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QUANTIFYING THE COST OF SUSTAINABLE WATER SERVICE IN SELECTED SMALL TOWNS IN CENTRAL REGION

Joseph Kwame Asante

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QUANTIFYING THE COST OF SUSTAINABLE WATER SERVICE IN SELECTED SMALL TOWNS IN CENTRAL REGION

by

Joseph Kwame Asante, BSc. (Hons)

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CERTIFICATION

I hereby declare that this submission is my own work towards the MSc. and that to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

Joseph Kwame Asante		22/04/10
(Student, PG 2608608)	Signature	Date
Certified by:		
Dr. Kwabena B. Nyarko		26/04/10
(Supervisor)	Signature	Date
Mr. S. Oduro-Kwarteng		22/04/2010
(Supervisor)	Signature	Date
Prof. S. I. K. Ampadu		04/05/2010
(Head of Department)	Signature	Date

DEDICATIONS

Glory be to almighty God and praise be to His name. Hallelujah! This work is dedicated to my wife Grace and my children, Christabel, Albert and Clara. I thank God for your care and support which has brought me this far.

God richly bless you.

ABSTRACT

Sustainable water service delivery is essential for socio-economic development but sustainability of water systems in the rural water sector in Ghana has received relatively little attention as at any given time about 30% of these systems are not functioning well or broken down. This study is focused on quantifying the cost of delivering sustainable water services in piped water systems under community management. These water systems were among the first batch of community managed piped water systems and represent a mix of technologies covering single towns piped systems, multi-village piped systems; different energy source (national grid, generator, solar); water source (surface or ground water, treatment); and with different levels of water system functionality. Data was collected on Capital Expenditure (CapEx), which is initial capital investment cost of the water systems, Operations and routine maintenance expenditure (OpEx) and Capital Maintenance Expenditure (CapManEx) from 1998 to 2008. Through field investigations and data analysis the factors affecting the cost and functionality of the water systems were identified and discussed. The CapEx per capita for the various systems and the cost drivers for CapEx with respect to water treatment technologies and the size of the system network is also discussed. The study annualized the cost of delivering sustainable water service assuming useful life of water systems of 20 years and inflation rate of 17.6% which provides useful information for planning. The per capita CapEx ranges from Gh¢ 40 -160 reflecting factors such as population of the community (economies of scale) and system technical complexity (single town piped system, multi-village system and water treatment technologies). The annual per capita OpEx ranges from Gh¢ 0.12 to Ghc 1.1 and CapManEx ranges from Gh¢ 0.10 to Gh¢ 5.10. The high CapManEx per person reflects the cost of system rehabilitation due to premature system rehabilitation. The study argues for the use of the cost information in the results for planning and budgeting particularly for capital maintenance expenditure to reduce avoidable pre-mature rehabilitation for sustainable service delivery.

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LIST OF ACRONYM

CWSA	Community Water and Sanitation Agency
CWSD	Community Water and Sanitation Division
DAs	District Assemblies
DWSTs	District Water and Sanitation Teams
RWSTs	Regional Water and Sanitation Teams
ESAs	External Support Agencies
AFD	Agence Francaise De Development
DANIDA	Danish International Support Agency
GOG	Government of Ghana
GPRS	Growth and Poverty Reduction Strategy
GSS	Ghana Statistical Service
GWCL	Ghana Water Company Limited
GWSC	Ghana Water and Sewerage Corporation
KNUST	Kwame Nkrumah University of Science and Technology
M/DAs	Municipal/District Assemblies
MDG(s)	Millennium Development Goal(s)
MWH	Ministry of Works and Housing
MWRWH	Ministry of Water Resources Works and Housing
MLGRD&E	Ministry of Local Government and Rural Development and Environment
NCWSP	National Community Water Supply Programme
NWP	National Water Policy
NGOs	Non-Governmental Organization
PS	Private Sector
PURC	Public Utility Regulatory Commission
SIP	Strategic Investment Plan
SSF	Slow Sand Filtration
STWSSs	Small Town Water Supply Systems
WSS	Water Supply System
IRC	International Water and Sanitation Centre
UNICEF	United Nations Children's Fund
WASH	Water, Sanitation and Hygiene
WASHCost	Water Sanitation and Hygiene Service Cost Project
WATSAN	Water and Sanitation
WHO	World health Organization
WSDB	Water and Sanitation Development Board
O&M	Operation and Maintenance
OpEx	Operation and Maintenance Expenditure
CapEx	Capital Expenditure
CapManEx	Capital Maintenance Expenditure
M&E	Monitoring and Evaluation
WRC	Water Resource Commission
PURC	Public Utilities Regulatory Commission
GENSET	Generator Set

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CHAPTER ONE: INTRODUCTION

1 Background

A significant measure to improve public health, spur economic development, and reduce poverty is universal access to and use of clean water and sanitation services. A legacy of insufficient and unsustainable water and sanitation service delivery means that 884 million individuals still lack access to improved drinking water, and 2.5 billion individuals lack access to improved sanitation (WHO/UNICEF, 2008). Nearly 10% of the total burden of disease worldwide is attributable to unsafe water, sanitation, and hygiene and the associated diseases claim 3.6 million lives annually (Pruss-Ustun *et al.*, 2008). Access to improved water and sanitation is important because it is the foundation for healthy communities, and results in significant health, economic, and social gains (Montgomery *et al.*, 2009).

Water is essential to the existence of man and all living things and is a cross-cutting element of the Growth and Poverty Reduction Strategy (GPRS II) of the Republic of Ghana. It is also linked to all Eight of the Millennium Development Goals (MDG's) as cited in the National Water Policy document (MWRWH, 2007). Ghana aims to achieve the MDG target of 76% rural water coverage by 2015 but the national water coverage to rural communities and small towns is 55.4% as at 2008, (CWSA, 2009). According to the SIP document, (CWSA, 2008) , an estimated amount of US$ 505.3 million would be required in order to achieve the target of 76% rural water coverage by the 2015 and that Ghana's Development Partners have already committed US$ 175 million of the required amount for disbursement in the Community Water and Sanitation Sub-Sector during the period 2008-2012. However, other cost elements required to guarantee the sustenance of water and sanitation service delivery in rural Ghana is not considered and planned for in the document. The SIP document therefore only focuses on provision of new water and sanitation systems and run the risk of undermining functional sustainability of the systems by encouraging rapid construction of infrastructure rather than long-term, critically needed, investments in operation and maintenance and needed support cost.

The cost of sustainable water supply service is the cost which will ensure that water service is delivered in sustainable manner. A water supply system is said to deliver service on sustainable manner if the facilities are maintained in a condition which ensures a reliable and adequate potable water supply. The cost besides the capital expenditure (CapEx) required to ensure service delivery on sustainable manner includes Operational Expenditure (OpEx), which is the cost of day to day running of water systems and for carrying out preventive maintenance and minor repairs, the Capital Maintenance Expenditure (CapManEx), which is the cost of carrying out major repairs, replacements of worn out parts, rehabilitations and future expansions of the water system and also Support cost which is the cost of monitoring operations of water systems and for sector institutional strengthening and capacity building.

1.1 Problem Statement

Universal access to sustainable water service requires investment to expand coverage and continues support to keep existing water systems functional. Sustainability of existing water systems in the rural and small towns' water sector in Ghana has received relatively little attention, as at any given time about 30% of these water systems are not functioning well or broken down. These systems with a high frequency and long duration of breakdowns are indication of non-existing planned maintenance due to limited funds. An understanding of the cost of sustainable water service provision is important for the delivery of sustainable water services.

1.2 Objectives of study

The main objective of the study is to determine the cost of sustainable water service delivery in Small Towns.

The specific objectives of the study are:

1. To determine the cost components of sustainable water service in selected Small Towns
2. To identify factors which affect the cost in selected Small Towns

1.3 Justification of study

The study determines the understanding of Cost for sustainable water service delivery and will contribute to better planning, design and implementation of water projects that deliver sustainable services in Ghana's Small Towns' water sector.

1.4 Scope of study

The study was conducted on twelve (12) selected small towns' water systems and determined the Capital Expenditure (CapEx), Operation and Maintenance Expenditure (OpEx), the Capital Maintenance Expenditure (CapManEx) and support costs of running the systems. The OpEx and CapManEx could not be determined for five (5) of the water systems due to unavailability of data.

1.5 Structure of the Report

The report is presented in six chapters. Chapter one provides background information, problem statement, the objectives, scope and justification of the study. Chapter two provides review of available literature on the subject of study. Chapter three introduces the Small Town's Water Sector in Ghana and provides the key elements of the community water and sanitation policy of Ghana. Chapter four introduces the study area and explains the methodology used for the study. In Chapter five, the results and discussions of the study are provided. The final chapter also provides conclusions drawn from the discussions of the study and further provides some recommendations.

CHAPTER TWO: LITERATURE REVIEW

2 INTRODUCTION

This chapter presents literature review on sustainable service delivery and factors influencing it, the cost of sustainable water service delivery, cost recovery and financial sustainability of water service delivery.

2.1 Sustainable Water Service Delivery

Carter et al. (1999) cited pragmatic definition of sustainability as "whether or not something continues to work over time". The document reveals that in the context of water and sanitation service delivery, the test of sustainability is whether water continues to be abstracted at the same rate and quality as when the supply system was designed and constructed, whether the excreta and wastewater disposal systems continue to function and be used as planned, and whether environmental quality continues to improve. The document further reveals that "if potable water flows from water supply system, then all of the many elements which are required for sustainability must have been in place. There must have been money for recurring expenses and for occasional repair, there must have been acceptance from the consumers of the service, the water source supplying the service must have been adequate, the design must have been properly done, and there must have been sound construction of the water system."

Davis and Brikke′ (1995) also points out that, Water supply service is sustainable if the water source is not over exploited but naturally replenished and the water system is maintained in a condition which ensures a reliable and adequate potable water supply. Also the benefits of the water supply must continue to be realized by all users over a prolonged period of time.

Collins (2000) suggests that the management of water systems after its inauguration does not always receive due attention and it is in this area that the concept of sustainability comes under the greatest pressure. The document pointed out that assumptions made and activities undertaken during the planning phase of the water system must be examined for long-term implications, and measures must be taken to ensure that the sustainability of the system is not compromised. It revealed that the management of all phases of the water service delivery process depends critically on the degree of community participation in each of the relevant activities. It further points out that community involvement and participation is a vital and indispensable element in the long-term sustainability of water supplies, and this concept must be reflected in the activities of planning, implementation and management of water supply systems. Carter et al. (1999) however, reveals that sustainability, in the sense of continued delivery and uptake of services, is threatened by numerous attitudinal, institutional and economic factors, and community participation approaches alone are no guarantee of success. The key to sustainability is that all stakeholders involved in consumption/use, maintenance, cost recovery, and continuing support perceive it in their best interest to deliver high quality services.

Montgomery et al. (2009) proposed three necessary sustainability components as a foundation for sustainability for water and sanitation services that can be researched, expanded, and refined by engineers, scientist, and practitioners in order to inform evidence-based policies that promote long-term functionality in water and sanitation supplies. The proposed components are: (1) effective community demand, (2) local financing and cost recovery, and (3) dynamic operation and maintenance. From an extensive study in rural Sub-Saharan Africa on these components, the document outlines (i) participatory planning, (ii) appropriate technological choice and (iii) social marketing as enabling factors for effective community demand. For local financing and cost recovery, (i) local borrowing and saving schemes and (ii) financial planning and community cross-subsidies were also outlined as enabling factors In the case of dynamic operation and maintenance, (i) clear management responsibilities, (ii) accessible spare parts and technical expertise, (iii) monitoring and evaluation and (iv) ongoing outreach and support were outlined as enabling factors. The document further outlines the main obstacles for the three sustainability components as follows: (i) physical isolation, (ii) limited time and resources, (iii) lack of incentives, (iv) technology based on donor preference and (v) little awareness regarding social marketing approaches were outlined for Effective Community Demand. For Local Financing and Cost Recovery, (i) lack of financing services, (ii) bureaucratic process for obtaining loans, (iii) limited knowledge, and (iv) mistrust of water and Sanitation funds were outlined. In the case of Dynamic Operation and Maintenance, (i) lack of consensus, (ii) isolation of rural communities, (iii) local technicians not supported financially and (iv) lack of incentives for donors to provide long-term support were the outlined obstacles. The document finally proposes ways of overcoming these obstacle as follows: (i) earmarking sufficient planning funds in project budget,(ii) selection of technology based on local choice and socioeconomic conditions,(iii) promotion of neighborhood person-to-person behavior change messaging and (iv) development of local critical thinking skills in schools were the ways proposed to overcome the obstacles for Effective Community Demand. In overcoming the obstacles for Local Financing and Cost Recovery, (i) enabling communities to establish their own funding schemes, (ii) provision of training and continues support for financial planning and (iii) creation of a system to allow for equitable access to water and sanitation services were proposed. In overcoming the obstacles in achieving Dynamic Operation and Maintenance, the proposed measures were,(i) facilitating open discussion, (ii) creation of community-based financial plan,(iii) including main users in decision-making process,(iv) allocating funds for M&E in project budget and (v) formalizing operating procedures.

According to the O & M guidelines for Small Towns Water Systems in Ghana (CWSA, 2004), a water system is said to be operated and maintained in a sustainable manner if the five items listed below which will be considered in this study are achieved.

a. The water system delivers to consumers the design quantity of water over the design life of the water supply system.
b. Producing water to Ghana Standards Board Water Quality Standards.
c. Delivery of water in a cost effective manner (in accordance with tariff guidelines).
d. Delivering water in a virtually uninterrupted manner (at least 95% of the time).
e. Planned routine and periodic maintenance are carried out for all electro mechanical equipment and civil works structures

2.2 Factors Influencing Sustainable Water Service Delivery

According to Brikke′ (2000), sustainable water service depends to a large extent on effective and efficient operation and maintenance of water systems and factors that contribute to sustainable water service have a direct influence on operation and maintenance of the water supply systems. The document revealed and explained the factors as follows:

2.2.1 Technical Factors- the selection of technology for the water supply system, the complexity of the technology and its capacity to respond to a demand and a desired service level, and the impact of it on the environment. Also, the technical skills required in operating and maintaining it, the availability, accessibility and cost of spare parts, and the consequent cost of maintenance of the system influences the sustainability.

2.2.2 Community Factors- the availability of technical skills to operate and maintain the water supply system within the community, and to implement preventive maintenance activities and carry out minor and major repairs. The ability and willingness of community members to demand and pay for the water service, the participation of all social groups within the community both men and women, existence of financial and administrative management carried out by a legitimate and organized community structures, the felt need for an improved water service provision by the community, the socio-cultural aspects related to water in the community and the individual domestic and collective behavior regarding hygiene and sanitation.

