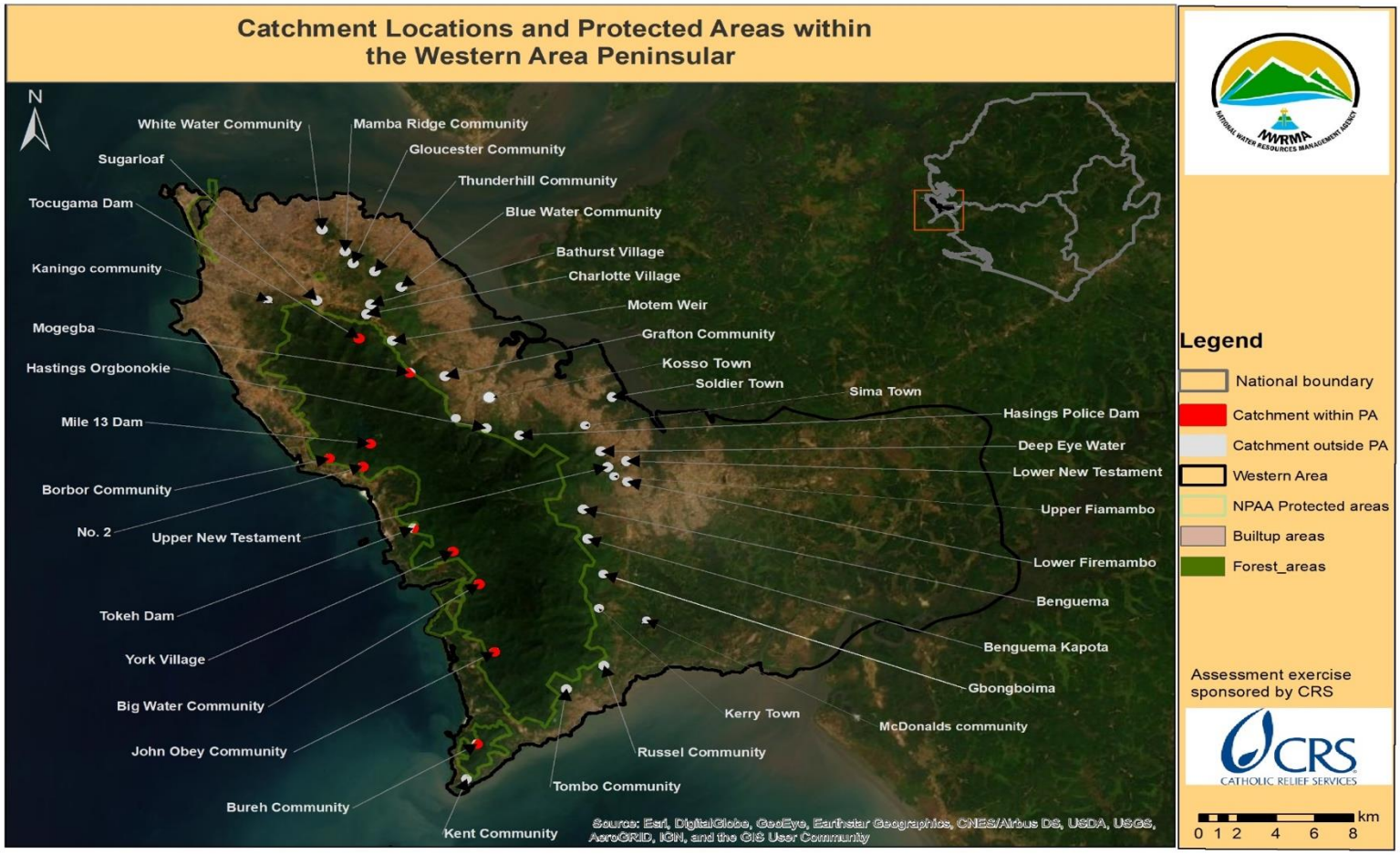
REPORT ON STAKEHOLDER ASSESSMENT OF THE WESTERN AREA WATER CATCHMENT AREAS



National Water Resources Management Agency (NWRMA)

Contents

1.0 INTRODUCTION

1.1 Background

The Western Area catchment of Sierra Leone is predominantly underpinned by an increasing population density coupled with demand for land for the construction of a new or extending of an existing settlement. This has put excessive pressure on land and forest leading to widespread clearing of forested areas previously serving to recharge water in supply facilities. In addition, climate change may increase hydrological variability making it more difficult to meet increasing water supply demands. These combined effects of encroachment and climate change lead to increasing pollution and scarcity of both surface and groundwater resources for different uses. This is clearly demonstrated by the shortage of water in the various dams within the Western Area Peninsular making it extremely difficult for Guma Valley Water Company to meet their demands.

Watershed inventory is a fundamental tool and is seen as the first step in the designing, planning and implementation of water management strategies. An assessment of the Western Area catchment is a process which is aimed at delivering improvements for effective water resources planning and management. Water resources assessment generally looks into the status of water resources or a particular catchment, the water balance as well as the current and future demand for water in a particular region. This process also takes into consideration stakeholder assessment as it identifies and characterizes the different stakeholders and their responsibilities.

The management, sustainability and development of the water resources is informed by certain factors which include the current and projected water demands, risks, challenges and opportunities in a particular catchment area. One of the major challenges of sustainable water resource management is to assess how much water is available to meet social, ecological and economic needs. Thus, an assessment of the Western Area catchment will help us to understand the real and potential threats to the catchment by identifying the drivers, pressure, state and impact. Hence, this will enable us to propose a response or appropriate actions to tackle these threats.

This assessment is in line with the previous mapping exercises done by the Freetown WASH Consortium and its partners (GVWC, MoWR, WASH-Net, FCC and WARDC) in 2018 of which nineteen (19) catchment areas were visited. The outcome of this field assessment will be followed by delineation and mapping of sub-catchments so as to identify opportunities that will ensure sustainable water resources planning and management.

1.2 Rationale for the water catchment assessment

Water is life, and access to clean and safe drinking water is one of the main issues in alleviating poverty. In Sierra Leone, increase in population density and demand for land has put great pressure on land and forest leading to widespread clearing of forested areas. The resulting farm bush landscape is poorly capable of retaining water, resulting in quick water runoff, soil erosion and water shortages. Even though Sierra Leone lies in one of the wettest places on earth with an average rainfall of 3000 mm per year, water shortage in the dry season is now very common. Protection of water catchment areas, the areas that drain into the water source is therefore crucial to retain water and to ensure sufficient water supply throughout the year.

Human activities in a catchment area can lead to water pollution and negatively impact public health. Therefore, assessment of catchment areas for the protection and restoration of the affected catchment area is important in securing clean and safe drinking water. Prevention of pollution is essential to detect any sources of contamination and will help in securing good quality water year-round.

According to a survey conducted by WASH Consortium in 2018, 50% of the catchment areas in Western Area Peninsular have been lost due to human activities. This is not only causing a drastic decrease in the quantity of water but also its quality as most of the water sources are polluted and are posing huge risks to the people who are currently using the untreated water for drinking purposes. The decrease in the quantity and quality of the water resource has caused untold suffering on the inhabitants of the Western Area. The main water supply company, Guma Valley Water Company, is usually challenged with a low level of water in their dams in the dries and long queues at water collection points leading to water insecurity. This situation has been worsened by the climate-related shocks and risks such as; prolonged dry spells, flooding and flash floods which are increasing in both intensity and frequency.

The need, therefore, to precisely monitor, assess and forecast the availability, condition and use of Sierra Leone's water resources is now more important than ever. The past and current water crisis and the recent extreme climatic events in the Western Area pose significant challenges to the management of Sierra Leone's water resources as we attempt to deal with an ever-increasing demand for water.

1.3 Purpose of the report

The purpose of this report is to provide a first-hand assessment of the current status of water catchment areas in the Western Area since the inception of the National Water Resources Management Agency (NWRMA). NWRMA is mandated to protect, restore and sustainably manage the water resources of Sierra Leone. This assessment will subsequently serve as an important input to ongoing interventions in the sector; the RAIN project and the WASH revamping project both implemented by CRS and Guma Valley Water Company respectively. It also aims to contribute to the achievement of a number of existing projects and will complement in particular to the National Medium-Term Development plan for 2019-2023.

The overall aim of the assessment is to assess water catchment areas in the Western Area for improving water management and for dealing with issues of water scarcity.

The specific objective of the assessment includes but not limited to the following;

1. Identify the level of encroachment and assess the real or potential threats to water catchment areas.
2. Determine the current status of the various water sources within the catchments
3. Determine the current status of the dams/weirs in the catchment
4. Assess the livelihood issues associated with the catchment
5. To provide clear and concise information on how the catchment could be managed.
6. To provide baseline information for future research.

1.4 Institutional arrangements

The National Water Resources Management Agency Act no. 5 of 2017 gave the Agency the mandate to regulate, utilize, protect, develop, conserve, control and generally manage water resources throughout Sierra Leone. NWRMA is the primary Agency responsible for water resources management.

In lieu of the above and recognising the principles of integrated water resources management (IWRM), the effective participation of stakeholders is central to the IWRM approach. An approach that requires different sectors to achieve a future action on water and sustainable development.

Therefore, in exercising its mandate in addressing the problem of water catchment protection and restoration, a major factor responsible for water stress in Western Area,

NWRMA must coordinate and collaborate with different stakeholders, within the framework of sustainable and equitable utilisation of Sierra Leone's water resources.

