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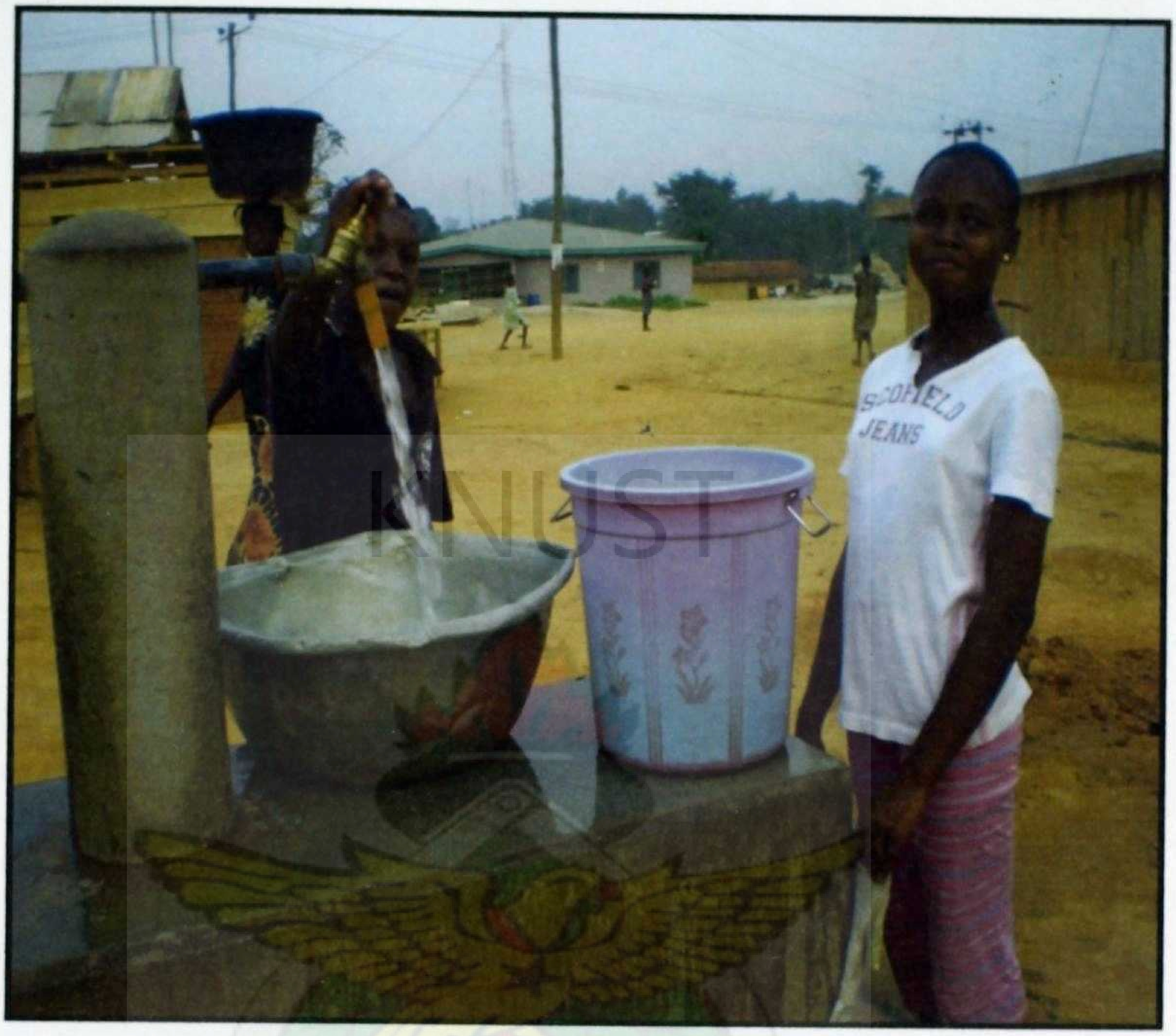

LIFE CYCLE COST OF SUSTAINABLE WASH SERVICE DELIVERY: A CASE STUDY OF BOSOMTWE-ATWIMA-KWANWOMA DISTRICT (BAKD)

Appiah-Effah, Eugene

MSc. Thesis
February 2009

WRESP – KNUST

Faculty of Civil and Geomatic Engineering
Department of Civil Engineering

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Master of Science Thesis
By

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by

Appiah-Effah Eugene, BSc. (Hons)

Thesis submitted to
The Department of Civil Engineering,
Kwame Nkrumah University of Science and Technology
In Partial Fulfilment of the Requirements for the Degree of

MASTER OF SCIENCE
Faculty of Civil and Geomatic Engineering
College of Engineering

February 2009

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 or 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.