2.2.3 Environmental Factors -the environmental factors which are likely to influence operation and maintenance as well as sustainability as a whole are the quality of the water source, its quantity and continuity which will in turn influence the choice of technology of the water supply system.

2.2.4 Legal and Institutional Framework -the technical, community and environmental factors evolve within a legal and institutional framework and therefore there is the need for clear policies and strategies towards operation and maintenance at the national level which can be implemented. Support activities, such as technical assistance, training, monitoring, water quality control, and the setting up of alternative financing mechanisms are all likely to influence sustainable water service delivery.

Montgomery et al. (2009) also cited eight main identified sustainability factors as: policy context, institutional arrangements, financial and economic issues, community and social aspects, technology and natural environment, spare parts supply, maintenance, and monitoring. These identified factors agree with the factors offered by Brikke′ (2000). This study found the factors exhaustive enough and explored the factors on the water systems under the study. This was to ascertain whether any of these factors ever affected sustainable water service delivery from the selected water systems.

2.3 Cost of Water Service Delivery

Cardone and Fonseca (2003), summarized the cost of water service delivery in three main components as (1) Financial Cost (capital cost of the service infrastructure, operation and maintenance cost, and servicing capital cost), (2) Economic Cost (environmental cost and opportunity cost) and (3) Cost of Sustaining the Service (institutional capacity building and skills training, monitoring and assessment, policy formulation and creation of enabling environment)

According to Brikke´ and Rojas (2001), although there are multiple ways to classify cost of water service, it is accepted that water supply services produce three types of costs: (i) initial investment costs, (ii) recurrent costs and (iii) future investment costs. The document further reveals that it is possible to distinguish between fixed costs, which are independent from the level of water consumption, and variable costs, which change according to water consumption. The document further provides operations and maintenance costs of delivering sustainable water service to include the following:

Material costs – cost of consumables, chemicals, energy, tools, spare parts and equipment

Works personnel cost – cost of staff involved in operation, maintenance, routine preventive maintenance, repairs, and construction for minor rehabilitation

Management personnel – cost of staff involved in planning, supervision, financial management, administration, and monitoring

Financial costs - interest, amortization, depreciation, exchange rate variations, inflation

Environmental costs - water source protection and conservation, waste water treatment

Support costs – training support, technical assistance, institutional strengthening, monitoring and evaluation

Future investment costs – cost of major overhauls (rehabilitation), replacement, and extension

Other costs – transport, services paid to a private contractor, unaccounted for water due to leakage, bad administration and vandalism.

The document further suggests that operation and maintenance costs are not only subject to a certain periodicity but are also subject to variations due to the economic environment, inflation or exchange rate fluctuations which can influence the price of spare parts or energy. It asserts that while identifying these costs, it is important to highlight not only cost items, but also their periodicity and possible variations over time. It reveals that expenditure on spare parts is also irregular and varies according to the quality of operation and maintenance, and to the type of spare parts and that spare parts are divided into three categories as follows:

1) Frequently needed which should be kept as close as possible to the village (shop, mechanic);

2) Occasionally needed (every six months or year), which can be at a major centre close by;

3) Those needed for major rehabilitation or replacement (every few years) which can be kept at the local region or state capital.

Baumann (2002) also suggest that the cost of maintenance is often quoted without reflecting the full cost. The document reveals that the real cost of maintenance includes cost of spare parts, distribution, transport, labour, cost of establishment of support organizations, etc. The document further suggest that many of these cost items are difficult to quantify, as for instance a community member might travel a full day to buy spare parts and would not calculate the cost for lost labour and travel. It is cited in the document that for the sake of simplicity, most studies try to separate these aspects and calculate only the cash contribution a community has to make, i.e. repairs and spare parts. It is also found in the document that costs for maintenance range from about US$ 0.10 (for direct action hand pumps) to US$ 2.50 (for diesel pumps) per capita and per year. It points out that the cost analyses normally exclude depreciation, which means the cost of rehabilitation and replacement of equipment are not counted. The document asserted that the costs of rehabilitation and replacements are often covered under development budgets and seems to makes sense for it not to be considered under the analysis of cost of maintenance. It however, further reveals that at macro level, it would be necessary to look into the economic costs of rehabilitation and that the cost paid fully by the communities is only one component of the total maintenance cost. In addition to this part, it is necessary for governments or district authorities to budget for back up services i.e. extension/supervision, well maintenance, etc.

Davis and Brikke' (1995), identified how to optimize costs of water service or reduce O&M cost as an important aspect of water service costs analysis and provided the following as ways at which water service costs can be significantly reduced or optimized:

- choosing a technology with inexpensive spare parts and/or inexpensive operating costs
- reducing the transport costs to go and buy spare parts and chemicals (making spare parts more accessible and available)
- reducing dependence on chemical use (alternative water treatment technology for instance, such as multi-stage filtration system)
- reducing dependence on fuel or electric consumption by using solar, gravity, or wind energy
- firmly installing a maintenance culture within the community and professional staff
- organizing preventive maintenance activities where users are also involved
- installing systematic leakage control
- applying economies of scale for larger systems (reduces costs for the consumer)
- applying a control for unaccounted-for water (because of both leakage and bad management)
- installing proper administrative and financial control mechanisms.

2.4 Cost Recovery and Financial Sustainability of Water Systems

In Ghana, water users in rural communities and Small Towns are not supposed to pay up to 95% of the initial investment of providing water systems because this is paid by the government and external agencies. (CWSA, 2004) As cited by Davis and Brikke′ (1995), governments are facing the greatest difficulties in meeting recurrent costs of providing water service, and the tendency is to make beneficiaries pay for the water they use, in order to recover partially or totally the costs of supplying this service, and to give to the communities more responsibility in the actual management of the water supply system. Support costs have been subsidized by the government and external agencies in the past but for financial sustainability of water service delivery, full coverage of O&M costs is the eventual goal for which communities will need to contribute both the direct and support costs of O&M. especially if replacement costs have to be included. In some cases, O&M funds are expected to pay for the complete overhaul and replacement cost of equipment when it wears out.

According to Brikke ' (2000) tariffs are used primarily to recover the cost of providing water service and designing a tariff requires that one keeps in mind equity, affordability and willingness to pay. We have to ensure equity in the sense that, all members of the community, rich/poor, men/women, should have equal access to the benefits of the improved water supply service. O&M costs can only be recovered from users if they are both able and willing to pay for a water supply. The document points out that people should not have to pay more than 3–5% of their income for water and sanitation services (affordability criteria) and that a higher percentage of income expended on water will mean other important needs may not be fully met.

Setting up a tariff should be done with and by the community, as it will allow the community to bear the full responsibility of applying the decisions made, and as it will be better accepted by the community. It is inevitable that overtime tariff levels and structure have to be revised as a result of demand patterns, changing costs structure, inflation, and the need for increased funds for major expansion. Delays in adjustments of tariffs can have serious consequences for financial sustainability of the water service delivery and is therefore appropriate to review the tariff levels and structure at least once a year for piped schemes and once every two years for others. (ibid)

Nyarko et al. (2007) reveals that cost recovery of water services refers to the recovery of all costs associated with a water system, programme or service to ensure long-term sustainability. It is therefore important to know the cost elements and how best to recover the cost to sustain the services. It is cited in the document that Rogers et al. (2002) identified the various cost components and then distinguished between full supply cost, full economic cost and full cost. The cost components are operation and maintenance costs, capital costs, opportunity costs, and costs of economic and environmental externalities. The operation and maintenance costs and the capital charges represent supply cost. Supply cost, opportunity cost and economic externality constitute the full economic cost. Opportunity cost represents forgone benefits for the next alternative use. Economic externalities may arise from the changes in economic activities as a result of the project. The full economic cost and environmental externality constitute the full cost. The public health externalities, for example, may include pollution from wastewater, while the cost imposed on the ecosystem constitutes environmental externalities.

Full recovery of cost from users results in economic efficiency, which in theory results in optimum water use with neither over usage (wastage) nor under usage (below adequate health and other criteria). Full cost recovery therefore provides incentives for the efficient use of facilities. The cost may be determined based on historical or marginal costing. The historical approach is based on cost that has actually been incurred, whereas marginal cost is based on the cost of expanding services. The question of which cost should be recovered is often a dilemma for both planners and communities. The way out of this dilemma is to discuss this question and review various possible options (ibid). As cited in the document, the various options according to Brikke ' & Rojas (2001) include immediate full cost recovery, progressive full cost recovery, recovery of only operation and maintenance, and recovery of only operation and maintenance with an initial subsidy. As a minimum, the supply cost, which is the operational and capital cost, should be recovered to ensure sustainable service delivery. It is therefore important to ensure that this cost is recovered from the beneficiaries, and when this genuinely cannot be achieved then clear mechanisms for subsidies should be put in place to ensure sustainability.

It is also cited in the document that a survey of water charges in 122 developing countries by Briscoe and de Ferranti (1988) revealed that there was no cost recovery in 28% of the countries, and only part of the operation and maintenance costs were recovered in 30% of the countries. Full cost recovery was attempted in just 6% of the countries studied. Studies by Dworkin (1980) suggest that the water supply systems that provide the most reliable service are those where communities contribute to operation and maintenance costs in full.

CHAPTER THREE: THE SMALL TOWN'S WATER SECTOR IN GHANA

3 Introduction

This chapter provides an overview of Small Towns Water Sector, the key elements of the community water and sanitation policy in Ghana, the sector policy on financing Water and Sanitation projects and finally policy on operations and maintenance of small town's water systems.

3.1 Overview of the Ghana water sector

The Ghana Water and Sewerage Corporation (GWSC) now Ghana Water Company Limited (GWCL) had the responsibility to provide and manage potable water supply and sewerage services for domestic and industrial purposes throughout Ghana until the year 1994 as indicated in the Strategic Investment Plan (SIP) document (CWSA, 2008). The Government of Ghana (GOG) launched a National Community Water and Sanitation Programme (NCWSP) in the year 1994 to accelerate the delivery of water and sanitation services to rural communities and small towns and created the Community Water and Sanitation Division (CWSD) within the GWSC. In 1998, the government established the Community Water and Sanitation Agency (CWSA), and gave it mandate to facilitate the provision of sustainable potable water and related sanitation services as well as hygiene promotion to rural communities and small towns. The CWSA was to exercise its mandate through resource mobilization, capacity building, standards setting and quality assurance with the active participation of all stakeholders (ibid)

3.2 Definition of Small Town Water Sector in Ghana

The Small Towns' water supply sector is part of the community water supply sector. It consists of CWSA, District/Municipal Assemblies, DWSTs, WSDBs and community members in these towns. According to the small towns policy document (CWSA,2003), small towns are defined as communities of between 2,000 and 50,000 population who require improved water supply and related sanitation facilities. The towns are further categorized based on population as indicated in table 3.1

Table 3-1: Population categorization of rural communities

Category	Population range
Category I	2,000-5,000
Category II	5,100-15,000
Category III	15,001-30,000
Category IV	30,000-50,000

According to CWSA national diary (CWSA, 2009), within a little over a decade (1994-June2008) of implementing the NCWSP, there has been significant acceleration in the water and sanitation facilities to rural communities and small towns in Ghana. Delivery figures for Piped Systems now stand at 272 for Small /Rural Communities Schemes and 322 Small Towns systems making 594 constructed Piped Systems.

3.2.1 Typical Technologies of Small Town Water System

According to the small towns policy document (CWSA, 2003), the main water supply technologies to be adopted for small towns water service delivery shall include:

a. Groundwater based piped systems;

b. Spring or highland water supply systems (Gravity systems);

c. Surface water/Slow sand filtration piped systems;

d. Package Treatment Plants;

e. Other technologies to be adopted, where necessary.

3.2.1.1 Water Source Selection

According to the document the selection of water sources should ensure minimum development costs, and should be in accordance with the following order of preference:

a. Groundwater abstraction;

b. Springs;

c. Relatively unpolluted surface water sources;

d. Polluted surface water sources.

3.2.1.2 Energy Source Selection

The Selection of energy sources according to the document shall be in accordance with the following order of preference:

a. Grid Electricity;

b. Solar Energy;

c. Diesel Generator.

3.2.2 Life Span of Small Towns Water System

According to the small town policy document (CWSA, 2003), the general design life for construction of Small Towns Water Supply Systems shall be 10 years from the expected time of commissioning and individual components of the system may have varying design periods determined from the expected time of commissioning between a minimum of 10years to a maximum of 15 years. For tariff setting computations, the Small Towns Operations and Maintenance (O&M) guidelines policy document (CWSA, 2004) provides the design life of Small Towns water systems to be 25 years. For this study the life span of small town water system is taken as 20 years.

3.3 Water Sector Reforms

According to the SIP document (CWSA,2004), in the year 1993, the Government of Ghana initiated reforms in the water sector as part of measures to accelerate the provision of water and sanitation service to the people of Ghana. Key elements of the reforms were the decoupling of rural water from urban water supply, the establishment of promotional and regulatory bodies and the encouragement of increased private sector participation in the water supply process.

The significant reform actions taken since the year 1993 are summarized below:

a) The ceding of urban sanitation and public health activities to the District Assemblies with the promulgation of the Local Government Act

b) The setting up of the CWSA to cater for rural water supply and water related sanitation activities

c) The conversion of GWSC, from a State Corporation, to GWCL (a limited liability company) to enable it perform its function under the Companies Code

d) The transfer of over 110 small towns water systems from GWCL to District Assemblies for community management

e) The establishment of the Public Utilities Regulatory Commission (PURC) to regulate tariffs and activities of public utilities

f) Establishment of the Water Resource Commission (WRC) to control the use and development of all water resources in the country.

GWCL was given responsibility for urban water supply, while District Assemblies and communities were enabled to provide these services to rural and small towns, facilitated by the CWSA on a demand-driven approach.