Hence, in order to achieve IWRM through national cohesion, a joint stakeholder assessment of the Western Area water catchment saw the participation of the Environment Protection Agency (EPA), National Protected Area Authority (NPAA), Ministry of Environment, Ministry of Water Resources, Ministry of Agriculture and Forestry, Freetown City Council, Western Rural District Council, Civil Society Organisation- WASHNET SL, Catholic Relief Services, Water4Life and Guma Valley Water Company.

1.5 Acknowledgement

NWRMA wishes to extend its sincere appreciation to the Hon Minister of Water Resources - Ing Philip K. Lansana and the Deputy Minister of Water Resources – Mrs Nimatulai Bah-Chang for providing strategic leadership to the Agency. We also wish to extend our profound thanks and appreciation to the **Catholic Relief Services** (CRS) for providing the necessary logistics to undertake the field assessment. The Agency also acknowledges the tremendous effort and enthusiasm exhibited throughout the field assessment by its colleagues from the Environment Protection Agency (EPA), National Protected Area Authority (NPAA), Ministry of Environment, Ministry of Water Resources, Ministry of Agriculture and Forestry, Freetown City Council, Western Rural District Council, Water4Life, Civil Society Organisation- WASHNET SL, and the Guma Valley Water Company.

2.0 WESTERN AREA CATCHMENT OVERVIEW

The western area catchment comprises both Western Area rural and urban and hosts more than fifty water catchments. However, only thirty-Eight (38) catchments were visited during this assessment. This is mainly as a result of some catchment areas have been totally destroyed and non-existent. The catchment areas form a stretch of about 22km from Kaningo in the West to Thunder Hill in the East and are made up of rugged and hilly terrains, mostly affected by huge forms of encroachment. Most of the sources are springs flowing from the mountains within the forests through weathered Gabbroic rocks and valleys to the low-lying areas.

Name of catchment areas in the Western Area visited

No	NAME OF CATCHMENT	Region	Coordinates	
			Eastings (m)	Northings (m)
1	White Water	Western Area Urban	695699	937237
2	Thunder Hill	Western Area Urban	698406	934740
3	Bluewater	Western Area Rural	699786	933803
4	Charlotte	Western Area Rural	697994	932194
5	Kongo dam	Western Area Rural	697604	930743
6	Sugarloaf	Western Area Rural	695405	933000
7	York	Western Area Rural	702468	918048
8	Guma Dam, Mile 13	Western Area Rural	698187	924463
9	Deep eye water	Western Area Rural	710119	924021
10	Lower Faiamambo	Western Area Rural	711493	922207
11	Upper Faiamambo	Western Area Rural	710822	922509
12	Benguema-Kapota	Western Area Rural	709435	918789
13	Benguema	Western Area Rural	709216	920562
14	Hastings Police dam	Western Area Rural	705912	924973
15	Bureh	Western Area Rural	703716	906569
16	Mamba ridge	Western Area Urban	696881	935927
17	Kaningo	Western Area Rural	691101	934307
18	John Obey	Western Area Rural	704612	912064
19	Tombo	Western Area Rural	708328	909844
20	No. 2	Western Area Rural	697807	923107
21	Kent town	Western Area Rural	703165	904495
22	Kerry town	Western Area Rural	710028	914633
23	Gbongboima	Western Area Rural	709209	921767
24	Hastings Orgbonokie	Western Area Rural	704167	925390
25	Borbor	Western Area Rural	696059	923592
26	MaDonalds	Western Area Rural	710824	923106

27	Tokeh	Western Area Rural	700411	919429
28	Lower new testament	Western Area Rural	711438	923434
29	Upper new testament	Western Area Rural	710454	923071
30	Grafton	Western Area Rural	702059	928497
31	Bathurst	Western Area Rural	698209	932781
32	Mongebga	Western Area Rural	700213	928707
33	Gloucester	Western Area Rural	697294	935216
34	Sima Town	Western Area Rural	709318	925549
35	Mortem	Western Area Rural	699333	930610
36	Big Water	Western Area Rural	703814	916093
37	Russel	Western Area Rural	710268	911250
38	Kossoh Town	Western Area Rural	704583	927241

2.1 Catchment development history

Several works have been done by various sector players like MoWR, Guma Valley Water Company, Welthhungehilfe, Freetown Wash consortium, NPAA, EPA, MAF, CRS and other sectors players in developing and protecting these catchment areas since 1914 when dams were constructed in some of these catchment areas.

Over the last decades, several activities have taken place in these catchment areas such as the construction of new dams and rehabilitation of dams in order to improve the quantity and quality of water to the people within the communities where these catchments are located.

Very recently, some catchment restoration was done by planting trees in some catchment areas that were depleted and there are plans also to do more in these catchment areas.

2.2 Heritage and culture value

Over 90% of the water catchments in the Western area are located within the Western Area Peninsular National Park (WAPNP). WAPNP is of crucial importance for the supply of water to residents of Western Area. It consists of a range of hills and is about 37 km long and 14km wide with several peaks with the highest being 900m above sea level. It is about 5KM from the city centre and it is a marine sanctuary that hosts about 50 mammals like western Chimpanzee, Columbus monkey and a lot of other animals and with over 200 types of birds (according to G.D Field, Thompson 1993, and 1997).

3.0 METHODOLOGY

In order to be able to make informed decision and future plans and to assess the ability of a catchment to satisfy potential water demands, the National Water Resources Management Agency together with other MDA's and catchment stakeholders undertook a detailed assessment of 43 water catchment areas from the 26th January to 31st January 2020 within the Western Area (Urban and Rural).

The assessment team comprises major water and environmental players like; National Water Resources Management Agency, Environmental Protection Agency (EPA), Ministry of Environment (MoEnv), Freetown City Council (FCC), Western Rural District Council (WARD C), National Protected Area Authority (NPAA), Wash-net, Ministry of Water Resources (MoWR), Guma Valley Water Company (GVWC), Catholic Relief Services and Ministry of Agriculture.

A mixed research method including both qualitative and quantitative approach was used to conduct the catchment assessment. Questionnaires were prepared and administered to the various communities visited. Focus group discussions were also held with representatives of different groups of people within the communities to discuss catchment protection and management issues, livelihood issues, and other catchment related issues.

Percentage of encroachment is determined from the focus group discussion, wherein community people stated the precise location of the greenbelt three to five years to the current position of the green belt.

The assessment focusses on the following:

- Locations, physical conditions and the nature of landscape for the affected catchment.
- Hydro-morphological status of stream network within the catchments.
- Water quality and quantity status
- Livelihood issues associated with the catchments
- Documentation of the assessment result on the environmental problems related to the affected catchments.

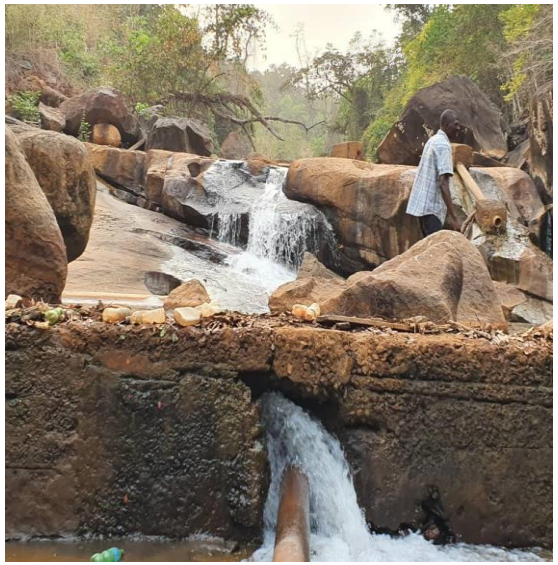
4.0 FINDINGS

Based on the assessment, below are the findings:

No	Name of community	Location	Current status of catchment	Pictorial evidence
1	White Water	FBC campus, back of the botanical garden	**Type of source, construction and management body** Spring, flows from the same catchment uphill. Constructed by GVWC and is partially being controlled by them. Sadly, the community youths (gangs) have almost hijacked the entire source and have dug several wells within the catchment, constructed parallel supply lines and are now using it on a commercial basis. The facility is poorly managed **Land ownership and % of Depletion** 90 % of the catchment is depleted and onto which Fourah Bay College (FBC) is located. **Activities are undertaken in the catchment area and upstream** Gardening, Logging, firewood harvesting, construction of house structures uphill, the catchment also serves as a waste dump site for FBC **Intake structure (if any and water supply areas** Yes, Reinforced concrete weir. The weir is responsible to supply water to Mountain cut, Courtright, Leicester road, Berry street and Sorie town. A total of about 40,000 people is being supplied by this dam.	 Broken fence and low water level  Waste-dump at catchment

2	Thunder Hill	Thunder Hill Community	**Type of source (s) and management body.** Stream source is from the Gloucester Saddle. It is constructed by GVWC and is poorly managed. **Land ownership and % of Depletion.** About 90% is depleted due to massive encroachment activities as evidence of private beacon can be seen. **Activities are undertaken in the catchment area** and **upstream.** Firewood harvesting, farming, gardening and construction of dwelling houses, & presence of beacons. **Intake structure (if any and water supply areas).** Reinforced concrete weir. It supplies water to Thunder hill community which has a population of about 120,000 people.	 Catchment area highly deforested  Dry reinforced concrete weir.