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DEDICATION

To God Almighty

And

My Mum, Dad & Siblings

ABSTRACT

The main aim of the study was to estimate the life cycle cost of sustainable water and sanitation service delivery and the quality of service delivered. The life cycle cost analysis involved investment, capital maintenance, operation and maintenance and support costs and were used to assess how project sustainability throughout the facility life will be achieved. The study was conducted on one (1) small town water supply scheme in Kuntanase, three (3) boreholes with hand pump one each in Kuntanase, Abono and Petriensa and three (3) household latrines in Kuntanase. The design life of the WASH facilities was considered to be twenty (20) years. Data was gathered from stakeholders at all levels by means of interviews and administration of questionnaires. The stakeholders included the Community Water and Sanitation Agency (CWSA), District Assembly (DA)/District Water and Sanitation Team (DWST), Water and Sanitation Development Boards (WSDBs), Water and Sanitation (WATSAN) committee members, and Community members. The costs of investment, operation and maintenance, capital maintenance and support costs were estimated and converted to their annual costs based on historical cost data collected during the study period. The quality of WASH service was analyzed using forty (40) questionnaires based on the quantity, characteristics (water quality), reliability and affordability of the water supply facilities. The results showed that the Government of Ghana/Partner Agencies provides the investment cost and some aspect of the support cost leaving out the capital maintenance (replacement) and operation and maintenance costs. The capital maintenance, operation and maintenance costs are paid by the users of the facilities. Normally the Government of Ghana/Partner Agencies ignores operation and minor maintenance and replacement (capital maintenance) which are often paid by the users but as soon as the users fail to pay for these costs, the system breaks down. The quality of service derived from the house connection is high compared to the communal stand pipe connection. The quality of service of water supply in Abono is relatively low compared to that of Petriensa and Kuntanase though the people are willing to pay more for a better service.

ACKNOWLEDGEMENTS

I thank the Lord God Almighty for His guidance, wisdom and strength that He granted for me to be able to undertake this project to completion.

I wish to express my sincere gratitude to the Water Resource and Environmental Sanitation Project (WRESP) office and to all lecturers for their inputs in this project especially during the presentations. I also wish to thank my dedicated supervisors, especially Dr. K.B. Nyarko, Mr. S. Oduro-Kwarteng and Dr. Patrick Moriarty for their guidance and advice throughout this project.

Special thanks to Mr. Mark Tachie, Mrs. Charlotte Asabea Djan and Mrs. Mary Mensah all of Bosomtwe-Atwima-Kwanwoma District Assembly for their constant support. My sincere thanks to Mr. Asare (Technical Manager) of Kuntanase Small Town Water Supply Scheme and the entire WATSAN committee members of BAKDA.

Many thanks to Barbara Gyapong-Korsah, Prince Antwi-Agyei, Dwuodwo Yamoah Antwi and Charles Nyarko as well as to all my WRESP colleagues.

Finally, my sincere gratitude to my parents, Mr and Mrs. Effah and siblings Chris, Michael and Edmund for their unending support and prayers.
God richly bless you all.

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LIST OF ABBREVIATIONS AND ACRONYMS

BAKD	Bosomtwe-Atwima-Kwanwoma District
CAPEX	Capital Expenditure
CAPMANEX	Capital Maintenance Expenditure
CWSA	Community Water and Sanitation Agency
CWSP	Community Water and Sanitation Project
DA	District Assembly
DWST	District Water and Sanitation Team
EU	European Union
HC	House Connection
HDW	Hand Dug Well
HP	Hand Pump
IDA	International Development Agency
IRC	International Water and Sanitation Centre
JMP	Joint Monitoring Program
K (VIP)	Kumasi (Ventilated Improved Pit)
KSTWSS	Kuntanase Small Town Water Supply Scheme
LCC	Life Cycle Cost
LCCA	Life Cycle Cost Analysis
MDGs	Millennium Development Goals
MWRWH	Ministry of Water Resource Works and Housing
NGO	Non Governmental Organization
NPV	Net Present Value
O & M	Operation and Maintenance
OPEX	Operational Expenditure
PC	Public Connection
RWSP	Regional Water Supply Project
SAE	Society of Automotive Engineers
SIP	Strategic Investment Programme
STWSS	Small Town Water Supply System
UNDP	United Nation Development Project
UNICEF	United Nations International Children Education Fund
WASH	Water Sanitation and Hygiene
WATSAN	Water and Sanitation
WHO	World Health Organization
WSDB	Water and Sanitation Development Board
WSMP	Water and Sanitation Sector Monitoring Platform

CHAPTER ONE

1. INTRODUCTION

This chapter provides background information to the study. It also presents the problem statement, objectives of the study, justification, operational definitions and the structure of the report. It spells out the importance of the Water Sanitation and Hygiene (WASH) sector in achieving the Millennium Development Goals. It also briefly explains the importance of the life cycle cost in determining the total cost of providing a facility and its relation to the quality of service delivered.

