and the financing of related services. This is achieved by integrating the capital plan into the planning process, ensuring an adequate budget for new, expanded or improved services and ensuring proper allocation of fees to users of new infrastructure.

Once the Guidelines are adopted they should be used by key stakeholders to guide the future of the wastewater system. The final WWMP document should contain an Executive Summary outlining WWMP highlights, findings and course of action. Each section should conclude with observations that summarize the key points of that section. Maps and tables are useful to illustrate much of the information contained in a WWMP and should be included where applicable.

Annex 1 provides a sample Table of Contents showing all the sections of a complete WWMP. Since wastewater management is a specialized area, it may be helpful to include a glossary. A glossary of common wastewater terms that may be used or expanded as needed is contained in this document.

8.0 PLAN MONITORING, REVIEW AND UPDATING

It will be important to reevaluate and update the WWMP bi-annually or whenever the system's needs change, to include new information on its implementation, monitoring, new techniques or greater clarification and meet the growing challenges of the entity.

8.1 Plan Monitoring

Monitoring is critical to the long-term success of the WWMP. Establishing timelines for deliverables and conducting assessment activities for determining the effectiveness of specific actions will ensure wastewater entities receive high value for their commitment to the planning process. The entity therefore should establish a plan monitoring committee to oversee and evaluate implementation of the Plan. The committee should reflect the following interests:

- The geography, demography and political organization of the plan area
- A balance between technical and non-technical interests
- Continuity with the advisory committee, if possible through inclusion of members of the committee who have gained experience in development of the plan
- Objectives of the government ministry under which the wastewater entity is established, through the inclusion of ministry staff.

The planning committee (see Table 2), should provide the scope of work for the plan monitoring committee to advise the wastewater entity on all matters involving the implementation of the plan and evaluating its effectiveness. The scope of work should address the purpose, mandate, structure, meeting frequency and procedures for the plan monitoring committee. The wastewater utility should establish a reporting structure for the plan monitoring committee that ensures that committee reports and recommendations are given open consideration by the wastewater utility.

The report containing the progress made with plan implementation, including plan elements completed and adherence to schedule and costs should be submitted on a date specified by the planning committee.

8.1.1 Plan Review and Amendment

The progress and status of the WWMP should be assessed every 5 to 10 years, or more frequently when circumstances have changed significantly from when the original plan was developed. The WWMP review will determine whether or not an amendment or update is required.

During the review, the cost estimates for capital expenditure and operations and maintenance costs should be updated to ensure costs are current. If significant time elapses between plan development and implementation, an amendment should be undertaken. The following should be reviewed to ensure the Plan is still relevant and current:

- Cost estimates
- Objectives and outcomes
- Approach and technologies
- Regulations and standards
- Public support for the plan

While a full amendment may address all of the above, an update to the plan could be undertaken to revise cost estimates. The public should be made aware of a revision to cost estimates through advertisement, press coverage or other communication. If a full amendment of the plan is undertaken, more extensive public consultation involving non-governmental organizations (NGOs) and civil society should be part of the process.

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APPENDIX A
MAIN COUNTRY OBLIGATIONS UNDER THE LBS PROTOCOL[14]

The focus and main objective of the LBS Protocol is to reduce impacts of priority pollutants by establishing effluent and emissions limits and implementing best management practices in the Wider Caribbean Region. To fulfill obligations under the LBS Protocol a GEF CReW participating country should do the actions described below.

General obligations

- Classify recreational water bodies to ensure the most important areas are protected from the negative impacts of pollution.
- Establish legally binding standards for sewage effluent and discharges.
- Formulate policies, plans and legal mechanisms for the prevention, reduction and control of pollution from agricultural non-point sources of pollution that may adversely affect the WCR.
- Develop a National Programme of Action for Pollution Prevention.
- Identify and assess major sources and activities contributing to pollution of the coastal and marine environment.
- Develop management plans and demonstration projects to reduce pollution of the marine environment.

Effluent limitations for domestic wastewater

The effluent limitations in relation to the source categories (identified above) are described below.

Annex III - Effluent Limitations

Each Contracting Party shall ensure that domestic wastewater that discharges into, or adversely affects, the Convention area, is treated by a new or existing domestic wastewater system whose effluent achieves the effluent limitations specified below in paragraphs 1, 2 and 3 of this Part, in accordance with the following timetable:

[14] See http://www.cep.unep.org/lbs-collage-files/revised-lbs-faq-1.pdf

Category	Effective Date of Obligation*	Effluent Sources
1	0	All new domestic wastewater systems
2	10	Existing domestic wastewater systems other than community wastewater systems
3	10**	Communities with 10,000 - 50,000 inhabitants
4	15	Communities with more than 50,000 inhabitants already possessing wastewater collection systems
5	20	Communities with more than 50,000 inhabitants not possessing wastewater collection systems
6	20	All other communities except those relying exclusively on household systems
∗ In years after entry into force for the Contracting Party ** Contracting Parties which decide to give higher priority to categories 4 and 5 may extend their obligations pursuant to category 3 to 20 years (time frame established in category 6).		