3	Bluewater	Wellington community	**Type of source(s) and Construction and management body** Stream, the source is from upper Wellington hills. It is constructed and managed by GVWC. The facility is poorly managed. **Land ownership and % of Depletion** About 90% is depleted due to massive encroachment as a result of urbanization. Currently, there are only a few economic trees and tertiary vegetation found within the catchment. **Activities undertaken in the catchment area** Construction of dwelling houses, small scale agricultural activities like gardening are prevalent. **Intake structure (if any and water supply areas** Reinforced concrete weir, the size is very small and has several leakages. It supplies water to wellington community which has over 200,000 people	 Massive encroachment around catchment  Undersized weir with leakages around

4	Charlotte	Charlotte village	**Type of source(s) and Construction and management body** Spring, Source is from Kongo dam, and regent falls. Constructed and currently managed by GVWC. The facility is poorly managed Road and house construction activities **Land ownership and % of Depletion** About 90% is depleted due to massive encroachment. Currently, there are only a few economic trees and tertiary vegetation found within the catchment **Activities undertaken in the catchment area** Construction of dwelling houses, gardening, farming and boulders as a result of the Regent-Grafton road construction. **Intake structure (if any and water supply areas** Reinforced concrete weir. Currently, there is massive leakage and most of the water is wasted. It is used to supply the Allen Town and parts of Calaba Town community of over 120,000 people	 Massive leakage in reinforced concrete weir
5	Sugar Loaf	Regent community	**Type of source(s) and Construction and management body** Spring source within the Western Area Pennisula National Park constructed in the colonial days and is being managed by GVWC **Land ownership and % of Depletion** About 20% of the catchment is been depleted **Activities are undertaken in the catchment area** Firewood harvesting, construction of dwelling houses, logging and farming. **Intake structure (if any and water supply areas** Reinforced concrete weir. Massive seepage at the weir causing the weir not to retain much water.	 Dry weir with surrounding seepage.

			It is one of the sources that supplies the Leicester, Gloucester, and Korthright. A total number of about 300,000 people get their water supply from this catchment.	 Babadorie Reservoir getting dry
6	Kongo Dam	It is located in the regent community close to the Tacogama sanctuary	**Type of source(s) and Construction and management body** Spring, the source is from the upper catchment area. It was constructed in 1914 and is being managed by GVWC. **Land ownership and % of Depletion** Less than 20% of the catchment is depleted **Activities are undertaken in the catchment area** Logging, firewood harvesting and Marijuana farm (Jamba) **Intake structure (if any and water supply areas** Reinforced concrete dam. Massive seepage at the dam causing the weir not to retain the much-needed water. It is one of the sources that supplies the Barbadorie reservoir for onward supply to Hill station, Regent, some part of Hill cut road and some part of Kamayama community. A total number of about 300,000 thousand get their water supply from this catchment	 Low water level in the reinforced concrete Kongo Dam

7	York	This is located in the forest of York	**Type of source(s) and Construction and management body** Spring, it flows from the hills in the Tokeh forest. It was constructed in the 1960s and is being managed by the community people. **Land ownership and % of Depletion.** 5 % of the catchment is being depleted and it is within WAPNP. **Activities are undertaken in the catchment area** Logging, firewood harvesting and evidence of beacon towards the catchment **Intake structure (if any and water supply areas)** Reinforced concrete weir. Currently, there is massive leakage and most of the water is not going through the pipe. It is supplying about 1000 people in the York community.	 Firewood harvesting  Massive leakage and overflow over intake pipe

8	Guma Dam.	Located at mile 13	**Type of source(s) and Construction and management body** Spring, it flows from the hills in the forest and forms a lake. It was constructed in the 1960s and is being managed by Guma Valley Company. **Land ownership and % of Depletion.** Less than 30 % of the catchment is depleted upstream in the recharge areas and the land is owned by Guma Valley Company **Activities are undertaken in the catchment area** Logging, firewood harvesting, coal burning, stone mining and construction of dwelling houses **Intake structure (if any and water supply areas** Earth and rockfill dam. Currently, there is minimal leakage at its scour valve and most of the water is to supply about 1,500,000 people in Freetown. It is the main water supply source for the city of Freetown	 Construction activities at lower catchment areas  Low water level in dam

9	Deep eye water		**Type of source(s) and Construction and management body** Spring, it flows from the hills. It was constructed in 1986 by CRS and is being managed by the community people. **Land ownership and % of Depletion.** 98 % of the catchment is depleted and the land is completely owned by community people. **Activities are undertaken in the catchment area** Massive stone mining around the catchment and closer to the weir and construction of dwelling houses within the catchment **Intake structure (if any and water supply areas** Reinforced concrete weir. Currently, there is insufficient water in the weir due to the depleted catchment. It was designed to supply Deep eye water and the surrounding communities with a population of about 10,000. Sadly, it can't even supply up to 500 people.	  Highly deforested and stone mining activities
10	Lower Faiamambo		**Type of source(s) and Construction and management body** Spring, it flows from the hills. It was constructed in 1986 and rehabilitated in 2014 by SALWACO and is being managed by WARDC **Land ownership and % of Depletion.** 70 % of the catchment is depleted and some of the catchment lands are owned by NASSIT whiles the remaining is owned by the community people.	 Deforestation and construction activities

			Activities are undertaken in the catchment area Stone mining, construction of dwelling houses and firewood harvesting **Intake structure (if any and water supply areas** Reinforced concrete weir with massive leakage Currently, there is insufficient water in the weir due to the depleted catchment and the dilapidated weir. It was designed to supply to Lower Faiamambo and the surrounding communities. with a population of about 200,000. Sadly, it can't supply up to 500 people again.	 Dilapidated weir with insufficient water
11	Upper Faiamambo		**Type of source(s) and Construction and management body** Spring, it flows from underneath the rocks. It was constructed in 1986 and rehabilitated in 2014 by SALWACO and is being poorly managed by WARDC **Land ownership and % of Depletion.** 70 % of the catchment is depleted and some of the catchment lands are owned by NASSIT whiles the remaining is owned by the community people. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses and firewood harvesting **Intake structure (if any and water supply areas** Reinforced concrete weir and chamber and is completely roofed to reduce the evaporation rate. Water from this weir is being pumped into the spherical reinforced concrete reservoir. Currently, there is insufficient water in the weir due to the depleted catchment. It was designed to supply to upper faiamambo, proposed NASSIT estate, council area down to the market and the surrounding	  Insufficient water in the protected weir.

			communities with a population of about 400,000. Sadly, it can't even supply up to 200 people anymore.	
12	Benguema-Kapota		**Type of source(s) Construction and management body** Spring, it flows from up hills in the forest. It was constructed by the colonial people and rehabilitated in 1992 by RSLAF. It is being well managed by RSLAF **Land ownership and % of Depletion.** 90 % of the catchment intact even though the land is partially owned by the government and the community. **Activities undertaken in the catchment area** None **Intake structure (if any and water supply areas** Reinforced concrete weir and chamber, water from this weir flows by gravity into the reservoir. Currently, there is sufficient water in the weir due to the well-managed catchment. It was designed to supply to Benguema Military training barracks and kapota community with a population of about 400,000. Sadly, Kapota community has been cut off from the supply of water from this dam.	 Well managed catchment with sufficient water

13	Benguema		**Type of source(s) Construction and management body** Stream flow is from two directions in the forest. This is a viable source that can supply a community close to 800,000 people **Land ownership and % of Depletion.** 40 % of the catchment is depleted **Activities undertaken in the catchment area** Farming, firewood burning, charcoal burning and logging. **Intake structure (if any and water supply areas)** There is no intake structure construction as the source is not used to supply water to Benguema community even though the community is in dare need of water.	 Potential and viable stream source  Two to three tributaries joining the main stream, moderately deforested.

14	Hastings Police Training School (PTS) dam		**Type of source(s) Construction and management body** The stream flows from two directions in the forest and is being co-managed by the SLP and GVWC. This is a viable source that can supply community(s) close to 800,000 people **Land ownership and % of Depletion.** 40 % of the catchment is depleted **Activities undertaken in the catchment area** Farming, firewood burning, charcoal burning. **Intake structure (if any and water supply areas)** There is a weir constructed in 1941 by the colonial people. It is supplying water to Hastings, Police training school, Rogbangba, Jui, youth farm, Airfield, and other surrounding communities with a population of 800,000.	 Farming, firewood and charcoal burning  Good source with moderate water level

15	Burreh		**Type of source(s) Construction and management body** Spring source which flows from the forest. It was constructed by Welthungerhilfe in 2011 and currently managed by the community people. **Land ownership and % of Depletion.** 50% of the catchment is depleted **Activities undertaken in the catchment area** Farming, firewood burning, charcoal burning and sand mining. **Intake structure (if any and water supply areas)** There is a weir constructed in 1941 by the colonial people and is supplying water to Burreh village and the surrounding villages with a population of over 2000.	 Intensive logging and deforestation  Empty weir with tree debris and siltation

16	Mamba ridge		**Type of source(s) Construction and management body** Spring flows from Leicester saddle. It was constructed by GVWC and currently managed by GVWC **Land ownership and % of Depletion.** 80 % of the catchment is depleted and the land where the catchment is situated is owned by private people **Activities undertaken in the catchment area** Gardening, Laundry, stone mining, construction of dwelling houses with evidence of private beacon everywhere. **Intake structure (if any and water supply areas)** There is a weir constructed and managed by GVWC and is used to supply water to three communities with a population of over 15,000.	  Gardening and construction activities (top), High water level with undersized weir (bottom)
17	Kaningo		**Type of source(s) Construction and management body** Spring flows from underneath rocks. It was constructed and managed by the Community. GVWC have plans to construct a spring box at the source. **Land ownership and % of Depletion.** 100 % of the catchment is depleted and the land where the catchment is situated is being converted into private lands. **Activities undertaken in the catchment area** Gardening, laundry, massive stone mining and construction of dwelling houses.	 Deforestation and stone mining activities

			Intake structure (if any and water supply areas) There is no intake structure and is used to supply water to some part of the Kaningo community and the surrounding smaller communities with a population of over 20,000.	 Depleted spring source
18	John Obey		**Type of source(s) Construction and management body** Spring flows from the forest upstream. It was constructed by a philanthropist and currently managed by the community people **Land ownership and % of Depletion.** 70 % of the catchment is depleted and the land where the catchment is situated is owned by private people. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses and logging. **Intake structure (if any and water supply areas)** The weir is poorly constructed and 60% of the water that flows is being wasted through seepage. The source is supplying water to John Obey community and the surrounding smaller communities with a population of over 12,000.	  Intensive logging activity (top) Low water level in weir (bottom)

19	Tombo	Tombo Hills	**Type of source(s) Construction and management body** Spring flows from the forest upstream. It is currently being constructed by an Irish funding group and is been supervised by the Ministry of Water Resources. **Land ownership and % of Depletion.** 70 % of the catchment is depleted and is faced with a huge threat for a project of such nature that runs over 2m USD. The land where the catchment is situated is owned by private people and the community. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses logging and farming. **Intake structure (if any and water supply areas)** The newly constructed weir is poorly constructed as seepage is evidence. The intake pipe is being connected to the sidewall of the weir and not the chamber. This will cause insufficient or no water to flow through the 150mm diameter DI pipes at the peak of the dries. 60% of the water that flows is being wasted through seepage and is supplying water to Tombo and some part of Madina, Kassy and Warai communities with a population of over 50,000 people.	 Stone mining, construction of dwelling houses logging and farming activities.  Weir poorly constructed with seepage underneath.

