2018

National Water Reuse Policy

Prepared by:
Environmental Protection Department

In collaboration with
Barbados Water Authority
Town and Country Development Planning Office
Environmental Health Department

October 2018

TABLE OF CONTENTS

LIST OF TABLES

National Water Reuse Policy

1.0 Introduction

1. Barbados is categorised among the most water scarce countries with less than 305 cubic meters of water available per person per year based on the Falkenmark water stress indicator. The total groundwater abstraction is currently estimated at 195,455 to 213,636 cubic meters (43 to 47 million gallons per day (MIGD)), out of which 145,454 to 163,636 cubic meters (32 MGD to 36 MIGD) is abstracted from twenty-two (22) public supply wells and two spring sources operated by the Barbados Water Authority (BWA). It is also estimated that private well abstractions are between 36,364 to 54,545 cubic meters (8 MIGD to 12 MIGD). Total abstractions from the available groundwater resources during an average rainfall year exceed 98% of available renewable water resources. Under drought conditions demand can exceed the available supply and have negative consequences to the productive sectors of the economy.

2. To ensure that development activity and economic growth is not compromised as a result of limited water resources, efficient use of all available water resources must be undertaken. The traditional interpretation of the term water must expand beyond conventional freshwater sources to encompass treated wastewater (reclaimed water), storm water and other sources as part of the total water resources. This approach would supplement the amendments to the *Town and Country Planning Development Order 1972* in 1995 which required the construction of water storage tanks to harvest rain water for secondary purposes. Reclaimed water[1] or treated wastewater and stormwater could therefore be used to satisfy agricultural production requirements, and potentially augment potable water supplies through groundwater recharge schemes. **Pure water does not exist naturally.** However, it is recognised that water must be fit for its intended purpose whether that be domestic, agricultural or industrial uses.

3. In 2005, the BWA commissioned the Water Reuse and Desalination Augmentation project. Amongst other objectives, the project sought to: 1) Quantify the availability in Barbados of renewable water resources, including non-potable and potable water supplies; 2) provide an alternative source of irrigation water for golf courses and agriculture; 3) review the viability to recharge groundwater supplies; 4) provide an alternative for non-contact industrial use; 5) avoid or defer capital investments for new wastewater effluent outfalls; and 6) reduce or eliminate adverse environmental effects from discharging wastewater effluent to the sea.

4. The project culminated with the submission of three reports namely the Water Augmentation Project Concept Paper, draft Water Reuse Act and draft Water Reuse Regulations, 2006. These documents recommended the possible administrative

[1] Reclaimed water means effluent that has been adequately and reliably treated, so that as a result of that treatment, it is suitable for a beneficial use or a controlled use that would not otherwise occur and is no longer considered wastewater.

and legal framework along with proposed standards to regulate the use of reclaimed water.

5. This paper is divided as follows:

    a. Section two exams the current context of water demand and water reuse. It highlights some of the challenges, potential uses of reclaimed water, policy and legislative instruments in use, and the critical issues which need to be addressed;
    b. Section three explains the current organisational structure and provides a synopsis of the roles and responsibilities of critical statuary agencies;
    c. Sections four presents the proposed policy that is required to address the critical issues within the context of national and international policy instruments and strategic plans. A vision and policy objectives are articulated with recommendations for a revised organisational structure and realignment of roles and responsibilities. Targets are proposed within this paradigm;
    d. Section five speaks to gaps that require filling in the current legislation and the critical need to prepare a comprehensive legal instrument to realise the core objectives of the new policy; and
    e. Section six presents short, medium and long term recommendations.

2.0 Reuse Situation

2.1 Water Demand

6. Klohn-Crippen Consultants[2] conducted a water demand analysis in 1997 on the 1993 consumption data set. During that period the total production was 57.2 mil m^3. Table 1 shows the estimated water usage by sector. Based on this data set, domestic and agricultural activities were identified as the two (2) highest users of water. It is estimated that approximately eighty to ninety percent of the water used for domestic activity is discharged as wastewater. This represents a sustainable source of wastewater that could be treated and used as reclaimed water in other productive activities where potable water quality is not required.

Table 1: Estimated Water Consumption for 2013

Sector	Consumption Estimate	Per Capita
Domestic	30.60 Million m^3/year[3]	Low income 140 Litres/capita/day High income 320 Litres/capita/day

[2] Klohn-Crippen Consultants Ltd and Stanley Associates Engineering Ltd, 1997. Draft Report on Task 8 Water Demand Analysis for the Water Resources Management and Water Loss Study.
[3] This figure includes unaccounted for water.

Commercial	3.55 Million m^3/year	37 Litres/capita/day
Government	1.59 Million m^3/year	17 Litres/capita/day
Statutory Corporations		3 Litres/capita/day
Hotels	1.47 Million m^3/year	678 Litres/bed-nights
Ship	0.29 Million m^3/year	
Irrigation	4.90 Million m^3/year (Public) 11.3 Million m^3 /year (Private)	
Golf Course	0.90 Million m^3/year	
Industrial	2.60 Million m^3/year	

2.2 Reclaimed/Effluent Reuse

7. Effluent or reclaimed water derived from wastewater treatment plants has been used by several establishments in Barbados for some time. Several hotels on the south coast and west coast utilised reclaimed water with and without the approval of the Environmental Protection Department (EPD) since the 1990s. Currently, there are sixty-eight wastewater treatment plants of which eighteen (18) practice wastewater reuse. The current EPD approved uses of reclaimed water however, only cover a narrow spectrum of golf course and foliage irrigation which was based on the limited provisions of the *Health Services Act, Cap. 44* and the *Health Services (Disposal of Offensive Matter) Regulations, 1969*. The method of application of reclaimed water was restricted to drip irrigation with the necessary disinfection to reduce pathogenic micro-organisms and therefore reduce health risks. Table 2 highlights those establishments and private residents that reuse reclaimed water for irrigation purposes. More recent requests have utilised systems to treat grey water for subsequent landscaping application.

Table 2: Developments that Practice Wastewater Reuse

Establishment	Type of Establishment	Reuse Infra-structure	Disinfection	Wastewater Reused
Manta Ray Bay	Condominiums	Yes	Chlorine	Yes
Private Residence	Residence	Yes	?	Yes
Beach View/Overlook	Apartments	Yes	Chlorine	Yes
Waterside	Condominiums	Yes	Chlorine	Yes
Palm Rosa Home	Residence	Yes	Chlorine	Yes
Sandy Lane	Hotel	Yes	U.V	Yes
Sandy Cove Resort	Condominiums	Yes	Chlorine	Yes

Establishment	Type of Establishment	Reuse Infra-structure	Disinfection	Wastewater Reused
The Sands	Condominiums	Yes	U.V, Chlorine	Yes
Villas on the Beach	Hotel	Yes	Chlorine	Yes
Coral Reef Club	Hotel	Yes	Chlorine	Yes
Bona Vista Home	Residence	Yes	Chlorine	Yes
Hi Point Farm	Residence	Yes	None	Yes
Natural Heritage Department	Offices	Yes	Chlorine	Yes
Harrison Cave Phase 2	Tourists Attraction	Yes	None	Yes
Royal Westmoreland	Residences	Yes	Chlorine	Yes
Private Residence	Residence	Yes	Chlorine	Yes
GAIA	Commercial	Yes	Chlorine	Yes
Private Residence	Residence	Yes	Chlorine	Yes

8. A number of establishments have in anticipation of regulatory approval of expanded uses of non-potable water and reclaimed water, installed the necessary infrastructure in the form of dual plumbing systems as detailed in Table 3. These systems further expand the range of uses of non-potable and reclaimed water to include flushing of toilets.