Source: Annex III LBS Protocol

Agricultural Non-Point Sources of Pollution

In relation to agricultural non-point sources of pollution GEF CReW participating countries must:

- Conduct an evaluation and assessment of agricultural non-point sources of pollution[15] which may include:
    a) an estimation of loadings that may adversely affect the Convention area
    b) an identification of associated environmental impacts and potential risks to human health
    c) the evaluation of the existing administrative framework to manage agricultural non-point sources of pollution
    d) an evaluation of existing best management practices and their effectiveness
    e) the establishment of monitoring programmes.

[15]In particular, if these sources contain nutrients (nitrogen and phosphorus), pesticides, sediments, pathogens, solid waste or other such pollutants that may adversely affect the WCR (Annex III, LBS Protocol)

APPENDIX B
LEGISLATION RELEVANT TO WASTEWATER MANAGEMENT

The legal and regulatory framework for wastewater management in GEF CReW participating countries are listed here.

Antigua and Barbuda

Public Health Act, Cap. 353 regulates treatment and disposal of liquid waste
Public Utilities Act, Cap 359 maintains sewerage system
Pesticides & Toxic Chemicals Act regulates use and disposal of pesticides and toxic chemicals
Physical Planning Act, 2003 is responsible for conduct of environmental impact assessments (EIAs)
National Solid Waste Management Authority Act is responsible for disposal of ship-generated waste
Draft Environmental Protection and Management Bill, 2014 is responsible for protection of marine environment
Public Health Regulations vest public health officers with the duty to enforce against nuisances

Barbados

Marine Pollution Act (MPA), 1998 establishes discharge standards for marine environment
Coastal Zone Management Act Cap. 394 establishes Coastal Zone Management Unit to be responsible for protection of the marine environment
Town and Country Planning Act, Cap. 240 regulates developing planning process which includes wastewater infrastructure
Tourism Development Act, Cap. 341 and Income Tax Act, Cap 73 grant rebates for wastewater treatment
Income Tax Act provides incentives to farmers to adopt sustainable farming practices

Belize

Coastal Zone Management Authority Act (CZMA) establishes the strongest framework for wastewater management

Pesticides and Toxic Chemicals Act lists hazardous chemicals prohibited from dumping at sea

Port Authority Act Prohibits pollution of territorial waters

Environmental Protection (Effluent Limitations) (Amendment) and Pollution Control Regulations provide framework for prevention, control and reduction of land-based and marine sources of pollution to implement country's obligations under the LBS Protocol. Also requires treatment of domestic and industrial systems and sets limits for discharges.

Environmental Impact Assessment Regulations make EIAs mandatory for activities that have negative impact on environment

Fisheries Regulations monitor minor water quality parameters

Guyana

Environmental Protection Act, 1996: governs EIA process and control of pollution by controlling the concentration of discharges

Pesticides and Toxic Chemicals Act: establishes Board to control disposal of pesticides and toxic chemical

Environmental Protection (Water Quality) Regulations 2000: establish effluent limitations for industries

Jamaica

Natural Resources Conservation Authority Act requires a licence to discharge wastewater, construction of wastewater treatment facilities, promulgates treatment standards.

Town and Country Planning Act grants development consent to wastewater facilities.

National Water Commission Act & Water Resources Act provide framework for these entities setting water and sanitation policies and undertake monitoring and environmental impact assessments

Permits and Licences Regulations require permits for construction and operation of new wastewater treatment plant. Establishes treatment standards for trade effluent.