20	No. 2		**Type of source(s) Construction and management body** Spring flow from the hills in the forest upstream. Constructed by Welthungerhilfe and is managed by the community people but the yield drastically reduces in the dries which affect the communities and activities at the famous No.2 beach. There is another huge gravity potential source if improved upon; the yield will be 10 times bigger than the existing source and will be capable of serving No. 2 and its surrounding communities. **Land ownership and % of Depletion.** Currently, 60 % of the catchment is depleted and the depletion is at a faster rate which poses a huge threat to the catchment. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses logging, sand mining and coal burning. **Intake structure (if any and water supply areas)** The weir is in bad shape as there are seepages. It supplies water to No. 2 community, No. 2 beach and the surrounding communities with a population of over 5000.	 Bush clearing and coal burning activities  Poorly designed and empty weir

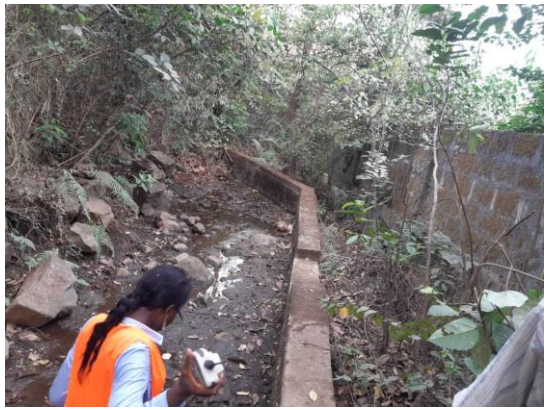
21	Kent town		**Type of source(s) Construction and management body** The community only relies on four (4) hand-dug wells as there is no gravity potential found within the community. The wells are being managed by the community people. Burning of firewood for charcoal and sand mining are activities found within this area.	 Community hand-dug well
22	Kerry town		**Type of source(s) Construction and management body.** The community relies on wells as they don't have a gravity source on their own. There is a gravity potential if developed can serve the town and the areas that host the Ambulances and other medical facilities. **Land ownership and % of Depletion.** Currently, 30 % of the catchment is depleted and the land is allegedly owned by the government and community people. **Activities undertaken in the catchment area** Stone mining, construction of logging, farming and coal burning. **Intake structure (if any and water supply areas)** There is no intake structure but if developed can serve waterloo and its surrounding communities with a population of over 15,000 people.	 Stone mining and farming activities

23	Gbongboima		**Type of source(s) Construction and management body** Stream, this source was once earmarked as a potential source to serve the entire waterloo and its surrounding communities **Land ownership and % of Depletion.** Currently, 20 % of the catchment is depleted and the land is allegedly owned by the government. **Activities undertaken in the catchment area** Stone mining, construction, logging, farming and coal burning and marijuana. **Intake structure (if any and water supply areas)** There is no intake structure but if developed can serve waterloo and its surrounding communities with a population of over 500,000 people.	 Potential and viable source
24	Hastings Orgbonokie		**Type of source(s) Construction and management body** Spring flows from the hills overlooking the other side of Hastings and Kosso town. **Land ownership and % of Depletion**. Currently, 30 % of the catchment is depleted and the land is allegedly owned by the government and the two communities. **Activities undertaken in the catchment** area Stone mining, construction of dwelling houses downstream, logging, farming and coal burning. **Intake structure (if any and water supply areas)** Weir constructed but there is seepage causing about 30% of the inflow to be wasted. It is supplying some parts of Hastings village, Hastings new site and the	 Viable spring source with approximately 30% deforested.

			surrounding communities with a population of about 12,000 people	 Clean spring source
25	Borbor		**Type of source(s) Construction and management body** spring flows from the hills, the facility was constructed by a philanthropist Mr Jeffery and is currently being managed by the community people. **Land ownership and % of Depletion.** Currently, 90 % of the catchment is depleted and the land is allegedly owned by private people. The catchment is in very bad shape. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses downstream, logging, farming and coal burning. **Intake structure (if any and water supply areas)** Constructed weir is in a bad shape but there is seepage causing about 30% of the inflow to be wasted. It is supplying Borbor village and the surrounding communities with a population of about 1,000 people.	 Poorly shaped weir with seepage within surrounding.

26	Tokeh		**Type of source(s) Construction and management body** There are two spring sources that flow from two separate directions from the Tokeh hills. One facility was constructed and managed by "The Place Hotel" and the other facility was constructed by an NGO and managed by the community people (Africana Dam). **Land ownership and % of Depletion**. Currently, about 60 % of the community catchment and 40% of the place catchments are depleted and at an alarming rate and the land is allegedly owned by private people even though it is within the WAPNP. There is a camouflaged forest beyond which is a massive encroachment with beacons in the catchment. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses, logging, farming and coal burning. **Intake structure (if any and water supply areas)** The weir, which was constructed by "The Place Hotel", is in good shape but needs to be improved upon. It is used to supply the Place Hotel and some parts of the Tokeh community with a population of about 2000. The Tokeh community weir is in bad shape and there is seepage causing about 30% of the inflow to be wasted. It has a smaller capacity which makes it impossible to meet its daily demand. It supplies water to the Tokeh community and the surrounding communities with a population of about 3000.	 Weir No. 1 with high gravity potential and high water level managed by "The Place Hotel"  Weir No. 2 (Africana) with low gravity potential and low water level managed by the community.

27	Lower new testament		**Type of source(s) Construction and management body** Spring flows from the hills. It was constructed by Plan International in 1992 and rehabilitated in 2014 by SALWACO. It is managed by the WARDC. **Land ownership and % of Depletion.** Currently, about 100% of the catchment is owned by community people. Highly depleted and encroached. **Activities undertaken in the catchment area** Stone mining and construction of dwelling houses. This catchment is in a very bad shape **Intake structure (if any and water supply areas)** The weir constructed is mostly filled by debris and silts, sanitary materials and other materials due to the houses constructed and other human activities of the communities around the weir and upstream. It supplies water to the Morko town, new testament area, and some part of the Waterloo community with a population of about 5000.	 Highly depleted and encroached catchment  Intense deforestation

28	Upper new testament		**Type of source(s) Construction and management body** Spring flows from the hills. It was constructed by Plan International in 1992 and rehabilitated in 2014 by SALWACO. It is managed by the WARDC. **Land ownership and % of Depletion.** Currently, about 90% of the catchment is owned by community people. 90% of the catchment has also been encroached and depleted. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses, firewood harvesting and coal burning. **Intake structure (if any and water supply areas)** The weir constructed is completely dried up due to human activities within the catchment. It supplies water to Upper new testament area and some part of the Waterloo community with a population of about 2000.	  Intense deforestation (top) with a completely dried weir (bottom).

29	Grafton		**Type of source(s) Construction and management body** There are two sources, one stream and the other spring. The spring sources are managed by Magram and Intrapex. The stream or gravity source is managed by the community people. **Land ownership and % of Depletion.** Currently, the stream or gravity source is 10% depleted. The spring source is about 95% depleted with houses everywhere. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses and firewood harvesting. **Intake structure (if any and water supply areas)** The weir from the spring source has a very small capacity that does not retain enough water to meet its demand. The spring has completely dried up due to human activities within the catchment. The stream weir is bigger, but its water retention capacity is drastically affected by seepage.	 Stone mining and deforestation activities within catchment.  Low capacity stream weir

30	Sima town		**Type of source(s) Construction and management body** Spring flows from the underneath the surrounding rocks constructed by CRS in 1974 and managed by community people. The yield is good and doesn't dry throughout the year **Land ownership and % of Depletion.** 90% is depleted, only a small portion is left which over overhang the source. The catchment is owned and managed by community people. **Activities undertaken in the catchment area** Stone mining and construction of dwelling houses. **Intake structure (if any and water supply areas)** The weir is old and dilapidated. The size of the weir is big enough but most of the water flows as wastewater due to the seepage on the weir. This greatly affects water supply to the intended communities. It supplies water to Sima town and its surrounding communities with a population of 5000 people.	 Massive encroachment  Weir being dried out