3.4 Key Elements of the Community Water and Sanitation Policy

The key elements of the Community Water and Sanitation policy are the following:

1. Demand responsive approach through which communities decide whether they want to participate and their preferred service level based on their willingness to fulfill a number of obligations, including contribution toward capital cost

2. Decentralization of planning, implementation and management of services by:

   a. Making communities decision-makers and managers of the water supply and sanitation facilities

   b. Making District Assemblies more autonomous and better able to assist communities to obtain improved services and

   c. Linking the NCWSP into District Development Plans and activities

3. Intensive community development and training programmes to ensure that there is adequate understanding of the overall programme concept and strategy, to enable communities make informed choices about preferred service levels and management options, and acquire the skills to sustain services
4. Private sector (including NGO) provision of all goods and services, and responsiveness to the communities
5. Public sector playing a facilitating role with the CWSA managing the NCWSP, providing technical assistance to District Assemblies and strengthening private sector participation and capacity
6. Stakeholder consultation, including External Support Agency and NGO co-ordination, joint annual reviews and sharing of experiences
7. Encouraging learning, innovation, participatory monitoring and evaluation, and impact assessments, especially in areas such as:

a. Full participation of women at all levels of the programme
b. Application of low cost technology and service level options
c. Effective hygiene promotion and training
d. Sustainable supply chains of goods and services and especially spare parts at the local level
e. Targeting areas that have lower coverage, and
f. Increasing the role of communities in decision-making, service financing and implementation.(ibid)

3.5 Water Projects Finance and Cost Recovery Policy in Small Towns Sector

As cited in the SIP document (CWSA, 2004), the CapEx portion of providing water service is provided by the Government with assistance from External Support Agencies (ESAs) and the beneficiary community members. The government and the ESAs provide 95% of this capital cost while the communities contribute 5% of the cost. The reviewed policy of CWSA on this indicates that, after the initial community contribution, water tariffs should cover operations and maintenance, major repairs, replacements and extension to new areas (CWSA 2003). Thus, the tariff should recover the supply cost of the service. The support cost, which is the cost of running the WASH sector mainly, comes from the government of Ghana and the ESAs. The majority comes from the government and about 15 % of the investment provided by the (ESAs) is allocated to the government agencies (as management fees) to manage the implementation of the projects. By this procedure, the communities are supposed to pay for the operations and maintenance of running the water systems and also pay for replacements and expansions works of the water systems. The policy stipulates that community piped systems should be designed to ensure that tariffs do not exceed the cedi equivalent of 1 US$/$m^3$ of water used.

The model bye-laws on establishment and operations of WSDBs published by the government (MLGRD&E,2008) enjoins the WSDBs to establish at least three accounts which shall be designated as "Operational Account", "Capital Account" and "Sanitation Account". The document reveals that the WSDBs shall make payment at least weekly of all revenue accrued from water sales and other receipts to the Operational Account and shall pay all regular operation and maintenance costs from it. It also has it that the Capital Account shall be used for major repairs, extensions and replacement of the water systems and that the capital account shall not be used to support routine operation and maintenance. It request the WSDBs to make monthly payments of not less than 20% of the net monthly revenue accrued from water sales after all operation and maintenance costs have been paid into this account. The document further reveals that District/Municipal Assemblies may allocate funds annually through its regular budgetary allocation to the capital account. It also reveals that the sanitation account shall be used to promote sound sanitation and hygiene practices in the communities including household latrine construction and waste water management. It task the WSDBs to make monthly payment of not less than 10% of the net monthly revenue accrued from water sales into this account. It again states that the District/Municipal Assemblies may allocate funds annually into the sanitation account through their regular budgetary allocation. The government policy on who pays for major rehabilitation works resulting from design errors and inappropriate technological choices of water system in the small towns' sector is not clear. This is also confirmed in the Operations and Maintenance guidelines of the CWSA for small town's water systems where the cost elements have been listed and include both operational and capital expenditure (through depreciation of the various assets). Sector Policy on Operations and Maintenance of Small Towns Water Systems

According to small towns policy (CWSA, 2004), the key policy in operation and maintenance of small towns' water supplies is sustainability. Here a system is considered sustainable if it can meet the following requirements.

1. Delivering to consumers a quantity of water in according with CWSA design criteria.

2. Producing water to Ghana Standards Board Drinking Water Quality standards.

3. Delivery of water in a cost-effective manner in accordance with tariff guidelines and to the approval of the District Assembly.

4. Delivering water in a virtually uninterrupted manner (at least 95% of the time).

The second facet of this policy is the carrying out of planned maintenance for all Mechanical/Electrical equipment and Civil Works structures.

Furthermore there will be systematic, continuous recording of Technical, Financial and Administrative data on the operation and maintenance of the water supply systems for analysis, decision making and reporting. Reporting by communities shall be to District Assemblies with copies to the Regional office of CWSA.

There will be training of staff of Private Companies/Communities who will run the Water Supply Systems. They will be given practical training in the field and theoretical training in an institution to be followed by certification and follow up. Retraining will be provided at periodic intervals.

In general, the water supply system will be operated in accordance with;

(a) Equipment manual directions

(b) Manual of Operations (to be prepared by Small Towns Consultants)

There are three main options for Management of Operations and Maintenance of Water Supply Systems.

1. The Community through its WSDB and employees, operates and maintains the Water Supply System entirely by itself, with a trained Manager, Operator, and Financial/Administrative staff, calling upon the services of plumbers, electricians, mechanics etc., within the community and its staff hired or on a retainer basis from within the community.

2. The community through its WSDB hires staff to see to its daily Operation, Financial, Administration, Technical) and Maintenance and signs a contract with a firm or firms to perform other technical, Financial or Administrative functions on a periodic basis, such as the preparation of Financial reports, internal auditing or some aspects of planned maintenance.

3. The community through its WSDB contracts a firm to completely operate and maintain the Water Supply System including meter reading, billing and revenue collection, for an agreed fee, to set performance standards for a set period of time.

Each WSDB, in consultation with its community must take a decision on its management option.

However, the most appropriate option chosen depends on four main factors:

- The Complexity of the Water Supply System Technology
- The quantity of water being produced/number of people served,
- The location of the community in relation to major road networks, and commercial centers, and finally
- The commitment of the community.

Generally, the following guidelines shall apply:

1. Communities with up to 5,000 people served with groundwater, spring based or slow sand filtration systems may adopt Option 1, provided they are interested and committed to the operational management of the Water Supply Systems themselves.

2. Communities of 5,001 – 15,000 people served with simple boreholes, gravity or slow sand filtration based piped systems may adopt Option 2.

3. Communities with populations of above 15,000, and/or communities served with complex Water Supply Systems may necessarily adopt Option 3, unless they have the requisite expertise within the community.

Other options may be considered exclusively for the production and distribution components of the Water Supply System. Option 2 or 3 may be adopted for the management of the production component of a system, provided it consists of a surface water treatment plant or several mechanized boreholes. However, the same or a different option may be adopted for the distribution network, depending on its size and complexity.

Public Education should be carried out regarding the complexity of operation and maintenance of large schemes during the mobilization and construction phases of the project cycle before commissioning of the Water Supply.

CHAPTER FOUR: STUDY AREA AND RESEARCH METHODOLOGY

4 INTRODUCTION

This chapter gives brief description of the study area and background to the small towns water systems used in the study. It also gives the method used in carrying out the study which explains how sampling was done, procedure for data identification and collection and analysis.

4.1 Study Area

The study was conducted in the Central Region which lies in the southern and coastal part of Ghana occupying an area of 9,826 sq km of the total land area of 238,533 sq km of Ghana. The selected small town's water systems for the study are located in seven municipal/districts assemblies out of the now seventeen municipal/districts in the region. The names of the interested assemblies are, Assin North and Upper Denkyira East Municipal, Assin South, Twifo Heman Lower Denkyira, Komenda Edna Eguafo Abrem, Asikuma Odoben Brakwa and Awutu Senya Districts.

4.1.1 Location Map

The location map of the selected small towns under the study is as shown in Figure 4.1

Legend: Districts of the selected Small Towns

District No.	Name
1b	Upper Denkyira East Municipal
2a	Assin North
2b	Assin South
3	Twifo Heman Lower Denkyira
4	Asikuma Odoben Brakwa
5	Komenda Edina Eguafo Abrem
6	Awutu Senya

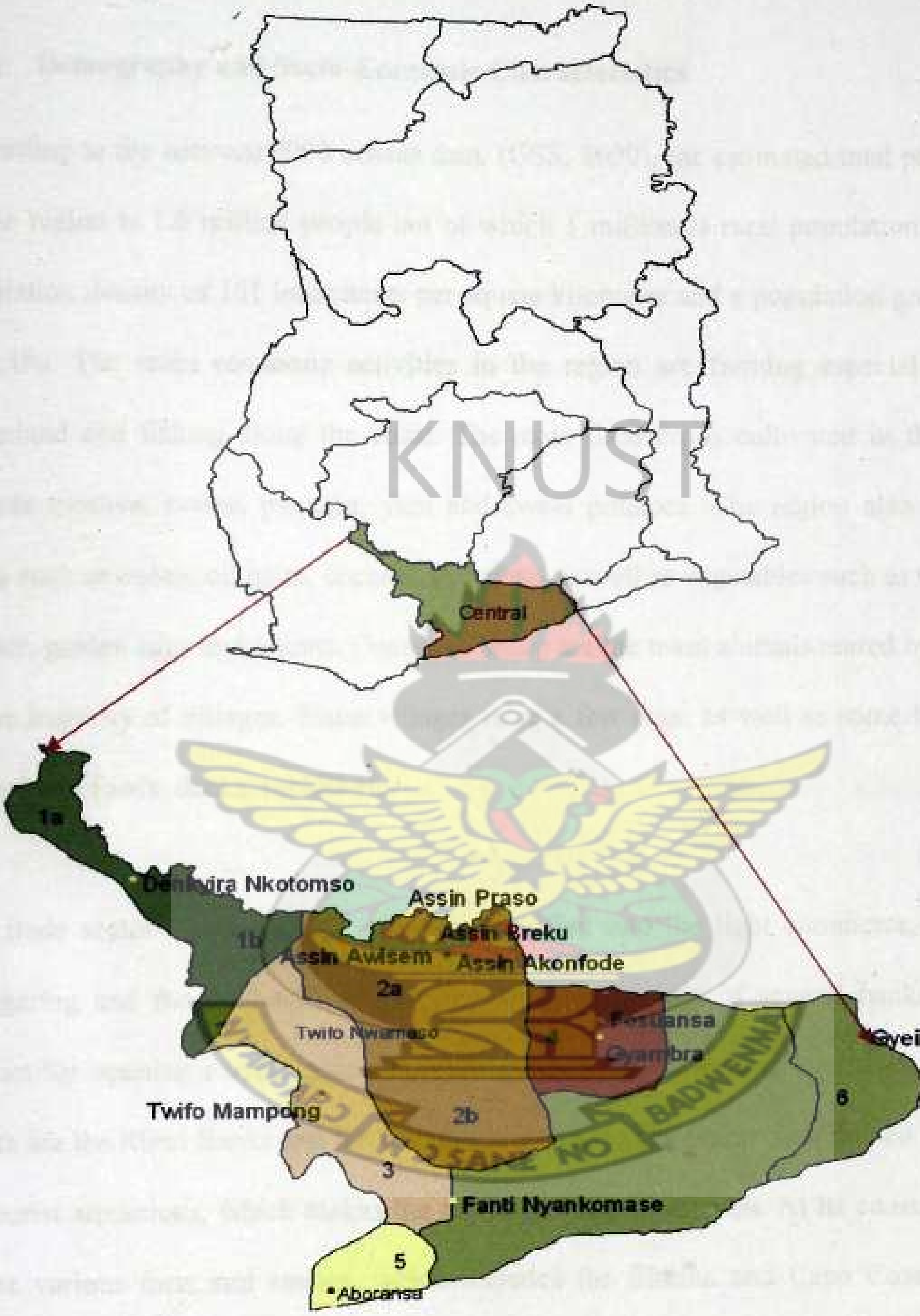

Figure 4-1: Location map of Study Small Towns

4.1.1 Demography and Socio-Economic Characteristics

According to the national 2000 census data, (GSS, 2000), the estimated total population of the region is 1.6 million people out of which 1 million is rural population. It has a population density of 161 inhabitants per square kilometer and a population growth rate of 2.1%. The main economic activities in the region are farming especially in the hinterland and fishing along the coast. The main food crops cultivated in the region include cassava, maize, plantain, yam and sweet potatoes. The region also has cash crops such as cocoa, oil palm, coconut and citrus as well as vegetables such as tomatoes, pepper, garden eggs and onions. Goats and sheep are the main animals reared by farmers in the majority of villages. Some villages raise a few pigs, as well as some back-yard animal like fowls, ducks, rabbits etc.

The trade sector in the region may be classified into the light commerce, the fish-mongering and the food-selling. Villagers use the services of several banks in their district for opening current accounts, savings accounts, or getting loans. Among such banks are the Rural Banks and the Commercial Banks. The region is endowed with a lot of tourist attractions, which makes the region leading in tourism. At its coasts one can locate various forts and castles, which includes the Elmina and Cape Coast castles. There are also forest reserves which include the Kakum National Park with a canopy walk. Trading, catering and hotel businesses are therefore important economic activities in the region. The Ghana living standard survey revealed an average annual per capita income in the region as Ghc 464 higher than the national average of Ghc 397 per capita (GSS, 2008).

4.1.2 Geology and Hydro-geological Conditions

The geology of the Central Region broadly comprises Pre-Cambrian Basement rocks overlain by small areas of Palaeozoic, Mesozoic and Tertiary sediments at two locations on the coast. The basement broadly falls into two groups, volcanics and sediments that have been replaced and metamorphosed by igneous intrusive granitic and basic rocks. More than two-thirds of the Central Region is underlain by the Cape Coast Granite Complex, with Birimian and Tarkwaian rocks in the northwestern districts and Birimian, Togo Series and Sekondian rocks along the coast. All groundwater resources in the Central Region, apart from those in the small tertiary basin, are located in the discontinuous aquifers formed by the weathered and fractured part of the Granite complex.

4.1.3 Ground Water Quality

In the Central Region salinity is a major problem in coastal aquifers. Although deeper boreholes drilled in this area may tap into Secondian aquifers with freshwater, the groundwater encountered in the coastal aquifers is generally too saline for water supply purposes. Also due to the shallow nature of basement aquifer units in the region, they are relatively susceptible to microbial or industrial pollution in urban environments.

4.2 Data for the Study

The study captured data on technology, the components and characteristics of selected water systems. It also captured the Capital Expenditure (CapEx) of providing the systems, the Operations and Maintenance Expenditure (OpEx) of running the systems, the Capital Maintenance Expenditure (CapManEx) and Support cost. The conceptual frame work for quantifying the cost of sustainable water service delivery and the framework indicating details of the Cost Components of water service delivery for this study are shown in figures 4.3.1 and 4.3.2.