Wastewater and Sludge Regulations and Sewage Effluent Regulations allow safe management, treatment and disposal of sewage and industrial sludge

Draft Sewage and Wastewater Regulations (2011) prepared to support LBS ratification

Environmental Monitoring and Management Plan ensures that standards are being met

Draft Wastewater Management Policy 2006 is in process of developing policy guidelines for planning, development, operation and management, financing and delineation of role and responsibilities of different stakeholders in wastewater management

Public Health Act and Nuisance Regulations authorize action where breach in sanitation occurs

Saint Lucia

Public Health Act, 1975 empowers Minister to make regulations for the prevention or removal of discharges into any river, stream, water course

Physical Planning and Development Act, 2002 empowers the Development Control Authority to conduct EIAs

Water and Sewerage Act, 2005 gives power to Minister to prevent any matter from entering water and mitigate any pollution therefrom

Pesticides and Toxic Chemicals Control Act regulates disposal of pesticides and toxic chemicals

Public Health Regulations: Sewage and Disposal of Sewage and Liquid and Industrial Waste Works prohibit the discharge of sewage and other liquid wastes and provide specifications on the siting and construction of sewage treatment facilities

Voluntary Standard for Recreational Water Quality, 2010 establishes parameters and limits for riverine and coastal waters

St. Vincent and the Grenadines

Central Water and Sewerage Authority Act vests entity with responsibility inter alia or controlling water pollution

Town and Country Planning Act, 1992 provides for the preparation of EIAs for sensitive developments

Suriname

Marine Pollution Act establishes comprehensive legislative framework for coastal and marine environment

Draft Marine Pollution Regulations establish enforcement measures for the Act

Trinidad and Tobago

Environmental Management Act, 2005 makes provision for control of water pollution and issue of certificates of environmental clearance

Water and Sewerage Act establishes authority in the utility for wastewater management

Town and Country Planning Act 35:01 deals with the grant of development consent

Certificate of Environmental Clearance Rules and Schedule II Water Pollution Rules, 2001 divide the country's receiving waters into 4 categories and are stricter than Annex III of the LBS Protocol

Municipal Corporations Act, 1990 give responsibility to local governments for providing wastewater services to communities, such as collection, septic system management, primary and secondary treatment, solids handling and effluent discharge

Guidance Notes:

If regulations or local bye-laws (relevant to Guyana, Jamaica and Trinidad and Tobago) already exist, the wastewater entity in preparing the WWMP should simply list the laws and regulations already in place that are relevant to the WWMP.

If legal authority[16] does not currently exist for any of the required elements of the WWMP, the WWMP should indicate a schedule of activities for obtaining it. The legal authorities should implement the following actions:

- Identify the proper authority that is responsible for requiring wastewater treatment system users to comply with standards of design, construction, use and maintenance.
- Establish the power to ultimately disconnect users if they fail to comply with the established conditions of use. Other civil or criminal recourse should be available to the wastewater utility in cases where deliberate and significant violations of these conditions occur and there is a substantial impact to receiving waters or endangerment of human health.
- Make illegal discharges subject to corrective response action using any existing laws prohibiting a type of discharge, regardless of the user class (for example, domestic, commercial or industrial).

[16] Legal authority refers to powers granted to the wastewater utility to provide services to the public.

- Prohibit downspout, roof drain and area drain connections to sanitary sewer systems.
- Include construction and installation requirements in the building code. Building codes normally provide legal authority for the proper construction of privately-owned, sewer lines.

APPENDIX C
OVERVIEW OF WASTEWATER TREATMENT

This overview is intended to provide a brief description of wastewater treatment and introduces the reader to the key elements of a wastewater management plan. Although each plant is designed for particular conditions, there are many similarities in how different processes operate.

All living things generate some amount of waste. Wastewater or sewage is essentially a combination of liquid- or water-carried waste removed from residences, institutions, as well as commercial and industrial entities and is the byproduct of many uses of water. When water is used by our society, the water becomes contaminated with pollutants. There are household uses such as showering, dish washing, laundry and, of course, flushing the toilet. Additionally, companies use water for many purposes including processes, products and cleaning or rinsing of parts. After water has been used, it enters the wastewater stream and it flows to the wastewater treatment plant for the purpose of removing the wastewater pollutants to protect the environment and protect public health.

If this waste is not collected, left untreated and improperly disposed of, pollutants would negatively affect our water environment. The impacts of untreated waste water range from chronic ecosystem damage due to oxygen depletion of receiving waters from the biodegradation of organic matter; ecosystem damage of eutrophication of waters resulting from excessive inputs of nutrients present in waste water; and potential health risks from water-borne pathogens from discharges to waters used for recreational activities, such as swimming and canoeing. Untreated wastewater also contains sewage litter and other sewage solids that can impact the environment, for example, through the smothering of river beds or posing a hazard through its ingestion by wildlife. Sewage solids can also damage commerce by making beach and riverside resorts unattractive to potential visitors to the Caribbean.

Without treatment, the water from toilets, baths, sinks and washing machines from domestic and residential premises, industrial waste water discharges to sewers and rainwater contaminated with metals, oils and other pollutants in rainwater run-off from urban areas draining to sewers would have significant adverse impacts on the water environment.