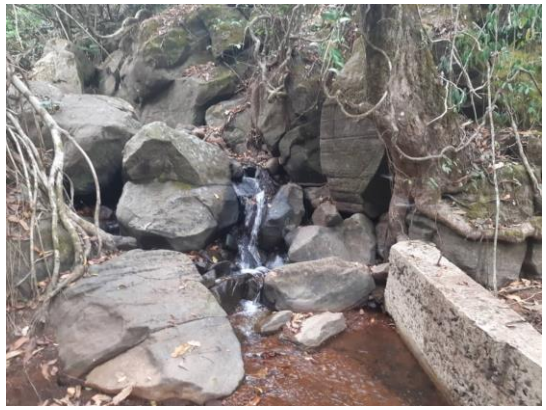
31	Bathurst		**Type of source(s) Construction and management body** Spring flows from the hills of the Gloucester saddle and was constructed in 1960 by the colonial people and managed by community people. The yield has grossly depreciated but doesn't dry completely during the dries. **Land ownership and % of Depletion.** 90% is depleted, only a small portion is left which over overhangs the source. The catchment is owned and managed by community people. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses, coal burning and firewood harvesting. **Intake structure (if any and water supply areas)** The weir and its sump are in bad shape with a huge amount of water lost due to seepage. This greatly affects water supply to the intended communities. It supplies water to Bathurst and its surrounding communities with a population of about 2000 people.	 Bush clearing and deforestation  Weir does not retain water due to high seepage

32	Mogegba		**Type of source(s) Construction and management body** Spring flows from the hills of Grafton, there are temporary weirs constructed by CRSG and GVWC coupled with several other pipe connections by private people. The catchment is not managed by any committee. It has a very good yield that can supply several surrounding communities. **Land ownership and % of Depletion.** 50% is depleted and the land is owned and managed by community people. The catchment is under serious threat. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses, coal burning and firewood harvesting. **Intake structure (if any and water supply areas)** There are temporal weirs constructed by CRSG and GVWC. It supplies water to CRSG compound, GVWC bowser filler points, and the surrounding communities.	 Coal burning and dwelling construction.  Catchment under massive deforestation threat

33	Gloucester	Gloucester Saddle	**Type of source(s) Construction and management body** Spring flows from the hills of the Gloucester Saddle. The catchment is not managed by any committee nor FBC or the community people. **Land ownership and % of Depletion.** 90% is depleted and the land is owned and managed by the government. There are several beacons within catchment with few houses being constructed. **Activities undertaken in the catchment area** farming, and construction of dwelling houses with beacons less than 20 meters from the weir. **Intake structure (if any and water supply areas)** There are two weirs constructed by FBC upstream and downstream which collect water and for possible supply to the FBC reservoir. It supplies water to FBC campus and the surrounding communities with a population of more than 20,000 people.	 Weir 1 with high gravity potential and concrete peg demarcating private land ownership.  Weir 2 with low water level and seepage

34	McDonald's	Located between Koba water and Macdonalds community	**Type of source(s) Construction and management body** Spring flows from the hills, constructed by WHH in 2011 and managed by community people. **Land ownership and % of Depletion.** 60% depleted and the land is owned by community people. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses, coal burning and firewood harvesting. **Intake structure (if any and water supply areas)** A spring box is constructed of reinforced concrete and is used to supply water to Koba and Mcdonalds community with a population of about 2,800 people.	 Bush clearing and deforestation  Spring box getting dried

35	Big Water	Big water community	**Type of source(s) Construction and management body** The stream flows from a swamp through the forest. It was constructed by NaCSA and managed by the Russel community people **Land ownership and % of Depletion.** 30% depleted and the land is owned by community people. Encroachment is by People from Tombo and Madina communities. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses, coal burning and firewood harvesting. **Intake structure (if any and water supply areas)** There is no weir	 Coal burning and firewood harvesting  Low water level in stream

36	Russel		**Type of source(s) Construction and management body** Spring flows from the hills and constructed by WHH in 2011 and managed by community people. **Land ownership and % of Depletion.** 40% depleted and the land is owned by the community people. **Activities undertaken in the catchment area** Stone mining, construction of dwelling houses, coal burning and firewood harvesting. **Intake structure (if any and water supply areas)** The weir is in bad condition as most of the water is wasted due to seepage. It supplies water to Russel and the surrounding communities with a population of about 5000 people	 Spring source from hill with stone mining and deforestation  Weir in very bad condition with insufficient water

37	Mortem		**Type of source(s) Construction and management body** Spring flows from the hills. **Land ownership and % of Depletion.** 10% depleted and the land is owned by community people. **Activities undertaken in catchment area** Stone mining, marijuana farming, coal burning and firewood harvesting. ` **Intake structure (if any and water supply areas)** Weir has high gravity potential with clear water. Present volume of water not too sufficient to supply the community.	 Deforestation and marijuana farming  Weir with private pipe connections.

38	Kossoh town		**Type of source(s) Construction and management body** Spring flows from the hills overlooking Kosso town. It was constructed in 2016 by H.E Sam Sumana and managed by the head man and his team **Land ownership and % of Depletion.** 40% depleted and the land is owned by community people. **Activities undertaken in catchment area** Stone mining, coal burning and firewood harvesting. Construction of dwelling houses **Intake structure (if any and water supply areas)** Weir constructed is small to retain the huge flow of water. It supplies water to Kosso town, Jui and the surrounding communities with a population of about 22,000.	 Stone mining, burning and firewood harvesting.  Construction of dwelling houses within catchment

5.0 SUMMARY OF FINDINGS

- Increase in deforestation around the catchment areas as a result of urbanization, logging, fuelwood and coal burning.
- Massive encroachment as evidence of beacons for private individuals was seen in and around some of the catchment areas.
- Small scale agricultural activities like vegetable gardening are prevalent around catchments areas
- Stone mining activities are among the major occupations of the locals around the catchments which have led to the diversion of some of the waterways.
- Some dams constructed along the catchments are small resulting in wastage of water especially in communities like Mamba Ridge.
- Also due to upstream activities like laundering, agricultural activities and construction among others have impacted the quality of the water especially the turbidity and other ambient water quality parameters.
- The catchments are left unprotected and are not demarcated nor there fences. This serves as a major reason why these catchments have been encroached by locals.
- Issue of land tenure system especially in catchment areas outside the WAPNP
- The non-existence of water catchment management committees in most of the catchment areas and where there are in most cases they are not well structured.
- Most of the water catchment areas do not have reservoirs/ storage capacities and water treatment plants or means of treating the water before being supplied.
- While the catchment has been encroached on or undergoing massive deforestation at an alarming rate, however, there is an opportunity to restore, reclaim or reforested.

6.0 COMMUNITY PARTICIPATION

Western area catchment plays an important role in the provision of water to the residents of Freetown and its environs. However, the massive deforestation and encroachment either as a result of livelihood support, expansion of their communities, creation of new settlements and other purposes have resulted in the drastic reduction in the quality and quantity of water supplied to the city.

The lack of catchment management committees in these communities, lack of bylaws, the enforcement of regulations and other related measures are the major reasons being used by community people to justify their actions on the catchment areas.

Meanwhile, realising the effect of water shortages and the frequent climatic hazards in these communities, there is an overwhelming willingness from community people to adhere to laws and regulations that will minimise encroachment into these catchments. However, issues of alternative livelihood for their sustenance were raised as a great concern and they requested that this be taken into account.

7.0 WATER QUALITY

Before the commencement of the Western Area catchment assessment, the NWRMA met and determined the objectives of the water quality monitoring program. The team also agreed that the five core parameters of SDG 6.3.2 which include Dissolved Oxygen, Electrical Conductivity, pH, Orthophosphate and Total Oxidised Nitrogen will be used to determine the ambient water quality. In addition, as part of the quality assurance, the team verified the availability of sufficient reagents and calibrate the equipment to be used.

Setting Objectives

The following objectives were set for monitoring of ambient water quality monitoring at the Western Area catchments

1. To determine whether the water sources in the Western Area catchments meet ambient water quality
2. To determine contamination in the sources
3. To determine the impact of anthropogenic activities on the water sources

7.1 Preliminary Surveys and Actual Data Collection

Prior to the commencement of the water quality monitoring and assessment intervention, the Hydrological Services department developed a map of the water sources that will be sampled and water quality tested.

The table below shows the list of the catchment water sources and the dates that the samples were collected in the field.

Table 1 Surface water quality monitoring stations

Location	Sample Collection Date
Kaningo	27/01/2020
Borbor	27/01/2020
Tokeh	27/01/2020
Tokeh Dam 2	27/01/2020
York	27/01/2020
White water	28/01/2020
White water 2	28/01/2020
Gloucester	28/01/2020
Gloucester 2	28/01/2020
Sugarloaf	28/01/2020
Kongo Dam	28/01/2020
Charlotte	28/01/2020
Bathurst	28/01/2020
Mongegba	28/01/2020
Mortem	28/01/2020
No2	29/01/2020
Kent	29/01/2020
Russel	29/01/2020
Tombo	29/01/2020
Benguima	29/01/2020
Mcdonald	29/01/2020
Bureh	29/01/2020
Big water	29/01/2020
John obey	29/01/2020
Benguema kapota	30/01/2020
Upper faiamambo	30/01/2020
Lower faiamambo	30/01/2020
Upper new testament	30/01/2020

Lower new testament	30/01/2020
Gbongoima	30/01/2020
Gbongoima tributary	30/01/2020
Deep eye water	30/01/2020
Grafton	30/01/2020
Grafton Main Source	30/01/2020
Deep eye water	30/01/2020
Mile 13	31/01/2020
Hastings orgbonokie	31/01/2020
Hastings police dam	31/01/2020
Samie town	31/01/2020
Mamba ridge	31/01/2020
Thunder hill	31/01/2020
Bluewater	31/01/2020

7.2 Water Quality Parameters

For the National Water Resources Management Agency to commence the reporting of SDG 6.3.2 indicator which is the proportion of bodies of water with good ambient water quality, the Hydrological Services Department agreed on the following core parameters and some other parameters listed in the table below.