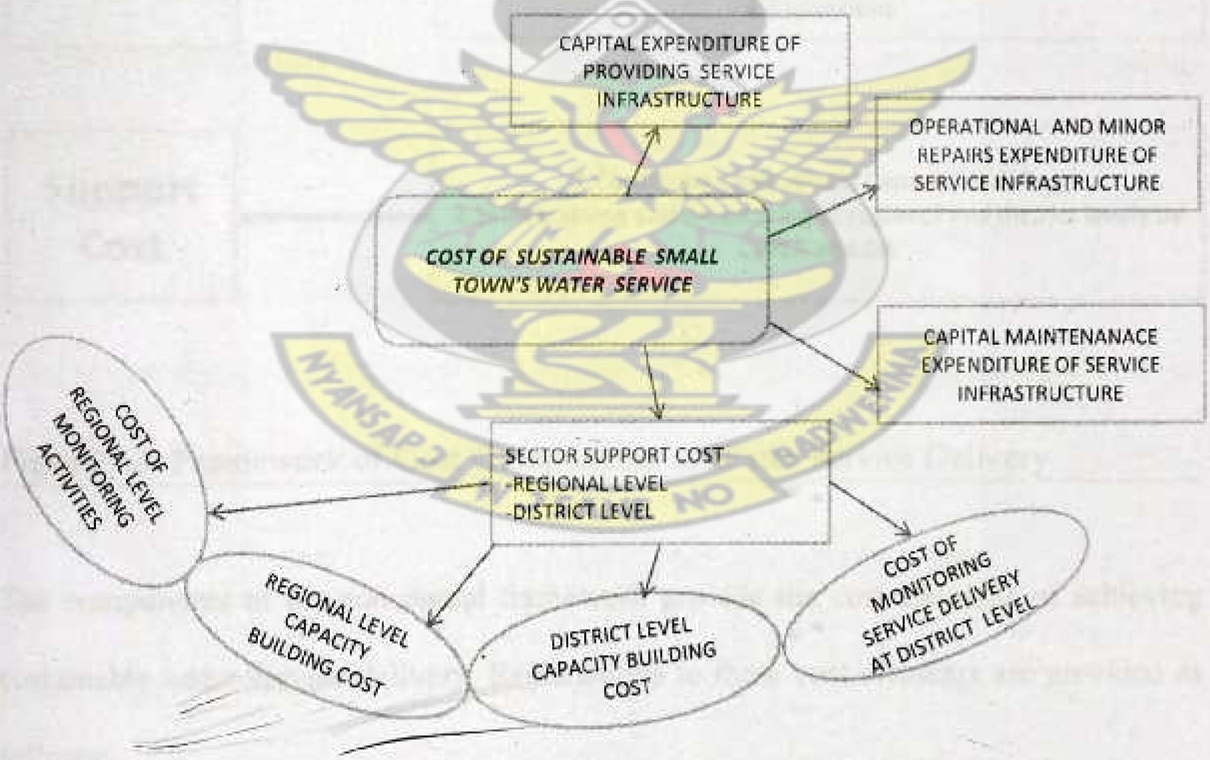

Figure 4-2: Conceptual Framework for Quantifying Cost

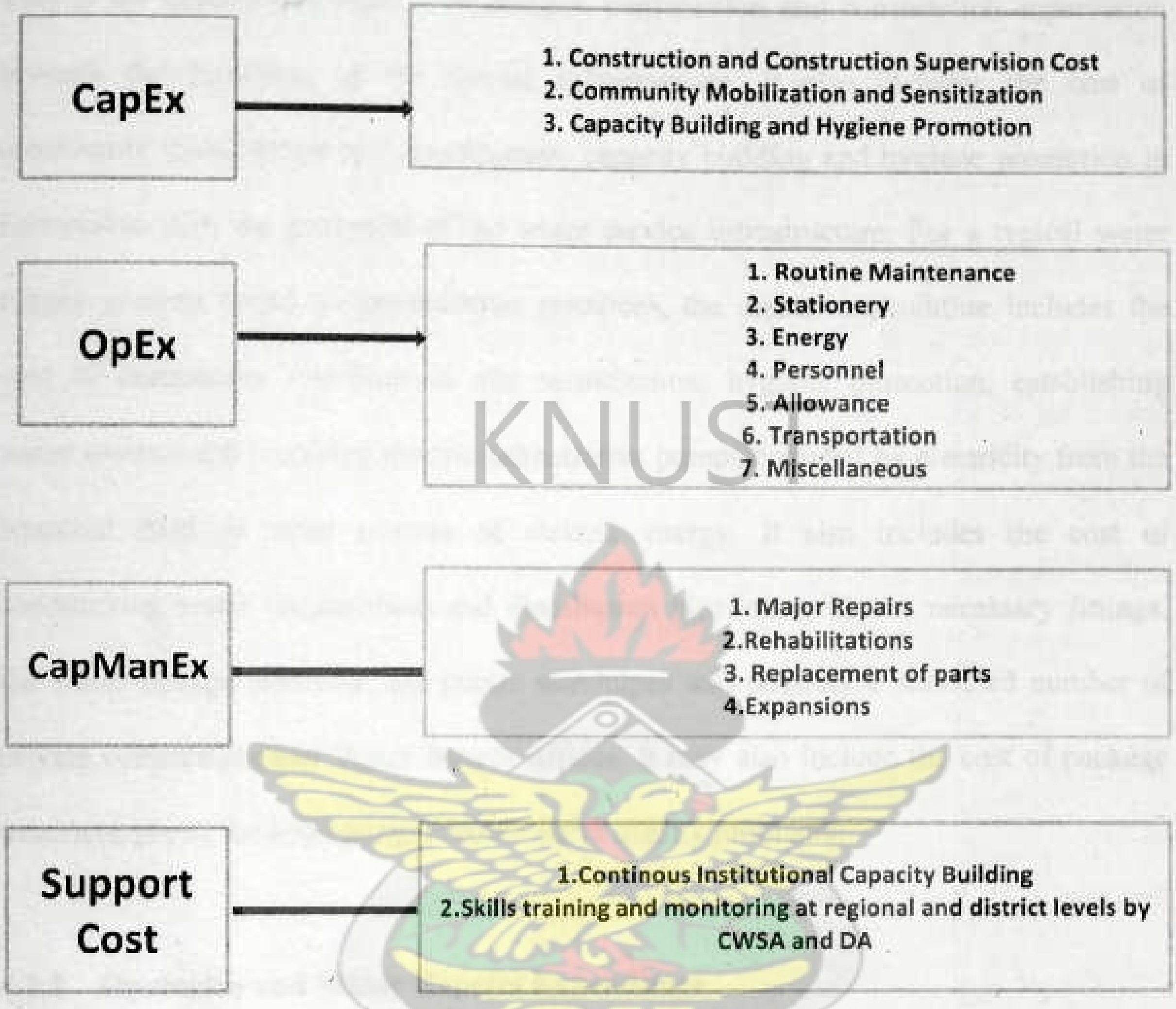

Figure 4-3: Framework of Cost Components of Water Service Delivery

The components of the conceptual framework provide the cost elements of achieving sustainable water service delivery. Explanations to these cost elements are provided as follows:

4.2.1 Capital Expenditure

This is the expenditure made in designs, construction and construction supervision towards the provision of the service infrastructure. It also includes the cost of community mobilization and sensitization, capacity building and hygiene promotion in connection with the provision of the water service infrastructure. For a typical water supply systems based on groundwater resources, the capital expenditure includes the cost of community mobilization and sensitization, hygiene promotion, establishing water sources and installing electric submersible pumps operated by electricity from the National Grid or other sources of electric energy. It also includes the cost of constructing water transmission and distribution pipelines with the necessary fittings, the water storage reservoir, the public standpipes and possibly a restricted number of private connections and Water Boards offices. It may also include the cost of package treatment plants for addressing possible water quality problems.

4.2.2 Operation and Minor Repairs Expenditure

This covers the costs of day-to-day operations of the facilities and consists of salaries, administrative cost, energy use, materials, etc. It also includes the cost of carrying out minor repairs and preventive maintenance of the service infrastructure.

4.2.3 Capital Maintenance Expenditure

This covers the expenditure on major repairs, replacement of worn out parts of the water system and the asset rehabilitation and possible future extensions.

4.2.4 Sector Support cost

This covers the cost of institutional strengthening, capacity-building, back-up support, and regulation, monitoring and policy formulation in the water sector. For this study the sector support cost is limited to the cost of institutional strengthening and capacity building at regional and district levels with respect to WASH activities. It also includes the cost of back-up support and monitoring WASH activities at the regional and district levels. Cost of back-up support and monitoring activities includes staff salaries, field allowances, cost of fuel and vehicle maintenance etc., and the cost of institutional strengthening and capacity building includes cost of staff training, provisions of logistics for work and the cost of organising capacity building workshops and conferences.

4.3 Selection of Systems for the Study

The sampling technique adopted was the Purposive Sampling where systems which were expected to have some level of record keeping of their operations were selected. Seven (7) out of Twelve (12) Small Towns water systems constructed in 1998 in the region were selected because they have been in operation for about a decade as at the time of the study and have kept some operational records. However, the other five (5) systems were included in the study for objective 2 of this study to help understand the factors affecting the cost of sustainable water service delivery.

4.3.1 Data Collection

The following steps outline the data sources and collection procedures.

4.3.1.1 Data sources

The CapEx of the water schemes was identified and obtained from project completion report as secondary data at the Central Regional office of the CWSA.

The OpEx was identified and obtained from the water system operational records in the selected small towns at the Water and Sanitation Development Boards (WSDBs) offices.

The rehabilitation cost component of the CapManEx was identified and obtained from payment certificates at the accounts department of the regional CWSA office. The other components of this expenditure were identified and obtained from the operational records at the WSDBs offices.

The Support cost was identified and obtained at the accounts departments of the regional CWSA and the District Assembly (DA) offices.

4.3.2 Data Collection Procedure

The data collection procedure comprises of review of project completion reports and contract payment certificates, the use of tables and checklist to gather data from operational records and field investigations.

4.3.2.1 Review of project completion reports and Contract Payment Certificates

Project completion reports and contract payment certificates were reviewed to obtain data on CapEx and rehabilitation costs of selected water systems. Data on the water system components and characteristics were also obtained from review of project completion reports.

4.3.2.2 Use of Tables and Checklist

Tables and Checklist were developed to guide the collection of OpEx, CapManEx and Support cost data. Copies of tables and checklist are attached in appendix 4

4.3.2.3 Field Investigations

Field investigations of the selected small towns' water systems were undertaken to determine factors which affected the cost of sustainable water service delivery.

The whole data source and collection procedure is summarized in Table 4.1 below.

Table 4-1: Summary of data source and means of collection

Data Type	*Source of Data*	*Means of data collection*	*Date*
Data on Water System			
System components and characteristics	Project completion report at the regional CWSA office	Review of project completion report	August 2009
Costs Data			
Initial Investment cost of water systems	Project completion report at the Central Regional office of CWSA	Review of project completion report	August 2009
Rehabilitation cost of water systems	Contract payment certificates at accounts department of regional office of CWSA	Review of payment certificate	August 2009
Operation and Maintenance (O&M) cost records of water systems	Water system operational records of Water Boards at the communities	The use of tables See appendix 1 for copy of table	September 2009

Support cost: regional level	Records at accounts department at the Central Regional office of CWSA	The use of checklist See appendix 1 for copy of checklist	September 2009
Support cost: district level	Records at the finance office of District Assembly	The use of checklist See appendix 1 for copy of checklist	September 2009

4.3.3 *Data Analysis*

The following bullet points outline the data analysis procedure;

- Determination from secondary data the CapEx (as built) of all twelve water systems
- Adjust the CapEx to a base year using inflation rate for the period of study (1998-2008) from Ghana Statistical Service
- Likewise, adjust the annual OpEx , CapManEx and support cost of running seven selected water systems for the period of the study to a base year
- Compute the annual equivalent CapEx of each of the seven selected water systems considering the useful life of 20 years of the water system and also using the inflation rate of 17.6% for the study period
- Compute the unit CapEx per capita from the annual average figure considering the design population of the water systems

- Compute the annual equivalent average OpEx, CapManEx and Support Cost of running the seven selected water systems considering the number of years of operation of the systems and using the inflation rate for the period of study
- Compute the unit OpEx and CapManEx per capita from its annual average figures using the design population of the water systems
- Also compute the unit Support Cost per capita from its average annual figure using the rural population of the region and the districts where the water systems are located
- Compute the total unit cost of developing and sustaining water service from the above for the seven selected water supply systems
- Identify the factors which affect the cost components of sustainable water service delivery of the water systems from the field investigations.

5 CHAPTER FIVE: RESULTS AND DISCUSSIONS

This chapter provides key results of the study and discusses them under the following headings; (i) features of the water systems, (ii) the cost of providing the water systems and factors affecting it and (iii) the cost of sustainable water service delivery and factors affecting it.

5.1 Features of the Water Systems

Summary description of the key water system units and their characteristics for all twelve water systems for the study is provided in Table 5.1 below

Table 5-1: Summary Description of Water Systems

Small Town's Water System	Design Pop.	Water Reservoir/Tank Capacity (m^3)	No. of Stand Pipe Connections	Length of transmission pipe (m)	Length of distribution pipe (m)	Power Source			Water Source	
						Gen Set	Solar	Nat. Grid	Borehole	River
Assin Breku	5,452	25	6	313	1694	√			√	
Akonfode	3,163	15	5	184	1075	√			√	
Twifo Mampong (1)	3,844	25	5	321	723	√			√	
Aboransa (1)	10,784	95	19	388	9306	√			√	
Assin Praso (2)	4,474	30	6	1350	3305	√				√
Denkyira Nkotomso (1)	1,579	15	3	831	876		√		√	
Twifo Nwamaso	4.446	25	5	144	715		√		√	
Assin Awisem	1,700	15	4	143	594		√		√	
Gyeikrodua	3,483	15	3	582	665			√	√	
Fosuansa	1,949	15	3	423	420			√	√	
Gyambra	1,407	15	3	473	905.7			√	√	
Fanti Nyankomase	2,552	25	4	228	1120			√	√	

(1) Water System equipped with iron removal unit
(2) Water system equipped with treatment plant

5.2 Cost of Providing Water System

The results of the adjusted Capital Expenditure (CapEx) of providing the Small Towns Water System to a base year (2008) reveals a range from a minimum of Ghc 39.54 per capita in Gyeikrodua to a maximum of Ghc 154.63 per capita in Denkyira Nkotomso (See Figure 5.1). The features of the water systems are shown in Table 5.1 above and the difference in the CapEx per capita of the various systems is discussed in section 5.2.1 below.

