Water Availability, Source, and Management in the Western Area Peninsular Forest

A Study For The Conservation of the Sierra Leonean Western Area Peninsula Forest Reserve (WAPFR) & its Watershed Project.

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Conservation of the Sierra Leonean Western Area Peninsula Forest Reserve (WAPFR) & its Watershed

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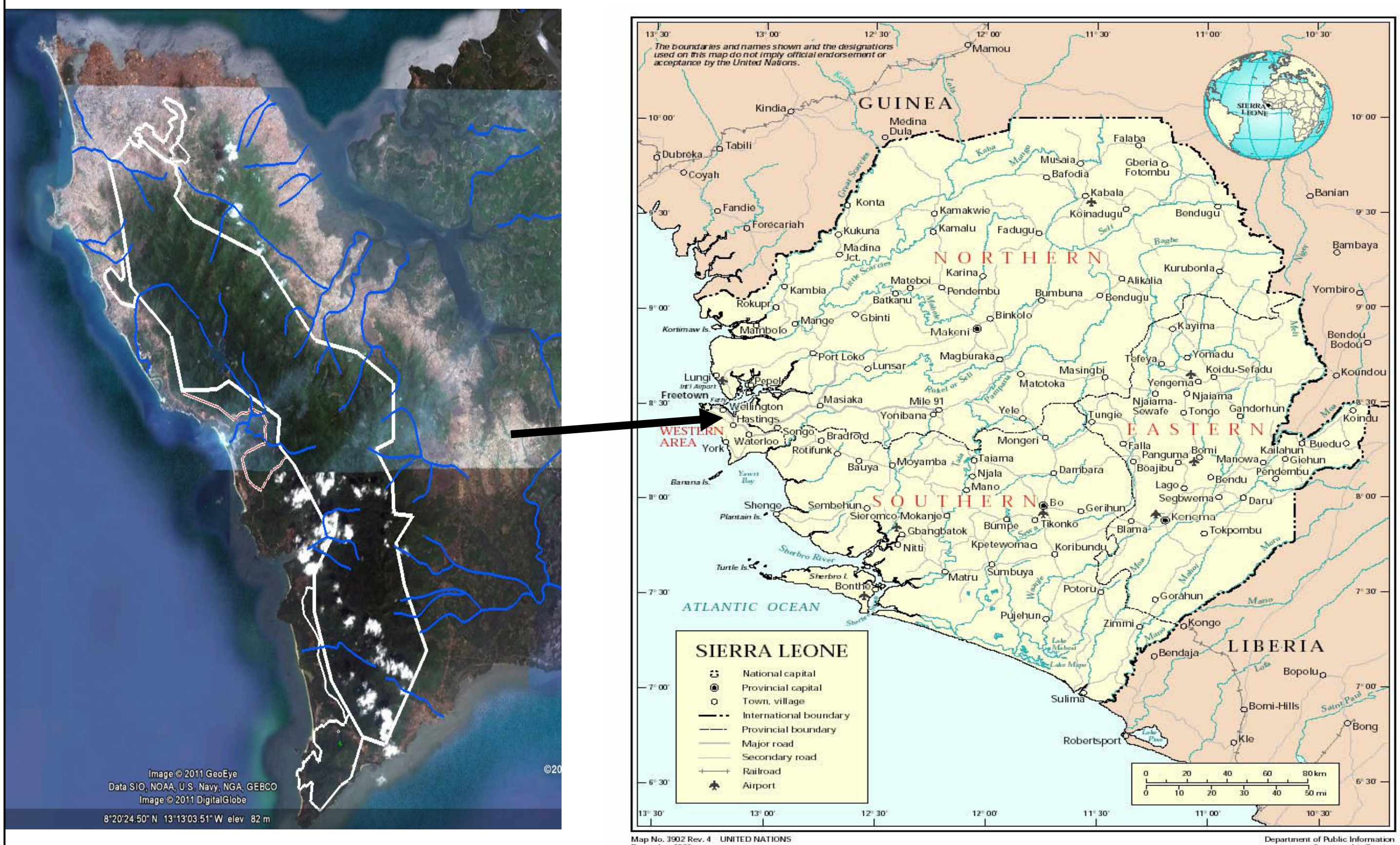

Map of Sierra Leone out setting the study area

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EXECUTIVE SUMMARY

A research to investigate water availability, source, and management in nine communities in the Western Area Peninsular Forest commissioned by the WAPFoR project was successfully carried out. The study used a number of tools and procedures including; structured questionnaire, focus group discussion, laboratory analysis, stream channel measurement, stream velocity and yield, as well as observations to accomplish the study. Data compiled from these sources were analysed to produce this report and the main findings, conclusion and recommendations are enumerated below.

The study shows that there is enough water within the nine communities that would support their water needs now and up to a projected time of 10 years. However, the caveat to this is that the pristine forest zone from where the streams originate as well as the stream channels must be protected always.
The study also revealed that all but one (Sussex) communities depend on streams (surface water) for their domestic and agricultural water needs. Some communities have dual sources of water; water wells, spring boxes, and stream.

Most of the streams were discovered to have pH values within the WHO standard, some water sources have chemical components like iron (Fe) higher than the acceptable WHO standard. All of the water sources tested positive with bacterial contamination (E. coli, Faecal coliforms, non-Faecal coliforms) due to human activities close to the water ways or point sources.

Community members are willing to pay in kind and money for safe water and have suggested water management committees replacing village heads for their communities the study revealed.

While the report has a number of conclusions based on the assignment, the main conclusion for this summary is that there is ample water in all of the communities in the study. Most of the communities rely on streams and or springs for their water source and all of them have been found contaminated with bacteria, even though all the streams have chemical and physical properties in conformity with WHO standard. The water sources are ideal in terms of quantity and physical and chemical content but will have to be treated for bacteria if they are to be used as safe water by the communities.

Damming may not be appropriate in all of the cases. However, trapping the source water into bowl like structures or just laying pipes of various dimensions in the water can appropriately make water available for other processes like lift pumping, treatment, and other collection and storage means. To avoid human traffic to source water, water distribution system must take into account facilities taking water into homes. Where this is impossible multiple standpipes in communities will adequately provide the necessary water demand.

Based on the findings and conclusion, the study recommends that safe water in appropriate water infrastructure is made available to all communities in this study. Community members should be involved after training in the treatment and management of their water sources.

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List of abbreviations

1. EC – CSP – European Community Country Strategy Paper
2. ENFORAC – Environmental Forum for Action
3. FAO – Food and Agriculture Organisation
4. GVWC – Guma Valley Water Company
5. MAFFS – Ministry of Agriculture Forestry and Food Security
6. PRLA- Participatory Rural Livelihood Assessment
7. PRSP – Poverty Reduction Strategy Paper
8. SALWACO – Sierra Leone Water Company
9. TOR – Terms of Reference
10. WAPFoR – Western Area Peninsular Forest Reserve
11. WHH - Welthungerhilfe
12. WHO –World Health Organization

1 Introduction to the study

Some 50 years ago more than 60% of Sierra Leone was covered by closed high forests. Today, only approximately 5% (180,250 ha) of these forests remain. A drastic decrease in ecosystem richness and biodiversity went along with the loss of forest habitats.

The Western Area Peninsula of Sierra Leone, which is part of the Upper Guinean Forest Ecosystem, is home to roughly 1 to 1,5 million people (20% of the country's total population), including the capital city of Freetown. The WAPFoR, occupying the centre of the peninsula, covers about 17,000 hectares of closed forest. The Reserve is one of the eight biodiversity hot-spots of the country and hosts 80-90% of Sierra Leone's terrestrial biodiversity including some endemic species. Western Area Peninsula constitutes the only area on West Africa's coastline, where mountain tropical rain forests directly meet the ocean. WAPFR has a high existence value and a high use value as the source of drinking water for some 20% of Sierra Leone's population. Yet, this unique ecosystem which is indispensable for the livelihood of 1.5 million people has come under multiple anthropogenic pressures to the point that its existence is endangered. The main reasons of degradation are: – increased land clearance for farms, new settlements, fuel-wood extraction/charcoal production and illegal (corporate) logging. Due to these pressures the overall area of the forest reserve has decreased by 32% since its constitution. The actual perimeter of the area covered by high forest does no longer correspond to the official demarcation of the WAPFR in wide areas and no physical demarcation (sign posts) of the Reserve's boundaries exists.

To slow down and ultimately stop this trend a new demarcation and zonal management plan will be developed (for core and buffer zones) in a participatory bottom-up process involving stakeholders at all levels, especially the villages and the Rural District Council Waterloo. Therefore, the self help potential of those communities living in villages adjacent to the reserve will be developed. Existing or emerging community based groups and associations will be enabled to generate an income from sustainable activities (e.g. agroforestry, animal husbandry, horticulture, ecotourism) as an alternative to illegal logging and charcoal production. The Action will promote furthermore the establishment of wood lots to allow the coverage of domestic fuel-wood demand. Moreover, links to micro-credit institutions and international conservation organizations will be established to foster alternative income options other than from the Forest Reserve. Awareness at all levels of the Reserve's crucial importance for the livelihood and the drinking water supply for the peninsula's population will be created. The direct interdependence of forest conservation and safeguarding water supply will be demonstrated in practical examples and widely disseminated. Capacities for the enforcement of forests laws and regulations will be built, especially on local level and by the support of the Forest Department. Innovative pro-poor economic instruments linking conservation to the carbon markets will be piloted (e.g. Reduction of Emissions from Deforestation and Forest Degradation).

The proposed Action has been developed in consultation with the target communities and close cooperation with key government institutions. The Western Area Rural District Council in Waterloo, the Ministry of Lands, Country Planning and Environment (MLCP&E) and the Forest Department (under MAFFS) are fully supportive of the Action and the latter two will become involved as associates.

The Project is complementary to the Western Area Rural District Council's District Development Plan and fully in line with the PRSP and the EC-CSP and will be implemented by Welthungerhilfe as lead partner and ENFORAC as local partner. A number of well experienced ENFORAC members will serve as implementing agents.

Activity 2.7: "Support pilot activities emphasizing direct interconnection between forest conservation and safeguarding water supply and its description" reads:

The tropical rainforests in the upper parts of catchment areas in the WAPFR provide valuable ecosystem functions in maintaining constant supplies of good quality water. They act like a sponge, absorbing the abundant rainfalls occurring during the rainy season and releasing the absorbed water over the dry season. The root system stabilizes the soil, prevents erosion, reduces surface run-off and supports the percolation of rainwater into the underground where it replenishes the aquifers.

Loss of forest leads to increased flooding during the rainy season, increased and prolonged drought during the dry season catastrophic losses to water quality. Yet in general people have little awareness of the impacts forest degradation can have on water resources. Many local dwellers perceive and suffer from a reduction in water quantity availability and a decline in water quality but hardly ever relate this to deforestation or forest degradation.

The WAP's rural population depends on water stemming from micro-catchments for its drinking water supply and already complains about decreased water availability. In two of the four wards (York and Waterloo) water supply is clearly top-ranking among the villagers (before education and health). Women were prioritizing water much more than men in York Ward, whereas in Waterloo Ward men and women equally shared their concern for water provision[1].

But they do not realize that their involvement in deforestation and forest degradation is the underlying reason for the decrease in water availability. E.g. in the York Ward of the WAP, only one sixth of the

[1] According to Development Plan, Rural District Council Waterloo 2006-08

households can rely on water services; 48,000 households in York are unsupplied. Illegal activities in terms of logging and fuel wood extraction from the forests are the cause for the decline of quality and quantity of water they rely on for their livelihood.

Reforestation and afforestation of the catchment area will be supported in at least five villages. The community and local governments will be involved in monitoring the changes in flow in correlation to rainfall. Communities and local governments will consider by this practical example that maintaining the forest cover in the micro-catchment area will guarantee their water supply. In parallel, water supply infrastructures will be improved e.g. construction of simple gravity flow scheme with water supplied via public stand-posts or water kiosks. Technical and management capacities of the target group will have be improved by establishing and training Water User Associations or similar organisational forms of community based of self help groups for the operation and maintenance of water supply infrastructures. According to the District Council's plans the Project will focus its water related activity in York Ward (partly Waterloo Ward). This will ensure the sustainability of the communities' drinking water supply and serve as a visible and tangible example.

Welthungerhilfe will have to employ a water-specialized contractor for design and implementation of the water supply facilities. The District Council in Waterloo will be included in the assessments and planning phase. In parallel a broad based awareness raising campaign (ENFORAC) on the importance of maintaining WAPFR for the water supply of Freetown addressing urban dwellers and high ranking political decision makers will be carried out.

1.1 Context of the Study

The five-year "Conservation of the Sierra Leone Western Area Peninsula Forest Reserve (WAPFR)" Project has commenced its operation in the second quarter of 2009. It is implemented by the Welthungerhilfe and the Environmental Forum for Action (ENFORAC) of Sierra Leone. The project which has a total funding volume of EUR 3,1 million is jointly funded by the EC (80%) and Welthungerhilfe (20%).

In order to achieve its objective to conserve and manage the Western Area Peninsula Forest Reserve (WAPFR) and its watershed in a sustainable manner, for the benefit of the adjacent population (approximately 1.5 Million people are living on the Peninsula and 50,000 people living in 30 villages around), the project aims to achieve the following results: (i) the WAPFR is newly demarcated and zonal management plans are established; (ii) local communities around the Forest Reserve participate actively and benefit from services rendered through the reserve and additional programmes; (iii) innovative, pro-poor financing mechanisms for forest conservation are piloted, such as carbon finance programme (REDD, avoided deforestation) and private business enhancement for ecotourism.

The provision of quality and affordable water supply to some of the communities within the forest area is one of the activities of this project. This could only be implemented when the communities are assessed to have a clear picture of their water supply situation.
It is no gain say that water requirement of communities are felt needs. However, for every community requiring water, a needs assessment should be undertaken to determine the type of source water for the community. The assessment should also provide information on cost benefit of the type of source water compared to other water source systems as well as a fair estimate of cost of the water project. Once these are verified and determined to be worthy of support, a plan to undertake the water project should be put in place and such plan is implemented.
River Number 2 Community was requesting in writing of WAPFR project support to the installment and improvement of their water supply. The demand was deemed positive by the co-management component 2 of the WAPFR project. It was decided to send a consultant to elaborate the real situation for water supply in River number 2 to define a sustainable implementation plan. However, it has become apparent that a much wider study is required for the WAPFOR project as subsumed in the project document. This study will now cover 10 communities situated in three clusters, within the project area.

1.2 Overall Project objective

The overall objective of the action is to support the introduction and establishment of participatory processes in decision making on the use of natural resources in the Western Area Peninsula. Environmentally sustainable and effective use of natural resources and pro-poor sustainable growth will be achieved. Environmental sustainability is a cross cutting issue in the PRSP and recognized as a key challenge for addressing poverty.

Stakeholders from civil society as well as from government agencies at all levels are integrated and their competences strengthened. Serious capacity constraints in nearly all Ministries, Departments and Agencies and local councils are considered a main challenge putting the Poverty Reduction Strategy (PRS) into practice.