The three main reasons for the treatment of wastewater, therefore, are:

1. The protection of persons from waterborne diseases which may develop from contact with untreated wastewater
2. The protection of the natural environment, including the rivers, coastal and marine environments and coral reefs, from the damaging effects of untreated wastewater
3. The support of important life systems and economic systems.

Before wastewater can be treated it needs to be collected. It is collected from homes, businesses and other buildings through connecting sewer pipes called laterals. These laterals join the wastewater facilities on the private premises with those facilities constructed underneath the public roadway. The pipes along roadways are often called main or trunk sewers and allow the wastewater to flow to the treatment facility, either by gravity or with the help of pumping stations to eventually reach a wastewater treatment plant.

There are three main types of collection systems:

1. Surface water drainage that collects rainwater run-off from roads and urban areas and discharge direct to streams, rivers and waterways
2. Combined sewerage that collects rainwater run-off and waste water from domestic, industrial, commercial and other premises
3. Foul drainage that collects domestic waste water from premises (no rainwater is collected).

Both surface water and foul drainage may eventually connect to combined sewerage where there are no rivers or other waterways to which surface water drainage can discharge.

There are many different ways of treating sewage but the most appropriate method for a particular area needs to be determined after careful consideration. While a variety of systems exist in GEF CReW participating countries, the majority of them utilize waste stabilization ponds wherever possible (Figure 1) as well as mechanical processes that include the use of percolating filters or activated sludge. This is so because waste stabilization ponds use natural processes and therefore have lower maintenance and operating costs. These ponds are also less susceptible to breakdowns and are very effective in achieving effluent quality standards. They also have the advantages of not only being low cost, but are easily designed; and offer flexibility, economical use of energy and ease of operation (Pearson, 1996; Xian-wen, 1995; Zhen-bin et. al., 1993).

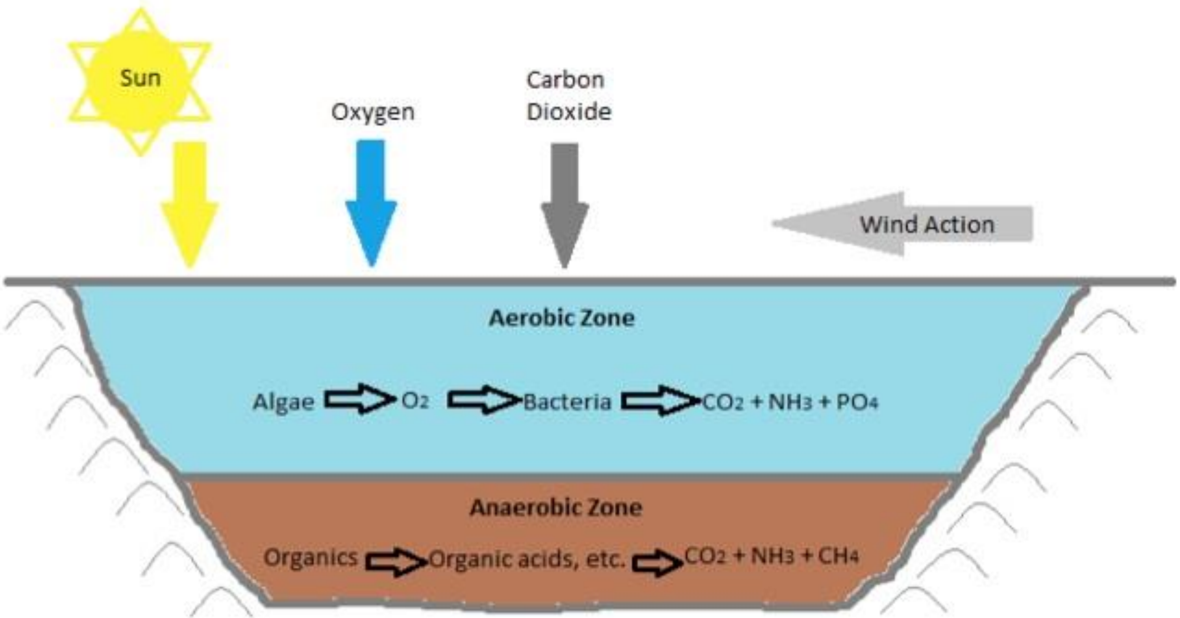

Figure 1: The basic biological interactions in a stabilizing pond

Therefore, the various alternatives should be evaluated in terms of land availability, costs of land and ease of expansion of the system to meet future population requirements. Despite the varying methods, wastewater treatment processes are generally classified as taking the wastewater through four stages or levels: **preliminary, primary, secondary and tertiary**[17].