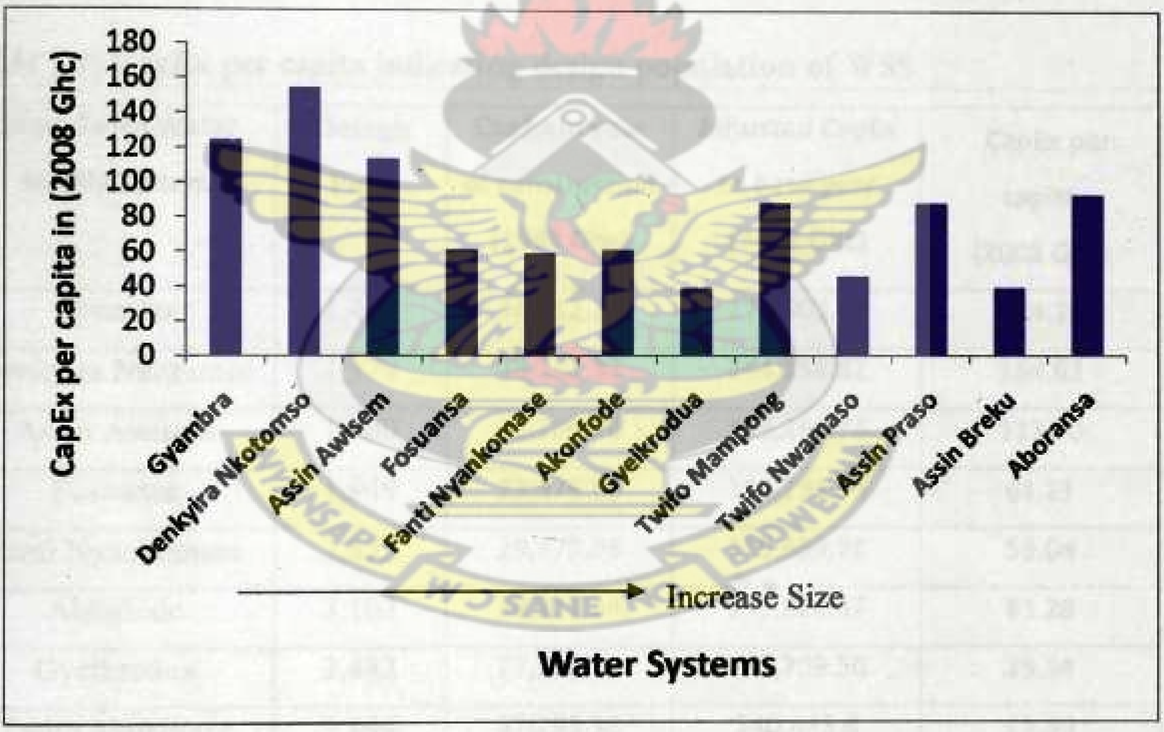

Figure 5-1: CapEx per capita of water systems (as built)

5.2.1 Factors Affecting Cost of Providing Water Systems

The Capital Expenditure (CapEx) per capita of providing the water systems are arranged in increasing order of design population (see table 5.2). It is generally expected that water systems with lower design population should give higher CapEx per capita and vice versa (the principle of economies of scale). The result generally reflects this but with some anomalies. The anomalies confirm that other factors besides the design population of the water system also affect the CapEx. Analysis of the features of the water systems in Table 5.1 together with the result shown in table 5.2 reveals that the CapEx is also affected by the source of water, treatment technologies and size of network of the systems.

Table 5-2: CapEx per capita indicating design population of WSS

Small Town Water Supply System	Design Pop.	CapEx in year of construction (1998 Ghc)	Adjusted CapEx to base year (2008 Ghc)	CapEx per capita (2008 Ghc)
Gyambra	1,407	34,512.76	174,603.49	124.10
Denkyira Nkotomso	1,579	48,261.32	244,158.82	154.63
Assin Awisem	1,700	38,205.76	193,286.74	113.70
Fosuansa	1,949	23,579.68	119,291.95	61.21
Fanti Nyankomase	2,552	29,779.96	150,659.78	59.04
Akonfode	3,163	38,311.24	193,820.37	61.28
Gyeikrodua	3,483	27,220.16	137,709.50	39.54
Twifo Mampong	3,844	67,293.36	340,443.8	88.56
Twifo Nwamaso	4,446	40,590.64	205,352.08	46.19
Assin Praso	4,474	78,176.68	395,503.60	88.40
Assin Breku	5,452	42,669.36	215,868.54	39.59
Aboransa	10,784	199,474.60	1,009,161.84	93.58

In table 5.2, the Aboransa Water system is found to have the highest design population and yet not the water system with the least CapEx per capita. It is because is a multi-village system designed to supply water to seven communities and therefore has a relatively large distribution pipe network of 9306 m and nineteen (19) public stand pipe connections as indicated in Table 5.1. It also has an iron removal system made of cascade aerator, 25 cubic meter sedimentation tank and a pressure sand filter. The Assin Praso water system which also gives a relatively high CapEx per capita though in a relatively higher population scale zone is a surface water source system with a treatment facility. The Twifo Mampong and Denkyira Nkotomso water system's higher values of CapEx per capita than expected shown in table 5.2 is explained by the fact that they all have iron removal treatment units installed. (See Table 5.1) Thus the factors are source of water, treatment technologies and size of network of the systems.

5.3. Factors Affecting Sustainable Water Service Delivery

The test for sustainable water service delivery in the context of this study is the system whose operations and maintenance satisfies the following conditions:

- The water system delivers to consumers the design quantity of water over the design life of the water supply system.
- Producing water to Ghana Standards Board Water Quality Standards.
- Delivery of water in a cost effective manner
- Delivering water in a virtually uninterrupted manner (at least 95% of the time).
- Planned routine and periodic maintenance are carried out for all electro mechanical equipment and civil works structures (CWSA, 2004).

Investigations conducted during the field work revealed that six out of the twelve water systems under the study suffered a break in delivering service on sustainable manner. However, when they ceased to deliver service, measures were put in place to restore the service delivery after some time. The list of the systems indicating those that delivered service on sustainable basis and those that suffered break in service delivery is indicated in Table 5.3

Table 5-3: Water Systems Indicating Manner of Service Delivery

Water System	System Delivered Sustainable Service	System Suffered break in Service Delivery	Year of Const.	Year of System breakdown	Year of Rehab. Works	Rehab. Cost (Ghc)
Fosuansa		√	1998	2007	2008	224,268
Denkyira Nkotomso		√	1998	2001	2007	94,828
Twifo Nwamaso		√	1998	2000	2007	85,627
Assin Awisem		√	1998	2001	2008	80,502
Assin Praso		√	1998	2002	2008	122,396
Assin Akonfode		√	1998	2001	2008	90,513
Assin Breku	√		1998	-	-	-
Twifo Mampong	√		1998	-	-	-
Aboransa	√		1998	-	-	-
Gyambra	√		1998	-	-	-
Fanti Nyankomase	√		1998	-	-	-
Gyeikrodua	√		1998	-	-	-

5.3.1 Factors that Contributed to Interruption in Water Service Delivery

Field investigations revealed that all the three solar powered systems broke down and ceased to deliver service because of failure of the solar systems. The surface water system broke down because of failure of its raw water intake structure, one of the systems broke down because its borehole water source was depleted and the remaining system which also suffered had excessive iron concentration emerging in its borehole water source after the system has been operated for 9 years. These have been discussed in detail in the subsequent sections.

5.3.1.1 Akonfode Water System

The Akonfode water system broke down and ceased to deliver service because the borehole water source receded.(See table 5.3) From the design report available to this study, the borehole source established for the system had an unimpressive yield of $2.45m^3/h$. Though the water was pumped at a rate consistent with the yield of the water source, a progressive decline in the yield of the borehole source was observed and recorded as indicated in Table 5.4 This may probably be due to the fact that the water source could not naturally replenished itself because of long hours of pumping in order to extract enough quantity of water to meet the water demand requirements of the community. It got to a stage where the borehole yield could no longer sustain the operations of the systems so the system was abandoned by the community. According to the small town's water system design guidelines (CWSA, 2003), the borehole yield for such water systems should have been a minimum of $5m^3/h$. It is important for water system designers in the rural and small towns sector in Ghana to comply with all the directives in the design guidelines of the CWSA to help contribute to sustainable water service deliveries. At the time of the field work, it was observed that the water system has been rehabilitated and a new borehole water source of yield 6.78 m^3 /h has been established to replace the old source and also the water system which was originally powered by diesel generator set is now connected to the national electricity grid. As a result of these, the system ceased to deliver service for seven (7) years.

Table 5-4: Water Pumping Records of Akonfode Water System

Year	Hrs of Pumping	Pumping rate (m^3/h)	Year	Hrs of Pumping	Pumping rate (m^3/h)	Year	Hrs of Pumping	Pumping rate (m^3/h)
1998	8	2.25	1999	8	1.63	2000	8	0.88
	9	2.22		9	1.67		9	0.89
				8	1.38		8	0.75
				9	1.56		9	0.78
				8	1.00		8	0.63
				9	1.11		9	0.67

Source: Technical Manager (Akonfode water system)

5.3.1.2 The Fosuansa Water System

This water system had to be rehabilitated when the water system started experiencing periodic brownish colouration in the water delivered at the taps which was believed to be excessive iron concentrations in its borehole water source. This lasted for about a year according to information gathered on the field. During the field work it was observed that the water system has been rehabilitated and an iron removal package treatment plant has been installed on the system to deal with the mentioned water quality problem and also a new WSDB office has been constructed as part of the rehabilitation works. Please refer Table 5.3 and Appendix 3 for other information on the rehabilitation works.

5.3.1.3 The Denkyira Nkotomso, Twifo Nwamaso and Assin Awisem Water systems

These water systems were all installed with solar systems as the source of energy. These systems broke down because their solar panels which provides source of energy to the systems all failed. The failure of the solar panels could probably be due the manner at which they were mounted on steel columns very close to the ground level. The mounted solar panels were fenced with chain link fencing material and was hoped that was protective enough. Information gathered on the field revealed that the causes of the failure of the solar system included development of cracks in the panels resulting from stones thrown accidentally to hit the panels by children playing. It was observed during the filed work that the solar panels have been abandoned and almost covered with weeds. These panel perhaps could have worked if the were mounted on elevated steel columns. It is important that in order to ensure sustainable water service deliveries, system units should be constructed or installed in a way that makes their operation and maintenance easy for the communities to manage. During the field work, it was also observed that all three water systems have been rehabilitated and the Denkyira Nkotomso water system is now connected to the national grid of electricity. The Twifo Nwamaso and the Assin Awisem water systems have also been now provided with diesel operated generator sets with structures already installed on the systems to get them connected to the national electricity grid when those communities gets connected to the grid. It was also observed that new WSDB office have been provided for each of the water system as part of the rehabilitation works. The provision of the WSDB offices is believed to enhance the commitment and the activities of the WSDBs to help promote sustainable water service delivery. Please refer Table 5.4 and Appendix 3 for other information on the rehabilitation works. As a result of these, each of the water systems ceased to deliver service for about seven (7) years.

5.3.1.4 The Assin Praso Water System

The Assin Praso water system was a surface water system with a sump as the water intake structure where a submersible pump lifts the water to a treatment plant. This system broke down because the pump could no longer lift the water to the treatment plant. This was believed to be as a result of the high turbidity nature of the river water source which builds up sediments in the sump which turn to conflict with the pump action and often causes the pump to breakdown. The field investigations revealed that the community found this situation very challenging to manage because anytime there was such pump breakdown they had to travel to Cape Coast Ghana Water Company office to access a dewatering pump which could pump the accumulated silt out of the sump in addition to replacing the broken down submersible pump. The treatment plant according to a functionality study report, is a modified slow sand filtration system whose filter bed need to be loaded at a constant rate and to ensure that micro-organisms are always active in the sand, the filter beds are supposed to be operated continuously. (DANIDA/CWSA 2004) The situation at the water intake denied the treatment plant with continuous flow of water and that affected the performance of the treatment plant and was evident again from the field investigations that the situation was beyond the capacity of the community to manage. The system eventually broke down because of these and was abandoned till it was rehabilitated. During the field survey, it was observed that a borehole source has been established to replace the surface water source and the treatment facility has become redundant. The water system has also been provided with new WSDB office. Please refer Table 5.3 and Appendix 3 for other information on the rehabilitation works. As a result of these, the water system ceased to deliver service for six (6) years.

5.3.2 Factors that Promoted Sustainable Water Service Delivery

The field investigations revealed that the factors that contributed to the sustainable water service delivery included; (i) Commitment of the WSDBs, (ii) Dynamic Operation and Maintenance of the Water Systems, (iii) Technical and Financial Management Support from the RWSTs and the DWSTs and (iv) Simple water system technologies whose technical management capacity requirements is readily available within and around the community. These identified factors confirm some of the factors identified in literature by the work of Brikke' (2000) and Montgomery et al. (2009). The investigations revealed that water systems which had very committed WSDB enjoyed better accounting of their finances and good keeping of their operational records and had their routine and planned maintenance activities carried out as scheduled which made their O&M dynamic. Water systems which were regularly visited by the RWSTs and the DWSTs had their O&M monitored regularly and its WSDBs enjoyed regular technical and financial management support which builds their capacity and enables them to become efficient in their delivery of services. It was also observed that the WSDBs were more comfortable with the single piped water system of a mechanized borehole with submersible pump powered with the national electricity grid which pumps water to high level tanks and distributed under gravity to stand pipes at strategic location within the community.

5.4 The Cost Components of Sustainable Water Service Delivery

The cost components have been identified to be CapEx, OpEx, CapManEx and Support Cost as defined previously in section 4.2.The results for these costs components in per capita per annum for running the water systems is shown for seven water system (see fig.5.1) The annual CapEx ranges from a minimum of Ghc 1.43 per capita for Bereku water system to a maximum of Ghc 4.49 per capita for Gyambra water system. The OpEx ranges from a minimum of Ghc 0.12 per capita per annum for Akonfode water system to a maximum of Ghc 1.06 per capita per annum for Gyambra water system. It is observed that Gyambra water system records the highest annual CapEx per capita as well as the highest annual OpEx per capita. This could probably be due to the fact that it has the least designed population of 1407 among the systems under the study. The annual CapManEx per capita ranges from a minimum of Ghc 0.11 for Twifo Mampong water system to a maximum of Ghc 5.07 for Fosuansa water system .It must be explained that this high value of annual CapManEx per capita recorded by the Fosuansa water system is due to the rehabilitation works carried out on the system to solve the water quality problem which was discussed in section 5.3. It is observed that besides water systems which were rehabilitated and making their CapManEx quite substantial, the annual CapManEx per capita is averagely half of the annual OpEx per capita. This means that for planning purposes, half of operational expenditure should be kept for possible capital maintenance activities if we wish to achieve water service delivery on sustainable manner. The annual support cost of running the water systems also ranges from a minimum of Ghc 0.41 per capita to a maximum of Ghc 0.49 per capita.