Table 3: Establishments with Dual Plumbing systems[4]

No.	Establishment	Visited/ Inspected	Dual System	Water Sources
1	Barbados Fire Service, Grantley Adams International Airport, Christ Church	Yes	Yes	Rainwater & potable water (RP)
2	Harrison's Cave, St. Thomas	Yes	Yes	RP and treated wastewater[5]

[4] Inspection of Dual Plumbing Systems at the Barbados Fire Service Station, Grantley Adams International Airport (GAIA), Christ Church and Harrison's Cave, St. Thomas.
[5] Effluent from the wastewater treatment plant is used in the drip irrigation system.

No.	Establishment	Visited/ Inspected	Dual System	Water Sources
3	Barbados Fire Station, Arch Hall, St. Thomas	No	Yes	RP
4	District E Police Station, St. Peter	No	Yes	RP
5	Eric Holder Complex, St. Joseph	No	Yes	RP

9. Despite the potential benefits of expanded uses of reclaimed water, there are some adverse environmental and health challenges that require management intervention. Inspection of some of these systems indicates: (1) Some establishments have no colour coding of valves and pipes to distinguish potable water from non-potable water, (2) inadequate physical separation of potable and non-potable water pipes, and (3) inadequate plumbing drawings to assess the system at the planning stage of the development. If not properly policed and controlled, there is serious potential for cross connection issues with the BWA water supply network, with potentially catastrophic consequences.

2.3 Non-potable Water Use

10. In 1995, the Government announced a rainwater harvesting policy which was enacted through amendments to the *Town and Country Planning Order, 1972* by Statutory Instrument 1996/15. This required the harvesting of roof water to ensure the reduction in the use of potable water. New residences with floor areas between 1500-2990 square feet are required to install a rainwater storage tank with a capacity of 13.6 m^3 (3000 gallons). A tank of 27.2 m^3 (6000 gallon) is required for residences with a floor area greater than 3000 square feet. By Statutory Instrument 1987/87, a non-residential building with a floor area in excess of 1000 square feet has to provide storage at a rate of 4 gallon per square foot. Over the eighteen years of implementation of the Policy, the Town and Country Planning Development Office estimates that approximately 13,000 tanks should have been installed based on applications that satisfy the criteria.

11. The Policy was implemented in the absence of design standards for storage tanks, guidance on the use of the harvested rainwater, guidance for the prevention of mosquito breeding, and a clear regulatory mechanism to ensure public health standards are maintained.

12. Some commercial establishments as demonstrated in Table 3 above are using the harvested rainwater for the flushing of toilets and other reports suggest that the water may be used for irrigation of foliage and other ornamental plants. Some commercial applicants have expressed the desire to use rainwater for laundry and as top-up water for swimming pools.

13. However, some applicants have expressed reservation about the rain water harvesting measures, remonstrating vehemently about the additional cost required to distribute the water and inadequate legal opportunities to utilise the water effectively in their particular situations. As a result, it is suspected that there are several constructed water storage tanks with unused stagnant rainwater, inadequate mechanisms to prevent entry and egress of mosquitoes and are therefore excellent sites to proliferate the *Aedes Aegypti* mosquito population.

14. There may be some merit to these complaints as Barbados saw an upsurge in dengue fever in 2012-2014, the introduction and widespread transmission of Chikungunya in 2013-2014 and most recently local transmission of the Zika virus late in 2015. The expected financial burden of these diseases is quadruple: expenditure for the treatment of infected person; a reduction in productivity due to absenteeism; loss of earning by diverted tourism visits and an increase in marketing cost. Despite the suspected association of increase in water storage tanks with the increases in febrile illnesses transmitted by mosquitoes, it is recognised that the water storage tanks are not the only source to proliferate the vector. The surveillance and monitoring of water storage tanks is therefore a critical component to the integrated vector control programme of the Ministry of Health and Wellness.

15. There is great potential in the expanded use of non-potable and reclaimed water. However, the appropriate policy, legislation, and administrative framework must be in place to manage the potential health and environmental risks associated with water reuse. The current capacity of the respective regulatory agencies to physically regulate water reuse at the planning, construction and operational stages is limited given the current and historical human and financial constraints in the sector.

2.4 Potential Water Reuse Options

16. The uses of reclaimed water may fall into two broad categories: potable and non-potable uses. Under potable uses there are indirect potable reuse (IPR) and direct potable reuse (DPR). Indirect potable reuse is defined as the augmentation of a community's raw water supply with treated wastewater followed by an environmental buffer. This may involve mixing with surface or groundwater followed by additional treatment before introduction into the potable distribution system. On the other hand, direct potable reuse is defined as the introduction of treated wastewater directly into a water distribution system without intervening storage (pipe-to-pipe).

17. The predominant standards for water reuse are the United States' Guidelines on Water Reuse, 2004 and the World Health Organisation's Guidelines for the safe use of wastewater, excreta and greywater. The potential water reuse options vary and include: urban, industrial, agricultural, environmental and recreational, groundwater recharge and augmentation of potable water supplies. A brief description of each is presented in the subsequent sections.

2.4.1 Urban Reuse

18. Urban reuse systems provide reclaimed water for various non-potable purposes including:
    a. Irrigation of public parks and recreation centers, athletic fields, school yards and playing fields, highway medians and shoulders, and landscaped areas surrounding public buildings and facilities;
    b. Irrigation of landscaped areas surrounding single-family and multi-family residences, general wash down, and other maintenance activities;
    c. Irrigation of landscaped areas surrounding commercial, office, and industrial developments;
    d. Irrigation of golf courses;
    e. Commercial uses such as vehicle washing facilities, laundry facilities, window washing, and mixing water for pesticides, herbicides, and liquid fertilizers;
    f. Ornamental landscape uses and decorative water features, such as fountains, reflecting pools, and waterfalls;
    g. Dust control and concrete production for construction projects;
    h. Fire protection through reclaimed water fire hydrants; and
    i. Toilet and urinal flushing in domestic, commercial and industrial buildings.

2.4.2 Industrial Reuse

19. The use of reclaimed water in the industrial process is dependent on the nature of the industrial process and subsequently the quality of the process input water. Typically reclaimed water can be used as cooling water, boiler make-up water, or industrial process water. In most, if not all cases, pre-treatment is required to improve the water quality to prevent either product contamination or equipment damage as a consequence of specific contaminants which are process dependent. As a result, the end user reclaimed water quality requirements for use in industrial processes must be clearly defined.

2.4.3 Agricultural Reuse

20. The use of reclaimed water in agriculture has the potential to significantly reduce demand for potable water supplies to irrigate vegetables, fruits, pasture lands and other agricultural crops. Water quality again is a significant aspect to the use in this area.