Efficient, equitable and effective mechanisms for the management of natural resources are established. The target population is engaged in alternative income generating activities (e.g. agroforestry, horticulture, ecotourism). Productivity is improved while keeping the natural resource stock intact, as low productivity, unsustainable farming practices and increasing demand for fuel-wood and charcoal in urban areas have contributed to deforestation and high levels of soil degradation.

Deforestation, which was more than triple the sub-Saharan Africa average in the period 1990-2000, is slowed down and sustainable forest management is introduced. Renewable natural resources (agriculture, fisheries and forestry) contribute over 50% of GDP and support the livelihood of 75% of the country's population. However, current trends of widespread environmental degradation, resource depletion and low agricultural output highlight a need to ensure that Sierra Leone's natural endowment delivers high productivity and economic growth without jeopardizing the base of living.

Young men and women in rural and urban areas talk of a sense of marginalisation, which stems from traditional hierarchies based on age, negative perception of young people after the war and lack of jobs. Furthermore, cultural traditions tend to promote unequal gender relations. Hence, the Action aims on the improvement of the position of youth and women.

1.3 Objective of this study

The specific objectives of this study are:

- To undertake a water needs assessment in nine communities in WAPFoR
- To engage communities in dialogue on the nexus between forest and availability of water
- To prepare a report which include the water situation in the nine communities, and a plan for water project implementation in these communities

1.4 Research Questions

This study seeks to answer the following research questions.

a) Is the source water an ideal one for the community?
b) Is the source water protected?
c) Can the source water be available all year round?
d) Is damming the most appropriate?
e) What type of distribution is required to ensure all members of the community access the water points?
f) What is the real cost of the project?
g) What cost can be borne by WAPFR?
h) Is there a potential for an alternative?

1.5 Study output

Deliverables

The required deliverables of the study are therefore:

1. Presentation of draft report to co-management group 2 of WAPFR project
2. Assessment report combined with an implementation plan for individual communities

1.6 Structure of the report

The report is structured along the following lines. An introduction highlighting some details of the project including the objectives from which this research was borne. The introduction contextualized the study and detailed its objectives as well as the research questions and the study output. Following the introduction is the methodology adopted by the research. The method dwells on the procedure adopted by the research team to harness the data and a synthesised literature review follows methodology. Next to follow are the analyses, results and discussion of the compiled data, from which conclusions and recommendations are adduced. There is an annex section in which materials that requires further readings is placed.

2 Desk review

2.1 Sierra Leone's Water Situation

Sierra Leone is part of the global system. It situated on the West Coast of Africa, along the equator which hosts one of the world's biodiversity and ecological systems. Sierra Leone is an ecological hotspot due to the threat posed to the country's largest tropical rainforest –the Gola Forest - that make up the Upper Guinea Forest. The country has lost significant area of forest to deforestation due to human activities. The country ranks 35 out of 48 in the African region's water poverty index with an index of 40.[2] Sierra Leone also ranked last in Africa in the 2002 Environmental Sustainability Index.[3] This indicates that the exploitation of the country's natural resources including water is not well planned, coordinated, and governed in such a way that should support future generations.

a) Surface Water

Sierra Leone shares several river basins with neighbouring countries. Rivers such as the Kolente (Great Scarcies) and the Kaba with Guinea, the Mano with Liberia, and the Moa with Guinea and Liberia. The inflows into Sierra Leone from these transnational watercourses are considered negligible. Sierra Leone is a member of the Mano River Union, a regional body whose activities impact on agriculture and rural development.[4]

Nine major rivers drain the country these are the Rokel/Seli, Pampana/Jong, Sewa, Waanje and the Coastal Streams and Creeks that originate from within the country. The rest are the Great and Little Scarcies and Moa Rivers that originate from the Fouta Jallon Plataeu in the Republic of Guinea, and the Mano River that originates from the Republic of Liberia. These rivers range in length from 160 km for the Great Scarcies to 430 km for the Sewa River and in area from 2,530 km^2 for the coastal streams and creeks to 14,140 km2 for the Sewa River. The monthly runoff for the river basins follows the variability of the rainfall. The total mean annual runoff from the river basins is of the order of 160 km^3.[5]

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[2] World Resource Institute, Natural Environment Research Council, Centre for Ecology and Hydrology 2002

[3] UN-Water/Africa. African Water Development Report 2006.

[4] FAO, 2005. Irrigation in Africa in figures – AQUASTAT Survey

[5] United Nations Economic Commission for Africa,. Water Supply and Sanitation Policy for Sierra Leone March 2007.

Table 2.1: Water availability information for Sierra Leone

Country	Population Millions	Precipitation rate mm/yr	TARWR Volume 2005 Km^2/yr	TARWR Per capita 2000 m^3/yr	TARWR Per capita 2005 m^3/yr	Surface water % TARWR	Ground water % TARWR	Overlap % TARWR	Incoming waters % TARWR	Out-going waters % TARWR	Total use % TARWR
Sierra Leone	5.16	2,500	160	36,322	30,960	94%	31%	25%	0%	0%	0.2%

Source: FAO – AQUASTAT, 2005. TARWR= Total Actual Renewable Water Resources[6]

b. Groundwater

Most of the country is underlain by Precambrian crystalline formations, which have no primary porosity. Groundwater accumulation therefore occurs in fractures, joints, and fissures. The aquifers are therefore not continuous but disjointed.[7] Internally produced ground water estimates at $50km^3$ annually and much of this (80%) overlaps between surface and ground water.[8]

2.2 Water use

Total water withdrawal in the year 2000 was estimated to be 379.9 million m^3. Irrigation is the major water user, with a withdrawal of 353.6 million m^3 in 2000, followed by the domestic sector with 19.6 million m^3 and industry with 6.7 million m3. About 80 percent of the rural population obtains its water from surface sources, including many streams and ponds. Groundwater is used for a limited number of rural wells and recent installations for large cities. A number of provincial towns enjoy pipe- borne treated water.[9]

2.3 Water Resources Problems and Governance Structure

Sierra Leone is endowed with vast water resources consisting of both surface and groundwater resources. However, these resources are unevenly distributed in space and time. In the dry season in particular, they are inadequate to meet the country's needs. The resources are also threatened with rapid population growth, increased industrial activities, environmental degradation causing soil erosion, drainage of wetlands and pollution of rivers.[10] Food security and climate change and variations are also causal effects on water resources. Also knowledge about the resource is inadequate. Another potential threat for water resources is the rapid increase in the number of mining companies in the country whose activities, particularly processing ores will impact water uptake and use.

The Ministry of Energy and Power now Ministry of Energy and Water Resources is charged with the responsibility of addressing water issues in Sierra Leone. While this is so, there are also many players affecting water issues and very little coordination exists between these players. This gives the impression

[6] TARWR is an index that reflects the water resources theoretically available for development from all sources within a country. It is a calculated volume expressed in km^3/year. When divided by the country's population and adjusted to m^3/year the per capita volume is derived.

[7] United Nations Economic Commission for Africa, "Water Supply and Sanitation Policy for Sierra Leone," March 2007.

[8] FAO, Irrigation in Africa in figures – AQUASTAT Survey, 2005.

[9] Ibid.

[10] United Nations Economic Commission for Africa, "Water Supply and Sanitation Policy for Sierra Leone," March 2007.

that there is no central body responsible for the management of the water resources towards meeting the needs of socio-economic development and those of the environment. Posing a critical challenge is the fact that the existing laws and regulations are scattered in different enactments.[11]

a. Ministry of Energy and Water Resources

The ministry is responsible for the Water Energy and Power Sectors. Together with the Ministry of Health and Sanitation, it is responsible for Water Supply and Sanitation. It is therefore responsible for formulating policies and plans, their co-ordination, monitoring and evaluation to achieve the government's development objectives in the water and sanitation sector.

b. Guma Valley Water Company

It is a parastatal established in 1961 by an Act of Parliament, and is responsible for the water supply of the city of Freetown and its environs. It operates under the Ministry of Energy and Water Resources. It has power to control water abstraction and pollution in the catchment upstream its water sources. It is also expected to be self-financing.

c. Water Supply Division of Ministry of Energy and Water

This division covers urban and rural areas outside the areas served by the GVWC. It operations are guided by the Water Supply and Control Act of 1963. Hence it has power to control water abstraction and pollution in the catchment behind its water supply sources.

d. Sierra Leone Water Company

With the growth in urban and rural settlement and the transfer of the Water Supply Division from the Ministry of Works, to the Ministry of Energy and Water Resources, it became clear that a new organization was required to meet the needs of the growing population. The Sierra Leone Water Company (SALWACO) was therefore established in 2001 to be responsible for urban water supplies in the whole of Sierra Leone outside the jurisdiction of the Guma Valley Water Co. It is also under the Ministry of Energy and Water Resources. Like the GVWC, it has power to control water abstraction and pollution in the catchments from which it takes water for its supply areas. The water supply systems under its control are expected to be self-financing.

e. Land and Water Development Division

This is under the Ministry of Agriculture, Forestry and Food Security. Its functions include improving the conservation and effective use of land and water resources and provide agro-climatic data for sustained agricultural production; carrying out land evaluation for classification of inland valley swamps and other ecologies for suitability in irrigated rice production; developing a national irrigation and drainage programme to reduce the dependency on rain fed agriculture and collecting data on surface, and groundwater resources.

[11] Ibid.

2.4 Household Water Analysis for Sierra Leone

Literature and documentation on water studies for rural western area is scarce. This would mean that little or no work has been done on water availability and management in Rural Western Area.

According to statistical report from Statistic Sierra Leone, 88% households nationwide spend less than 30 minutes reaching nearest drinking water source, with urban households having 87.4% access while rural households have 88.4% access. [12] The Statistics Sierra Leone further reports that 26.7% of households in Sierra Leone had access to pipe borne water, 22.8% of households used surface water as their main source of drinking water, 17.7% used protected well/spring, 18.4% used unprotected well/spring.[13]

Green Scenery and Development Technology Centre associated with the Dublin Institute of Technology in 2009 undertook a collaborative research on household water management in Sierra Leone. The report revealed that access to improved drinking water is 52% for the whole country, 85% urban for areas, and 32% for rural areas. The report further depicted that only 57% of households have access to improved water and adequate sanitation in urban areas, while only 10% of households have similar facilities at the rural level.[14]

2.5 Water in Western Rural District

In the Western Rural District 73.9% of households spend less than 15 minutes to reach nearest drinking water source, 16.4% takes 15 to 29 minutes to reach drinking water source and 7% takes 30 to 59 minutes to reach drinking water source.[15] Statistics further show for Western Rural District that 10.3% households received their main source of drinking water through pipe into homes, 40.1% received water through public tap, 30.1% access water from protected well/spring, and 6.9% has their main source of drinking water from surface water.[16]

3 Methodology and Data Analysis

The methodology used for this study began with a discussing and developing the terms of reference (TOR) agreeable to the researcher and the WAPFoR project (see annex for details of TOR). Following this was a desk review or literature review on water issues for Sierra Leone (see in-text review) and community visitation. From this and other sources, selection criteria were developed to assist the researcher to select the nine communities from among a total of twelve proposed for the research. The nine communities were selected based on the following selection criteria:

- Geographical position of the communities in set clusters within the forest area provided to the researcher, i.e. consideration given to the mountain region, the coastal communities, and the mid section of the peninsula forest.
- The review of the PRLA and other documents
- Personal request from community heads for support
- Field report from entry point meetings by the researchers to the twelve communities

[12] Statistics Sierra Leone, "Core Welfare Indicator Questionnaire Survey (CWIQ)," November 2007.
[13] Ibid
[14] Green Scenery and Development Technology Centre,
[15] Ibid
[16] Ibid

3.1 Community Visitation

An entry point meeting to engage the communities was designed and carried out. This meeting was to familiarize the research team with the communities and sensitize the communities about the purpose of the research. It also allowed the researchers using the selection criteria to select the nine communities as explained above.

3.2 Data Collection

Data collected were from four sources:

- Desk review
- Questionnaire administration and observation
- Yield and water quality assessment
- Focus group discussion

A) Desk Review

Amongst the key information collected during desk review, one was the current estimated population growth rate of 2011 for Sierra Leone (www.ciasourcebookfact.com). This is estimated at 2.25 and this information was used to calculate future population projection using the geometric progression method: $p_f = p_p(1+r)^n$ where p_f is the future population, p_p is the present population, **r** is the population growth rate and *n* is the design life period. Geometric progression method is the most widely known empirical method used as suggested by Hardenberg (Ahmed and Rahman: 2003). In addition to future population calculation from information gathered from desk review, present population for each community was calculated from information collected on national average household size from 2004 population census report and the number of households in each community. This information and ones collected such as per capita consumption from Ahmed and Rahman, 2003 and Smet et al 1999 supported in the calculation of the present water demand from the equation:
$Q_d = p_f x q$ where Q_d is the daily quantity of water demanded, p_f is the present population of the community and *q* is the rate of water consumption per capita per day.

B) Questionnaire design and administration

A structured questionnaire was designed and submitted to the client for comments , which was later reviewed by authors and data collectors. The reviewed questionnaires administered for all the communities using sample size of 10 per community. Questionnaire administration in the study area took the following pattern; a random manner such that after interviewing the first household, the interviewer jumps the second in that row and interview to the third and so on. Household heads were the main target, however, if a household head is not around, then the next elderly person was considered.

C). Yield and Water Quality Assessment

i. Yield Assessment

The water yield assessment was conducted for communities with river or stream as their water sources.