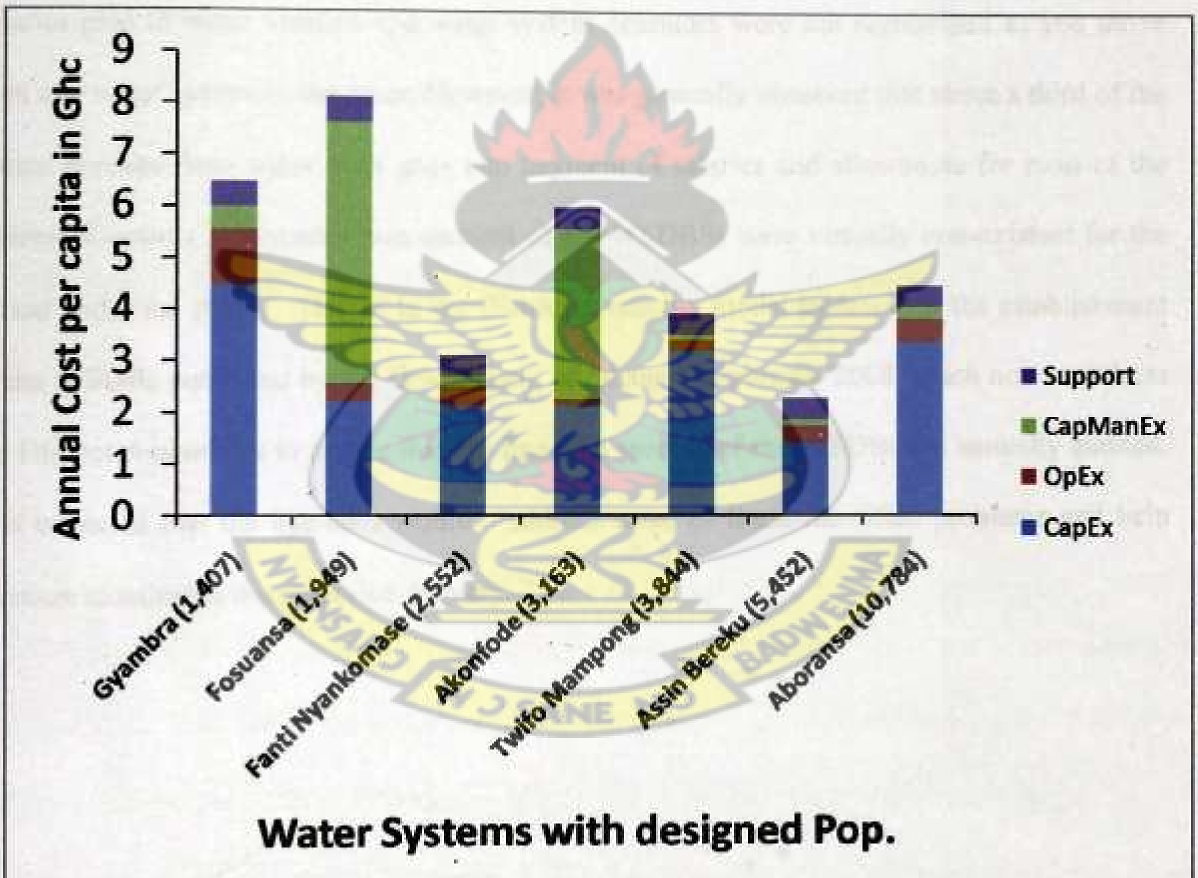

Figure: 5-2 Cost components of Sustainable Water Service Delivery

5.4.1 Disaggregated OpEx of Water Systems

The result of the disaggregated OpEx of seven water systems reveals that salaries and allowances averagely forms the greater portion of the OpEx (See figure 5.3).The salaries and allowances actually ranges from a minimum of 49% to a maximum of 82%, the administrative and energy cost combined ranges from a minimum of 20% to a maximum of 50% and the preventive and minor repair cost ranges from 0% to a maximum of 7%. These revelations would not promote sustainability of the water systems. It was observed during the field work that there was a lot of motivation among the WSDBs to pay bonuses to themselves especially at year endings in the name of Christmas bonus and lucrative allowances at quarterly WSDBs meetings. Salaries paid to water vendors and water system operators were not regularized as you move from one water system to the other. However, it was generally observed that about a third of the annual revenue from water sales goes into payment of salaries and allowances for most of the systems. Controls in financial management of the WSDBSs were virtually non-existent for the period under the study. Thanks to the District Assembly model by-laws for the establishment of the WSDBs published by the Government of Ghana in February 2008 which now mandates the District Assemblies to ensure that the financial records of the WSDBs are annually audited. It is expected that the bye-laws would address some of these identified problems and help promote sustainable water service delivery.

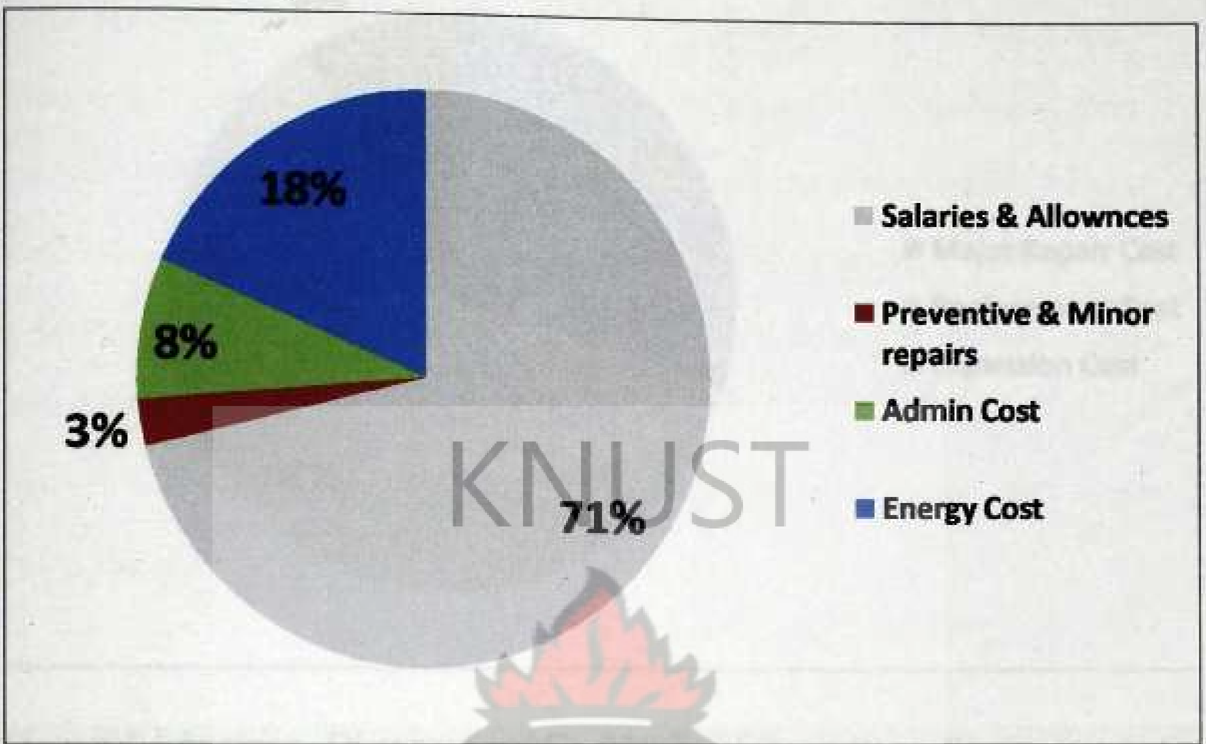

Figure: 5-3 Average Disaggregated OpEx of seven water systems:

5.4.2 Disaggregated CapManEx of Water Systems

The result for the disaggregated CapManEx for five water systems also reveals that averagely replacement Cost forms the greater portion (See figure 5.4). The replacement cost ranges from a minimum of 31% to a maximum of 68% and the major repair cost ranges from a minimum of 7% to a maximum of 45%. For the expansion cost, most of the water systems analyzed recorded 0% with only one of them (Bereku water system) recording a high value of 62%.

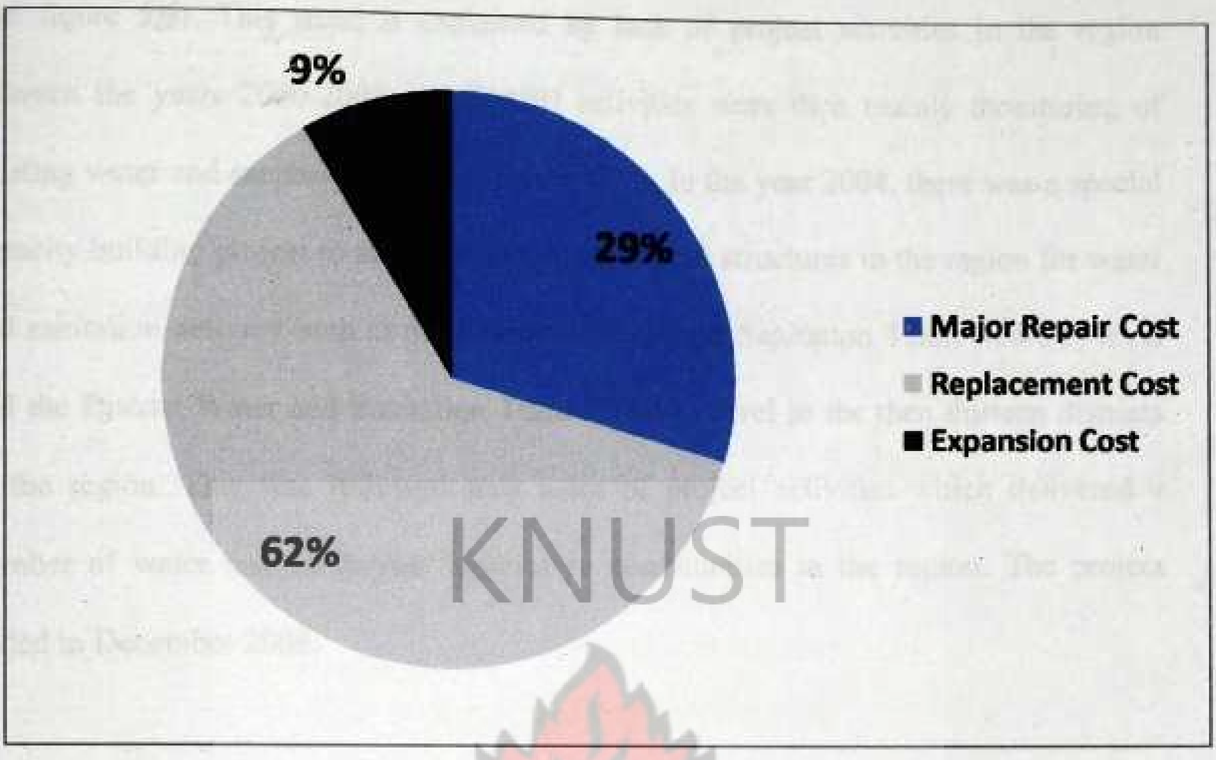

Figure: 5-4 Average **Disaggregated CapManEx of five water systems:**

5.4.3 Support Cost to WASH Activities in the Central Region

To ensure sustainable water service delivery from water systems, it requires support cost to build capacity in terms of institutional strengthening and provision of logistics in the rural and small town water sector, to undertake monitoring and evaluations of the operations of water systems and for skills development of the sector practitioners. A trend analysis of total support cost to WASH activities in the region reveals a downward trend in the beginning and a sharp rise in the year 2004.This continues with a gentle downward trend up to the year 2007 and then a small rise at the end of the study period (see figure 5.5). This trend is explained by lack of project activities in the region between the years 2000-2003 and WASH activities were then mainly monitoring of existing water and sanitation facilities on the field. In the year 2004, there was a special capacity building project to strengthen the institutional structures in the region for water and sanitation delivery both at the Regional Water and Sanitation Team (RWST) level and the District Water and Sanitation Team (DWST) level in the then thirteen districts in the region. This was followed with a lot of project activities which delivered a number of water and sanitation facilities in communities in the region. The project ended in December 2008.

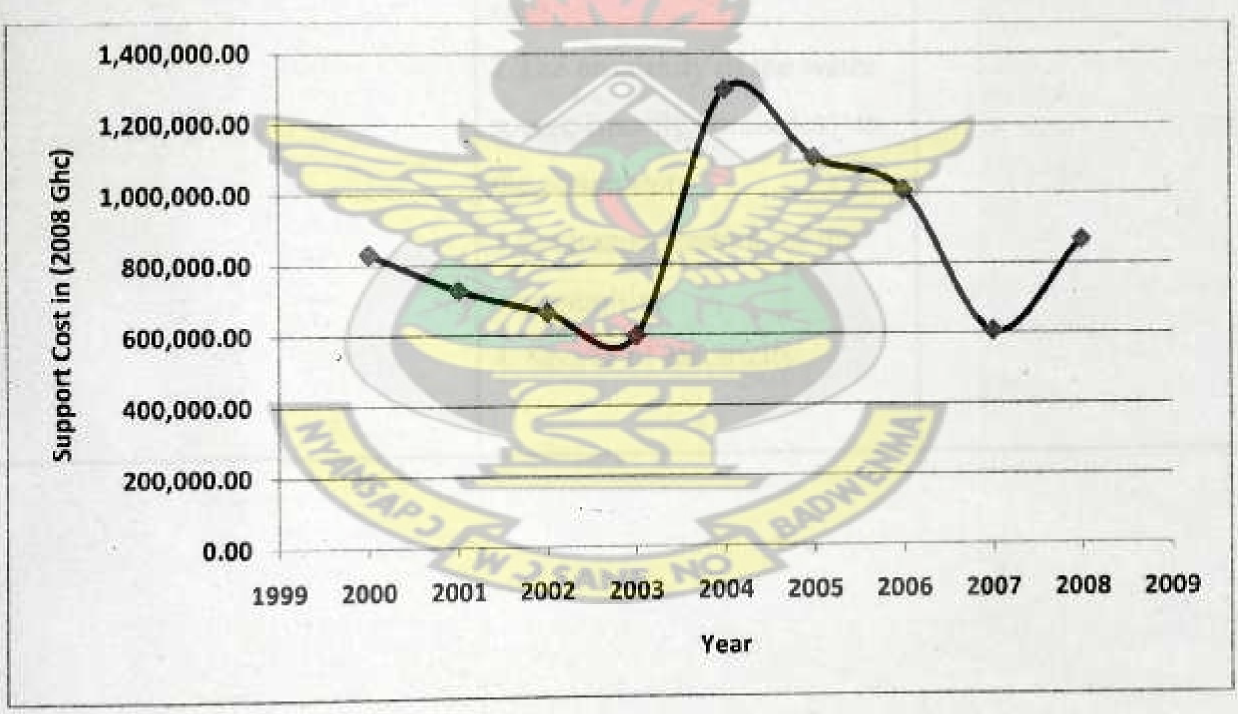

Figure: 5-5 Support Cost to WASH Activities in Central Region

5.4.4 Factors Affecting the Cost Components of Water Service Delivery

The factors found to affect the various cost components of water service delivery from this study is summarized in table 5.5.