Table 2 Core and some progressive water quality parameters

	Parameters	Parameter Short Name	Target Value	Unit	Target Type
Core Parameters	Dissolve Oxygen	DO	6	mg/l	Lower
	Electrical Conductivity	EC	500	us/cm	Upper
	pH	pH	8-Jun		Range
	Orthophosphate	OP	0.035	mg P/l	Upper
	Total Oxidised Nitrogen (Nitrate + Nitrite)	TON	1.8	mg N/l	Upper
	Other Parameters (WHO)				
	Water Temperature (^{o}C)				
	Turbidity		<5.0	NTU	Upper
	E. Coli		0		Lower

7.3 Water Quality Testing for E. coli

The compartment bag test was used to determine the presence or absence of E. coli in the water samples. A 100ml of the water sample is collected in a Thio bag and the growth medium is then added to the sample bag and massaged to release the growth media into the sample water. The sample water is then poured into the CBT bag ensuring that all the five compartments are full. The CBT bag is then stored at 25 ^{0}C - 30^{0}C temperature for 48Hrs. After the completion of the 48Hrs incubation period, there will be colour change from yellow to green if the water sample is positive for E. coli.

7.4 Photometer Md610 Testing for Chemical Parameters

The MD610 is used for the testing of chemical parameters and work with the Akvo Caddisfly. The Akvo Caddisfly is a digital platform that can obtain the MD610 photometer results from the water quality tests and transmit them to the web database through a smartphone. The database does not only store the information but also can produce graphs for easy interpretation.

7.5 Results and Data Analysis

7.5.1 Core Parameters

Results for water quality testing of the core parameters (DO, EC, pH, OP and TON) are given in table 3 below. Parameters that do not meet the target values are coloured red.

Table 3 Water quality SDG 6.3.2 core parameter results

Location	pH	EC (µS/Cm)	DO	OP	TON
Kaningo	6.76	18	5.12	0	1
Mile 13	7.5	10	7	0.4	1
Borbor	7.25	19	6.58	0.1	1
No2	6.2	12	6.5	0.15	2
Tokeh	6.98	17	8.75	0	1
Tokeh Dam 2	7.15	18	6.95	1.1	1
Kent	7.3	16	6.81	0.2	4
York	7.31	17	7.29	0.2	1.01
Russel	7.18	16	6.3	0.2	2
Tombo	7.02	16	6.9	0.2	5
Benguema kapota	7.08	17	6.57	0.09	2
Benguima	7.37	18	7	0.4	1.01
Mcdonald	6.81	38	6.41	0	1
Bureh	7.3	16	6.81	0.07	2
Big water	7.3	14	6.7	1.73	2
John obay	7.1	19	6.46	0.2	2
Upper Faiamambo	6.8	17	6.42	0.7	3
Lower Faiamambo	6.9	46	6.43	0.9	4.08
Upper new testament	6.9	17	6.84	0.69	2

Lower new Testament	7.42	32	6.46	0.76	3
Gbongoima	7.6	20	6.4	0.5	1
Gbongoima tributary	7.8	9	6.7	0.2	1.5
Deep eye water	7.6	14	7.69	1.2	4
Grafton	7.6	16	7.88	0.15	3
Grafton Main Source	7.7	14	7.19	0.11	3
Hastings orgbonokie	7.3	14	8	0	2
Hastings police dam	7.18	17	7.46	0.2	1
Deep eye water	7.6	14	7.69	1.2	4
Samie town	6.96	20	1.65	0.78	2
Mamba ridge	7.7	57	8.9	1	2
Thunder hill	8.01	18	9.9	0.56	5
Blue water	7.8	23	9	2.6	7
White water	7.05	27	7.18	0.08	1.24
White water 2	7.01	19	5.2	0.06	0.85
Gloucester	7.05	15	6.53	0.98	7
Gloucester 2	6.82	14	7.96	0.67	4
Sugar loaf	6.95	15	7.84	0.3	1
Kongo Dam	7.11	11	7.1	0.5	0.2
Charlottee	7.65	55	6.8	0.3	1.54
Bathurst	7.2	13	7.11	1	3.8
Mongegba	7.27	19	5.5	0.1	2
Mortem	7.38	15	6.4	0.24	2

The water quality results are assigned "1" when targets are met and "0" when not met using the IF conditional function in excel. The results are shown in Table 4 below.

Table 4 Percentage compliance for each core parameter at all the surface water monitoring stations

Location	pH	EC	DO	OP	TON
Kaningo	1	1	0	1	1
Mile 13	1	1	1	0	1
Borbor	1	1	1	0	1
No2	1	1	1	0	0
Tokeh	1	1	1	1	1
Tokeh Dam 2	1	1	1	0	1
Kent	1	1	1	0	0
York	1	1	1	0	1
Russel	1	1	1	0	0
Tombo	1	1	1	0	0
Benguema kapota	1	1	1	0	0
Benguima	1	1	1	0	1
Mcdonald	1	1	1	1	1
Bureh	1	1	1	0	0
Big water	1	1	1	0	0
John obay	1	1	1	0	0
Upper faiamambo	1	1	1	0	0
Lower faiamambo	1	1	1	0	0
Upper new testament	1	1	1	0	0
Lower new testament	1	1	1	0	0
Gbongoima	1	1	1	0	1
Gbongoima tributary	1	1	1	0	1
Deep eye water	1	1	1	0	0
Grafton	1	1	1	0	0
Grafton Main Source	1	1	1	0	0
Hastings orgbonokie	1	1	1	1	0
Hastings police dam	1	1	1	0	1
Deep eye water	1	1	1	0	0
Samie town	1	1	0	0	0
Mamba ridge	1	1	1	0	0
Thunder hill	1	1	1	0	0
Blue water	1	1	1	0	0
White water	1	1	1	0	1
White water 2	1	1	0	0	1
Gloucester	1	1	1	0	0
Gloucester 2	1	1	1	0	0
Sugar loaf	1	1	1	0	1
Kongo Dam	1	1	1	0	1
Charlottee	1	1	1	0	1

Bathurst	1	1	1	0	0
Mongegba	1	1	0	0	0
Mortem	1	1	1	0	0
Percentage compliance per parameter	100	100	90.5	9.5	38.1
Percentage compliance of water bodies			67.6		

The results indicate that of all the core parameters, only pH, EC and DO parameters meet the percentage compliance threshold by having 100% scores for pH and EC whilst DO scores 90.5%. OP and TON, however, are below the 80% threshold of meeting good water by scoring 9.5% and 38.1% respectively.

With regards pH, all results of the water sources fall within the permissible limits of 6 to 8 as shown in the figure below.

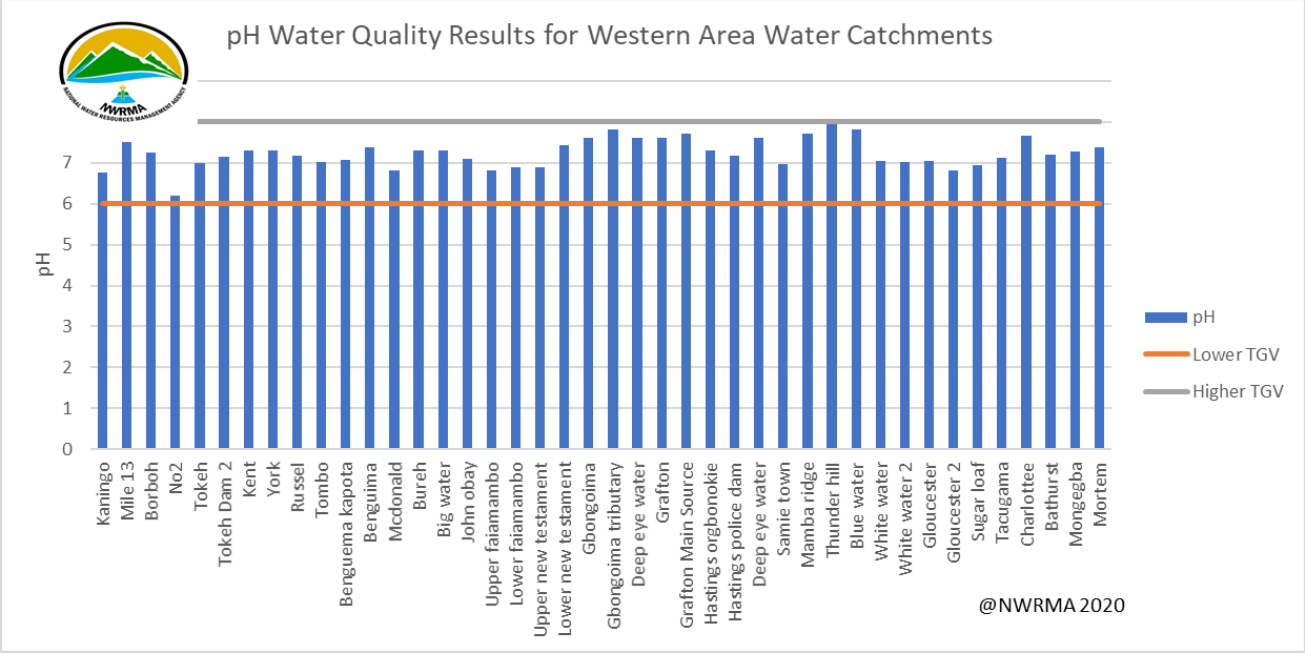


Figure 1: pH results of western area water sources

In addition, all the water sources result for electrical conductivity are below the upper limit of 500 (µS/Cm) as shown in the figure below.