The assessment started with a visit to the stream, GPS coordinates and elevations were noted. Stream flows assessment involved measuring the discharge and stage of a particular stream using floats. This is the simplest and inexpensive method but not very accurate due to external factors such as surface wind flow, channel morphology and the type of floats used. The process involves the measuring of the velocity of a stream and the cross sectional area of the channel using floats, stopwatch, measuring tape and poles. The process began with measuring a straight section of a channel of about ten (10) metres (or more) marked by two measuring poles. Three different floats at different times are released on the surface of the stream and the time taken to reach the ten (10) metres end is noted. This is repeated for two or three times for each float, noting times in a field note book and later calculating the average time. Using this information the stream velocities were determined using the formula below:
Average Stream Velocity (V m/sec) = (C x Average surface water velocity), where C is the velocity factor that is equal to 0.85 (this factor adequately accounts for both horizontal and vertical variation in the flow velocity within the channel)

Upon completion of the float measurement, the width of the stream is measured at four or more different points within the ten-metre distance earlier measured along the stream. Each width is further subdivided into four equal distances and the depth of the water at each point is measured and noted. This information is used to estimate the cross sectional area of the channel using the trapezium rule:

Area $(m^2) = w[d_1+d_2/2]$, where w, is the width of the stream, and d_1 and d_2 are depths of the stream along the width of measurement. Also GPS coordinates and elevation readings in addition to photographs of particularly water sources were recorded.

ii. Water Quality Assessment

A two days exercise on drinking water quality assessment for nine (9) communities in the conservation of the Sierra Leone Western Area Peninsula Forest Reserve (WAPFR) was undertaken. The nine communities are listed below:-

- Sussex Community:- Two samples were analyzed well No.1 and well No.2
- Big Water:- One sample stream
- Burreh Town:- One sample stream
- Mongegba:- Two samples (i) stream (ii) spring box
- Charlotte:- Two samples (i) stream (ii) water fall
- Madina:- One sample stream
- Macdonald:- One sample stream
- Russel:- One sample spring box
- Koba Water:- One sample stream

The physical, chemical, and bacteriological parameters of each sample were investigated using portable laboratory instruments. These samples were aseptically collected in pre-sterilized sample containers.

a). Physical Analysis

This was done using WAGTECH and HACH portable instrument. The HACH portable conductivity meter (CO150) and PH (EC10) were used to test for water conductivity, Ph, salinity, total dissolved solids (TDS), and temperature. The turbidity meter was used to determine turbidity.

b). Chemical Analysis

For chemical test the INTERFACE PHOTOMETER 7500 and PALLINTEST PHOTOMETER 5000 was used to determine concentrations of some dissolved chemicals, including residual Chlorine, iron, fluoride, nitrate/nitrogen, manganese, etc. and following the test procedures in the water analysis hand book.

c). Bacteriological Analysis

The membrane filtration technique was used to enumerate faecal indicator bacteria using the POTARLAB kit and membrane faecal coliform (m-fe) broth for E-Coli and membrane LAURYL SULPHATES broth for faecal coliform. After mixing for 1min, volumes of the water samples (10ml, 20ml, and 50ml) were measured and filtered through a membrane filter pads with pore size 0.45µm in the pre-sterilized filtration unit assembly. These filter pads trapped any bacteria present, these filter were then placed on top of sterile absorbent pads soaked in membrane-faecal-coliform broth in pre-sterilized petri dishes. The petri dishes were later incubated for 14-18hr in a twin incubator at 44^{o}C for faecal coliform and 37^{o}c for e-coli, in a WAGTECH POTABLE kit after 60min resuscitation period. Faecal coliforms present were identified by the formation of blue colonies on the filter, while non-faecal coliforms formed pink colonies. These colonies were then counted methodically and expressed per 100ml water sample. Non-faecal coliforms were identified by their yellow colonies.

D). Focus group discussion

A checklist and some key questions were designed for focus group discussion with key community members in each of the study community. The key issues highlighted in the checklist were:

- Forest resources and their benefits
- Water availability
- Use and management of water resources
- Environmental degradation

3.3.Data Analysis

Data collection was followed by data processing and analysis using simple descriptive statistics that were presented as tables and charts below.

4. Result and Discussion

4.0 Introduction

The findings and discussion below are based on data collected and observed during the study period. The study critically focused on domestic water uses in the study area although evidence of other water uses such as agricultural, commercial, etc. were discovered. Data are presented as tables, charts to be followed by discussion of key findings for each community and issues identified.

4.1 Socioeconomic and Demographic issues

4.1.1 Demographic Trend

In the table below, the total present population of the study area is 4,996 and the estimated future population (in ten years) will be 6,241 based on calculations as discussed in the methodology. The main implication is that the pressure on the forest resources of the Western Area Peninsula will significantly increase if proper conservation and protection mechanism of the forest resources are not put in place.

Table 4.1.1: Community Demographic Trend

Community	Present Population	Future Population
Charlotte	176	220
Mongegba	812	1014
Madina-Boyoh	1,170	1462
Russel	130	162
Macdonald	650	812
Koba water	104	130
Big water	351	439
Sussex	1200	1499
Bureh Town	403	503
Total	**4,996**	**6241**

4.1.2 Household Head

From the table below, it is evident that more males are family heads (57) than females (29). This shows that women are gradually becoming heads of households with more household responsibility, portending of being divorced, single parent or deceased women. This is better illustrated from the graph on the next page.

Table 4.1.2: Household Heads in Communities

COMMUNITY	Madina	Charlotte	Big Water	Koba Water	Sussex	Bureh Town	Mongegba	Macdonald	Russel	Total Comm. Respondents
Household Head										
Male	6	9	6	8	6	6	6	4	6	57
Female	3	1	4	2	4	4	2	5	4	29
Total Respondents	9	10	10	10	10	10	8	9	10	85

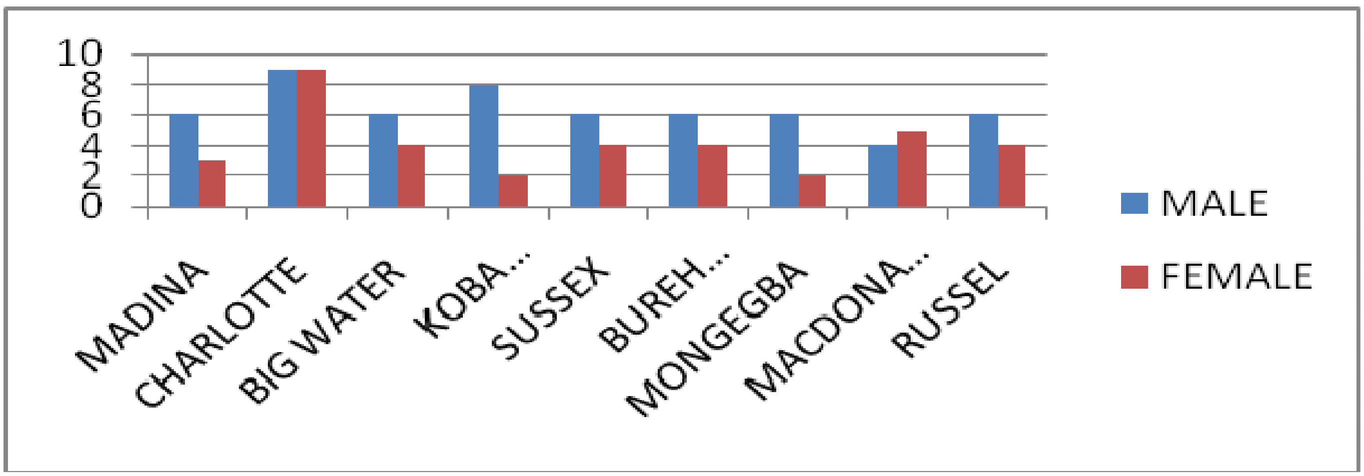


Figure 4.1.2: Graph showing male female household heads per community

4.1.3 Household Head Dependants

Out of total respondents, the dependency on household head ratio is almost equal between (372:369 for male and female respectively) male and female household head as depicted from the table below. Even though there are more male household heads, female household heads appear wielding more responsibility and therefore possible economic burden on the female household heads.

Table 4.1.3: Total dependency on household heads per community

Community	Madina	Charlotte	Big Water	Koba Water	Sussex	Bureh Town	Mongegba	Macdonald	Russel	Total
MALE	32	20	58	61	39	52	38	43	29	372
FEMALE	53	12	43	44	44	46	39	59	29	369

4.1.4 Household Heads Education Level

Table 4.1.4: Educational level of household heads

Community	Madina	Charlotte	Big Water	Koba Water	Sussex	Bureh Town	Mongegba	Macdonlad	Russel	Total
Years of Education										
1 to 5 yrs	0	1	0	7	0	2	0	3	4	17
6 to 10 yrs	1	1	4	2	1	1	4	0	4	18
11 to 15 yrs	4	2	2	0	0	0	1	7	2	18
Above 15yrs	2	3	0	0	4	4	0	0	0	13

This parameter serves as an indicator of the educational status of each community. From the data analysed, more respondents fall between the educational level category of 6-15 years, indicating secondary level education and a small above 15 years, indicating tertiary level of education. However a significant number fall within the primary education level. This means the potential for sustainable economic development in the communities could be slow if capacity development is not enhanced (See table or graph below).

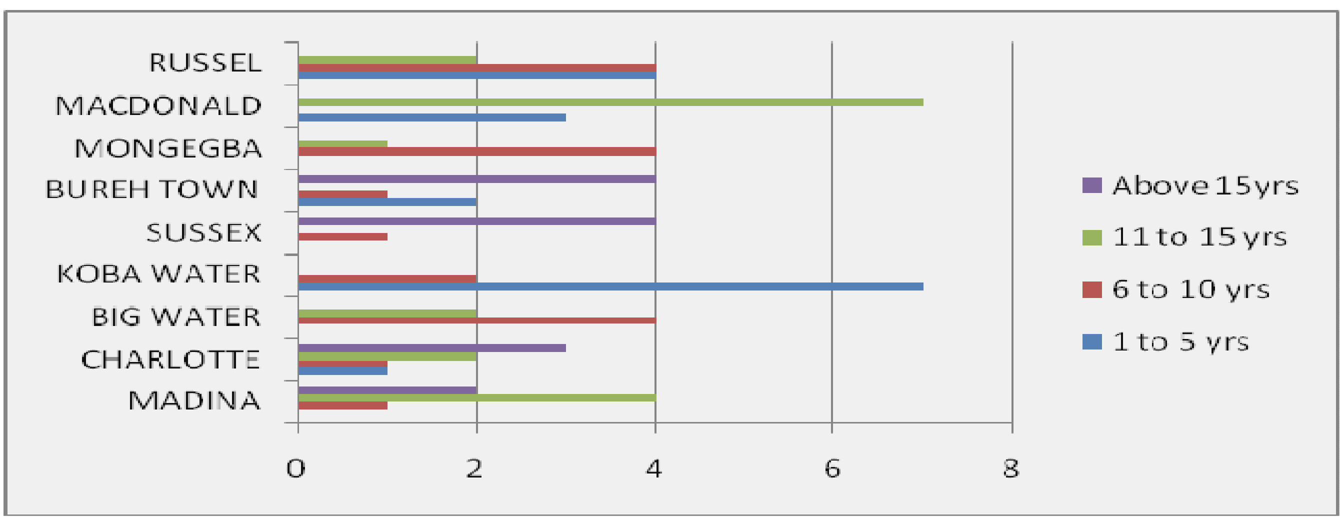


Figure 4.1.4 Graph showing level of schooling in each community

4.1.5 Occupational and Income Status

From the table below, it is evident that there are more farmers (27) and small petty traders (20) than other forms of occupation in these communities, which provide bulk of the income (30 and 23 for farming and petty trading respectively). In fact monthly incomes of the communities do not exceed SLL 100,000.00, whilst remittances do not play significantly to support community members, and even access to loan is almost non-existent. This resonates with the argument on the level of education above and also implies that poverty in the communities abound, concomitantly indicating that there is high pressure on the natural forest resources with the tendency to increase if the present situation is not reversed, hence impacting negatively on the availability of water resources in the Western Area Peninsula Forest.

Table 4.1.5: Occupation

COMM	MADINAA	CHARLOTTE	BIG WATER	KABA WATER	SUSSEX	BUREH TOWN	MONGEGBA	MACDONALD	RUSSEL
SALARY WORK	0	3	1	0	1	3	1	1	3
FARMING ACTIVITIES	0	4	0	10	0	5	8	1	2
PETTY TRADING	6	0	1	0	3	4	1	5	3
PENSION/ALLOWANCE	0	2	0	0	0	0	0	0	1
CASUAL LABOUR	0	1	0	0	0	0	0	0	1
FISHING ACTIVITIES	2	0	1	0	1	0	0	0	0
PRIVATE BUSINESS	0	0	0	0	0	0	0	1	0
RENT FEES	0	0	0	0	0	0	0	0	0

4.2 Water Source and Availability

4.2.1 Water Sources

There exists water in various forms in all of the communities in the study area. Below are the sources water identified by community**.** In the study area, all water wells identified except for the ones in Sussex are dried and the mechanical pumps are not functional. For the pipe borne water, Sussex is the only community with functional system even though it is well below capacity. It is functional because it is the only source of water for domestic consumptions as the water wells are not good. The two spring boxes identified in Mongegba and Koba Water communities are dilapidated, disuse and unprotected. However, they could be rehabilitated. Specifically for Charlotte community, even though three water sources were identified, only the unprotected spring is used by the community. A pipe borne system is observed in Charlotte but is not functioning at all and the stream and water falls are not used for drinking but for other domestic and agricultural purposes.


Picture 1: *Madina water source. Photo: Joseph Rahall*

In all the communities, streams and rivers were identified as the major source of water for all their uses, and all of the stream flows from the forest and empty into the Atlantic Ocean. Most of the streams flow with low velocity but are running throughout the year. The channel morphology of all the streams is made up of granitic bedrock in all the section of the channel. For most of the streams, heavy human activities such as brushing for farming, charcoal production, wood cutting, and construction were observed. Specifically for Ajai Water in Madina-Boyoh axis, a landslide that occurred in the past at the upstream of the river causes heavy colouration and turbidity of the river during the rainy season, making it unfit for domestic uses. However, in the dry season, the communities heavily depend on this stream.

Rainwater harvesting was identified by respondents as one of the sources of water to all the communities but is only available during the rainy season. However, respondents prefer this source of water for drinking purpose to other sources when available.

In the case of water shortage, all respondents say they experience water shortage in the months of January to April, when the stream flow reduces and some even dry up, for example in the case of Charlotte.