The treatment of wastewater has the objective of returning much cleaner wastewater to the environment. A consequence of sewage treatment is that significant quantities of sludge are generated. Presently, for several GEF CReW countries sludge is either discharged to surface waters through pipes or disposed from barges at sea. The implementation of Annex III of the

[17] Adapted from http://www.nwcjamaica.com/PDFs/Website(PUBLICATIONS)%20-%20Wastewater%20Treatment.pdf

LBS Protocol as adopted in the Sewage Regulations, 2012 of Jamaica and the Water Pollution Rules, 2006 (as amended) of Trinidad and Tobago has resulted in not only higher discharge standards but also in greater quantities of sludge being produced. A WWTP also would provide guidance in introducing technological developments in sludge re-utilization[18].

Figure 2: Soapberry STP in the Kingston Metropolitan Area, Jamaica

Upon reaching the plant, the flow first encounters preliminary treatment. Preliminary treatment is followed by primary treatment, then secondary treatment and perhaps advanced or tertiary treatment. Different types of wastewater treatment are designed to remove the various contaminants of sewage solids, pathogens, nutrients, toxic chemicals and metals dangerous to wildlife and humans alike. Effective treatment also means treated waste water can be returned to the environment to maintain river flows for conservation, fisheries and recreational interests.

The treated wastewater is referred to as effluent. The effluent is discharged to a water body such as a river, stream or groundwater. Some GEF CReW participating countries, e.g. Guyana, Jamaica and Trinidad and Tobago, have put measures in place to control the location and quality of discharges to minimize the impact that the effluent may have on the receiving waters. Appendix A sets out the standards under the LBS Protocol that must be maintained for discharges entering certain classes of receiving waters.

[18] Use of sewage sludge as a soil enhancer and fertiliser on agricultural land remains the environmentally favoured option, with around 80% being applied to agricultural land.

The other by-product of sewage treatment is sewage sludge, which needs to be appropriately re-utilized or disposed of. These solids or “sludge” removed from the wastewater stream also needs to be treated. Some kinds of wastewater can be re-used even before they leave the house or industrial plant to be treated. To do this it is worth thinking about the four kinds of water that are part of a domestic system:

- *water*: for drinking, washing, cooking (potable); for transporting wastes (non-potable); and for other uses such as watering gardens and washing cars (non-potable)
- *greywater*: from baths, washing machines, showers and sinks
- *blackwater*: human wastes (urine, faeces and blood)
- *stormwater*. water that originates after precipitation events

The amount of water used for potable and non-potable purposes may be reduced. This in turn reduces the amount of greywater and blackwater being created and therefore the amount needing treatment. It is possible to re-use greywater and stormwater for non-potable purposes. Stormwater may enter the pipes that are carrying the wastewater for treatment and this can also be managed. Addressing the many sources of both point source and diffuse pollution from human activities presents a considerable challenge; the LBS Protocol aims to do that through its promotion of an understanding of the totality of pollution and other impacts on the water environment for the development of a holistic approach to addressing them.