Table 5-5: Factors Affecting Cost Components of Water Service Delivery

Cost Component	Factors	Water Systems
CapEx	1. Complexity of the design/Technological Choice (Water Source, Specific Installations to the system to deal with water quality issues etc.) 2.The proximity of the water source (mostly boreholes) to the community 3.Settlemnet Pattern of the communities 4. Source of electricity	All twelve (12) water systems

OpEx	1.Type of energy(Nat. grid, diesel, solar) 2. Frequency of routine maintenance 3. Proximity of spare parts and other resources required for operations to the small town 4. Conditions of service of staff and WSDB members of the water system	.Gyambra .Fosuansa .Fanti -Nyankomase . Akonfode .Twifo -Mampong .Assin Bereku .Aboransa
CapManEx	1.Design errors 2. Water quality problems 3. Frequency of planned maintenance	Akonfode . Fosuansa .Assin Praso NB: Only Factor No. 3 applies to all the seven (7) water systems shown against OpEx

Support Cost	1. Frequency of RWSTs and DWSTs visits/monitoring of the operations of the water system 2. Conditions of service of RWSTs and DWSTs 3. Accessibility and proximity of the water system from the regional and district capitals 4.Availability of logistics at the regional CWSA office and the DWST offices at the district level	.Gyambra .Fosuansa .Fanti-Nyankomase . Akonfode .Twifo -Mampong .Assin Bereku . Aboransa

6 CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The following conclusions have been drawn from this study;

1.The piped water systems were provided at a cost ranging between Ghc 40-160 per capita reflecting factors like population of the community (economies of scale), technical complexity of the water system (single town piped systems, multi-village systems, water treatment technologies). The annual cost of water service delivery also ranged between Ghc 2.3-8.13 per capita reflecting factors like salaries and allowances paid to system operators and water vendors, cost of energy of running the system and expenditure on planned maintenance activities to ensure functionality of the systems.

2. The water systems which functioned till the time of the study generally had their CapManEx to be about half of the OpEx meaning that about half of OpEx spent has to be saved towards planned maintenance activities for sustainable service deliveries.

3. The water systems represented various levels of functionality for the period of the study because they were handed over for community management when measures have not been put in place to ensure adequate CapManEx to address any major failure on the systems.

4. The systems which were abandoned by the communities when they broke down prematurely included all the three solar powered water systems and they

resulted in expensive overhauling of the systems after six years in order to restore service delivery.

5. It is important to planned and budget for CapManEx towards planned maintenance activities to avoid expensive premature rehabilitations of water systems.

6.2 Recommendations

- The use of the cost information in the results is recommended for planners and decision makers to improve decision making and help ensure that water services in similar Small Towns are delivered on sustainable basis.
- Further studies on solar powered community managed water systems is recommended
- The study focused on water systems managed by communities themselves (WSDBs).Further research on systems whose management functions are delegated by the community to private firms is recommended

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APPENDIXES:

Appendix 1: Water System Components and Characteristics

Assin Breku	
Designed Population	5,452

Network	Originally in 1998	Time of survey in 2009
Tank Capacity(m^3)	25	25
Height of tank (m)	7	7
Number of stand pipes	6	12
Number of pressure reducing valves	2	2
Pipe length (m)	1694	1694

Pumping System		
Source of energy	Diesel	National grid
Type of generator	TS3 M	
Type of pump	SP8A-10	SP8A-10
Borehole number	072 BU3	072 BU3
Pumping yield (m^3/ h)	6.5	6.5
Depth of pump (m)	20	20
Total Hydraulic Head (m)	40	40
Delivery line length (m)	313	313
Dynamic Water Level (m)	14	14
Water table (m)	8	8

Water system handed over to community in: 21st April 1998

Twifo Mampong	
Design Population	3,844

Network	Originally in 1998	Time of survey in 2009
Tank Capacity(m^3)	25	25
Height of tank (m)	10	10
Number of stand pipes	5	5
Number of pressure reducing valves	3	3
Pipe length (m)	723	723

Pumping System		
Source of energy	Diesel	National grid
Type of generator	TS2 M	
Type of pump	SP5A-12	SP5A-12
Borehole number	081 BU3	081 BU3
Pumping yield (m^3/ h)	5.6	5.6
Depth of pump (m)	21	21
Total Hydraulic Head (m)	46	46
Delivery line length (m)	321	321
Dynamic Water Level (m)	19	19
Water table (m)	4.5	4.5

Water system handed over to community in: 1st April 1998

Assin Akonfode	
Design Population	3,163

Network

	Originally in 1998	Time of survey in 2009
Tank Capacity(m^3)	15	15
Height of tank (m)	5	5
Number of stand pipes	5	5
Number of pressure reducing valves	2	2
Pipe length (m)	1075	1075

Pumping System

Source of energy	Diesel	National Grid
Type of generator	TS2 M	
Type of pump	SP3A-9	SP3A-9
Borehole number	028 BU3	N/A
Pumping yield (m^3/ h)	2.45	6.78
Depth of pump (m)	34	N/A
Total Hydraulic Head (m)	43	N/A
Delivery line length (m)	184	N/A
Dynamic Water Level (m)	30	N/A
Water table (m)	15	N/A

Water system handed over to community in: 21st April 1998

N/A = Not Available

NB: System Rehabilitated in 2008

Assin Praso	
Design Population	**4,474**

Network

	Originally in 1998	Time of survey in 2009
Tank Capacity(m^3)	30	60
Height of tank (m)	1	5
Number of stand pipes	6	6
Number of pressure reducing valves	0	2
Pipe length (m)	3305	3305

Pumping System

Source of energy	Diesel	National Grid
Type of generator	TS3 M	
Type of pump	SP8A-10	N/A
Borehole number		N/A
Pumping yield (m^3/ h)	5.6	9.7
Depth of pump (m)	21	N/A
Total Hydraulic Head (m)	46	N/A
Delivery line length (m)	1350	30
Dynamic Water Level (m)	19	N/A
Water table (m)	4.5	N/A

Water system handed over to community in: 8th May 1998

N/A =Not Available

NB: System Rehabilitated in 2008

Gyambra	
Design Population	**1,407**

Network

	Originally in 1998	Time of survey in 2009
Tank Capacity(m^3)	15	15
Height of tank (m)	6	6
Number of stand pipes	3	3
Number of pressure reducing valves	1	1
Pipe length (m)	905.7	905.7

Pumping System

Source of energy	National grid	National grid
Type of pump	SP5A-8	SP5A-8
Borehole number	080 BU3	080 BU3
Pumping yield (m^3/ h)	4.25	4.25
Depth of pump (m)	30	30
Total Hydraulic Head (m)	35	35
Delivery line length (m)	473	473
Dynamic Water Level (m)	12	12
Water table (m)	5	5

Water system handed over to community in: 28th August 1998

Denkyira Nkotomso	
Design Population	1,579

Network		Originally in 1998	Time of survey in 2009
	Tank Capacity(m^3)	15	15
	Height of tank (m)	2	2
	Number of stand pipes	3	3
	Number of pressure reducing valves	3	3
	Pipe length (m)	876	876

Pumping System			
	Source of energy	Solar	National grid
	Type of generator	2160	
	Type of pump	SP5A-12	SP5A-12
	Borehole number	020 BU3	020 BU3
	Pumping yield (m^3/h)	16.2	16.2
	Depth of pump (m)	30	30
	Total Hydraulic Head (m)	54	54
	Delivery line length (m)	831	831
	Dynamic Water Level (m)	14	14
	Water table (m)	7	7

Water system handed over to community in: 7th May 1998

NB: System Rehabilitated in 2007

Fanti Nyankomase	
Design Population	2,552

Network	Originally in 1998	Time of survey in 2009
Tank Capacity(m^3)	25	25
Height of tank (m)	0	0
Number of stand pipes	4	4
Number of pressure reducing valves	4	4
Pipe length (m)	1120	1120

Pumping System		
Source of energy	National grid	National grid
Type of pump	SP5A-12	SP5A-12
Borehole number		
Pumping yield (m^3/ h)	3.8	3.8
Depth of pump (m)	35	35
Total Hydraulic Head (m)	54	54
Delivery line length (m)	228	228
Dynamic Water Level (m)	28	28
Water table (m)	10.85	10.85

Water system handed over to community in: 28th April 1998

Twifo Nwamaso	
Design Population	4,446

Network		Originally in 1998	Time of survey in 2009
	Tank Capacity(m^3)	25	25
	Height of tank (m)	5	5
	Number of stand pipes	5	5
	Number of pressure reducing valves	2	2
	Pipe length (m)	715	715

Pumping System			
	Source of energy	Solar	Diesel
	Type of generator	3960	
	Type of pump	SP8A-10	SP8A-10
	Borehole number	363 BU1	363 BU1
	Pumping yield (m^3/ h)	31	31
	Depth of pump (m)	45	45
	Total Hydraulic Head (m)	51	51
	Delivery line length (m)	144	144
	Dynamic Water Level (m)	33	33
	Water table (m)	16.9	16.9

Water system handed over to community in: 25th March 1998

NB: System Rehabilitated in 2007

Assin Awisem	
Design Population	1,700

Network	Originally in 1998	Time of survey in 2009
Tank Capacity(m^3)	15	15
Height of tank (m)	6	6
Number of stand pipes	4	4
Number of pressure reducing valves	2	2
Pipe length (m)	594	594

Pumping System		
Source of energy	Solar	Diesel
Type of generator	2160	
Type of pump	SP5A-12	SP5A-12
Borehole number	028 BU3	028 BU3
Pumping yield (m^3/ h)	17	17
Depth of pump (m)	40	40
Total Hydraulic Head (m)	49	49
Delivery line length (m)	143	143
Dynamic Water Level (m)	25	25
Water table (m)	10.85	10.85

Water system handed over to community in: 1st March 1998

NB: System Rehabilitated in 2008

Aboransa	
Design Population	10,784

Network

	Originally in 1998	Time of survey in 2009
Main Tank Capacity(m^3)	25	25
Dominase Tank Capacity (m^3)	25	25
Kafodidi Tank Capacity (m^3)	15	15
Aborebeano Tank Capacity (m^3)	15	15
Aboransa Tank Capacity (m^3)	15	15
Height of tank (m)	7	7
Number of stand pipes	19	19
Number of pressure reducing valves	0	0
Pipe length (m)	9306	9306

Pumping System

Source of energy	Diesel	National grid
Type of generator	TS3 T	
Type of pump	SP14A-18	SP14A-18
Borehole number	FP05 BU2	FP05 BU2
Pumping yield (m^3/ h)	9	9
Depth of pump (m)	70	70
Total Hydraulic Head (m)	107	107
Delivery line length (m)	388	388
Dynamic Water Level (m)	57	57
Water table (m)		

Water system handed over to community in: 23rd January1998

Fosuansa	
Design Population	**1,949**

Network

	Originally in 1998	**Time of survey in 2009**
Tank Capacity(m^3)	15	15
Height of tank (m)	5	5
Number of stand pipes	3	3
Number of pressure reducing valves	2	2
Pipe length (m)	420	420

Pumping System

Source of energy	National grid	National grid
Type of pump	SP5A-8	SP5A-8
Borehole number	478 BU1	478 BU1
Pumping yield (m^3/ h)	3.8	3.8
Depth of pump (m)	15	15
Total Hydraulic Head (m)	34	34
Delivery line length (m)	423	423
Dynamic Water Level (m)	9	9
Water table (m)	1.1	1.1

Water system handed over to community in: 1st July 1998

NB: System Rehabilitated in 2008

Gyeikrodua	
Design Population	3,483

Network	Originally in 1998	Time of survey in 2009
Tank Capacity(m^3)	15	15
Height of tank (m)	5	5
Number of stand pipes	3	3
Number of pressure reducing valves	1	1
Pipe length (m)	665	665

Pumping System		
Source of energy	National grid	National grid
Type of pump	SP2A-13	SP2A-13
Borehole number	077 BU3	077 BU3
Pumping yield (m^3/ h)	1.4	1.4
Depth of pump (m)	27	27
Total Hydraulic Head (m)	55	55
Delivery line length (m)	582	582
Dynamic Water Level (m)	25	25
Water table (m)	7.5	7.5

Water system handed over to community in: 19th August 1998

Appendix 2: Capital Expenditure Data of Small Town Water Systems

Name of Small Town/Water System	*CapEx in 1998 (FF)*	*CapEx in 1998 (Old Ghana Cedis)*	*CapEx in 1998 (New Ghana Cedis)*
Aboransa	4,986,865	1,994,746,000	199,474.60
Twifo Mampong	1,682,334	672,933,600	67,293.36
Twifo Nwamaso	1,014,766	405,906,400	40,590.64
Denkyira Nkotomso	1,206,533	482,613,200	48,261.32
Assin Awisem	955,144	382,057,600	38,205.76
Assin Praso	1,954,417	781,766,800	78,176.68
Assin Akonfode	957,781	383,112,400	38,311.24
Assin Breku	1,066,734	426,693,600	42,669.36
Gyambra	862,819	345,127,600	34,512.76
Fosuansa	589,492	235,796,800	23,579.68
Gyeikrodua	680,504	272,201,600	27,220.16
Fanti Nyankomase	744,499	297,799,600	29,779.96

NB: 1 FF = 400 Old Ghana Cedis as at July 1998
(Data Source: GWSC, 1998)

10,000 Old Ghana Cedis =1 New Ghc

Appendix 3: Water Systems Rehabilitated with Cost Details

Water System	*Cost of WSDB-Office new(GHC)*	*Cost of Package Treatment Plant(GHC)*	*Cost of Civil Works (GHC)*	*Cost of Consultancy (GHC)*	*Total rehab. Cost(GHC)*	*Year of signing Contract for rehab. Works*	*Year of completion of rehab. Works*
Fosuansa	26,061.38	33,310	155,991.19	8,906.10	224,268.67	2008	2009
Nkotomso	26,940.15	0	58,982.13	8,906.10	94,828.38	2007	2008
Nwamaso	26,940.15	0	49,781.13	8,906.10	85,627.38	2007	2008
Awisem	27,921.91	0	43,744.87	8,836.00	80,502.78	2008	2009
Praso	27,921.91	0	85,639.02	8,836.00	122,396.93	2008	2009
Akonfode	27,921.91	0	53,755.97	8,836.00	90,513.88	2008	2009

Appendix 4: Small Town's Water System Operational Cost Records

Small Town's Water System -Operational costs records table

Small Town Water System	Year	Total Revenue	O & M Expenditure (OpEx) -(GHC)			Total OpEx	Capital Maintenance Exp.(CapManEx)-(GHC)				Total CapManEx
		(GHC)	*salaries& Allowance*	*Preventive M'tc & Minor Repairs*	*Admin & Operational Cost*	(GHC)	*Major repairs Cost*	*Repl. Cost*	*Rehab. Cost*	*Expansion Cost*	(GHC)