21. The elements of greatest concern at elevated levels are cadmium, copper, molybdenum, nickel, and zinc. Nickel and zinc have visible adverse effects in plants at lower concentrations than the levels harmful to animals and humans. Zinc and nickel toxicity is reduced as pH increases. Cadmium, copper, and molybdenum, however, can be harmful to animals at concentrations too low to impact plants. Total dissolved solids and sodium concentrations in reclaimed water have implications for soil quality characteristics and can have an adverse impact on

plants. A challenge with agricultural reuse is a cost effective method of getting reclaimed water to the sites that require the water.

2.4.4 Environmental and Recreational Reuse

22. Environmental reuse includes wetland enhancement and restoration, creation of wetlands to serve as wildlife habitat and refuges, and stream augmentation. Uses of reclaimed water for recreational purposes range from landscape impoundments, water hazards on golf courses, to full-scale development of water-based recreational impoundments, incidental contact (fishing and boating) and full body contact (swimming and wading).

2.4.5 Groundwater Recharge

23. The purposes of groundwater recharge using reclaimed water may be: (1) to establish saltwater intrusion barriers in coastal aquifers, (2) to provide further treatment for future reuse, (3) to augment potable or non-potable aquifers, (4) to provide storage of reclaimed water for subsequent retrieval and reuse, or (5) to control or prevent ground subsidence.

2.4.6 Augmentation of Potable Water Supply

24. Treated wastewater is mixed with surface and/or groundwater, and the mix typically receives additional treatment before entering the water distribution system. Direct potable reuse is defined as the introduction of treated wastewater directly into a water distribution system without intervening storage (pipe-to-pipe). Both such sources of potable water are, at face value, less desirable than using a higher quality source for drinking. In the Barbadian scenario detailed study to define the sites, injection conditions, and water quality requirements will be necessary.

2. 5 Existing Legislation

25. *Section 4* of the *Health Services Act, Cap. 44,* along with the *Health Services (Building) Regulations, 1969, the Health Services (Disposal of Offensive Matter) Regulations, 1969 and Health Services (Nuisance) Regulations, 1969* provide for the control of effluent from wastewater treatment systems. In particular, Regulation 12 of the *Health Services (Disposal of Offensive Matter) Regulations, 1969* provide for final disposal of effluent in an acceptable manner to the environment. The *Town and Country Planning Act, Cap. 240* through Section 13 provide an overarching framework to regulate all development. Furthermore, the main legal authority for the control and regulation of water is articulated in Part II, Section 5 and Part VII Section 27 and 28 of the *Barbados Water Authority Act, Cap. 274A.* Further details on the statutes are provided in Table 4 below.

Table 4: Water Reuse: Relevant Legal Clauses in the Respective Statues

Statue	Clause
Health Services Act, Section 4 (1) a, c, and d	The Minister shall be responsible for the administration of this Act, and, without limiting the generality of the foregoing, his functions shall include *(a)* the prevention, treatment, limitation and suppression of disease, including the conduct of investigations and enquiries in respect thereof; the publishing of reports, information and advice concerning public health, including advice to the Government and the education of the public in the preservation of health; *(c)* the abatement of nuisances and the removal or correction of any condition that may be injurious to the public health; *(d)* the control of food and drugs in the interest of the public health and the seizure and destruction of food and drugs that do not comply with this Act or any regulations, and the protection of the public from fraud or deception in connection with food or drugs;
Health Services Act, Section 10 (1) e	10**.** (1) The Minister may, subject to negative resolution, make regulations for the proper carrying into effect of this Act, and in particular may make regulations; *(e)* providing for the institution of measures for ensuring the purity of the water supply;
Health Services (Building) Regulations, Regulation 9	9. All receptacles for the storage of rain or other water shall be water-tight, and properly covered and maintained in a sanitary condition to the satisfaction of the Medical Officer of Health.
Health Services (Disposal of Offensive Matter) Regulations, Regulation 11 & 12	11. No person shall cause or permit the effluent from any public sewerage system to flow into the sea or on or into any other place except at such sites and in such manner as the Minister may approve. 12. No person shall cause or permit the effluent from any public sewerage system or from any septic tank to flow into the sea or on or into any other place except at such sites and in such manner as a Medical Officer of Health may approve.
Health Services (Nuisance) Regulations, Regulation 3 (10) & (15)	10. Any water supply system which is not maintained in a sanitary manner. 15. any discharge, except in accordance with a permit granted by the Minister or a Medical Officer of Health, of any industrial waste or other noxious matter on to any beach or into the sea or into any river, ravine, water-course, pond, ditch drain or other place.
Town and Country Planning Act, 1985 Section 13	13. (1) For the purposes of this Act, the expression "development", subject to this section, means the carrying out of building, engineering, mining or other operations in, on, over or under any land, the making of any material change in the use of any buildings or other land or the sub-division of land.

Barbados Water Authority Act, 274A *Section 5. (b), (c), (d), (e), (f), (g), (h), (i), (j), (k), (l), (m), (n)*	5. The functions of the Authority are (b) to manage, allocate and monitor the water resources of Barbados with a view to ensuring their best development, utilisation, conservation and protection in the public interest; (c) after consultation with such persons as the Minister may direct or otherwise, to prepare and submit to the Minister from time to time proposals for the establishment of efficient, coordinated and economical water supply and sewerage systems capable of meeting the need for water and sewerage services throughout Barbados; (d) to prepare details of schemes for the development of water resources and for the supply of water and sewerage services and to construct, maintain and operate such schemes; (e) to keep under constant review the quality, reliability and availability of water supply and sewerage services and the rates to be charged for these services; to control and regulate the production, treatment, storage, transmission, distribution and use of water for public purposes; (f) to design, construct, acquire, provide, operate and maintain water works for the purposes of supplying water for public purposes; (h) to design, construct, acquire, provide, operate and maintain sewerage works for the purpose of receiving, treating and disposing of sewage; (i) to control and regulate the disposal of sewage through sewerage plants that are not part of the Authority's systems; (j) to conduct research programmes and prepare statistics for its purposes; (k) to disseminate information and advice with respect to the management, collection, production, transmission, treatment, storage, supply and distribution of water and where applicable, sewage; (m) to advise the Minister on the matters referred to in paragraph (e) and such other matters relating to water supply and sewerage services as the Minister refers to the Authority; (n) to perform such other functions as the Minister assigns or as the Authority considers necessary or expedient for its purposes.

26. These provisions are limited in scope and cannot manage the comprehensive implementation of an advanced water reuse policy landscape. It is evident that consideration needs to be given to introducing additional legislative tools and the current programme improved to ensure that the implementation of water reuse measures is done in a sustainable manner.

2.6 Critical Issues for Consideration

27. Untreated wastewater contains a range of hazards because of the microbiological and chemical constituents that may be present. Some of these contaminants may remain after treatment and these can pose both health and environmental risk if present in sufficient quantities. Pathogenic bacteria or viruses may transmit infectious diseases through direct skin contact, or consumption of contaminated food products. Chemicals such as heavy metals, halogenated hydrocarbons or pesticides, can have health impacts if individuals are exposed to sufficient quantities and for prolonged periods. The potential health effects may include lung damage, nausea, vomiting, diarrhoea, increases in blood pressure or heart rate, skin rashes, and eye irritation. In the Barbadian context the possible modes of human exposure to these hazards are:

    a. Direct contact with skin, eyes and mouth;
    b. Consumption through plumbing cross-connections between potable, non-potable and reclaimed water;
    c. Ingestion due to inadequate signage and colour coding of plumbing fixtures;
    d. Inhalation of aerosolised effluent (spray irrigation, water fountains and water aeration devices);
    e. Ingestion of food crops irrigated with contaminated water; and
    f. Contamination of general surfaces where human contact is likely.