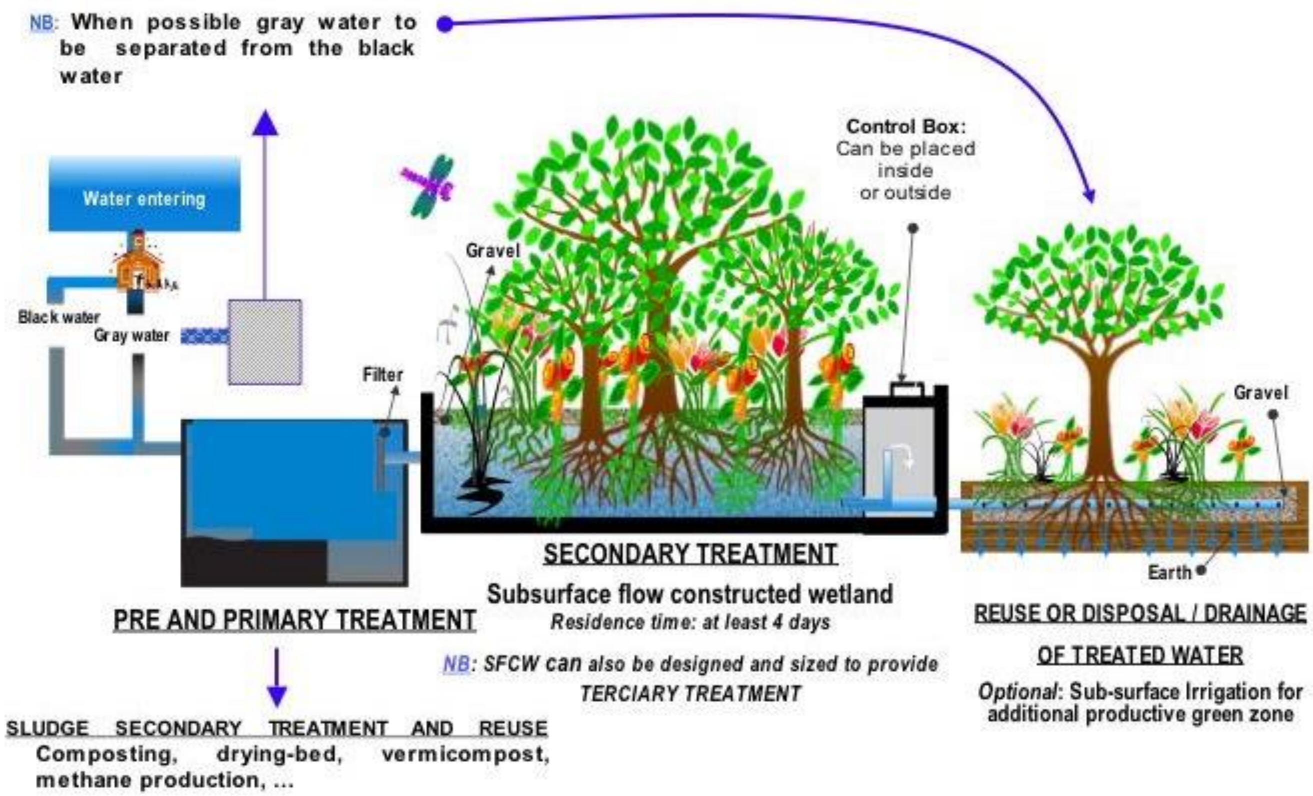

Figure 3: Overview of wastewater treatment system

The "Guidelines to Develop a Regional Wastewater Management Plan" provides a framework and a set of tools for identifying several solutions that will help to improve the quality of discharges to coastal and marine waters through sustainable approaches. The Guidelines as a "living document" should be updated at agreed periods to reflect new knowledge and information.

APPENDIX D
OPTIONAL TECHNOLOGIES FOR WASTEWATER MANAGEMENT

The rise in population and production rates in GEF CReW countries have increased water use, creating a corresponding rise in wastewater quantity. This increased water use and process wastewater generation requires more efficient removal of by-products and pollutants that allows for effluent discharge within established regulatory limits.

The need for more efficient wastewater treatment has been met with more technologically advanced, energy-intensive engineered treatment systems that require major capital investments and substantial ongoing operations and maintenance costs. Although highly effective, these advanced treatment systems are often out of reach for GEF CReW countries or their rural areas requiring them to seek effective alternatives. Low-energy input systems that utilize microalgae and the natural biological process of photosynthesis can drive efficient wastewater treatment systems and can be one of the options.

The following discussion describes the different types of wastewater treatment systems that may be managed by a wastewater utility in GEF CReW participating countries. They include package or decentralized systems and cluster or centralized wastewater systems.

Package Treatment Plants

A decentralized wastewater treatment system, commonly referred to as a "package treatment plant", utilizes the biological extended aeration principle of operation, which is a variation of the activated sludge treatment process. This system functions by creating an environment with sufficient oxygen levels and agitation to allow for bio-oxidation of the wastes to suitable levels for discharge.

Waste material in domestic wastewater is generally organic (biodegradable) which means that microorganisms can use this matter as their food source. A biological wastewater treatment system makes use of bacteria and other microorganisms to remove up to 90 per cent of the organic matter in the wastewater.

Biological wastewater treatment systems and processes were actually developed by observing nature. As waste entered a stream, the dissolved oxygen content in the water decreased and bacteria populations increased. As the waste moved downstream, the bacteria would eventually consume all of the organic material. Bacterial populations would then decrease, the dissolved oxygen in the stream would be replenished and the whole process would be repeated at the next wastewater discharge point.