Table 4.2.1a: Water Sources identified in each community

Water Source / Community	Stream/River	Spring	Wells	Pipe Borne	Spring Box	Rainwater Harvesting
Madina-Boyoh	X (N8^0 13' 36.46") (W13^{0}05'31.87")		x Not functional			x
Charlotte	x	x (N8^0 25'31.18") (W13^0 11'33.52")		X		x
Big water	x (N8^0 17'15.27") (W13^0 09'22.41")					x
Koba water	x (N8^0 17'23.22") (W13^0 05'30.20")				x	x
Sussex			x Used for other purposes	x		x
Bureh Town	x (N8^0 12'00.17") (W13^0 09'14.35")		x Not functional	x		x
Mongegba	x (N8^0 24'18.07") (W13^0 10'37.21")	x (N80 13'35.87'') (W130 10'31.07'')			x	x
Macdonald	x (N8^0 16'44.26") (W13^0 04'57.71")		x Not functional			x
Russell	x Dam is situated on the stream see dam reading			x(dam site) (N8^0 14'23.22") (W13^0 05'28.19")		x

Type of water source = x, GPS coordinates are in bracket

Table4.2.1b: Human Activities around Streams/Rivers

Human Activities at Streams / Community	Charcoal production	Farming	Wood Cutting	Construction	Stone Mining	Others
Madina-Boyoh			x	x		x
Charlotte	x	x	x			
Big water		x	x			
Koba water	x	x	x			
Bureh Town		x	x			
Mongegba	x	x	x		x	
Macdonald	x	x	x			
Russell	x	x	x			

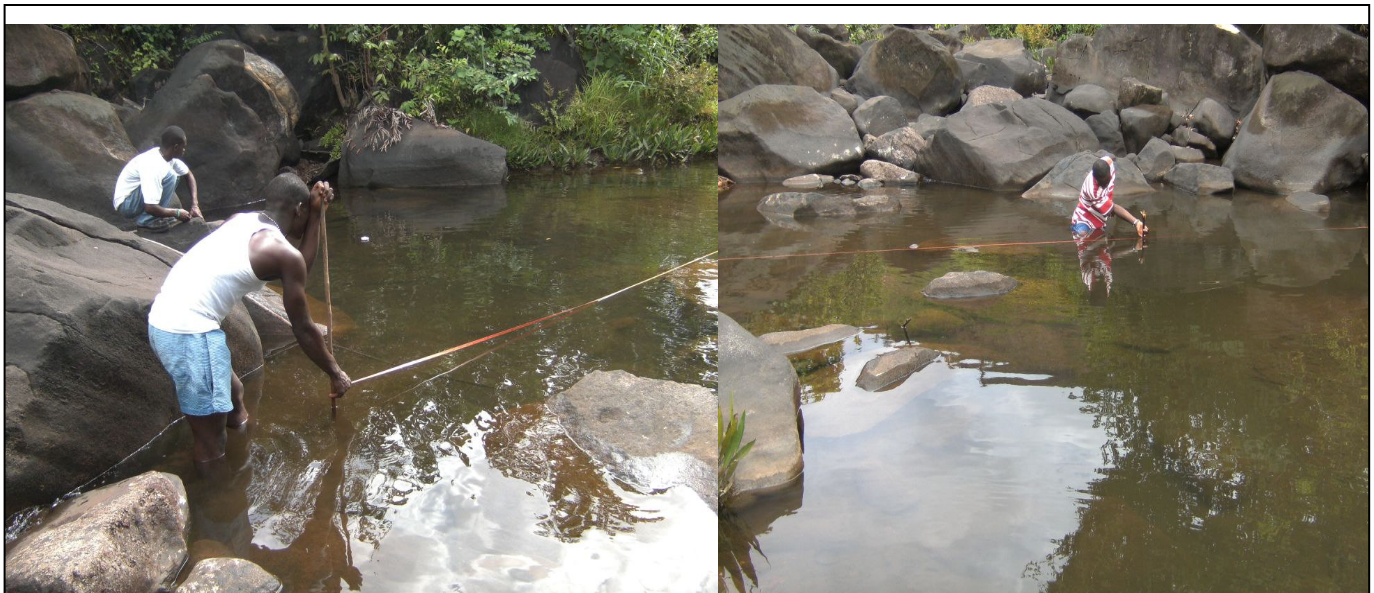
Picture 2: Charcoal production in Charlotte. Photo: Joseph

4.2.2 Water Yield Assessment

Rudimentary water yield assessed in the following communities below show high yield for all streams. The plausible explanation for such high yield observed is that the origins of the streams lie in the heart of the pristine forest. Hence current human activities along the mid and down sections of the streams do not drastically affect the flow, but the danger lies in the future if trends extend to the source of these streams. For Russell and Charlotte, there was no suitable site along the streams for such rudimentary yield assessment.

Table 4.2.2: Water Yield of Streams in Communities

Community	Name of Stream/River	Discharge (Litres/sec)	Elevation point (m)	GPS Coordinate
Mongegba		62898.8	70m	N8^0 24’ 18.07”
Madina-Boyoh	Ajai Water	7787.6	36m	N8^0 13’ 36.46” W13^0 05’31.87”
Koba water-Macdonald		36075	24m	N 8^o 16’44.26” W 13^0 04’57.71”
Bigwater	Whale River	37861.3		
Bureh Town	Yanneh water	39496	42m	N 8^0 12’00.17’’ W 13^o 09’14.35”



Picture 3: Measuring Water Yield: Photo Joseph Rahall

4.3 Water use, Demand and Consumption

4.3.1 Water Uses

From questionnaire administration and focus group discussion and analysis, the following uses of water are identified for all of the communities:

- Domestic uses (drinking, laundry, bathing, etc)
- Agricultural uses
- Development uses (construction)

Domestic and agricultural uses are the most predominant of all the uses with an estimated average volume between 110-510 litres per day for domestic purposes alone (***see table above).*** It was identified in this study that a lot of plastics and bottled water are brought into these communities (especially Bureh town with her natural beaches) for commercial purposes but the communities derive little benefits from the sales of the water sold in these communities. Furthermore, they also leave huge pollution burden on the communities and the environment in the form of plastics left discarded discriminately on the beaches and in the communities. It will be beneficial if some of the communities are supported to produce and market their own water, which will guarantee income generation, employment, and support conservation efforts of the Western Area peninsula Forest. It was also observe that some property developers usually extract water from these communities with their bowsers and nothing is provided to support the development of the communities and the conservation of the western area peninsula forest directly.

4.3.2 Water Demand and Consumption Pattern

Based on water yield assessed in table 4.2.2 above, total daily available water for use is estimated for some of the communities with stream and is presented in table 4.2.2 below. One percent (1%) of discharge per stream of communities as indicated in table 4.2.2 is used to estimate the daily flow availability for an eight-hour-a-day water demand. Result shows that there is enough water available for domestic consumption for all communities accommodating even multiple tap water system in each household than the present and future daily demands. This can only hold true however if the water catchment sources are not tampered with. Therfore every effort to conserve and protect the Western Area Peninsula Forest is required

Table 4.2.2 : Water Yield and Consumption Pattern in Communities

Community	Total Daily flow Available (Litres)	Present Daily Demand (Litres)	Future Daily Demand (Litres)
Charlotte		7040	11,000
Mongegba	18,114,854	32480	48,672
Madina-Boyoh	2,242,824	46800	70,176
Russel		5200	8100
Koba Water-Macdonald	10,389,600	33,644	50438
Big water	10,904.05	14040	21072
Sussex		55,200	86193
Bureh Town	11,274,848	18538	27766

4.4 Water Quality and Treatment process

4.4.1 Water Quality Parameter

From the water quality assessment of the streams and analyses, it is evident that the physical and chemical analyses indicate that most of the streams were found within the WHO recommended value. But however, bacteriological analysis shows that all the sources were contaminated with faecal coliform and Escherichia Coli (E.coli). This means some level of treatment is required for the streams to fit as potable and safe water for drinking and other domestic purposes (for detail analyses see table in annex)

4.4.2 Treatment of Drinking Water at Community Level

Since most of the water sources observed are raw water and quality analysis shows that the physical and chemical parameters are within the recommended WHO value, responses from communities also show that the water do not undergo any form of treatment before it is used for all domestic purposes. Even though high percentage (61%) of the respondent agreed that water is unsafe to drink without treatment, yet statistics show that water used is untreated because of the following reasons:

- None existent of habit of treating water before use
- Lack of awareness and possible lack of hygiene skills
- Possible the high cost of treatment

The plausible implication here is that the communities are exposed to water borne and related diseases, likely affecting their economic and reproductive activities. Whilst the study did not look in depth at the incidence and disease burden associated with the quality of the streams used for domestic purposes , 6% of the respondents revealed that diarrhea occurred within ten (days) before data was collected. Also according to respondents, the frequency of diarrhea is between 2-3 days.

4.5 Water Access

4.5.1 Distance and Frequency of Collection

Table 4.5.1: Distance in time from home to water source

COMM	MADINA	CHARLOTTE	BIG WATER	KABA WATER	SUSSEX	BUREH TOWN	MONGEGBA	MACDONALD	RUSSEL
Time									
0-5 MN	0	0	0	0	0	5	4	4	2
6-10MIN	5	3	0	10	0	0	0	4	3
11-15MIN									
20 MIN above	4	3	10	0	10	5	6		5

Data analysed show that 51.8%, 30.1% and 18.1% of the respondents walk 20 minutes and above, 6-10 minutes and under 5 minutes respectively to fetch water from sources. For the number of times water is collected, data show that 84.9% of respondents collect water five times a day, 12.8% collects water 6-10 times in a day and only 2.35 collect 20 times and above. Data also shows that 50.6% 34.8% and 14.6% spend 11-15 minutes, 6-10 minutes and less than five times respectively to collect water.

Taking that the average human walking speed per mile is 20 minutes (all factors being equal), it could be inferred from the data that a large proportion of respondents spend about three hours per day collecting water (this include distance to water source and time spend at source) alone. Although spending some time at water source may have some psychological and community cohesive benefits, yet it appears that significant productive time per day is lost in water collection alone. Should school children are involved in the collection of water, this will surely affect their attendance and academic concentration in schools, hence resulting to low academic performance. The broad implication of such situation is that it prolongs the overdependence and exploitation of forest resources, hinders current and future community development, and finally, reinforces poverty.

4.5.2 Time of Day water is Collected

Table 4.5.2: Water Collection Times of Day

COMM	MADINA	CHARLOTTE	BIG WATER	KOBA WATER	SUSSEX	BUREH TOWN	MONGEGBA	MACDONALD	RUSSEL	TOTAL
6AM-12 NOON	7	8	10	10	0	9	7	9	10	70
1PM-6PM	0	1	0	0	0	0	0	0	0	1
7PM-1AM	0	0	0	0	1	1	2	0	0	4
1AM AND AFTER	2	0	0	0	8	0	1	0	0	11

Eighty one point four percent (81.4% of) respondents collect water between the hours of 6am – 12 noon and 12.8% collect water 1am and after. Analysis shows that there is correlation between this and the previous discussion above because during the peak hour (6am-12 noon), water source may tend to be overcrowded. Furthermore, waking early in the morning to fetch water especially school going children may encounter hazards such as snakes and other dangerous animals along the way and even at water source. In addition, individual performance at schools, work and business places will be affected through sickness, fatigue and loss of concentration due to the early rise to fetch water. For Sussex in particular, all respondents fetch water between 7pm to after 1 am. This is because there is only one functional pipe borne water servicing a high population, and it is only during this period that pressure is high enough to bring water from the nearby Guma Valley system to the community.

4.5.3 Gender, Security and Privacy

Table 4.5.3: Gender Consideration in Colleting Water

COMM	MADINA	CHARLOTTE	BIG WATER	KABA WATER	SUSSEX	BUREH TOWN	MONGEGBA	MACDONALD	RUSSEL
Category									
WOMEN	3	0	0	2	3	1	0	0	6
MEN	0	3	2	0	0	0	1	0	1
GIRLS ONLY	1	0	1	0	0	0	0	1	1
BOYS	1	4	0	1	0	2	0	1	0
BOY AND GIRLS	5	3	6	7	6	7	7	8	2
WATER VENDOR	0	0	0	0	1	0	0	0	0

Gender analysis shows that individually, water is collected more by women (17.24%) to be followed by boys (10.3%) and men (8.05%). A high percentage of women in water collection reinforce the perception of the traditional role of women in the family unit. A high percentage (73.56%) of water collected by children (boys, girls and boys and girls combined) is revealed.

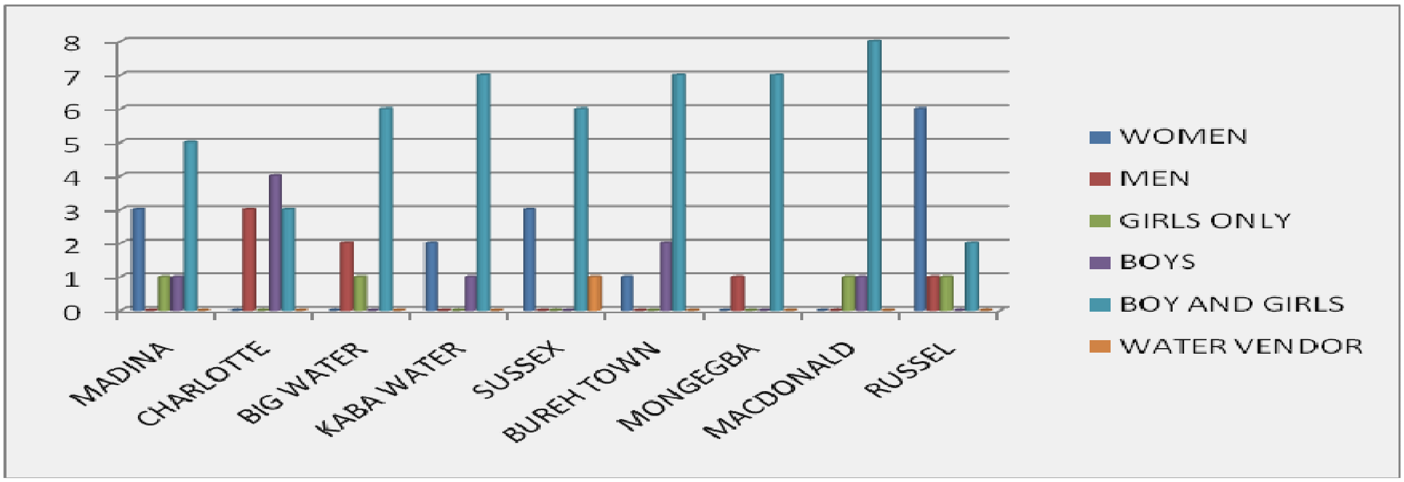


Figure 4.5.3a: Graph showing who collects water in the home in each community

Analyses show a gradual increase for boys and men fetching water, indicating a shift in perception that may be influenced by awareness in gender and human rights issues. The high percentage of boys and girls fetching water may be interpreted as a positive trend against gender discrimination at that level, however, the drawback of this is that children's schooling and healthy growth are likely to be affected, with possible implication that the future of the children and the future of the community will be at stake.