24

28. Barbados has a long history of wastewater treatment. The 1963 Groundwater Protection Policy advocated preliminary wastewater treatment for residential development in areas designated for the abstraction of potable water. In the 1970s is was recognized that wastewater impacted negatively on the marine environment and hotels that generated wastewater flows greater than $13m^3$ were required to install wastewater treatment plants. These developments were intermittent and the country never developed a wastewater treatment standard until the Environmental Protection Department proposed the draft table of prohibited concentration in 2004. The draft standards include discharge standards and ambient marine water quality guidelines for specific parameters that if released in sufficient concentrations and quantities can cause harm to the environment and human health. The standards and guidelines however remain in draft as the requisite legislation is yet to be prepared to bring the standards into force. Meanwhile, wastewater treatment and reuse of effluent continue without the appropriate guiding standards, protocols and a holistic monitoring programme to ensure protection of the general public from the inherent hazards of the reclaimed water.

29. Previous international studies on wastewater reuse projects demonstrate that pathogenic organisms, some of which included parasitic protozoan and antimicrobial resistance (AMR) organisms, are known to survive the secondary treatment process. Some authors concluded that without proper, additional

advanced treatment, these contaminants may pose a significant public health risk. Enteric protozoa such as *Giardia* and *Cryptosporidium* are pathogens of increasing importance to water reclamation. The cysts protect the protozoa making disinfection difficult and treatment is only effective under certain conditions of time and the appropriate dose of the disinfection agent. These parameters/contaminants are so important that some jurisdictions require monitoring for these pathogenic organisms in reclaimed water to assess compliance with regulatory standards. There are no environmental studies to determine the prevalence of *Giardia* and *Cryptosporidium* in the Barbadian environment but these pathogens are known to be present from stool samples from babies in the 1970s as conducted by the Ministry of Health.

30. A significant challenge faced by the Environmental Protection Department in implementing Cabinet Decision Note (02) 812/MPE 32 of August 13, 2002[6] is that of the national laboratory capacity. EPD currently monitors the twenty two potable water supply well heads and eighteen bathing beaches for health and environmental parameters. The wastewater treatment plant inspection programme was discontinued after the laboratory indicated that they were having a significant challenge in processing all the samples across all three monitoring programmes. The laboratory assessment of wastewater samples to judge compliance to proposed wastewater discharge standards is an indispensable tool that is required in health and regulatory surveillance programmes, but under the current circumstances cannot be completed due to poor infrastructure and inadequate human resources at the laboratory. The proposal for a new laboratory to facilitate analyses of environmental samples and food crops for chemicals residuals would render critical support to water reuse efforts. However, the assessment programme for wastewater treatment plants must be continued to provide comprehensive assessment if reclaimed water is to be expanded as a water conservation/augmentation measure.

31. Training wastewater treatment plant operators and inspectors is an essential dimension to the effective operation of wastewater treatment plant and the discharge of a quality effluent. Operators have received training from programmes organised and funded by regional and international intergovernmental agencies in the last two decades. In December 2015, officers of the Environmental Protection Department, Environmental Health Department, and the Coastal Zone Management Unit received training in the regulatory inspection of wastewater treatment plants through the United Nations funded project "Strengthening policy and institutional frameworks while building capacity for wastewater management in Barbados". This training needs to be complemented by updated operator competency base training for those existing wastewater treatment plants. The St. Lucia based Caribbean Water and Sanitation (CAWASA) Inc. has a certification programme for utility operators that could be utilized to achieve this. The goal would be to ensure that operators have the relevant skill sets to manage wastewater treatment plants in

[6] This Cabinet decision transferred the regulatory authority for water quality from the Barbados Water Authority to the Environmental Protection Department in an effort to separate operational and regulatory responsibilities.

a manner such that these plants produce a consistently high water quality that can support the intended national development objectives.

32. Section 2 highlighted that some commercial establishments have commenced installation of non-potable water reuse infrastructure. Inspection of these facilities suggests that the plumbing arrangements provide the potential for cross connections between the non-potable and potable water infrastructure. In some cases the colour coding has faded and potable and non-potable pipes are located in close proximity to each other. A plumbing standard would address these issues and minimise this potential health threat. Similarly, urban reuse of reclaimed water poses mainly health challenges as articulated above. There are no known urban reuse water features and practices in Barbados.

33. Water storage tanks for harvested rain water are intended to be isolated systems from the potable water supply. The intended objective of these tanks is to augment the existing water resources by utilising rainwater for non-domestic activities. Where these systems are used in dual plumbing system for irrigation and toilet flushing, there may be the need to top-up the water in the tank during periods of drought or low rain fall with water from BWA's mains. This raises the issue of cross connection of the plumbing fixtures and the potential public health threat of contamination of the BWA's reticulation system by non-potable water due to pressure differentials. It is believed, that some of these thanks were installed without the appropriate mechanism to pump the water from the tanks for non-potable use. Those tanks without the necessary plumbing components are believed to contribute to the proliferation of the *Aedes Aegypti* mosquito. Unconfirmed reports were received where applicants install tanks to meet the provision and remove those stank after the certificate is received. Other reports suggest that home owners are unaware of the underground tanks after procurement of their homes. This suggests inadequate policing of the provision and inadequate education regarding the intent and purpose of the provision.

34. Agricultural reuse of reclaimed water can pose similar challenges but can also have effects on crops due to the presence of toxic organics, clogging of agricultural equipment, malodours and discoloured water from organics, soil changes due to in-organics, and the distribution of infectious aerosols during application. Similarly harvested storm water runoff which is used by some farms as a means to augment potable water supplies to irrigate crops, pose the same if not greater risk than reclaimed water. Both the biological and chemical hazards may be present in greater quantities/concentrations than in reclaimed water. Currently, harvested storm water undergoes little if any treatment and may be used on a variety of root, vegetable and other commercial crops. Research conducted in Jordan, showed that river water which was allowed to be used to irrigate crops that are eaten raw, was of much poorer quality than the treated wastewater.

35. In addition, a number of private developments have harvested rainwater (stormwater) for irrigation and firefighting purposes. These include the

Millennium Heights Residential Development (2000), The Lion Castle Polo Estate (2003), the Mount Gay Distilleries Rum Ageing & Blending Facility (2005), the Farmers Dam & Water Impoundment (2006) and the Kensington Oval Redevelopment (2007)[7]. The impoundments range from 22,727 cubic meters (5.0 Million gallons) to 268,182 cubic meters (59 Miillion gallons). This type of drainage infrastructure may mitigate nuisance flooding from 2 to 4 year events and reduce the dependence on potable.

36. The quality of the nearshore marine waters is impacted by storm water runoff during intense rainfall activity. It is understood that storm water transports debris, microorganisms and other chemicals to the nearshore during these episodes. These discharges result in acute impacts to reef systems and prevent attainment of turbidity water quality guidelines for the marine environment for short periods. A second significant effect associated with intense rainfall is that of flooding as the drainage infrastructures are not designed to handle the increased flows from a combination of urbanisation and meteorological changes attributed to climate change.