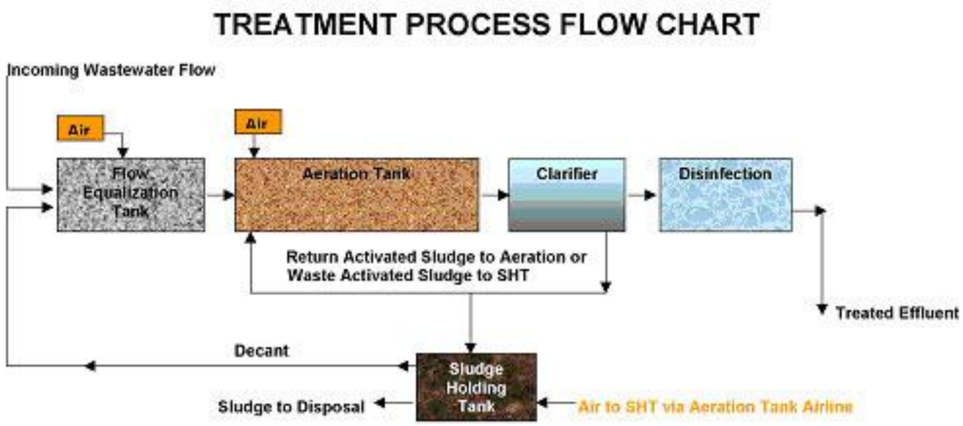

Figure 4: Treatment Process Flow Chart

In a wastewater treatment package plant, the influent wastewater enters the plant by passing through a comminutor and/or bar screen for gross solids removal. This step provides for the mechanical reduction of solids prior to aeration.

Once the wastewater has entered the aeration chamber, the untreated flow is mixed with active biomass in a rolling action that takes place the length and width of the chamber in a slow forward progression. This rolling mixing action is the result of air originating from air diffusers located along one side of the bottom of the tank. This insures that adequate mixing is maintained in the tank. The chambers are filleted on each side along the bottom to assure and enhance the rolling motion of the water and to eliminate any "dead zones" in the tank. The oxygen transfer achieved with the diffused air passing through the wastewater coupled with the rolling action provides a sufficient oxygen supply allowing microorganisms to oxidize treatable wastes in to carbon dioxide, water and stable sludge.

After aeration, the wastewater flows to the clarifier that typically has a hopper bottom configuration. The wastewater clarifiers are sized to provide the required retention time based on an average twenty-four hour design flow. During the settling period, solids settle on the bottom of the clarifier. Airlift pumps with adjustable pumping capabilities are used to return these solids, as activated sludge, to the aeration chamber to maintain the maximum efficiency of the biological process. When necessary, excess sludge is wasted to an aerated sludge digestion tank for additional treatment and reduction. A skimmer airlift pump is used to return floatable solids and scum to the aeration chamber for further processing.

The treated water flows from the clarifier to a disinfection chamber for treatment via chlorination or ultra-violet disinfection prior to discharge to complete the treatment process. Tertiary filters may also be used where a higher quality of effluent is required.

Centralized and cluster systems

Centralized wastewater treatment facilities serving smaller rural or suburban areas have been shown to cost between US$30, 000 - 60,000 per dwelling unit. The cost is dependent on the type of treatment system, the water quality requirements for the system, the distance between homes and the resulting collection system expense. However, if used in a cluster or village setting, the collection system costs can be reduced. In addition, the greater number of units connected to the system the lower the per-unit cost. When one combines the wastewater treatment costs with the higher densities achievable through enhanced treatment and land costs, the benefits of clustered developments with sewage treatment become apparent.

The management regimes for cluster and centralized servicing are well established and may be administered by one of the following agencies[19]:

- local government/parish authority (pertinent to Guyana, Jamaica and Trinidad and Tobago)
- a national authority
- a private enterprise service company.

[19] In the case of a small subdivision in a rural area, sometimes a 'sewage package plant' is an acceptable solution to the local authority.

Traditionally, wastewater systems have been managed in two ways. The first is where onsite or individual systems have been managed by the householder or stand-alone business. The construction, maintenance and operation of the system lie with the individual. In contrast, centralized collection and treatment systems are managed by a central agency which undertakes all management activities in a coordinated approach to wastewater servicing. This has normally been the practice on a local or parish approach to management of community-wide wastewater schemes. Responsibility for the centralized system could also be transferred to a separate agency, which would be governed in some way by the local or parish authority concerned.

The newer cluster systems can be managed by a local or parish authority (if they constructed them) or by a corporate entity. The latter would be set up by the property owners to manage the system on their behalf. This 'centralizing' of management reflects both the need to have a clear line of responsibility and the complexity of the systems being managed.

Onsite systems

There is an international trend towards placing onsite wastewater systems under integrated management programmes, particularly with respect to their operation, maintenance and monitoring. However the individual household management of onsite systems has come under increasing scrutiny by agencies concerned about public health. It is common to find that septic tanks and other onsite systems are poorly maintained and operated. There are often consequent problems with discharges to land and waterways and contamination of the water supply. Sometimes the cause of failure is lack of information about how to operate and maintain the systems. Sometimes it is an issue of cost.