For hazard analysis, all respondents (100%) say there is occurrence of various forms of hazards along and at the water source. The following were the hazards identified:

- Snakes (60%)
- Road accident (22.5%)
- Flies (17.5%)

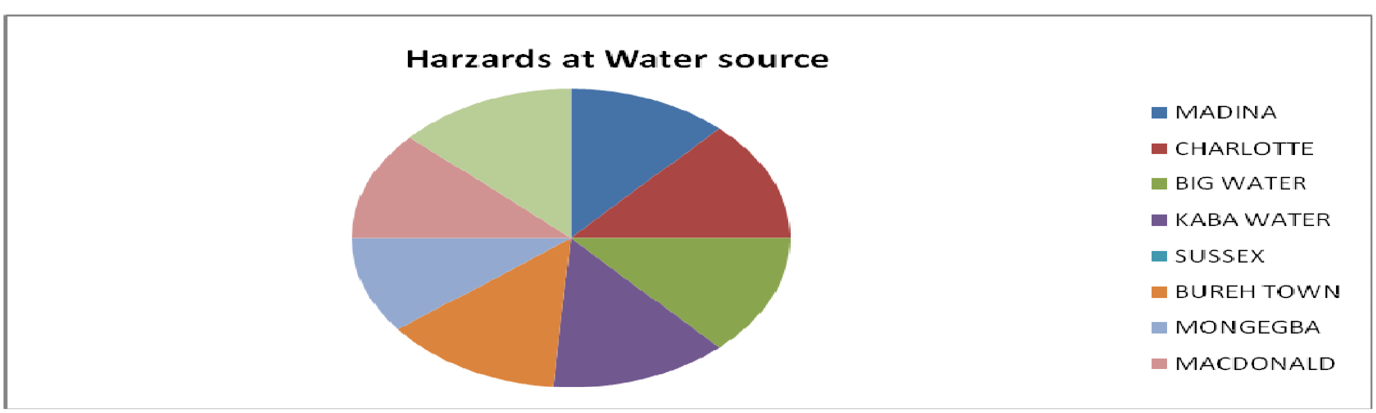


Figure 4.5.3b: Pie chart showing all respondent confirming that there is hazard at water source

This shows that there is high probability of encountering snakes when fetching water late at night, involving walking long distances in bush. Similarly, it was also observed that most communities in the study area lie close to highways. Crossing these highways to fetch water could lead to road accidents.
For the aspect of privacy, 92.8% of the respondents claim that both men and women bathe at the same water source, indicating little privacy. This leaves the women with little or no space for heartfelt private discussion. Furthermore, there is high potential for cases of rape although the study did not cover this aspect

4.6 Sanitation and Hygiene

4.6.1 Sanitation Facilities

Respondents were asked about the availability of sanitation facilities in their households and communities to which 56.2% responses were positive and 43.8% were negative. Such high negative responses tend to indicate big hygiene danger in most of the study communities. Quite a large number of people are without access to any form of sanitation facilities, which means they indulge in open free defecation (ODF), whereby some of it will end into the adjacent stream directly or indirectly, possibly responsible for the presence of faecal coliform observed in the water quality result. In fact one community in particular, Koba Water, does not have any form of sanitation facility due largely to the rocky nature of the ground that poses difficulty for digging of pit as observed. Here in general, open free defecation is rampant and nothing is done by the community, government or even by NGOs to address this problem. Infact responses to the question of the type of sanitation facilities in communities, show high responses (53.48%) for traditional pit latrines and 33.72% for open free defecation. This tends to reinforce the argument above.

About conditions of the latrines, all the respondents agreed that flies, odour and littered faeces are found around the drophole and the superstructure, thus supporting the discussion above and the possible unhygienic conditions of most of the communities. In fact the littering with faeces around the drop hole and the superstructure could be due to the use of the same toilet by both adult and children as indicated by 63.01% of the respondents. Such conditions are recipe for the possible prevalence of water borne and related diseases such as cholera, diarrhoea, dysentry and malaria.

4.6.2 Hygiene and Treatment Intervention

Responses about washing of hands after use of toilet show that 45.46% wash their hands after use of toilet and 54.54% do not. Those who wash their hands after use of toilet were further asked whether they use only water or water and soap, 76.47% responded that they use both water and soap. While among this group hygiene awareness may be understood and inculcated, it could be inferred thata a large percentage of the population of the communities continue with unhygienic behaviour scaling up the argument in section 4.6.1, hence increasing the health risks in the communities.

The other issue that the study superficially looked at was the form of treatment intervention sorted and the cost borne by communities infected with water borne and related diseases. To this, responses were not very clear and outright, and therefore no concrete discussion can be made on this and therefore would require further investigation.

4.7 Management, Operation and Maintenance

Picture 4: Communities engaged in focus group discussion. Photo: Joseph Rahall

Issues of community water supply management were covered during the focus group discussion with communities. Analysis of the focus group discussion shows the following:

- Communities understand the importance and benefit of water and it uses
- The linkages between forest and water resources and the hydrological cycle understood
- The causes and effect of environmental degradation discussed
- Measures of reducing environmental degradation for the protection of water resources discussed

Another issue that clearly stood out during the focus group discussion was the lack of operation and maintenance of water infrastructure in most of the communities as evidenced with Sussex tap and wells, the tap water system of Charlotte, the dam and storage facilities of Bureh Town and Russell, and the dilapidated spring boxes of Koba Water and Mongegba. The existing wells of Bureh Town, Madina and Charlotte are dried up and have dysfunctional mechanical pumps. To ensure that any future water facilities provided for the communities are operational and maintained, the communities proposed a shift from the present trend of water facility management by the head to a robust water and sanitation management committee. For the functioning of both the committees and the system, communities are willing to contribute both finance and some form of labour. However, communities suggest that water and sanitation committee members are trained and equipped to undertake their roles and responsibilities.

5.0 Conclusion and Recommendations

The Conclusion and Recommendations are divided into two. A general conclusion, which will answer the research questions based upon the facts from the questionnaire, other field data, perception of communities, and visual observation. Specific conclusions and recommendations pointing to the individual community's water needs, infrastructure and other related issues as they emerged from the study.

5.1.1 General Conclusion

There is ample water in all of the communities in the study. Most of the communities rely on streams and or springs for their water source and all of them have been found contaminated with bacteria, even though all the streams have chemical and physical properties in conformity with WHO standard. The water sources are ideal in terms of quantity and physical and chemical content but will have to be treated for bacteria if they are to used as safe water by the communities.

While most respondents say that their water sources were protected, it was observed that none of the streams were protected in the real sense. The communities with spring boxes equally were observed to be unprotected. All were in fact dilapidated. Except for Sussex that have their water wells unprotected, all other communities (Bureh Town, Madina, and Macdonald) with water wells were observed to be protected even though they were not in working order.

Discharge rate for all the streams calculated were found to have the capacity to be available throughout the year. For those streams that were not calculated due to insufficient water present at source e.g. Russel, Charlotte, and Koba Water, some improvement to the catchment will improve water availability throughout the year.

Damming may not be appropriate in all of the cases. However, trapping the source water into a bowl like structure or loosely laying pipe in the narrow section of the flowing stream can appropriately make water available for other processes like lift pumping, treatment, and other collection and storage means.

In the focus group discussions, all communities showed high preference for a water distribution system that would take water into their homes, short of this multiple standpipes in communities will adequately provide the necessary water in demand.

The real cost of the water project cannot be provided by this study. However, the study provides the basis for a more technical interrogation that will facilitate the calculation of the real cost of the project. Calculating the real cost of the project will help the WAPFoR project determine how much resources is available at its disposal, which it can commit to the water project.

As a final touch to this study, the research lives with the following questions:

- Why is it that the communities are not benefitting from the plentiful water resources in terms of economic production and development?
- Is it that people are deliberately deforesting the forest to access the land resources, forgetting the wider water shortage implication for the future?

Although this study attempted to find answer to these burning questions, it is therefore proposed here that finding final and complete solutions to these questions requires more detailed study.
Is there a potential for an alternative?

5.2 Specific Conclusion and Recommendation

5.2.1 Sussex

Sussex is a coastal lying community and a high percentage of the population is engaged in fishing. Because of the community's proximate location to the Atlantic Ocean, the water wells were observed to be contaminated with a range of chemicals (Fe, Mn, Nitrate-Nitrogen) which is likely to have lead to the increase in pH parameters of these wells. The wells were further observed to be largely unprotected and a causal factor for bacterial contamination. The community has a pipe borne water infrastructure, which is however in a rudimentary condition. The water in this pipe has its origin in the Guma Valley Dam. In one of the sections (Sherbro town) it was revealed to and observed by the researcher that the underlying strata of granitic bed rock makes it impossible to sink any form of water well of bore hole. The only form of water suitable and safe for this community is therefore the pipe borne water from Guma Valley Dam.

Recommendation
Pipe borne water availability should be maintained and improved upon and to scale up water supply to the community it would require WAPFoR to engage the Guma Valley Water Company to determine what it would take to increase availability of water by increasing water collection points in the community and possibly making water available in homes.

5.2.2 Big Water

Big Water is situated along the peninsular route in the far Western axis from Juba. The community is located close to the Whale River passing beneath the whale bridge. The river has its origin deep in the pristine WAPFoR and empties in the Atlantic Ocean. Whale River is the only source of water for Big Water and the population depends on it for water needs throughout the year. The river runs throughout the year and the community access the river just below the Whale Bridge. Yield assessment show that the river is capable of providing the water needs of the community. Focus group revealed that farming is done on a small scale in the forest.
Black Johnson is a community very close to the Big Water community and may benefit from a water project positioned in Big Water. Both communities have a population whose water needs can be met easily according to the yield assessment.

Recommendation

Damming of Whale River is possible only at the upper section of the river. The lower section where the communities access water was found to be high in iron concentration as well as bacterial infestation. Black Johnson should be made to benefit from the water project of Big Water since they are in proximate distances with each other and the river yield can accommodate the water needs of the population of both communities.

5.2.3 Bureh Town

Bureh Town is a coastal village community. Many community members are involved in fishing and a few in farming. Bureh Town is located along the main highway to Kent and has more than one alternative means of accessing water, even though not all of these alternatives are working. There is a water well in Bureh Town but in disuse due to the fact that it is dry and also the mechanical pump dysfunctional. There is also a water pipe structure in the community. This facility is currently out of use because according to community inhabitants, bush fire had destroyed the PVC pipes in the forest and further more the dam that was constructed is no longer yielding the water requirement for the community. A water storage facility apparently supporting the water pipe structure also exists at a higher elevation in the community. This structure is also not in use and the plumbing construction was observed to be inappropriate to accommodate large volume of water should it be intended for use.

At present Bureh town community depends heavily on a stream (Yanneh water) whose upstream was discovered to have enough water with high yield rate. At the downstream, the water is accessed by Bureh town for domestic purpose, including for drinking. It was observed more than once, inhabitants from Kent also collect water from the Bureh town stream. This was confirmed in the focus group meeting.

Recommendation

The Yanneh stream in Bureh Town should be developed to provide water for the community. The existing pipe infrastructure can be utilized and further built upon to provide a comprehensive water system for Bureh Town. This facility can be extended to Kent by providing piped facility at least mid distance to Kent so that Kent inhabitants need not travel all the way to Bureh Town for water. The best option however would be to deliver the piped water to Kent from Bureh Town, this can however be a challenge given the distance.

5.2.4 Mongegba

Mongegba is close to the Grafton community. Mongegba is largely dependent on a stream nearby for domestic and agricultural water needs, but the community also collect water from around the dilapidated spring box just outside the community. The stream has more potential to support the water needs of the community compared to the spring box even though the spring box may provide some additional support. Stream yield calculation for Mongegba shows that the stream can provide all the domestic water need for the community into the immediate future.

The source of water for spring box is now very vulnerable to extensive human activities and prone to dry up and contamination due to the same human activities. However, should effort by the community be made to increase the vegetation cover of the source water for the spring box this facility could be saved and investment in its rehabilitation profitable.

Recommendation
The potential for the Mongegba stream to be developed as source water for the community is high. The stream originates from the pristine forest and damming can be possible at the upper water source above the proximate positions of nearby Grafton Scout dam. This is to cope with the elevation of Mongegba if gravity fed system is required to transport the water to the community. Dealing with the rocky nature of the stream channel should be raised as a challenge and may require special construction technique.
The spring box should not be overlooked even though it has a high iron (o.4) concentration. Efforts to protect the source water and the rehabilitation of the spring box should be made to further benefit the community.

5.2.5 Russell

Russell is along the highway to Tombo. Its water source is a dam which was constructed by NACSA. The dam is positioned at a high elevation than Russell and hence has the capacity to supply water by way of gravity to the community. While the dam area was dried (in April), it was observed that the dam construction was inappropriate and water which should be collected in the dam was wasting beneath the structure. The dam's location may not be appropriate anymore thus consideration should be made for one further up stream.

Apart from the constraints with the dam structure as well as the risk of been dried up, many pipe connections leading away from the dam are in dare need of replacement as they have warned out and leaking even the small water it collects to be transported to the community.

Recommendation
Russell's water infrastructure systems need more and careful attention due to its precarious nature. The piping infrastructure needs to change, as would the improvement of distribution network in the community. While the location of the dam is protected, and quite a distance away from the community, yet the threat of drying out at the present location needs upstream exploration for an alternative location of a dam. The pipe network within the community needs improvement to allow for more water access points.

5.2.6 Macdonald

Macdonald is situated along the Waterloo – Tombo axis in the WAPFoR. The Macdonald community is a large community extending behind the main highway. The community have two water wells which are presently out of use due to dysfunctional mechanical pumps. The wells have been out of use for more than one year due to the frequency of repair and the cost involved. Macdonald now heavily depend on

the nearby stream. The community access the source water just beneath the bridge. This point of access is froth with bacterial infestation according to the water test analysis.
On the upper part of the stream is a large section of the channel that collects a high volume of water. Water yield test carried out at the section reveals that there is enough water that can serve the water needs of the Macdonald population. But while this may be true for Macdonald a caveat is that this same stream runs through Koba Water at a higher elevation and is being used by the community for their domestic purpose including bathing, laundry, etc. At the Koba Water elevation, human activities close to the stream is evident, hence the downstream community is receiving much contaminants from the upstream community. In addition to this problem, human activities were observed to be high nearby the stream. For instance there exists a human dwelling close to the stream. Even though the stream had ample stream edge forest cover yet occupants in the dwelling house seem also to introduce unfit substances in the stream. Fire wood harvesting and char coal production were observed taking place. The char coal is produced close to the stream adding another layer of unfit substance introduction to the stream. Given that it was difficult to trace the source of the wood cutting, the stacked bundles of fire wood and wood meant for char coal production implied that harvesting of the wood is in the nearby forest. This means that the forest cover close to Macdonald is tampered with which may have a bounce-back effect on the only stream serving the community.

Recommendation
Macdonald and Koba Water are sharing the same source of water with Koba Water at the upstream with ample evidence of human activity around the stream. If water project involving the stream should be developed for both communities, it will be rational to have stakeholders from both communities to dialogue over the fate of the stream. Decisions involving the protection of the stream should be codified into bylaws for both communities to abide by.

Water management committees in the two communities should regularly interact to update each other on the status of water issues in the communities and to plan actions that would involve the activities regarding the stream.

Water should be made available in the communities to reduce human traffic to the stream thereby improving on the negative present human impact on the stream.
The stream should be protected. This should start with efforts in tree planting in deforested areas around the stream area. But the communities should be encouraged to plant trees generally to increase gains in their ecological services.

5.2.7 Koba Water

Koba Water is a high elevation community. The community from observation and community experience seats on a mass of rock with a thin layer of soil. A valley marsh exists in which the community carries out garden practices. As pointed out above, Koba Water depend on a stream it shares with Macdonald (see the discussion above). It was difficult to locate an area for water yield assessment, hence the Macdonald yield was therefore used, given that they share the same stream. In addition to the stream, a spring box also exists in the marshy valley. Plan International it was revealed constructed the spring box during the conflict period. The spring box facility is no longer in use although water is still collected for domestic use around the box. This implies that the spring box facility stand a chance of use if reconstructed.

Recommendation

Please refer to recommendations for Macdonald for the use of the stream in Koba Water. In addition to those, it would be necessary to explore the potential for a dam at a higher elevation or even at source in the pristine forest.

The spring box also stands a chance at Koba Water. The construction should be carefully thought-out to eliminate the drawbacks of the existing structure.