37. Despite these hazards, their associated risks can be managed through adequate treatment of wastewater combined with the implementation of a sequence of measures to reduce contact with reclaimed and non-portable water. The most significant issues revolve around public perception and acceptance of water reuse, and the level of financial commitment to augment the water reuse management framework required to regulate the disparate uses of reclaimed water, storm water and non-potable water in the various sectors.

38. It is clear that to reduce the risk of infection to human being, damage to agricultural crops and industrial equipment that may occur from the use of reclaimed, storm and non-potable water, an enhanced administrative and regulatory framework should be established and must:

    a. Adopt the appropriate wastewater treatment and water reuse standards;
    b. Ensure compliance of those treatment systems with the approved standards for reuse of reclaimed water;
    c. Provide the laboratory infrastructure and personnel to execute the necessary laboratory analyses for effective monitoring of wastewater treatment plants, chemical residuals in food crops and potential health impacts on users;
    d. Ensure adequately trained inspectors to regulate and monitor treatment plants and the associated distribution infrastructure;
    e. Adopt the appropriate plumbing codes to facilitate distinction between potable and non-potable water distribution systems;
    f. Provide financing and economic incentives for the installation of non-potable water storage tanks;

[7] Rain Water Harvesting-The Barbados Experience (A. Hutchinson 2009). A presentation made by Eng. Andrew Hutchinson to the Caribbean Water and Wastewater Association at St Lucia Water Week May 28, 2009.

g. Engage stakeholders through partnerships, cooperation and shared responsibility;
h. Provide guidance to protect the potable water distribution system from cross connections;
i. Train plumbers in the new standards; and
j. Establish a public awareness and communication programme to ensure that all stakeholders are informed of the potential benefits, risks, adopted standards and codes of practice for reclaimed, storm and non-potable water use.

3.0 Existing Organisational Framework

39. There is no definitive structure specifically for the promotion, use and regulation of reclaimed water use in Barbados. The existing arrangements are facilitated through existing policies; legislation such as the *Health Services Act, 1969 Cap. 44, Marine Pollution Control Act, Cap. 392A, the Town and Country Planning Act, 1985 Cap. 240 and the Water Authority Act, 1989 Cap. 274A*; and ad hoc monitoring programmes of the respective Departments.
40. In this regard, while awaiting the passage of appropriate supporting legislation, it is recommended that the following standards and guidelines will be utilised: 1. WHO Guidelines for the safe use of wastewater, excreta and greywater Volume 2: Wastewater use in agriculture, and 2. USEPA, 2004 Guidelines for water reuse for IPR and DPR.

3.1 Environmental Protection Department

41. EPD's mandate for environmental protection evolved from the provisions of the *Health Services Act, Cap. 44* and more recently the *Marine Pollution Control Act Cap. 392A.* The institutional structure and staff competencies reflected the primary mandate of addressing the engineering issues of public health from pollution control and wastewater treatment monitoring to the regulation of hazardous chemicals and wastes. The Department provides services of pollution monitoring, assessment and regulation of discharges to the environment. An important component of the work of the Department is the review of building development applications against the *Health Services (Building) Regulations, 1969* which utilises several engineering skills and knowledge.

42. Further to this, the Department is a consultation agency in the development review process. The EPD advises the Chief Town Planner on the risk and potential impacts likely from development activities when required by the Town and Country Development Planning Office. This involves the review of environmental impact assessments, environmental scoping studies and other technical development documents.

3.2 Town and Country Development Planning Office

43. The primary purpose of the planning office is to ensure optimum economic and social utilisation of development lands. This is done through provisions in the *Town and Country Planning Act, 1985 Cap. 240.* The establishment and imposition of planning controls by the Department on developments by virtue of the Act, assist in the rational use of land. Planning controls such as set-back criteria, buffer zones and segregation of incompatible development types seeks to ensure that among other objectives, noise pollution issues are eliminated or minimised at the design stage. One prominent element of the planning system is the Physical Development Plan which aids in the organisation and designation of land use.

3.3 Barbados Water Authority

44. The Barbados Water Authority was established under the *Barbados Water Authority Act, 1989 Cap. 274A* to amongst other things, manage, allocate and monitor the water resources of Barbados with a view to ensuring their best development, utilisation, conservation and protection in the public interest.

3.4 Environmental Health Department

45. The Environmental Health Department derives its authority from the *Health Services Act, 1969 Cap. 44* with the objective of promotion and preservation of the health of the inhabitants of Barbados. The Department therefore monitors health conditions and identifies potential health hazards at the ports of entry, communities and special establishments. The *Health Services Act, Cap. 44* allows public health officers to enter into any premises to identify and mitigate all health threats.

3.4 Barbados National Standards Institute

46. The Barbados National Standards Institute (BNSI) role and responsibility are captured in the *Control of Standards Act, Cap. 326A* and the *Weights and Measures Act, Cap. 331.* The primary functions of BNSI include: the preparation, promotion and implementation of standards in all sectors of the economy; the promotion of quality systems, quality control and simplification in industry and commerce; and the certification of products, commodities and processes.

3.5 Proposed Building Standards Authority

The proposed Building Standards Authority will be responsible for assessing the structural integrity of building in accordance with the Barbados National Building Code.

4.0 Policy Framework

4.1 Policy Context

47. The Policy is prepared in the context of and builds on existing policy instruments. Those instruments of importance are noted and the critical elements summarised below.

    a. The Groundwater Protection Policy divides the island into five control zones and provides for the preliminary treatment of domestic wastewater in lands designated as zone one and two. The suck well is used as the primary means of wastewater treatment through geochemical process in the coral limestone aquifer. The Policy restricts expansion in wastewater generating sources within zone one areas and also restricts the depth of disposal wells. The Policy is expected to be revised to include provisions for the protection of the abstraction source from chemical pollutants. The Revisions to the policy are the subject of a separate Cabinet paper being presented by the Ministry of Energy and Water Resources.

    b. The United Nations Framework Convention on Climate Change (UNFCC) is a Convention which assesses the implications of human activity on the global climate. Research has shown a gradual increase in temperatures globally over the past three decades. Specifically for the Caribbean, predictions model suggest that the region at the 1.5^{o}C limit will be 5%–10% wetter except for the northeast and southeast Caribbean, which are drier, and is expected to experience increases in annual warm spells of more than 100 days. At the 2.0^{o}C target, there is additional warming by 0.2^{o}–1.0^{o}C, a further extension of warm spells by up to 70 days, a shift to a predominantly drier region (5%–15% less than present day), and a greater occurrence of droughts. This suggest that the annual rainfall volumes will decrease putting a greater strain on the renewable groundwater supply for development activities.

    c. The Barbados Sustainable Development Policy sets out the landscape for sustainable development from a Barbadian perspective. Embedded within the Policy are the adopted sustainable development principles namely: quality of life, conservation of resources; economic efficiency; equity; and participation. In the context of water resources management, the policy sought to conserve available freshwater and within the agricultural sectors it encouraged the use of organic fertilizers and promoted natural resources recycling and reuse where possible.

    d. The National Strategic Plan of Barbados 2006-2025 recognised that protecting and preserving our natural and built environment is vital to achieving sustainable development. Goal four of the document sought to promote and facilitate the sustainable use of our renewable resources and the wise management of our non-renewable natural resources. The strategic plan

proposes a series of strategies which are designed to kindle the development of a green economy.

e. The Green Economy Scoping Study, 2014 identifies the potential for expanding the green economy and further identifies operational principles for developing a roadmap, The principles recommended are:

i) advances the well-being of society, particularly vulnerable groups;
ii) achieves the protection and/or restoration of ecosystems' health;
iii) enables efficiency in resource/energy use and management;
iv) promotes participatory governance;
v) enables responsive institutions; and
vi) promotes research, development and innovation.

f. The Barbados Growth and Development Strategy 2013-2020 analysed structural, systemic and external factors that influence and impede sustainable growth in the Barbadian economy and proposes a series of adjustments aimed at achieving reform, recovery and sustainability in the Barbadian economy through new development pathways.