Small Town Water System	Year	Total Revenue	O & M Expenditure (OpEx) - (GHC)		Total OpEx	Capital Maintenance Exp.(CapManEx)-(GHC)				Total CapManEx
Bereku		(GHC)	salaries& Allowance	Preventive M'tc& Minor Repairs	(GHC)	Major repairs Cost	Repl. Cost	Rehab. Cost	Expansion Cost	(GHC)
	1999	**976.35**	368.96	139.00	**655.97**	0.00	0.00	0.00	0.00	**0.00**
	2000	**1,157.05**	505.46	187.80	**920.26**	0.00	0.00	0.00	0.00	**0.00**
	2001	**1,440.93**	596.92	57.46	**786.12**	0.00	232.00	0.00	0.00	**232.00**
	2002	**2,032.77**	699.76	10.65	**1,365.20**	36.00	150.17	0.00	0.00	**186.17**
	2003	**3,093.03**	839.70	69.40	**1,010.30**	0.00	63.65	0.00	0.00	**63.65**
	2004	**3,643.86**	1,325.70	2.40	**2,020.10**	54.40	247.10	0.00	1,400.00	**1,701.50**
	2005	**4,362.30**	1,776.10	117.85	**2,697.05**	500.00	185.50	0.00	849.43	**1,534.93**
	2006	**5,991.60**	2,543.70	130.30	**3,374.00**	0.00	1,201.80	0.00	1,611.40	**2,813.20**
	2007	**7,090.70**	3,059.50	314.50	**4,488.00**	0.00	457.00	0.00	2,443.00	**2,900.00**
	2008	**9,419.20**	3,568.95	208.50	**7,435.95**	0.00	355.60	0.00	0.00	**355.60**

Small Town Water System	Year	Total Revenue	O & M Expenditure (OpEx) - (GHC)			Total OpEx	Capital Maintenance Exp.(CapManEx)-(GHC)				Total CapManEx
Fosuansa		(GHC)	*salaries& Allowance*	*Preventive M'tc& Minor Repairs*	*Admin & Operational Cost*	(GHC)	*Major repairs Cost*	*Repl. Cost*	*Rehab. Cost*	*Expansion Cost*	(GHC)
	1999	**494.93**	254.15	0.05	47.21	301.41	74.48	15.23	0.00	0.00	**89.71**
	2000	**662.33**	329.40	10.15	61.38	**400.92**	73.00	19.58	0.00	0.00	**92.58**
	2001	**799.47**	414.41	12.05	103.56	**530.02**	335.38	19.09	0.00	0.00	**354.47**
	2002	**1,038.15**	481.10	13.70	112.23	**607.03**	40.00	7.00	0.00	0.00	**47.00**
	2003	**1,165.39**	530.06	14.40	163.40	**707.86**	31.60	119.45	0.00	0.00	**151.05**
	2004	**1,437.54**	755.54	6.30	130.50	**892.34**	188.40	24.40	0.00	0.00	**212.80**
	2005	**1,801.27**	928.52	11.00	275.75	**1,215.27**	366.90	0.00	0.00	0.00	**366.90**
	2006	**1,086.50**	795.17	4.00	130.10	**929.27**	36.50	11.00	0.00	0.00	**47.50**
	2007	**1,398.08**	1,062.03	13.10	233.86	**1,308.99**	177.60	16.50	0.00	0.00	**194.10**
	2008	**1,676.30**	1,192.57	22.00	189.78	**1,404.35**	12.00	17.00	224,268.67	0.00	**224,297.67**

Findings

1. The quality of the operational records not good enough and demanded a lot of effort to extract the records and disaggregate the costs.
2. System functioning from the start of the operation in August 1998 till date
3. System suffered water quality problem with excessive brown coloration of the borehole source believed to be as a result of excessive iron Concentration
4. A package treatment plant was installed when system was rehabilitated in 2008 to deal with the water quality problem

Small Town Water System	Year	Total Revenue	O & M Expenditure (OpEx) - (GHC)			Total OpEx	Capital Maintenance Exp.(CapManEx)- (GHC)				Total CapManEx
Fanti-Nyankomase		*(GHC)*	*salaries& Allowance*	*Preventive M'tc &Minor Repairs*	*Admin & Operational Cost*	*(GHC)*	*Major repairs Cost*	*Repl. Cost*	*Rehab. Cost*	*Expansion Cost*	*(GHC)*
	1998	**940.79**	101.50	5.50	10.00	**117.00**	72.00	3.71	0.00	0.00	**75.71**
	1999	**1,772.67**	340.30	0.35	73.27	**413.92**	72.00	503.20	0.00	0.00	**575.20**
	2000	**1,723.33**	386.20	0.00	291.04	**677.24**	142.00	98.12	0.00	0.00	**240.12**
	2001	**2,274.37**	444.40	5.50	41.45	**491.35**	309.40	157.50	0.00	0.00	**466.90**
	2002	**3,016.22**	648.00	3.00	434.58	**1,085.58**	298.05	146.50	0.00	0.00	**444.55**
	2003	**2,106.25**	875.20	80.40	302.80	**1,258.40**	154.35	44.50	0.00	0.00	**198.85**
	2004	**4,118.34**	909.20	29.80	285.85	**1,224.85**	51.80	1,738.00	0.00	0.00	**1,789.80**
	2005	**5,534.14**	1,675.00	8.80	641.10	**2,324.90**	647.70	561.60	0.00	0.00	**1,209.30**
	2006	**3,941.48**	2,112.90	10.80	616.60	**2,740.30**	71.40	417.00	0.00	0.00	**488.40**
	2007	**1,928.22**	1,011.40	0.00	692.98	**1,704.38**	225.20	366.90	0.00	0.00	**592.10**
	2008	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A= Not Available

Finding: Available operational records starts from May 1998 and ends in June 2007

Small Town Water System	Year	Total Revenue	O & M Expenditure (OpEx) - (GHC)			Total OpEx	Capital Maintenance Exp.(CapManEx)-(GHC)				Total CapManEx
		(GHC)	salaries& Allowance	Preventive M'tc&Minor Repairs	Admin & Operational Cost	(GHC)	Major repairs Cost	Repl. Cost	Rehab. Cost	Expansion Cost	(GHC)
Akonfode	1998	**515.93**	208.02	6.50	115.99	**330.51**	80.00	0.00	0.00	0.00	**80.00**
	1999	**614.81**	287.71	11.18	197.77	**496.65**	159.40	0.00	0.00	0.00	**159.40**
	2000	**374.79**	177.95	9.45	157.94	**345.34**	14.00	0.00	0.00	0.00	**14.00**
	2001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2003	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2004	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2005	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2006	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2007	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2008	N/A	N/A	N/A	N/A	N/A	0.00	0.00	90,513.88	0.00	**90,513.88**

N/A=Not Applicable

NB: Water system broke down and ceased to deliver service from 2001-2008 due to depletion of the borehole water source

The borehole source originally gave unimpressive yield of **2.45m^3/h** and progressively reduced at the start of operation of the system in 1998 till 2000 when it became financially unsustainable to operate the system because of the high cost of pumping water

Small Town Water System	Year	Total Revenue	O & M Expenditure (OpEx) -(GHC)			Total OpEx	Capital Maintenance Exp.(CapManEx)-(GHC)				Total CapManEx
Twifo Mampong		(GHC)	*salaries& Allowance*	*Preventive M'tc&Minor Repairs*	*Admin & Operational Cost*	(GHC)	*Major repairs Cost*	*Repl. Cost*	*Rehab . Cost*	*Expansion Cost*	(GHC)
	1999	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2003	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2004	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2005	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2006	**1,232.52**	515.18	57.50	353.49	**926.17**	27.70	64.00	0.00	0.00	**91.70**
	2007	**5,727.72**	1,608.28	46.00	604.52	**2,258.80**	562.24	1,162.40	0.00	0.00	**1,724.64**
	2008	**5,091.61**	1,306.92	188.50	733.20	**2,228.62**	202.60	470.00	0.00	0.00	**672.60**
	2009	**3,064.70**	915.50	66.50	618.30	**1,600.30**	110.00	0.00	0.00	0.00	**110.00**

N/A=Not Available

Findings:
1. Water system functioning from the start of operation in April 1998 to date
2. The first WSDB handed over the management of the system to new WSDB in August 2006
3.Operational records from the start of operation till August 2006 missing

Small Town Water System	Year	Total Revenue	O & M Expenditure (OpEx) - (GHC)			Total OpEx	Capital Maintenance Exp.(CapManEx)- (GHC)				Total CapManEx
Gyambra		(GHC)	*salaries& Allowance*	*Preventive M'tc&Minor Repairs*	*Admin & Operational Cost*	(GHC)	*Major repairs Cost*	*Repl. Cost*	*Rehab. Cost*	*Expansion Cost*	(GHC)
	1999	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2003	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2004	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2005	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2006	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2007	**4,028.66**	1,976.60	0.00	147.50	**2,124.10**	449.70	343.10	0.00	0.00	**792.80**
	2008	**9,054.09**	3,723.20	15.00	1,300.39	**5,038.59**	556.40	2,365.98	0.00	0.00	**2,922.38**
	2009	**5,154.40**	2,102.90	0.00	504.50	**2,607.40**	254.00	10.00	0.00	0.00	**264.00**

N/A = Not Available

Findings:
1. Water system functioning from the start of operation in September 1998 to date
2. The first WSDB handed over the management of the system to new WSDB in may 2007
3.Operational records from the start of operation till May 2007 missing

Small Town Water System	Year	Total Revenue	O & M Expenditure (OpEx) - (GHC)			Total OpEx	Capital Maintenance Exp.(CapManEx)-(GHC)				Total CapManEx
Aboransa		(GHC)	*salaries& Allowance*	*Preventive M'tc&Minor Repairs*	*Admin & Operational Cost*	(GHC)	*Major repairs Cost*	*Repl. Cost*	*Rehab. Cost*	*Expansion Cost*	(GHC)
	1999	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2003	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2004	**16,104.09**	1,512.10	182.30	1,252.30	**2,946.70**	149.10	378.70	0.00	0.00	**527.80**
	2005	**14,790.98**	2,604.60	89.60	2,466.40	**5,160.60**	773.10	716.60	0.00	0.00	**1,489.70**
	2006	**19,102.00**	4,223.00		3,845.32	**8,068.32**					**2,567.93**
	2007	**23,232.12**	4,440.00		5,912.50	**10,352.50**					**4,374.90**
	2008	**24,411.91**	7,170.00		6,567.81	**13,737.81**					**13,489.95**

N/A=Not Available

Findings 1 Year 2004 &2005 operational records received from Interim Management Committee of the water system at that time

2. Year 2006 to 2008 records received from new substantive WSDB

Appendix 5: Results and Sample Details of Cost Analysis

Cost Components of Sustainable Water Service Delivery for Seven Water Systems

Cost Component in (per Capita per annum)	Gyambra	Fosuansa	Fanti Nyankomase	Akonfode	Twifo Mampong	Assin Bereku	Aboransa
CapEx	4.49	2.22	2.14	2.15	3.21	1.43	3.39
OpEx	1.06	0.35	0.36	0.12	0.2	0.32	0.46
CapManEx	0.44	5.07	0.2	3.3	0.11	0.12	0.23
Support	0.49	0.49	0.41	0.43	0.41	0.43	0.41
Total	6.48	8.13	3.11	6.00	3.93	2.30	4.49

Sample Cost Analysis of STWSS

		Bereku	**CapEx**	**OpEx**	**CapManEx**	Year
		First Cost	42,669.36			
				655.97	0.00	1999
				920.26	0.00	2000
				786.12	232.00	2001
useful life (yrs.)	20			1,365.20	186.17	2002
				1,010.30	63.65	2003
INFLATION	17.6%	i		2,020.10	1,701.50	2004
AGE (yrs.)	10	n		2,697.05	1,534.93	2005
DESIGN POP.	5452	p		3,374.00	2,813.20	2006
RURAL POP.	1000000			4,488.00	2,900.00	2007
				7,436.00	355.60	2008
	P	**NPV (year 1)**	42,669.36	7,935.68	2,918.42	
	A	**PMT**	**7,815.15**	**1,740.77**	**640.18**	
	UNIT COST		1.43	0.32	0.12	

SUPPORT COST FOR YEARS 2000-2008; CHECK-LIST

Regional Level:

Fixed Cost Details

1 Salaries
2 Field Allowance
3 Electricity
4 Telecommunication
5 Stationery
6 Repairs of vehicle
7 Running cost of vehicles
8 Regular capacity building (US$)

Variable Cost Details

Support to District Capacity Building:

1 Training Materials
2 Hotel Accommodation
3 Refreshment
4 Tuition fee
5 Assistance towards DWSPs preparation
6 Financial Management Support to the districts

Community Mobilization and Training:

1 Training of Partner Organization (Pos)
2 Hygiene Promotion
3 Training of Latrine Artisans
4 Training of WATSANS
5 Training of WSDBs
6 Training of community Women's Group
7 O&M, Follow -up

District Level :

1 District Support to DWSTs & EHAs
(for capacity building, monitoring and follow up activities)

2 *Salary for staff*
(Desk officer for water and sanitation,3 member DWSTs and 3-member EHAs)

Sample Analysed Support Cost Details

			Central Region Support Cost	Sampled Districts Annual Support Cost						
District Name				UD	MFANST.	AAK	AGONA	AEE	AOB	YEAR
District Pop.				***82,229***	***76,740***	***63,893***	***55,812***	***75,661***	***60,917***	
			19,795.51							2000
			26,747.87							2001
			43,734.28							2002
			58,496.22							2003
			470,533.95	350.00	0.00	0.56	4,226.77	2,000.00	1,000.00	2004
INFLATION	17.6%	i	466,153.34	1,000.00	5,512.27	4,000.00	2,264.34	5,225.00	17,008.00	2005
AGE	10	n	516,409.89	3,400.00	5,000.00	2,000.00	7,900.00	5,400.00	11,000.00	2006
Reg. Rural POp.	1000000	p	299,672.23	1,000.00	14,591.93	7,215.02	20,752.06	400.00	17,700.00	2007
			657,127.49	5,750.00	200.00	6,000.00	4,925.00	0.00	1,392.00	2008
				15,960.00	15,960.00	15,960.00	15,960.00	15,960.00	15,960.00	2009
	P	**NPV (year 1)**	879,761.07	80,317.40	82,952.45	68,443.17	72,257.10	77,128.34	82,258.42	
	A	**PMT**	**192,983.83**	**17,618.37**	**18,196.40**	**15,013.65**	**15,850.27**	**16,918.82**	**18,044.16**	
	UNIT COST		0.193	0.214	0.237	0.235	0.284	0.224	0.296	

District Specific Unit Total Support Cost	UD	MFANST.	AAK	AGONA	AEE	AOB	YEAR
	0.41	0.43	0.43	0.48	0.42	0.49	

Legend: UD=Upper Denkyira, MFANST. =Mfanstiman, AAK=Abura Asebu Kwamankese, AEE= Ajumako Enyan Essiam AOB= Asikuma Odoben Brakwa.