5.2.8 Madina

Madina situates along the highway to Tombo. The greater part of the community extends away from the main highway towards the sea at the back. On the other side of the highway, development appears to be slower, more recent, and human activities observed very close to the upper section of the stream that the community presently depends on for water. Ajai water the stream commonly referred to has its origin in the heart of the forest it passes beneath the bridge between Madina and another community, Boyoh and continue to empty into the sea. Madina and Boyoh communities at present depend on the Ajai stream as source of water for domestic purpose. But the use of the water is only for the six months of the dry reason. In the rainy season however, the water is hardly used. This situation is as a result of a landslide or rock-fall from the hillside years ago that permits significant level of soil erosion from the site of the cleavage. The eroded soil washed into the stream makes it reddish (after the colour of the soil) in colour and this condition also increases the turbid nature of the water. The water colouration and turbidity are the cause for the none use of the stream in the rains.

There are two water wells in Madina. Focus group reveals that the wells were used when they were first dug and they continued to serve the community. However, the perpetual challenge has been repairs of the mechanical pumps. Cost of repairs is high for the community to handle especially when the breakdown is frequent. It is unknown whether there is water in the wells or not since they are constructed without manholes. The community however, suspects the presence of water.

Recommendation

The water yield assessment shows that sufficient water is discharged by the stream for the consumption of the Madina community. Considering the proximity of Boyoh to Madina, and further considering that the two communities depend on the same stream for their water needs, it is only prudent that consideration be made for Boyoh community to benefit from any water project for Madina.

If damming is required it must be done beyond the point of the land slide to effectively eliminate the issue of water colouration and turbidity. It must be noted that the distance to the land slide site is quite far making it an issue for the cost involved in lying pipes. However, should this be overcome then there would be enough gravity to transport water to the communities.

The protection of the steam source and channel is also paramount. A consistent dialogue with the community to embark on stream protection is of great significance since human activities are observed to be very close to the stream and even in the distant hills.
The water wells can be of potential alternative. If proven that the wells can run with water throughout the year, then additional wells can be dug in the community to accommodate the demand from the population of both Madina and Boyoh. This would require some technical assessment to understand the yield of the water wells as against the population.

5.2.9 Charlotte

Charlotte is a mountain community with a long history of one landslide. The houses in Charlotte are carefully constructed and possibly mindful of another slide. The community is in dire need of water for domestic purposes. Agricultural water is abundant and comes from the famous Charlotte fall which makes a stream almost around the community. Charlotte uses the fall for other domestic purposes but not for drinking because they claim that it is already polluted by the time it get to them from upstream.

Drinking water is fetched from a spring like place at which water constantly accumulates as it is scooped out by residence. This water has a pH value below the WHO recommended safe level. Community people say the source water is available throughout the year (there are other places community members fetch water from at various times of the year but they dry out as the dry season progresses).

Water pipe network is observed in Charlotte. The origin of the pipe has not been clear, but residence say the connection is with the water system of Guma Valley. It has been difficult to ascertain wither the connection is from the Guma Valley dam which appears very unlikely. But given that the pipeline exist it is therefore possible to revive the water system by tracing its origin and assessing the cause for the lack of water in the pipeline at least in Charlotte.

Recommendation
The precarious nature of source water for Charlotte demands an immediate intervention for the community to access safe water. Both the dam and spring source water have pH values below the WHO standard.

The origin of the water pipe network should be investigated further to understand its nature, origin and condition. Such will inform the possibility for resuscitation and magnitude of the investment.

The Community Water Supply Management Framework

This final section is dealing with the framework of how the water infrastructure is constructed and managed, based on the communities' general trend of thinking and the research outcomes. Presented in scenario context is the approach that allows for options in the design and management of community water infrastructure, considering of course cost implications.

Scenario 1

This scenario assumes that the stream can be dammed at an elevation higher than the community. This means the dammed raw water is transported by gravity to the community and distributed within the community in stand pipes or in homes. This option provides raw and untreated water for the community considering that all available water sources are bacterial infested, such water will be unsafe for domestic purpose and communities would have to bear the brunt of water borne diseases.

Scenario 2

This scenario assumes that water from the stream is collected into a constructed bowl. The dammed water cannot be made available to the community through gravity, instead water is pumped into the community either using a mechanical or electrical submersible pump and distributed into homes or stand pipes within the community. This water is also raw and untreated and like the first scenario, it is unsafe for domestic purposes particularly for drinking. The community will be vulnerable to water borne diseases.

Scenario 3

This scenario is similar to the first and second above but here, the water is not dammed but collected from a pipe that is laid along a narrow reach of the water and transmitted into a large storage tank close to the community where it is distributed and use. This scenario could only be applicable where the water flows through out the year and the source is at a higher elevation than the community to allow the water to flow by gravity to the storage tank.

Scenario 4

This scenario takes into account water treatment, storage, and distribution. The water whether through gravity and lift pump from water source (stream or well) is sent into a community water treatment facility were treatment for bacteria and other forms of water borne vectors. The treated water is then pumped into a storage facility at a higher elevation and made to be distributed into the community either directly into homes or in stand pipes within the community.

Management of Water Infrastructures

As already discussed before, the communities are highly enthisiastic of having an efficiently managed water supply system as opposed to the previous management system experienced under the community head. This study therefore propose that a water and sanitation (Watsan) committee be set first in any community where water supply system is to be provided. Training for this group should be a must. This will ensure full participation from the planning and through the whole service provision process. Such participation will help them to understand the intricacy about water supply management, therby producing the sense of ownership, ultimately ensuring the effective and efficient management of the water services.

Congruently, the provision of safe and affordable drinking water is costy, like wise its operation and maintenance. Even if communities are provided with safe water for free, the sustainability of the service means there should be sufficient funds for its operation and maintenance. To ensure that, this study propose the development of a water services payment scheme for each community. This may be different for each community and each scheme designed will depend on factors such as the willingness to pay and the income level of the community.

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Annex

1/ **Terms of Reference**

The consultant's work load will be as following:

- Desk Research on Water Supply Mechanism in rural areas comparable to Western Area Peninsula Forest Reserve, 3 days
- Visit the communities in three clusters for field assessment taking into account the above mentioned questions and exchange with community: 20days
    - Cluster 1: Sussex, John Obey/ Black Water/ Big Johnson, Bureh Town/ Kent
    - Cluster 2: Montegba, Charlotte
    - Cluster 3: MacDonald, Russel, Koba Water, Medina

  The following tasks should be conducted in the communities:
    - Testing of basic water quality: pH, Fe, Ca
    - Key informants interviews and focus group meetings
    - Yield and discharge rates of source water for the communities to determine the sustainable nature of the source water
    - Water supply streams, past experiences and technical ideas

Conservation of the Sierra Leonean Western Area Peninsula Forest Reserve (WAPFR) & its Watershed

2/ Questionnaire sample

Project: COMMUNITY WATER MANAGEMENT STUDY IN WAPFoR			
Name of Interviewer:	**District:**	**Date:**	**Village:**
Name of Interviewee:	**House Ref No:**	**Gender:**	**Age:**

SECTION 1: HOUSEHOLD INFORMATION: Household Information & Housing Characteristics

1.1. Please indicate the total no. of people living in the household (h/h)

☐ 2 – 5 ☐ 6 – 12 ☐ > 12

1.2. Please indicate the number of males / females in each age group in the h/h.

Age	MALE (no.)	FEMALE (no.)
0 – 15 yrs		
15 – 30 yrs		
30 – 45 yrs		
> 45 yrs		

1.3 Gender of Children less than 5 years of age in h/h

Gender	*Number*
Male	☐
Female	☐

1.4 Gender of the head of the h/h: ☐ Male ☐ Female

Age of the head of the h/h: ☐ 0 – 15yrs ☐ 15 – 25yrs ☐ 25 – 35 yrs ☐ 35 – 35yrs ☐ > 45yrs

Religion : **Ethnicity :**

1.5 indicate the maximum level of schooling completed by the head of h/h :

☐ yr 01 – 05 ☐ yr 06 - 10 ☐ yr 11 – 12 ☐ > yr 12

1.6 Occupation of h/h Head (please select one option)

Occupation	
Unemployed / not working	

Farming & Agricultural labour	
Non- agricultural labour	
Small trading	
Government job	
Private sector job	
Other	

Other (Please specify):

1.7 Do you practice rainwater harvesting (rwh) during the wet season : ☐ Yes ☐ No

1.8 If household does not practice rwh why ?

Thatch / Mud roof so not suitable ☐

Too expensive ☐

Do not understand technology ☐

Other (Please specify):

1.9. Are you the owner of this house or do you rent it?

☐Owner ☐ rented☐ Free of charge

Other (Please specify):

OBSERVATION FORM - ***(Please observe and note the following details)***

1.10 Water Storage

What does the family use to store drinking water in ?	Jerry can	
	Traditional ceramic pot	
	Plastic receptacle	
	Saucepan / pot	
	Other	
Is this water covered ?	Yes	
	No	
Is the water container clean ?	Yes	
	No	

	Latrine in compound	
	No formal sanitation within compound	

1.11 Sanitation

Sanitation If latrine please specify type ☐ Concrete VIP latrine ☐ Traditional Latrine ☐ Open pit	Flushing toilet in house	
	Latrine in house	
	Latrine in compound	
	No formal sanitation within compound	
Water	Tap in house	
	Tap in compound	
	Private Well / borehole in compound	
	No private water point	

1.12 What is the distance between water source (well/stream) and A. Toilet_________ B. Refuse _________

Does the family have a latrine ?	Yes	
	No	
Are there ?	Flies	
	Faeces	
	Smell	
Are there hand washing facilities ?	Yes	
	No	
Do all members of the family including children use the latrine	Yes	

	No	

1.13 Are there animals observed in the compound, if so please specify type & number:

2. ACCESS TO DRINKING WATER: SOURCE TYPE & COLLECTION

2.1. What is your source of water for household?

D: Indicates Drinking Water Source

O: Indicates Water Source used for Other purposes *(washing, bathing etc. If more than one water source is indicated please note the order of preference as 1 / 2 / 3 etc.*

Drinking	Other	Wet Season	Dry Season	Drinking	Other
		In door tap in my house	In door tap in my house		
		In door tap at my neighbour's	In door tap at my neighbour's		
		Water trucking into my house	Water trucking into my house		
		water trucking into my neighbour's	water trucking into my neighbour's		
		Street tap	Street tap		
		Street water tank	Street water tank		
		Disconnected pipe	Disconnected pipe		
		Private protected well in my house	Private protected well in my house		
		Private protected well in my neighbour's	Private protected well in my neighbour's		
		public protected well	public protected well		
		Private non protected well in	Private non protected well in		

		my house	my house		
		private non protected well in my neighbour's	private non protected well in my neighbour's		
		Public non protected well	Public non protected well		
		Private spring box in my land	Private spring box in my land		
		Private spring box in my neighbour's	Private spring box in my neighbour's		
		Public spring box	Public spring box		
		Spring catchment with no construction	Spring catchment with no construction		
		Rain water collection	Rain water collection		
		stream or river	stream or river		
		pond	pond		
		Plastic bottle of Water or packet (Grafton, Magram...)	Plastic bottle of Water or packet (Grafton, Magram...)		
		Local plastic water	Local plastic water		
		Business water selling (5 gallons)	Business water selling (5 gallons)		
		Other	Other		

2.2 Is this water source ideal?

Yes. (Why) ***No. (Why)***

23. Is the water source you use protected? ☐ ***Yes.*** ☐ ***No.***

2.4. If yes how

☐ *Completely sealed with mechanical pump*

☐ *Partially covered with bucket and rope in use*

☐ *Exposed but fenced from domestic animals*

2.5 Please rank the following water sources 1, 2, 3, depending on season preferences as follows:

Source	**Priority Dry Season**			**Priority Wet Season**		
	1	**2**	**3**	**1**	**2**	**3**
Open wells						
Boreholes						
Public Tap stands						
Private House Tap						
Rainwater Collection						
River						
Spring						

Observation Data : Note the DISTANCE FROM THE RESPONDANTS HOUSE TO PREFERRED WATER SOURCE:

Water Source (Please Specify type)	**5 mins walk**	**10 mins walk**	**20 mins walk**	**>20 mins walk Please pecify.**
No. of Journeys per day				
Total estimated travel time per day				
Total queuing time per day				
Total estimated time spent fetching water per day				
Please specify method of travel (walk, bicycle, cart etc) :				

2.6. If there is a different drinking water source used in dry / wet season - please explain why?

2.7. Why do you use the drinking water source that you do ?

No cost ☐

Easy Access & Nearby ☐

Good quality ☐ Only source ☐ *Other (please specify):*	
2.8. Do you use the same water source for all non drinking household uses (bathing, washing clothes): ☐ Yes ☐ No	
2.9. If the answer is No, where do you take the water you use for washing yourself from ?	
2.10. Number of times per day you go to fetch water :	
2.11. Volume of the containers used to fetch water :	
2.12. Number of containers used per trip :	
2.13. Total volume collected (volume x number of containers x no. of trips per day):	
2.14. Do you have to pay to access this water? ☐Yes ☐ No ☐ Don't Know	
2.15. If yes, how much do you pay? *(Indicate price and quantity in gallons)*	
2.16. If yes, to whom do you pay ? ☐ user committee ☐ local government ☐ private company ☐ other	

2.17. Who usually collects the water from this source ?

Woman	
Girl Child only	
Boy Child only	
Both Girl & Boy Child	
Man	
Water Vendors	

Other (please specify):

2.18. What hazards are there at the water source

Hazard	Yes	No
Animals, snakes		
Risk of Assault		
Falls		
Road Accident		
None		

Other (please specify):

2.19. If you experience seasonal water shortages what months of the year does this occur:

Is the source dry during this period ?

How do your household manage/cope with this water shortage during these months?

Comments:

2.19.1 Undertake yield and flow rate assessment[17]

[17] This rudimentary yield and flow rate assessment applies only to cases of streams. Water wells yield rates assessment is complex and involves equipment like submersible pumps and mobile generators and complex calculations.

2.19.2 Take samples of water in clean transparent bottles

2. ACCESS TO DRINKING WATER: HOUSEHOLD WATER USEAGE

2.20. Estimation of the number of gallons per day used for drinking for the household

Wet Season ________________________________

Dry Season__________________________________

Ask first what is the container(s) used for drinking purpose. See how many gallons it holds. Ask for how long it last before they fill it or fetch water again. Calculate then the number of gallons per day.: _________________

2.21. Estimate the % of water used for each of the following other uses

cook	drink	Wash clothes	Wash dishes	Bathe	Clean House	Latrine	%
							100

2.22. Do you keep your drinking water separate from water used for other purposes ?

2.23. How do you store the water at your home after you have collected it ?

Plastic barrel ☐

Clay Jar ☐

Basin ☐

Jerry Can ☐

Bucket (with lid) ☐

Bucket (no lid) ☐

Plastic Bottle ☐

Other (please specify):

***Ask to see the drinking water vessel, and note the approximate make, size & if it has a lid which does not let light in.*

2.24. Do you use the drinking water container for other uses: _ Yes _ No

2.25. The container used for drinking water, is it kept on the ground or above ground level?

☐ On the ground ☐ above ground level

2.26. How long does it take to empty this water storage container:

2.27. How often do you clean this storage container

- ☐ Every time it is used
- ☐ Everyday
- ☐ Every three days
- ☐ Whenever it looks dirty
- ☐ Once a week

Other (please specify)

Bathing: Where do men and women bathe?