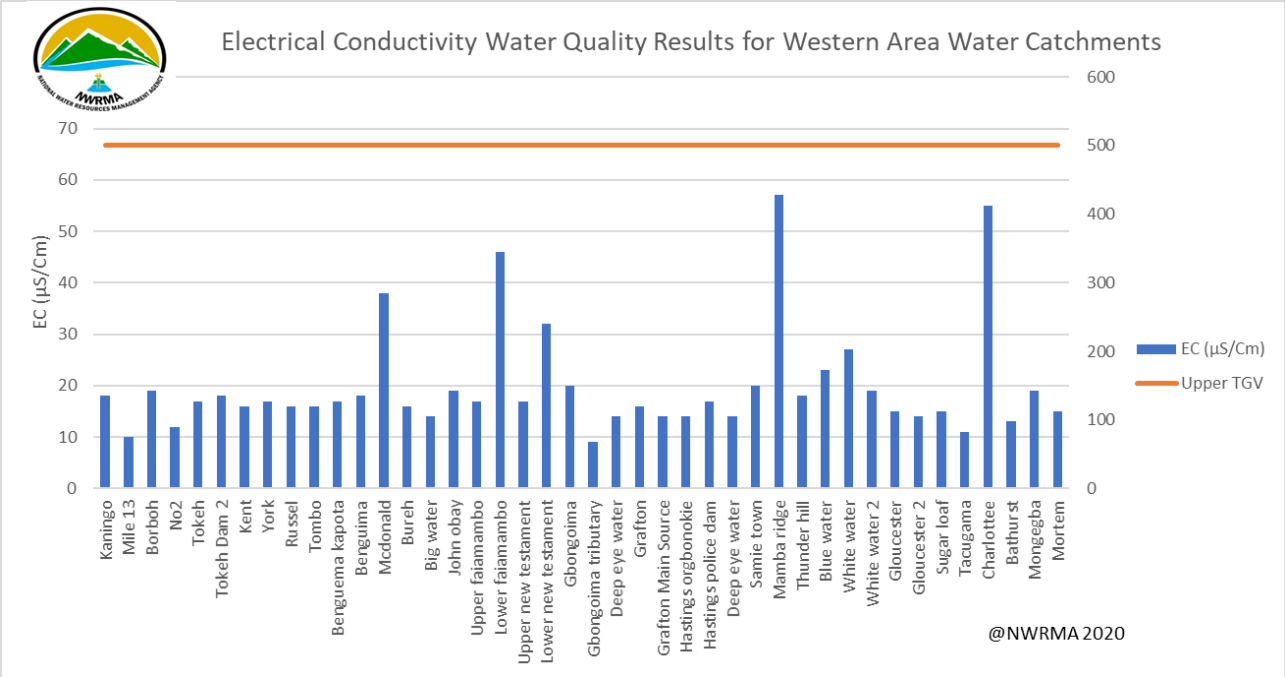


Figure 2: Electrical conductivity results for the western area

Furthermore, most of the water sources have Dissolve Oxygen values that are above the lower target values with the exception of Kaningo, Samie town, White water 2 and Mongegba.

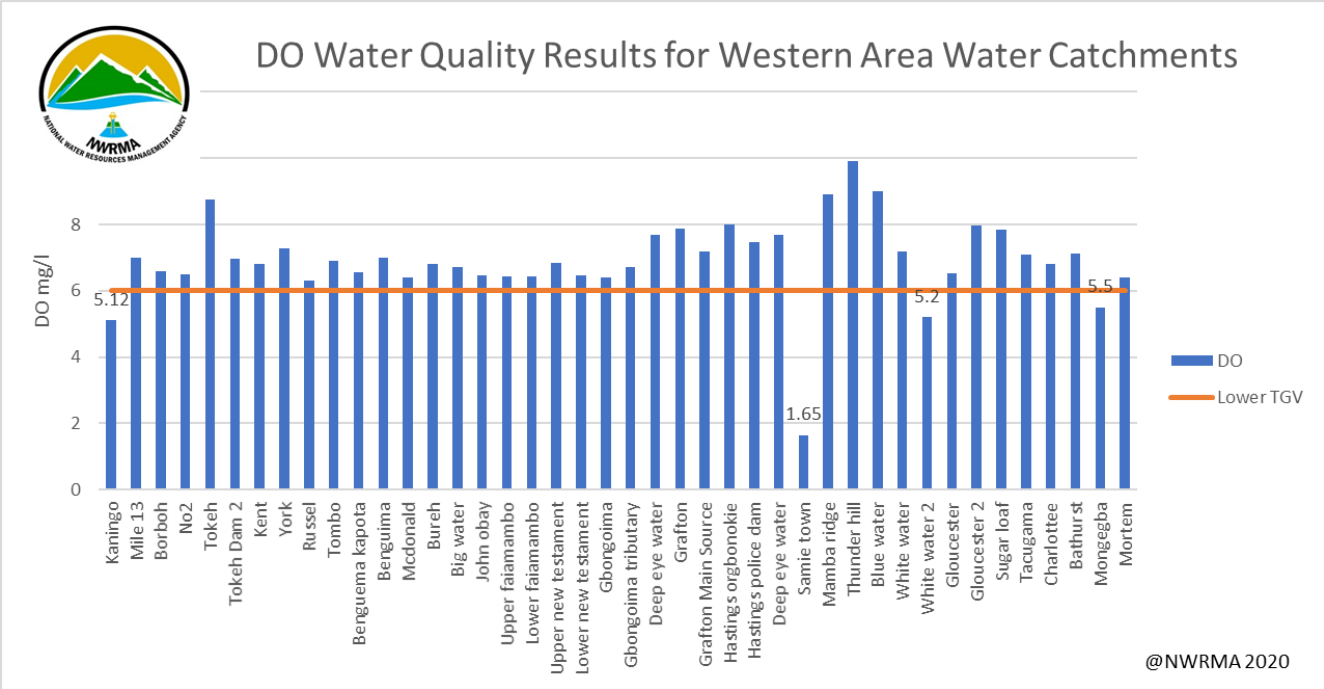


Figure 3: DO results for water sources in the western area catchments

On the other hand, all of the water sources at the catchments do not meet values above the minimum Orthophosphate values as shown in the figure below.

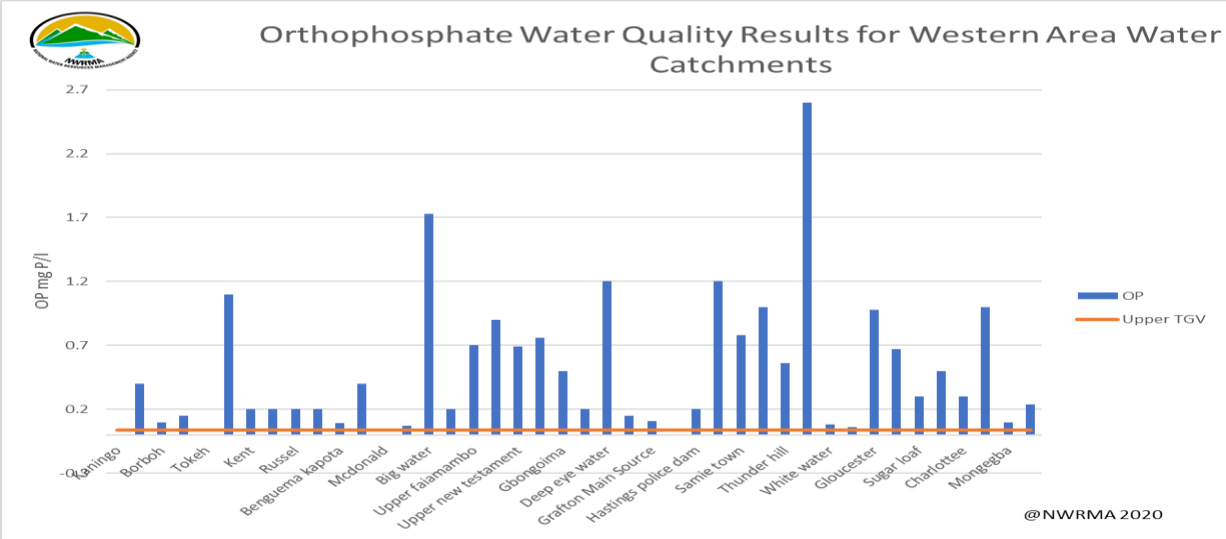


Figure 4: Orthophosphate results for water sources in the Western Area

Furthermore, many water sources have values that are higher than the permissible limit for TON as shown in the figure below.