48. External forces are also considered as reflected in international law, multilateral environmental agreements, and conventions to which the Government is signatory to as described below. Those of significant interest are:

a. Cartagena Convention, 1987
b. International Health Regulations, 2005
c. General Assembly 66/288: The Future we want
d. SIDS Accelerated modalities of Action (SAMOA) Pathway
e. Transforming our world: the 2030 Agenda for Sustainable Development

49. The combined direction of these international legal instruments is synergistic and propagates the enhancement of the quality of the life for citizens and residents. For instance, goal six of the Sustainable Development Goals 2030 seeks to ensure availability and sustainable management of water and sanitation for all. Specifically, the Sustainable Development Goals promote improvements in water quality, reduction in pollution, increased treatment of the proportion of untreated wastewater and increased recycling.

50. Taking these into consideration the Policy will set out procedures, rules, decision making criteria and allocation mechanisms that provide the basis for programmes and services. Policies set priorities, and associated strategies allocate resources for their implementation. The Environmental Protection Department will be primarily responsible for the coordination of the Policy but other stakeholders will have implementation responsibilities.

4.2 Policy Vision

51. The vision of the Government of Barbados is that *water is a national resource which shall be used to improve the quality of life for citizens, maintain the natural biodiversity of the land, and promote domestic, agricultural and industrial activities in support of sustainable development and a green economy*.

4.3 Safe use of reclaimed water, storm water and harvested rain water[8]

52. *The policy objective is to promote the safe use of reclaimed, storm and non-potable water in urban, agricultural and the industrial sectors such that human health and environmental quality is not compromised.*

53. Water use categories were suggested for Barbados by the 1997 and 2002 Task Forces on Water Resources (Policy Framework for Water Resources Management and Development in Barbados) and are presented in Table 5. Categories I and II were the only two categories requiring potable water whilst all others require access to non-potable water resources. This suggests that harvested rain water, storm water and reclaimed water could be used to supplement the potable water supply to service activities including washing of cars and structures, irrigation of edible crops, flushing of toilets, golf course irrigation and as cooling water in power generation where potable water is not required. This also suggest that water quality standards need only to address potable and non-potable uses.

Table 5: Categorisation of Water Use[9]

Category	Description
I	Potable requirements including Domestic use, watering animals, food processing, and toilet flushing in non-dual plumbing systems.
II	Recreation requirements including swimming pools and amusement parks
III	Irrigation of food crops inclusive of vegetables with possible direct human consumption.
IV	Irrigation of non-food crops inclusive of cotton, grass for animals and ornamental plants.
V	Non-potable domestic requirements such as toilet flushing in dual plumbing system.
VI	Non-potable other requirements such as golf course irrigation, cooling water, firefighting, washing of roads and watering lawns.

[8] A monitoring and evaluation system will be established to assess compliance of the objectives and determine when the objectives need adjustment to better meet the social, economic, and environmental needs of society.

[9] Water is Indispensable to Life-A Draft Policy Framework for Water Resources Development and Management in Barbados, March 2002.

54. In general, the quality of water required will differ depending on the use. Sources such as reclaimed water, storm water and harvested rain water are generally of a quality not fit for most direct domestic use. Given the above Government will:

    a. encourage treatment of these sources (sewage, storm-water and non-potable water) of water using traditional and non-traditional treatment methods to minimise or remove microbiological and chemicals pollutants that inhibit the use of the water for intended purposes such as agriculture or industry;

    b. investigate the feasibility of establishing a wastewater revolving fund to facilitate investment in wastewater treatment infrastructure, and training of wastewater operations. Where feasible establish the wastewater treatment revolving fund with the appropriate legislative tools and human resources to operate the fund;

    c. facilitate training of wastewater operators through partnerships with regional agencies and encourage certification of wastewater treatment plant operators;

    d. formalise the water use categories in legislation;

    e. establish water use standards for all categories and uses of water to ensure that all water meets the minimum standards for usage that complies with approved health criteria;

    f. establish plumbing code to ensure the safe transfer of different quality waters from one location to another and within same building;

    g. promote through partnership with educational institutions, professional associations and Government, the formation of a plumbers' association for the upgrade of knowledge and skills and the establishment of training and re-training programmes for plumbers; and

    h. establish a mechanism with the University of the West Indies as proposed in the Sustainable Development Policy 2004 to facilitate research in environmental pollution, water reuse, water efficiency, emerging contaminants of concern and other environmental and public health threats.

55. Approximately 22,227 m^3/day (five (5) million gallons/day) of sewage effluent from the Bridgetown and South Coast Sewage Treatment plants is discharged to the marine environment. This is an untapped resource and Barbados could follow the example of other countries (Jordan, Israel) who are categorised as water scarce and have utilised the comprehensive set of World Health Organization wastewater reuse guidelines for agriculture to make this water available for irrigation in agriculture. In that regard Barbados will:

a. Encourage the reuse of reclaimed water/effluent in agriculture within the confines of public health standards;
b. Establish a reclaimed water distribution network to move water from urban areas to agricultural area for use in agriculture;
c. Improve the laboratory infrastructure to ensure adequate testing of reclaimed water, food crops produced from reclaimed water and potential health impacts on users;
d. Restrict the use of reclaimed water to agricultural activity through surface drip and subsurface drip irrigation systems; and
e. Establish a vegetable greenhouse as a demonstration project at the Ministry of Agriculture utilising reclaimed water and employing computer technology to grow vegetables and other crops.

56. Barbados receives approximately 1500 mm of rain fall annually. This may be reduced by 20% due to climate change. Some of this water is discharged to the marine environment as contaminated surface runoff or as, groundwater discharge. Rainwater/stormwater mobilises animal faeces, other organic matter, dirt, debris, fertilizers, solid wastes and other hazardous chemical as it flows to the sea as storm water. By harvesting this rainwater, the pollution to the marine environment can be reduced through the interception of storm water before discharge to the marine environment and thereby increasing the opportunities to utilise this water in beneficial ways or purify it before discharge. Based on the water use categories Government will:

a. Further promote and encourage strategies to harvest rainwater;
b. Encourage groundwater recharge through onsite infiltration through appropriately located drainage wells or surface impoundments, to augment potable water supply and maintain the subsurface saline intrusion freshwater barrier;
c. Minimise contamination of the storm water by reducing surface runoff from developed properties through planning control in the Physical Development Plan;
d. Review the rain water harvesting provisions in the Town Planning Order 1972;
e. Evaluate the economic and financial instruments to encourage full installation of rainwater harvesting technologies;
f. Encourage and promote the use of aquifer recharge systems (Recharge trenches, wells, boreholes, or pits) with rain water from residential and institutional structures; and
g. Establish standards for the colour coding standards for the conveyance of potable and non-potable water for domestic, agricultural and industrials uses.