2.28. In your opinion how should drinking water be *More than one response can be selected.*

- ☐ it should have a good taste
- ☐ It should be clear
- ☐ It should have no smell
- ☐ It should be cool
- ☐ It should not make you ill

Other (please specify):

How do your drinking water appear?

a. Coloured b. has taste c. has some smell d. none of these

2.29. Do you normally boil the water for drinking: ☐ Yes ☐ No

2.30. If yes, what fuel do you use for boiling the water: ☐ Wood ☐ Charcoal ☐ Gas ☐ Kerosene

2.31. If no, why not: *More than one response can be selected.*

☐ I was not aware of this

☐ I do not have means for this (financial constraint)

☐ I do not see the use of boiling water

☐ It is not in my habits

☐ I do not have time for this

Other (please specify):

2.32. Do you normally filter the water you drink: ☐ Yes ☐ No

2.33. If you filter the water, what do you use?

☐ Candle ceramic filer
☐ filter with cloth at the water point
☐ cloth filter at home
☐ no filter
If other, please specify:

2.34. If you do not filter the water, why?

☐I am not aware of this ☐I do not have the means to buy filter

☐I do not see the use of filter ☐ It is not in my habits

Other (please specify):

Do you think water is safe to drink without treatment Yes No

2.35 . Where do you collect water for agricultural use?

2.36 . Who collects, transports, and manages water for agricultural use and how?

2.37 . Who is responsible for the upkeep of the community water infrastructure?

2.38. Are there conflicts in water distribution in general, based on gender, income level, ethnicity/ castes, etc.?

2.39. How can these be solved?

3. HYGIENE & SANITATION

3.1. Do you have access to a sanitation system : ☐_ Yes ☐_ No

3.2. If yes, which of the following type of sanitation system do you use:

_ My own private latrines
_ The neighbour's latrines (Access is granted)
_ Public or street latrines
_ Private flush toilet
Other (please specify):

3.3. If no, where do you normally go: *More than one response can be selected (2 maximum).*

_ Sea _ River _ Drainage _ House yard
_ Plastic bag _ Bush _ Street

Other (please specify):

3.4. If sanitation systems is a latrine please note the type of latrine *(visual observation)*

_ Hole in the ground, no slab
_ hole in the ground, concrete slab
_ hole in the ground, other material slab
_ VIP
_ flush
_ Latrine overhanging the sea with slab

Other (please specify):

3.5. *Visual observation: where is the drain off of the latrine?*

☐ Lined pit in the ground
☐ Unlined pit in the ground
☐ Sea
☐ River
☐ Sewage network
☐ septic tank

Other (please specify):

3.6. If there are latrines in your village and you do not use them ,why don't you use them

☐ there are no latrines
☐ they are dirty
☐ they are smelly
☐ they are private property
☐ they are too far away
☐ the door is broken
☐ they are locked

Other (please specify):

3.7. If there are latrines in your village do you help your children to use them : _ Yes _ No _Don't have children

3.8. Do you normally wash your hands after going to the toilet : ☐ Yes ☐ No

3.9. If yes, why: ☐ to prevent disease ☐ cleanliness

Other (please specify):

Diarrhoea Incidence

3.10. How many children below 5 years do live in your household? ____________________

3.11. Has any of your children suffered from diarrhoea in the past 10 days? No Yes

3.12. What do you think is the main cause of diarrhea?

3.13. Type and Frequency of Diarrhoea

	Name of the child:	Name of the child:	Name of the child:	Name of the child:
How often did the child have diarrhoea in the past 15 days? (cases)	☐ 1x ☐ 2x	☐ 1x ☐ 2x	☐ 1x ☐ 2x	☐ 1x ☐ 2x
How many days lasted the diarrhoea?	☐ less than 3 days ☐ more than 3 days ☐ I don't know	☐ less than 3 days ☐ more than 3 days ☐ I don't know	☐ less than 3 days ☐ more than 3 days ☐ I don't know	☐ less than 3 days ☐ more than 3 days ☐ I don't know
How was the stool during the illness?	☐ liquid ☐ solid ☐ bloody	☐ liquid ☐ solid ☐ bloody	☐ liquid ☐ solid ☐ bloody	☐ liquid ☐ solid ☐bloody
Did your child receive treatment?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no

3.14. What kind of treatment do you give your children when they have diarrhoea?

- ☐ Traditional Medicine/ Healer
- ☐ Buy medicine from the pharmacy
- ☐ visit the community health center / doctor

3.15. How much money do you spend for the treatment of one time diarrhoea? ____________________

Consumption of liquid and food

3.16. What kind of drinks do your children consume?:(multiple answer possible)

- ☐ breast feeding
- ☐ tea
- ☐ cow milk
- ☐ raw water --------------> from: ☐ household tap ☐ water kiosk ☐ borehole
- ☐ boiled water
- ☐ SODIS water
- ☐ filtered water
- ☐ chlorinated water
- ☐ other drinks: ____

Comments:

4.1. What are the main sources of income of your household: *More than one response can be selected.*

_ Salaried work _ casual labour or sale of labour

_ farming activities
_ fishing activities
_ petty trading
_ private business
_ pension or allowance
_ rent fees

Other (please specify):

4.2. Beside of the above mentioned activities, do you receive any other source of incomes ?

_ Money send from abroad _ money given by friends or family in Sierra Leone _ other

Other (please specify):

4.3. How many people are working or doing business in your household?

☐ None ☐ 1 ☐ _ 2 ☐ _ 3 ☐ _ 4 ☐ _ 5 ☐ _ more than 5

Proportional Piling (PP) : If we take the last month as a reference, if you put all these activities together, what was the total amount of cash you made for the HH

Organise a PP to assess the % of cash generated by each of the mentioned activities.

% of Income from Salaried Work		**% of Income from Farming / Fishing**	
% of Income from Petty Trading (selling goods)		**% of Income from private business**	
% of Income from pensions or state allowances		**% of Income from Rent**	
% of Income from remittances from overseas family members		**% of Income from Other Sources**	
Total Household Monthly Income			
Total Household Monthly Income after all expenses paid (savings)			

4.6 Access to Credit: Do you have access to credit from micro finance institute / bank / other source :
_ Yes _ No

If Yes, how much did you obtain by credit last month and what did purpose you use the money for ?

4. HOUSEHOLD ECONOMIC ACTIVITIES (ALL INFORMATION CONFIDENTIAL)

5. HOUSEHOLD WATER TREATMENT

5.1 Where do you get information about events (can select more than one answer) :

Paramount chief	
Village head / chief	
Community meetings	
School head master	
radio	
television	
Newspapers	
Local weekly market	
NGO's	

Other (please specify):

5.2 Do you think water is safe to drink without treatment : _ Yes _ No

5.3 Are you aware of any of the following methods of household water treatment:

Boiling	
Chemical (chlorine tablets)	
Ceramic filters	
Biosand filter	
Cloth filter	
SODIS	
Other	

Other (please specify):

5.3. What do you know about the system and where did you learn this information ?

5.4. Do you use any method apart from boiling to treat your drinking water (please specify what type) :

(if yes please go to question 6.6)

(if No please go to question 6.7)

5.5 . Yes: why did you select this technology:

Where did you purchase and how much did it cost you:

Do you treat all of the water the family uses for drinking, if not why ?

What do you like most about the technology ?

What do you dislike most about the technology?

Would you recommend this technology to others :

If the technology is broken can you afford a replacement and where would you purchase it ?

Do you think your neighbours would purchase a similar technology :

5.6. No – Why do you not treat your drinking water

Cost (cannot afford)	
No necessary water is clean and safe	
Do not like to change taste of water	
Need to discuss with partner	
Other	

Other (please specify)

How much can you afford to spend on treatment of your water

Cholera Prevention: Cholera Emergency Actions.

If there was a cholera outbreak in the area, would you be ready to undertake the following actions - consider the financial implication of the action.

5.7. To give grafton (packet or bottled water) only to children under 5:
Cost involved per day (number of children x 2 plastic per day) =

☐ Yes I would have enough money and I would do it
☐ No because I do not have enough money
☐ No because I do not see the use of it.

5.8. If yes to previous question, would you also be ready to drink packet / bottles water only for all the family.

Cost involved per day (number of people x 4 packets per day) =

☐ Yes I would have enough money and I would do it ☐ No because I do not have enough money ☐ No I do not see the use of it.

6.9. To prevent cholera would you be willing to boil water every day.

Cost: one plastic bag of charcoal per day (500 leones)

☐ Yes I would do it ☐ No (I do not see the use of it) ☐ (I do not have enough money) ☐ No (I do not have time)

6.10. To prevent cholera would you be willing to clean your latrines with bleach every week.

Cost: 15,000 leones per month.

☐ Yes I would do it ☐ No because I do not have latrines ☐ No (I do not see the use of it) ☐ No (I do not have money)

6.11 . To prevent cholera would you be willing to systematically wash your hands and face with soap.

Cost: 500 leones per day (to buy soap).

_ Yes _ No (I do not see the use of it) _ No (I do not have money for that)

6.12. To prevent cholera would you be willing to contribute to regular collective chlorination of the water point and disinfection of latrines of your area: Cost, 10, 000 leones per spraying (can be done by a private company or community based organisation)

☐ Yes ☐ No (I do not see the use of it) ☐ No (I do not have enough money for that)

6.13. In order to prevent cholera on a regular basis, what would be the amount you could spend per month in prevention activities? (regular cleaning of latrines and water points, boiling water every day...)

_ Less than 5,000
_ from 5,000 to 10,000
_ from 10,000 to 20,000
_ from 20,000 to 25,000
_ from 25,000 to 30,000
_ from 35,000 to 40,000
_ more than 40,000

3/ Water Test

WATER QUALITY MONITORING SUMMARY SHEET

Town	Sussex 1	Sussex 2	Big Water	Burreh Town	Mongegba 1	Mongegba 2	Charlotte 1	Charlotte 2
Chiefdom								
Section/Location	Rural Area	Rural Area	Rural Area	Rural Area	Rural Area	Rural Area	Rural Area	Rural Area
Water Source	Well 1	Well 2	Stream	Stream	Stream	Spring box	Stream	Water falls
Date	4-5-2011	4-5-2011	4-5-2011	4-5-2011	4-5-2011	4-5-2011	4-5-2011	4-5-2011
Time	10:42	10:49	11:35	12.09	13:35	13:58	14:47	1510
Water Temperature (^{o}C)	27.7	27.4	28.3	26.2	30.9	26.8	26.9	30.8
pH	6.5	5.6	6.8	6.8	6.9	6.2	5.6	6.1
Turbidity (NTU)	2.8	3.9	1.1	1.5	0.7	2.2	1.5	1.8
Conductivity (µS/cm)	58.1	872	38.5	31.1	40.6	44.8	64.6	84.6
Salinity)ppt)	Nil	0.3	Nil	Nil	Nil	Nil	Nil	Nil
TDS (mg/l)	29.2	436	19.9	15.6	20.3	22.4	32.2	42.4
Residual Chlorine (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Aluminium (mg/l)	0.04	0.15	0.09	0.07	0.13	0.08	0.12	0.11
Ammonia (mg/l)	0.02	0.06	Nil	Nil	Nil	Nil	Nil	0.01
Boron (mg/l)	-	-	-	-	-	-	-	-
Bromine (mg/l)	-	-	-	-	-	-	-	-
Calcium Hardness (mg/l) $CaCo_3$	6	15	2	2	8	2	4	10
Copper (mg/l)	0.02	0.12	0.01	0.03	0.02	0.01	0.02	0.03
Fluoride (mg/l)	1.35	1.58	0.23	0.16	0.14	0.12	0.11	0.18
Iron (mg/l)	0.5	0.9	0.4	0.3	0.2	0.4	0.2	0.3
Magnesium (mg/l)	12	16	5	13	10	8	5	6
Manganese (mg/l)	0.3	0.8	0.3	0.2	0.1	0.3	0.2	0.3
Molybdenum (mg/l)	0.25	0.46	0.09	0.06	0.01	0.04	0.03	0.18
Nitrite (mg/l)	.005	.008	.002	.001	.001	.002	.003	.005
Nitrate-Nitrogen (mg/l)	4.2	12.2	2.4	2.6	1.8	2.8	3.6	3.5
Potassium (mg/l)	0.7	2.4	0.3	0.8	1.1	0.3	1.2	1.5
Phosphate (mg/l)	0.47	0.66	0.23	0.18	0.16	0.25	0.27	0.26
Silica (mg/l)	-	-	-	-	-	-	-	-
Sulphate (mg/l)	4	15	2	8	5	12	4	6
Sulphide (mg/l)	0.04	0.08	0.04	0.02	0.04	0.05	0.03	0.02
Sulphite (mg/l)	25	42	18	16	12	15	10	18
Zinc (mg/l)	0.2	0.4	0.2	Nil	Nil	0.1	0.1	0.3
Chloride (mg/l)	-	-	-	-	-	-	-	-
Bi-carbonate (mg/l)	15	45	18	8	6	12	10	14
E. Coil (cfu/100ml)	165	285	65	200	50	250	265	150
Faecal Coliforms (cfu/100ml)	20	200	50	150	20	145	120	45
Non-faecal Coliforms (cfu/100ml)	120	150	100	165	65	220	200	150
Vibrio Parhaemonella sp. (cfu/100ml)	-	-	-	-	-	-	-	-
Salmonella sp. (cfu/100ml)	-	-	-	-	-	-	-	-

Conservation of the Sierra Leonean Western Area Peninsula Forest Reserve (WAPFR) & its Watershed