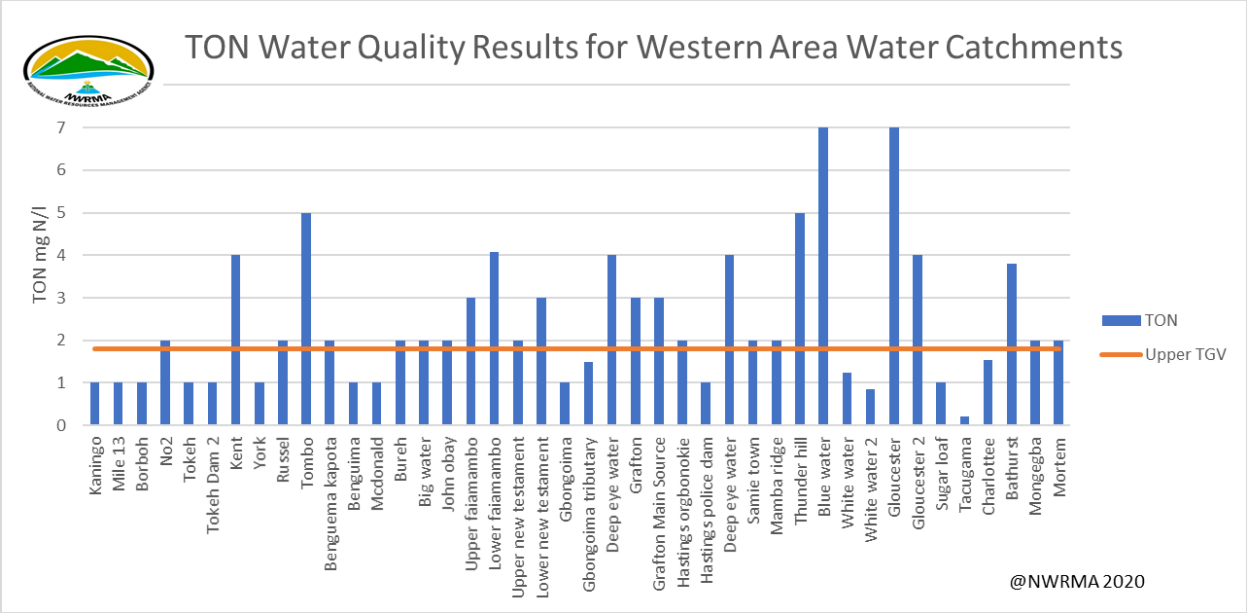


Figure 5: TON results for water sources in the western area catchment.

7.5.2 Progressive parameters

Other parameters tested for is E. coli and turbidity as shown in the table below. The results indicate that most of the sources are contaminated with E.coli.

Table 5 Results of turbidity and E.coli as shown in the table below.

Location	Turbidity	E.coli	Risk Assessment
Kaningo	0	100	Very High Risk
Mile 13	0	13.6	High Risk
Borbor	0	13.6	High Risk
No2	0	100	Very High Risk
Tokeh	0	100	Very High Risk
Tokeh Dam 2	0	100	Very High Risk
Kent	0	48.3	High Risk
York	0	32.6	High Risk
Russel	0	100	Very High Risk
Tombo	0	13.6	High Risk

Benguema kapota	0	100	Very High Risk
Benguima	0	100	Very High Risk
Mcdonald	9	0	Low Risk
Bureh	0	100	Very High Risk
Big water	0	48.3	High Risk
John obay	0	100	Very High Risk
Upper faiamambo	1	100	Very High Risk
Lower faiamambo	0	100	Very High Risk
Upper new testament	1	48.3	High Risk
Lower new testament	6	100	Very High Risk
Gbongoima	0	13.6	High Risk
Gbongoima tributary	0	48.3	High Risk
Deep eye water	11	100	Very High Risk
Grafton	0	2.6	Intermediate Risk
Grafton Main Source	0	13.6	High Risk
Hastings orgbonokie	0	13.6	High Risk
Hastings police dam	0	100	Very High Risk
Deep eye water	11	100	Very High Risk
Samie town	0	100	Very High Risk
Mamba ridge	9	100	Very High Risk
Thunder hill	0	48.3	High Risk
Bluewater	0	100	Very High Risk
White water	0	100	High Risk
White water 2	0	1.2	Intermediate Risk
Gloucester	5	100	Very High Risk
Gloucester 2	0	100	Very High Risk
Sugarloaf	0	2.1	Intermediate Risk
Kongo Dam	0	0	Low Risk
Charlottee	0	0	Low Risk
Bathurst	0	8.4	Intermediate Risk
Mongegba	0	0	Low Risk
Mortem	0	0	Low Risk

7.6 Discussion and conclusion on water quality

The catchment assessment conducted in the Western Area was done due to the ever-increasing threats on the catchments that serve as the main source of water supply for communities. The use of the SDG 6.3.2 ambient water quality indicator is to determine the water quality status of the water sources in the western area and to determine the impacts of the anthropogenic activities

To assess the status of the water sources the following core parameters DO, EC, Ph, OP, TON and other parameters were tested for.

The results for DO, EC and pH are above the 80% which makes the parameters to meet the threshold. If DO values are below the 6mg/l the aquatic ecosystem will be seriously impacted on. It is also an indication that the water source is seriously contaminated with organic matter or wastes. Very low values of DO are also an indication that the water source might be contaminated with sewage.

The presence of higher turbidity values for some water sources is an indication of catchment degradation and runoffs due to limited infiltration as a result of the decline in soil cover. Finally, the water sources are mostly contaminated with E. coli. This might be due to the fact that all the water sources/dams are open to the environment, making room for man and animals to contaminate the water sources by open defecation.

7.7 Conclusion on water quality

The analysis of the catchment water sources with regards to water quality using SDG 6.3.2 indicator, the percentage compliance of the water bodies scores 67.6% which is not "good" due to the fact that it is below the 80% threshold.

Furthermore, some water sources have turbidity values that are higher than the 5 NTU WHO threshold value for drinking water and additionally, the fact that most of the water sources are contaminated with E. coli makes the untreated water sources unsafe for drinking.

8.0 ENGINEERING STRUCTURES

8.1 Intake structures

Most of the intake structures are undefined and poorly constructed leading to huge overflow and seepage. This has led to a decrease in the quantity of water retained which has subsequently resulted in the low quantity of water supplied to the various communities. In some cases, the intake structures are badly damaged.

8.2 Reservoirs

There are few reservoirs available within the catchments wherein water flows from intake structures into the reservoirs before it is distributed to the community people. Most of these reservoirs have exceeded their design lifespan whilst some are not watertight leading to huge wastage through seepage.

8.3 Pipes and Fittings

Transmission pipes are made of Ductile Iron/HDPE/Galvanized Iron (GI) pipes with various type of fittings and their respective fittings. The deplorable conditions of some of these pipelines are of great concern as there are massive leakages along with them.

9.0 PRIORITISATION OF WATER CATCHMENT AREAS

Critical water catchment or sub-catchment areas have been identified for urgent intervention on the basis of the alarming rate at which these catchments or sub-catchments have been depleted or been encroached. Immediate actions are required now for the restoration and maintenance of these catchment areas. There is an urgent need to create a buffer zone in these areas and to effectively integrate reforestation measures around the established buffer zones in areas deforested so as to ensure soil stabilization and vegetative cover. These catchments or sub-catchments include:

1. Gloucester saddle; this consists of Gloucester, Bathurst, Mogegba and Charlotte.
2. Deep-eye water
3. Torkeh
4. Kaningo
5. Tombo
6. Guma/Sussex
7. Number 2
8. Borbor
9. Thunder Hill
10. Mamba ridge
11. Bluewater
12. Lower New testament
13. Upper New Testament
14. Lower Firemambo
15. Upper Firemambo
16. Kosso town

17. White Water
18. Bathurst
19. Benguema

10.0 LIVELIHOOD ISSUES

The assessment explored the implications of livelihood activities, namely fuelwood harvesting, charcoal production, stone mining, timber production, marihuana and other agricultural activities. Qualitative data were collected from respondents in each water catchment area through key informant interviews and focus group discussions and the results analysed. The assessment found that encroachment affected livelihoods associated with farming, stone mining, and fuelwood production through its implications for good water quality and quantity and the sustainability of the catchment areas. All the respondents acknowledged the effect of encroachment though deforestation and farming practices on the catchment areas and their effects on water supply to their communities. The assessment also indicates the livelihoods of the communities are also at risks as they don't have water for basic use and other economic activities.

11.0 LIMITATIONS

This assessment does not consider streamflow measurement and also did not include the assessment of all catchments areas due to logistical constrains. Another key limitation is the absence of Ministry of Lands, Housing and Country Planning in the assessment.

12.0 CONCLUSIONS

This report identified key challenges in relation to sustainable water resources management in the Western Area. These include but are not limited to deforestation for charcoal burning and fuelwood, marihuana farming, siltation of dams; weir sizes very small compared to flows, bush clearing for farming and in most cases low storage capacity of the reservoirs. This is compounded by increasing human settlement, poor water quality and reduced surface water sources. The report also identifies the need for stakeholder engagement particularly the parliamentary oversight committee on water resources to be involved in the management of water catchment areas. The report further identifies the need to systematically map and delineate catchment areas, undertake flow measurement and create buffer zones in every water catchment area. The assessment additionally

identifies the link between water availability, deforestation and livelihood issues and the need for alternate livelihood.

The report concludes that the best approach to improving water resources management is through the involvement of all stakeholders in the planning and decision making in the spirit of integrated water resources management.

13.0 RECOMMENDATIONS

With regards to the results obtained from the assessment of the Western area catchment sources, the following recommendations are put forward:

- There is an urgent need to effectively integrate reforestation measures, map and delineate water catchment areas and establis buffer zones.
- There is a need for armed guards and forest guards to patrol catchment areas and establish a security guard post at all catchment areas.
- Stop agricultural activities around the catchment areas as the fertilizers may affect the quality of the water and will affect the consumers.
- Guma Valley should improve on the weirs/dams and ensure proper water connection to prevent wastage as this will improve the water retention and supply chain to desperate communities in high demand season.
- Relevant MDA's and CSO's should build Co-management committees with community stakeholders to better manage the water catchment areas.
- Strong land-use policies to be adopted with regards the protection of the catchments backed up with strong political will.
- Engage and involve the parliamentary oversight committee on water resources management
- To construct permanent structures like giant columns or chain link fence or with other forms of materials to protect all sub catchments especially the endangered ones.
- Engage community leaders, people, and other stakeholders on livelihood issues associated with the catchments.
- Provide subsidiary livelihood supports to dependents of the catchments by creating alternative source of income.
- Undertake intensive stakeholders' engagement and awareness campaign on the need for water resources management.