4.4 Regulation

57. *The policy objective is to ensure compliance with water reuse guidelines, standards, and codes of practice as amended over time and improve the quality of storm, ground and marine waters.*

58. The treatment and disposal of wastewater along with the application method for fertilizers is a significant national issue. The impacts of wastewater disposal on the environment were documented by Stanley Associates Engineering Ltd Standley Associates, 1978; MoH et al, 1989; MoH et al 1991; Delcan, 1995; Halcrow 1998, Klohn-Crippen Consultants Ltd, 1997; Hydroqual, Inc. 2004; and R.J. Burnside International Ltd, 2011. These studies identified disproportionate adverse impacts from groundwater on coral reef and other marine ecosystems as compared to surface water discharges. These impacts were attributed to nitrogen from both agricultural and domestic wastewater sources. Emerging research is highlighting the potential impacts of Environmental persistent pharmaceutical pollutants, and endocrine disrupting chemicals.

59. It is clear that there exist significant interconnectivity between groundwater and marine water quality with emerging studies showing the presence of commonly used pharmaceuticals and pesticides in low concentrations. To reverse this trend, a coordinated approach between regulatory Departments is necessary. The proposed regulatory arrangements for the management of wastewater treatment and water reuse system are shown in Table 6.

Table 6: Proposed Responsibility of Competent Departments[10]

Department/Ministry	Existing Responsibility	Recommended Responsibility
Environmental Protection Department	1. Review of building development applications 2. Inspection and regulation of wastewater treatment plants 3. Monitoring the quality of potable water at the source	1. Regulating wastewater treatment plants in accordance with Cabinet Decision Note (02) 812/MPE 32. 2. Set standards for and regulate wastewater treatment and water reuse under the *Marine Pollution Control Act, Cap. 392A.* 3. Regulate the quality of potable water Cabinet Decision Note (02) 812/MPE 32.

[10] Table 5 is to be completed by the respective departments.

		4. Establish a research mechanism to address environmental impacts of pollutants discharged into the environment from whatever source in accordance with the Sustainable Development Policy 2004 5. Evaluate proposed wastewater treatment systems for compliance with discharge standards 6. Licensing of wastewater treatment plants
Barbados Water Authority	1. Provision of water supply services. 2. Monitoring, assessment, control and protection of water resources. 3. Monitoring the quality of potable water 4. Monitoring the performance and operate national wastewater treatment plants	1. Production and Distribution of potable water 2. Monitoring the quality of potable water 3. Design, construction and operation of national wastewater treatment plants 4. Implemention of programmes to monitor water consumption by sectors 5. Managing the Integrated Water Resources information management system and ensuring all stakeholders have access. 6. . Should fall under water resources agency
Environmental Health Department	*1.* Inspection of properties for compliance with *Health Services Act. Cap.44 and Regulations* 2. Monitoring the quality of potable water in the distribution system	1. Investigation of local transmission of disease. 2. Monitor environmental conditions to protect the public. 3. Conduct surveillance programmes to protect public health 4. Inspect water storage tanks after approval to ensure compliance with accepted public health standards.

		5. Inspect properties to ensure that dual plumbing systems comply with accepted codes of practice.
Town and Country Planning,	1. Control of development activity in accordance with the *Town and Country Planning Act, 1985 Cap.240 and Town and Country Development Planning Order, 1972*	1. Control of development activity in accordance with the Town and *Country Planning Act, 1985 Cap. 240* and *Town and Country Development Planning Order, 1972*
Barbados National Standards Authority	1. The preparation, promotion and implementation of standards in all sectors of the economy; 2. The promotion of quality systems, quality control and simplification in industry and commerce; 3. The certification of products, commodities and processes.	1. Research and develop national standards and codes of practice to facilitate water reuse for all sectors of the economy.
Building Standards Authority	1. Review development application against the National Building Code.	1. Review development application against the National Building Code. 2. Review plans for dual plumbing systems against agreed or adopted national standards. 3. Inspect properties to ensure that dual plumbing systems comply with accepted codes of practice.

62. Under the updated groundwater protection policy, a Water Resources Agency is proposed. The scope, role and responsibility is undetermined at this stage and a more detailed assessment of the institutional arrangements will be required to ensure the most effective institutional and legislative arrangements are implemented.

63. The Government shall:

a. Prepare and enact the required legislative instrument within a year of adoption of the water reuse policy;

b. Prepare and establish memoranda of understanding between critical Departments to further clarify roles and responsibilities to facilitate comprehensive implementation of the policy;

c. Establish a coordinating committee to operate for five years which shall comprise the Environmental Protection Department, Town and Country Development Planning Office, Environmental Health Department, Barbados Water Authority, Barbados National Standards Institute, Building Standards Authority and the Barbados Association of Professional Engineers to prepare technical guidance, public education material and implement the provisions of the water reuse policy;

d. Strengthen the laboratory infrastructure to facilitate the environmental and public health monitoring and surveillance programmes necessary to implement water reuse objectives;

e. Encourage environmental research to inform and sustain practical planning and best management guidelines in an effort to encourage adoption of systems by private development which goes beyond compliance with the minimum environmental discharge standards.

4.5 Communication

63. *The policy objective is to facilitate communication and participation of stakeholders in the wastewater treatment and water reuse system and provide adequate information on the approved guidelines, standards and codes of practice.*

64. The Government shall:

a. Formulate an integrated communications strategy for water reuse policy;

b. Facilitate the dissemination of information pertaining to the water reuse systems through a multi-media platform inclusive of individual websites of the regulatory stakeholders, half day seminars on technical and procedural issues, public perception and acceptance and general educational activities;

b. Engage stakeholders as sectorial groups for specialist information sessions and the general public through radio and television formats;

c. Establish an educational unit with a mandate to increase public awareness and acceptance about water reuse and facilitate training of stakeholders;

d. Share research information through national seminars, research symposiums and websites.

4.6 Targets

4.6.1 Wastewater Treatment

65. Comprehensive wastewater treatment and reuse legislation would be drafted and presented to Parliament by 2019.

66. Wastewater Treatment Plants would be upgraded and a wastewater distribution system installed to convey reclaimed water to agricultural districts for reuse by 2025.

67. Plan for the systematic extension of the wastewater collection system over a 20 year period prepared by mid-2019.

68. Establish a permitting system for wastewater treatment plants by 2019.

4.6.2 Non-Potable Water Storage Tanks

69. Revise the rainwater harvesting requirements to facilitate variable tank sizes based on usage requirements in combination with direct discharge of rainwater to subsurface by 2020.

70. Standards for water storage tanks prepared and adopted by mid-2019.

71. Plumbing codes prepared and adopted by mid-2020.

4.6.3 Stormwater

72. Evaluate the potential of establishing stormwater retention and infiltration areas by mid-2019 to mitigate flooding, provide secondary water for agricultural activity, and enhance groundwater recharge provided no significant impacts of the quality of the groundwater results.