Another problem is that failure to maintain the onsite system can mean that its life is drastically reduced. The homeowner may save money in the short term, but the system may have to be replaced earlier than normal. The value of the asset is lost. This recent scrutiny is likely to force communities which are otherwise comfortable with their onsite systems to review the situation.

One of the problems with this onsite system failure is that it can push a community into choosing offsite cluster or centralized systems. This physical technical system may not be necessary if the onsite systems are well managed.

Individual septic tanks

The concept of integrating the management of onsite systems is sometimes referred to as "decentralized wastewater management" (DWM). The objective of DWM is to provide centralized management of decentralized facilities, such as onsite septic tank and soakage trench systems on individual properties. This means that a level of management service equivalent to that of centralized and cluster wastewater systems can be accomplished. Sometimes DWM can include investigation and design of the system. This approach to operating and maintaining onsite systems would still need the householder to take some responsibility, for example, making sure that fats, oils and grease do not enter the system.

Fats, oils and grease (FOG) disposed to sewers from restaurants, pubs, canteens and residential premises cause significant problems in sewerage infrastructure. FOG readily sticks to pipes and tunnels, where they solidify and build up into hard accretions that can constrict or even block sewers. Accretions of problem FOG need to be removed manually, a task that involves sewerage companies to invest considerable time, effort and money that is ultimately paid for by sewerage customers. Householders can reduce these impacts by filtering and reusing oils, and using kitchen towels to dry-wipe oils and fats from pots, crockery and utensils as appropriate before washing them. Also, such measures can reduce the amount of detergent used, thereby reducing the potential environmental impact of phosphate used in detergents, which contributes to eutrophication.

Collective septic tank management

The majority of a community may feel that some regulation to require management of onsite systems is necessary. Or they may want to clearly indicate the expected standard for any new people settling in the area. A simple way to do this is to require everyone to perform to a certain level. This two-pronged approach may reduce pressure to move to a centralized technical system because the management of the onsite systems is faulty.

Such integration can:

- provide for the involvement of professional operation and maintenance (O&M) servicing, which removes the direct responsibility from the householder
- protect the investment in the onsite system hardware and soil treatment capacity by maintaining long-life performance
- bring better environmental and public health results.

This approach to operating and maintaining onsite systems would still need the householder to take some responsibility, for example, making sure that FOG does not enter the system.

APPENDIX E

MAPPING AND WASTEWATER MANAGEMENT PLANS

Mapping is an important tool for preparing a WWMP. A wastewater management map identifies where current wastewater servicing exists and where it is planned. A map is also critical for determining where wastewater servicing should be avoided (for topographical, environmental or financial reasons).

A wastewater map is useful for supporting policies in the development plan. For example, if a development plan requires new developments to connect to services where they are available, the map shows the services. The map can help identify where new development will connect and illustrate the cost implications of accommodating development in areas with specific services. Layering wastewater system maps over land-use designation maps will help integrate land use with wastewater management planning.

A map can also illustrate timelines or phasing of services. Existing regulations should instruct on this and should be checked. This can be shown in five-year horizons. A map can also show areas where disposal fields or ejectors are not allowed due to soil limitations, environmental or public health issues, new regulations or other reasons.

GEF CReW participating countries should also contact local government authorities, where they exist, for more information and assistance with wastewater mapping.

ANNEX 1

SAMPLE TABLE OF CONTENTS FOR A WASTEWATER MANAGEMENT PLAN

EXECUTIVE SUMMARY

INTRODUCTION

Methodology: Methods used, individuals involved, documents referenced

ASSESSMENT OF THE CURRENT SITUATION

Sources of wastewater

Overview of wastewater infrastructure in area

Current wastewater management system

Costs and financing of current wastewater management system

Functionality of current wastewater system

ASSESSMENT OF FUTURE WASTEWATER MANAGEMENT NEEDS

Anticipated growth and development patterns in area

Anticipated wastewater production and impacts on current system

WASTEWATER MANAGEMENT REQUIREMENTS AND COSTS

Wastewater management options available

Selected approach and necessary improvements

Probable costs associated with selected approach

Potential future regionalization of wastewater treatment (shared facilities/services with other communities), if applicable

WASTEWATER UPGRADE IMPLEMENTATION AND FINANCING

Staged implementation of upgrades (timing and location)

Capital costs, ongoing utility operating costs and financing mechanisms

Related policy guidance for development plan

SUMMARY AND CONCLUSIONS

APPENDICES, TABLES, FIGURES, GLOSSARY