WATER QUALITY MONITORING SUMMARY SHEET

Town	Madina	Russel	Macdonald	Koba Town			
Chiefdom							
Location	Rural Area	Rural Area	Rural Area	Rural Area			
Water Source	Stream	Spring box	Stream	Stream			
Date	5-5-2011	5-5-2011	5-5-2011	5-5-2011			
Time	12:51	13:10	13:32	14:15			
Water Temperature (^{o}C)	31.2	29.1	28.3	27.1			
pH	6.4	6.9	6.8	7.1			
Turbidity (NTU)	0.8	1.2	0.9	0.6			
Conductivity (µS/cm)	84.6	74.6	69.5	46.5			
Salinity)ppt)	Nil	Nil	Nil	Nil			
TDS (mg/l)	42.3	32.3	39.2	23.4			
Residual Chlorine (mg/l)	Nil	Nil	Nil	Nil			
Aluminium (mg/l)	0.04	0.03	0.04	0.06			
Ammonia (mg/l)	0.01	Nil	0.01	0.01			
Boron (mg/l)	-	-	-	-			
Bromine (mg/l)	-	-	-	-			
Calcium Hardness (mg/l) $CaCo_3$	14	8	9	6			
Copper (mg/l)	0.03	0.01	0.04	0.03			
Fluoride (mg/l)	0.32	0.16	0.33	0.21			
Iron (mg/l)	0.3	0.2	0.2	0.3			
Magnesium (mg/l)	5	3	7	4			
Manganese (mg/l)	0.3	0.1	0.2	0.2			
Molybdenum (mg/l)	0.25	0.13	0.14	0.18			
Nitrite (mg/l)	.004	.002	.001	.002			
Nitrate-Nitrogen (mg/l)	4.2	2.8	3.2	2.6			
Potassium (mg/l)	1.3	0.8	1.6	1.5			
Phosphate (mg/l)	0.29	0.35	0.38	0.44			
Silica (mg/l)	-	-	-	-			
Sulphate (mg/l)	2	1	4	6			
Sulphide (mg/l)	0.02	0.04	0.06	0.04			
Sulphite (mg/l)	8	15	12	6			
Zinc (mg/l)	0.02	0.1	0.3	0.2			
Chloride (mg/l)	-	-	-	-			
Bi-carbonate (mg/l)	10	18	12	8			
E. Coil (cfu/100ml)	150	50	20	50			
Faecal Coliforms (cfu/100ml)	55	120	Nil	40			
Non-faecal Coliforms (cfu/100ml)	220	60	55	20			
Vibrio Parhaemonella sp. (cfu/100ml)	-	-	-	-			
Salmonella sp. (cfu/100ml)	-	-	-	-			

TNTC Means Too Numerous To Count

World Health Organization recommended guideline values for potable water (Third Edition)

Boron	1mg/l
Nitrate-Nitrogen	<10mg/l
Escherichis coli	zero cfu
Water Temperature	No Value
Bromine	No value
Potassium	<6.0mg/l
Feacal coliform	zero cfu
PH	6.5-8.5
Calcium Hardness	<500mg/l
Phosphate	<20mg/l
Non-feacal coloform	<10cfu
Turbidity	<5NTU
Copper	<1.0mg/l
Silica	<15mg/l
Vibro sp	zero cfu
Electrical Conductivity	<450µs/cm
Fluoride	1.5mg/l
Sulphate	<400mg/l
Salmonella sp	Zero cfu
TDS	<248mg/l
Iron	<0.3mg/l
Sulphide	<0.5mg/l
Salinity	0.4ppt
Magnesium	<200mg/l
Sulphite	No value
Residual Chorine	0.3-0.5mg/l after 30min
Manganese	0.4mg/l
Zinc	<5.0mg/l
Aluminum	<0.2mg/l
Molybdenum	0.07mg/l
Ammonia	No value

4/ Water Discharge Rate

WAPFoR Community Water Supply Assessment Report								
Yield (Flow) Assement Analysis								
Community: Big Water								
Water Source: Whale River								
Flow Velocity								
Float Type	Time 1(sec)	Time 2 (sec)	Time 3 (sec)	Total Time (sec)	Average (sec)			
Cork	135	140	128	403	134.333333			
Plastics	110	130	126	366	122			
Aluminium can	115	124	118	357	119			
					375.333333			
					37.5333333			
Average Surface Water velocity = Total Velocity of Surface Area/ Distance of Surface Area								
Distance of Surface Area: 10m								
Total Velocity of surface area: 375.33								
Average Surface Water velocity= 375.33/10= 37.53m/s								
Average stream velocity (V)= 37.5*constant ©=37.53*0.85=31.9m/sec								
Channel Cross Section Area								
A (740 cm)	d1(cm)	B (700cm)	d2 (cm)	C (840 cm)	d3 (cm)	D (900 cm)	d4 (cm)	
0	10	0	44	0	34	0	12.5	
185	30	175	49	210	42.5	225	20	
370	27	350	51	420	47.5	450	32	
555	12	525	46	630	48	675	14	
740	3.5	700	7	840	13	900	7.5	
Width Analysis	Section A (cm)	(m)	Section B (cm)	(m)	Section C (cm)	(m)	Section D(cm)	(m)
	20	0.2	46.5	0.465	38.25	0.3825	16.25	0.1625
	28.5	0.285	50	0.5	45	0.45	16	0.16
	19.5	0.195	48.5	0.485	47.75	0.4775	23	0.23
	7.75	0.0775	26.5	0.265	30.5	0.305	10.75	0.1075
	75.75	0.7575	**171.5**	1.715	**161.5**	1.615	**66**	0.66
Total cross Sectional Area		**4.7475**	m					
Average cross sectional Area (A)		**1.186875**						
Flow Rate/Discharge (Q)= Average Stream velocity* Average Cross Sectional Area (V*A)						**37.8613125**	**metre cubed/sec**	
				Discharge in Litres		**37861.3125**	**litres/sec**	

WAPFoR Community Water Supply Assessment Report								
Yield (Flow) Assement Analysis								
Community: Bureh Town								
Water Source: (Yanna) River								
Flow Velocity								
Float Type	Time 1(sec)	Time 2 (sec)	Time 3 (sec)	Total Time (sec)	Average (sec)			
Cork	240	300	320	860	286.6666667			
Plastics	210	198	260	668	222.6666667			
Aluminium can	176	213	208	597	199			
					708.3333333			
Average Surface Water velocity = Total Velocity of Surface Area/ Distance of Surface Area								
Distance of Surface Area: 10m								
Total Velocity of surface area: 708.33								
Average Surface Water velocity= 708.33/10= 70.83m/s								
Average stream velocity (V)= 70.83*constant ©=70.83*0.85=60.21m/sec								
Channel Cross Section Area								
A (450cm)	d1(cm)	B (450cm)	d2 (cm)	C (540 cm)	d3 (cm)			
0	34	0	25	0	30.5			
112.5	49	112.5	31	135	33.5			
225	24	225	65	270	58			
337.5	40	337.5	66	405	51			
450	21	450	23	540	22			
Width Analysis	Section A (cm)	(m)	Section B (cm)	(m)	Section C (cm)	(m)		
	41.5	0.415	28	0.28	32	0.32		
	36.5	0.365	48	0.48	45.75	0.4575		
	32	0.32	65.5	0.655	54.5	0.545		
	30.5	0.305	44.5	0.445	36.5	0.365		
	140.5	1.405	**186**	1.86	**168.75**	1.6875		
Total cross Sectional Area		**4.9525**	m					
Average cross sectional Area (A)		**1.238125**						
Flow Rate/Discharge (Q)= Average Stream velocity* Average Cross Sectional Area (V*A)						**39.496188**	**metre cubed/sec**	
				Discharge in Litres		**39496.188**	**litres/sec**	

WAPFoR Community Water Supply Assessment Report								
Yield (Flow) Assement Analysis								
Community: Madina-Boyoh								
Water Source: Ajai River								
Flow Velocity								
Float Type	Time 1(sec)	Time 2 (sec)	Time 3 (sec)	Total Time (sec)	Average (sec)			
Cork	63	110	54	227	75.66667			
Plastics	157	111	104	372	124			
Aluminium can	70	68	55	193	64.33333			
				792	264			
Average Surface Water velocity = Total Velocity of Surface Area/ Distance of Surface Area								
Distance of Surface Area: 10m								
Total Velocity of surface area: =264m/sec								
Average Surface Water velocity= 264/10= 26.4m/s								
Average stream velocity (V)= 26.4*constant ©=26.4*0.85=22.4m/sec								
Channel Cross Section Area								
A (190cm)	d1(cm)	B (300cm)	d2 (cm)	C (200cm)	d3 (cm)	D (350 cm)	d4 (cm)	
0	4.3	0	8.2	0	15	0	4.8	
95	11	150	17.5	100	26	175	16	
190	5.5	300	3	200	5.5	350	8	
Width Analysis	Section A (cm)	(m)	Section B (cm)	(m)	Section C (cm)	(m)	Section D(cm)	(m)
	7.65	0.0765	12.85	0.1285	20.5	0.205	10.4	0.104
	8.25	0.0825	10.25	0.1025	15.75	0.1575	12	0.12
	15.9	**0.159**	**23.1**	**0.231**	**36.25**	**0.3625**	**22.4**	**0.224**
Total cross Sectional Area		**0.9765**	m					
Average cross sectional Area (A)		**0.24413**						
Flow Rate/Discharge (Q)= Average Stream velocity* Average Cross Sectional Area (V*A)						**7.7875875**	**metre cubed/sec**	
				Discharge in Litres		**7787.5875**	**litres/sec**	

WAPFoR Community Water Supply Assessment Report							
Yield (Flow) Assement Analysis							
Community: Kobawater- Macdonald Axis							
Water Source: Macdonald River							
Flow Velocity							
Float Type	Time 1(sec)	Time 2 (sec)	Time 3 (sec)	Total Time (sec)	Average (sec)		
Cork	321	256	212	789	263		
Plastics	351	222	189	762	254		
Aluminium can	245	234	310	789	263		
				2340	780		
Average Surface Water velocity = Total Velocity of Surface Area/ Distance of Surface Area							
Distance of Surface Area: 10m							
Total Velocity of surface area: 780							
Average Surface Water velocity= 780/10= 78m/s							
Average stream velocity (V)= 78*constant ©=78*0.85=66.3m/sec							
Channel Cross Section Area							
A (300 cm)	d1(cm)	B (530cm)	d2 (cm)	C (750 cm)	d3 (cm)		
0	35.3	0	12.4	0	53		
100	41	132.5	20.5	187.5	69		
200	37	265	30	375	68		
300	32	397.5	54	562.5	46		
		530	26	750	15		
Width Analysis	Section A (cm)	(m)	Section B (cm)	(m)	Section C (cm)	(m)	
	38.15	0.3815	16.45	0.1645	61	0.61	
	39	0.39	25.25	0.2525	68.5	0.685	
	34.5	0.345	42	0.42	57	0.57	
	0	0	40	0.4	30.5	0.305	
	111.65	1.1165	**123.7**	1.237	**217**	2.17	
Total cross Sectional Area		**4.5235**	m				
Average cross sectional Area (A)		**1.130875**					
Flow Rate/Discharge (Q)= Average Stream velocity* Average Cross Sectional Area (V*A)						**36.07491**	**Metre cubed/sec**
				Discharge in Litres		**36074.91**	**litres/sec**

Conservation of the Sierra Leonean Western Area Peninsula Forest Reserve (WAPFR) & its Watershed

WAPFoR Community Water Supply Assessment Report								
Yield (Flow) Assement Analysis								
Community: Mogbegba								
Water Source: Mongbega River								
Flow Velocity								
Float Type	Time 1(sec)	Time 2 (sec)	Time 3 (sec)	Total Time (sec)	Average (sec)			
Cork	145	234	301	680	226.666667			
Plastics	118	213	274	605	201.666667			
Aluminium can	128	108	231	467	155.666667			
				1752	**584**			
Average Surface Water velocity = Total Velocity of Surface Area/ Distance of Surface Area								
Distance of Surface Area: 10m								
Total Velocity of surface area: 584m/sec								
Average Surface Water velocity= 584/10= 58.4m/s								
Average stream velocity (V)= 58.4*constant ©=58.4*0.85=49.64m/sec								
Channel Cross Section Area								
A (440 cm)	d1(cm)	B (1100cm)	d2 (cm)	C (530 cm)	d3 (cm)	D (560 cm)	d4 (cm)	
0	38.6	0	34.1	0	28.5	0	30.7	
110	51	275	49	132.5	57	140	59.5	
220	46	550	88	265	56.5	280	45.5	
330	55	825	67	407.5	48.5	420	54	
440	49.5	1100	7.5	530	11	560	21.5	
Width Analysis	Section A (cm)	(m)	Section B (cm)	(m)	Section C (cm)	(m)	Section D(cm)	(m)
	44.8	0.448	41.55	0.4155	42.75	0.4275	45.1	0.451
	48.5	0.485	68.5	0.685	56.75	0.5675	52.5	0.525
	50.5	0.505	77.5	0.775	52.5	0.525	49.75	0.4975
	52.25	0.5225	38.25	0.3825	29.75	0.2975	37.75	0.3775
	196.05	1.9605	**225.8**	2.258	**181.75**	1.8175	**185.1**	1.851
Total cross Sectional Area		**7.887**	m					
Average cross sectional Area (A)		**1.97175**						
Flow Rate/Discharge (Q)= Average Stream velocity* Average Cross Sectional Area (V*A)						**62.898825**	**metre cubed/sec**	
				Discharge in Litres		**62898.825**	**litres/sec**	

Community Population Projection (2011-2021) using the geometric progression method					
Community	**Present Population**	**National Growth Rate**	**Design Life Period**	**Design Life Factor**	**Future Population**
Charlotte	176	2.25	10	1.2492	219.8592
Mongegba	812	2.25	10	1.2492	1014.3504
Madina-Boyoh	1,170	2.25	10	1.2492	1461.564
Russel	130	2.25	10	1.2492	162.396
Macdonald	650	2.25	10	1.2492	811.98
Kobawater	104	2.25	10	1.2492	129.9168
Bigwater	351	2.25	10	1.2492	438.4692
Sussex	1200	2.25	10	1.2492	1499.04
Bureh Town	403	2.25	10	1.2492	503.4276
Total	**4,996**	**2.25**	**10**	**1.2492**	**6241.0032**

Domestic Water Consumption Pattern in WAPFoR Communities						
Domestic Water Uses Category						
Category	**Quantity (lpd)**	**Household Size**	**Total**			
Drinking	3	6.5	19.5			
Bathing	10	6.5	65			
Laundry	10	6.5	65			
Cooking and washing utensils	6	6.5	39			
School (Teachers and Pupils/Students)	6	200	1200			
Hospital (in-patient and outpatient)	6	200	1200			
Others (including waste and leakage)	5	6.5	32.5			
Total	**46**		**2621**			
Community	**Present Population**	**Future Population**	**Water Quantity at Present (lpd)**	**Water quantity in future (25% increaseof water quantity at present)**	**Total present Consumption**	**Total Future Consumption**
Charlotte	176	220	40	50	7040	11000
Mongegba	812	1014	40	50	32480	50700
Madina-Boyoh	1,170	1462	40	50	46800	73100
Russel	130	162	40	50	5200	8100
Macdonald	650	812	46	57.5	29900	46690
Kobawater	104	130	36	45	3744	5850
Bigwater	351	439	40	50	14040	21950
Sussex	1200	1499	46	57.5	55200	86192.5
Bureh Town	403	503	40	50	16120	25150
Total	**4,996**	**6241**			**210524**	**328732.5**
Yield/Flow-Demand computation						
Community	Discharge (litres/sec) at 1% flow for 8 hours	Total Daily flow consumed	Present Daily Demand (Litres)	Future Daily Demand (Litres)		
Charlotte						
Mongegba	62898.8	18,114,854	32480	48,672		
Madina-Boyoh	7787.6	2,242,824	46800	70,176		
Russel						
Kobawater-Macdonald	36075	10,389,600	33,644	50438		
Bigwater	37861.3	10,904.05	14040	21072		
Sussex						
Bureh Town	39496	11,274,848	18538	27766		

5/ CD plate with pictures (**all pictures should be credited to Joseph Rahall**)