5.0 Guidelines for Local Legislation

73. The draft Water Reuse Act and Regulations prepared by Camp Dresser & McKey, 2006 and the suggested revisions by Environmental Advisors Inc., 2015 should be used as the basis to prepare legislation to govern wastewater treatment and water reuse. However, the Act should establish the Competent Authority to regulate wastewater treatment and water reuse, a licensing mechanism, a fee structure to recoup the administrative cost of the regulatory system, standards for wastewater treatment, water reuse categories, plumbing standards, disinfection, record keeping, reporting and penalties for non-compliance. Provision should also be established to include Barbados National Standards Institute's plumbing codes of practice for water reuse facilities.

6.0 Recommendations

74. The Ministry of Environment and National Beautification therefore recommends that:

    a. The Chief Parliamentary Counsel should be directed to prepare the necessary legislation to establish a Water Reuse Act and Water Reuse Regulations with the Environmental Protection Department/Water Resources Agency as the regulator;

    b. A committee comprising of the Environmental Protection Department, Town and Country Planning Development Office, Environmental Health Department, Barbados Water Authority, Barbados National Standards Institute, Barbados Building Standards Authority and the Barbados Association of Professional Engineers, be established for a period of **five years** to formalise and implement the framework;

    c. The Barbados National Standards Institute should be directed to upgrade the Barbados National Standard Code of Practice CP 16 (Part 1): 1981 UDC 691.1:628.15/.3 August 1981 to include provisions for the colour coding of plumbing fixtures for water reuse based on either the British or American water reuse plumbing codes. This update should include provisions for dual plumbing systems;

    d. The roles and responsibilities for the respective regulatory agencies identified in Table 6 be approved and where necessary translated into the appropriate legal instrument to facilitate implementation;

    e. The Government of Barbados through the Ministry of Environment and National Beautification shall establish a memorandum of understanding with the University of the West Indies to establish capacity and to conduct environmental research in areas of pollution control, monitoring and impacts inclusive of water reuse impacts;

    f. The Water Resources Agency/Environmental Protection Department should be directed to prepare an implementation plan and a communications strategy to facilitate the broad based education of all relevant stakeholders and competence based training for Plumbers in the new Plumbing code; and

    g. The laboratory infrastructure at the Government Analytical Services Laboratory should be improved to facilitate increased processing of environmental samples and analyses of complex chemical residuals in soils, water and air.

7.0 References

1. Economic Affairs Division, 2013. *"Barbados Medium-Term Growth And Development Strategy 2013-2020."* Ministry of Finance and Economic Affairs, Government of Barbados.
2. Environmental Advisors Inc, 2015. *"Proposed Revision to Barbados Water Authority Water Reuse Regulations, 2006."* Prepared for the Environmental Protection Department, Ministry of Environment and Drainage.
3. Environmental Protection Department "*File 617/T 2 Water Quality-Consequences of Heywoods Water Quality Incident"*. Government of Barbados.
4. Environmental Protection Department "*File 619 Vol. II Draft Water Resources Policy Framework 2010 – Present."* Government of Barbados.
5. Environmental Protection Department *File No. 601/ T1 Vol. I Water Storage Units for Individual Households 1994 to Present.* Government of Barbados.
6. Environmental Protection Department *File No. 615/1 Vol. I Barbados Water Authority-Water Reuse and Desalination Augmentation Options 2005 to Present.* Government of Barbados.
7. Environmental Protection Department. "*File 619 Vol. I Draft Water Resources Policy Framework 2002 – 2010*." Government of Barbados.
8. Hutchinson, Andrew, 2009. "*Rainwater Harvesting-The Barbados Experience.*" A presentation prepared for CWWA/Lucia Water Week May 28, 2009.
9. Hutchinson, Andrew, 2010. "*Rain Water Harvesting – Case Studies from the Barbados Experience*" Caribbean Water and Wastewater Conference, October 2010 Grenada, West Indies.
10. Hydroqual, Inc. Environmental Engineers and Scientist, 2004. Phased Water Quality Monitoring Programme Final Report: 2003 Wet and Dry Surveys of the South West Coast of Barbados: Mahwah New Jersey: 2004. Print.
11. Moore, W., Alleyne ,F., Alleyne, Y., Blackman, K., Blenman, C., Carter, S., Cashman, A., Cumberbatch, J., Downes, A., Hoyte, H., Mahon, R., Mamingi, N., McConney, P., Pena, M., Roberts, S., Rogers, T., Sealy, S., Sinckler, T. and A. Singh. 2014. *"Barbados' Green Economy Scoping Study*." Government of Barbados, University of West Indies - Cave Hill Campus, United Nations Environment Programme, 244p.
12. National Commission on Sustainable Development, 2004. *"National Sustainable Development Policy for Barbados"*. Ministry of Housing, Lands and the Environment (Environment), Government of Barbados.
13. Research and Planning Unit, Economic Affairs Division, 2005. *"National Strategic Plan of Barbados 2006-2025".* Ministry of Economic Affairs & Development, Government of Barbados.
14. Task Force *"Water is Indispensable to Life-A Draft Policy Framework for Water Resources Development and Management in Barbados."* Government of Barbados, March 2002.
15. United Nations Environment Programme, University of West Indies, and Government of Barbados, 2012. *"Green Economy Scoping Study – Synthesis Report BARBADOS."*

16. United Nations General Assembly, 2015. "Draft outcome document of the United Nations summit for the adoption of the post-2015 development agenda Transforming our world: the 2030 Agenda for Sustainable Development."
17. USEPA, U., 2004. Guidelines for water reuse. EPA/625/R-04/108, 25-167-250.
18. World Health Organization, 2006. *"Guidelines for the safe use of wastewater, excreta and greywater Volume 1: Policy and regulatory aspects."* World Health Organization.
19. World Health Organization, 2006. *"Guidelines for the safe use of wastewater, excreta and greywater Volume 2: Wastewater use in agriculture."* World Health Organization.
20. World Health Organization, 2006. *"Guidelines for the safe use of wastewater, excreta and greywater Volume 3: Wastewater and excreta use in aquaculture."* World Health Organization.
21. World Health Organization, 2006. *"Guidelines for the safe use of wastewater, excreta and greywater Volume 4: Excreta and greywater use in agriculture."* World Health Organization.

GLOSSARY OF TERMS

BWA	Barbados Water Authority
Effluent	means wastewater that is discharged or available after treatment, as may be regulated under the Environmental Management Act.
EHD	Environmental Health Department
EPD	Environmental Protection Department
Reclaimed Water	means effluent that has been adequately and reliably treated, so that as a result of that treatment, it is suitable for a beneficial use or a controlled use that would not otherwise occur and is no longer considered wastewater.
TCPDO	Town and Country Planning Development Office
Indirect Non-potable use	
Wastewater	means water and wastes discharged from dwellings, businesses, and industry, including such discharge to the Barbados Water Authority sewer system or to an on-site systems or facilities.
Water reuse	means the deliberate application of reclaimed water for a beneficial purpose

Water	a colourless, transparent, odourless, tasteless liquid that forms the seas, lakes, rivers, and rain and is the basis of the fluids of living organisms.
Non-potable water	Water that has not been examined, properly treated, and not approved by appropriate authorities as being safe for consumption
Stormwater	Stormwater runoff is rainfall that flows over the ground surface. It is created when rain falls on roads, driveways, parking lots, rooftops and other paved surfaces that do not allow water to soak into the ground.