1.1 Background

Every year, millions of the world's poorest people die from preventable diseases caused by inadequate Water supply, Sanitation and Hygiene (WASH) services. Diarrhoeal diseases are the most common health problems and causes of death worldwide and about 4.4 billion people suffer from this disease every year (World Bank, 2000). It is estimated that 1.8 million people die from it each year, including 4,000 children under five years of age who die from diarrhoea every day (WHO, 2000).

The lack of clean drinking water and sanitation is a severe public health concern in Ghana contributing to 70% of diseases in the country (UNDP, 2006). This is as a result of lack of financial resources to provide, maintain and extend the water supply and sanitation infrastructure (UNDP, 2006). Consequently, households without access to clean water are forced to use less reliable and hygienic sources and often pay more (OECD, 2007).

WASH services are cross-cutting issues. Estimated spending required in developing countries to provide new coverage to meet the MDG target is 42 billion United States dollars (US$) for water and US$ 142 billion for sanitation, or a combined annual equivalent of US$ 18 billion (WHO, 2008). The cost of maintaining existing services totals an additional US$ 322 billion for water supply and US$216 for sanitation or a combined annual equivalent of US$ 54 billion (WHO, 2008). In assessing financing requirements, estimates of cost should include the operation, maintenance and replacement of existing coverage as well as costs of new services (WHO, 2008).

Cost of WASH services that is investment, capital maintenance, operation and maintenance and support costs are a critical factor in determining the sustainability of WASH services (IRC, 2008). Therefore it is important to determine the life cycle cost of WASH services which is critical for sustainability and also to determine the cost and the quality of service in rural and peri-urban communities. Life cycle costs also serve as benchmarks which allow costs in one project or setting to be compared with those in other towns for WASH technology choices to meet long term sustainability.

1.1.1 Water and Sanitation (WASH) Coverage

The water supply coverage in Ghana has been improving yearly with the coverage of improved drinking water being 68% (WSMP, 2008). Also improved sanitation coverage in Ghana is about 38% (WSMP, 2008).

Improved and unimproved water and sanitation coverage estimates are obtained from the Joint Monitoring Programme for Water Supply and Sanitation (JMP) run jointly by WHO and the United Nations Children's Fund (UNICEF) since 1990. Coverage estimates are based on the current JMP classifications, shown in Table 1.1. JMP classifies the following as "improved" water supply: piped water into dwelling, plot or yard; public tap; tube well or borehole; protected dug well or spring; and collected rainwater. To be classified as improved, the water supply must provide at least 20 litres per capita per day from a protected source within 1 km of the user's dwelling."Improved" sanitation consists of flush or pour-flush toilet to piped sewer system, septic tank or pit latrine; a ventilated improved pit-latrine (VIP); pit latrine with slab; 3 or composting toilet. Estimates are based on household surveys of actual use, and resulting figures therefore reasonably reflect true "access".

Table 1.1: Defining Improved and Unimproved WASH interventions

Intervention	Improved	Unimproved
Water supply	• Piped water into dwelling, plot or yard • Public tap / standpipe • Tube well/borehole • Protected dug well • Protected spring • Rainwater collection	• Unprotected dug well • Unprotected spring • Cart with small tank/drum • Tanker truck • Bottled water • Surface water (river, dam, lake, pond, stream, canal, irrigation channels)
Sanitation	Flush or pour-flush toilet to: • Piped sewer system • Septic tank • Pit latrine • Ventilated improved pit-latrine (VIP) • Pit latrine with slab • Composting toilet	Flush or pour-flush toilet to elsewhere • Pit latrine without slab or open pit • Bucket •Hanging toilet or hanging latrines • No facilities or bush or field

Source: JMP (1990).

1.1.2 Importance of WASH Services

The 1995 paper on UNICEF strategies in water and environmental sanitation outlines the importance of WASH services for particularly children. Increasing the equitable access to and use of safe water and basic sanitation services and improved hygiene practices will reduce child mortality, improve health and education outcomes and contribute to reduced poverty and sustainable development as a whole (UNICEF,2005).

The Millennium Declaration and the Goals recognizes the importance of safe drinking water and sanitation to meet these global commitments. Therefore in achieving the MDGs, WASH services must be given the needed attention.

1.2 Problem Statement

Accessibility to good and adequate water on sustainable basis is one of the fundamental needs and rights of the individual for survival.

In Ghana, focus is mainly on investment which is found in the Strategic Investment Programs (SIPs). However, there are other components such as replacement (capital maintenance), operation and maintenance and support costs which are mostly ignored. Ignoring these cost components lead to frequent breakdowns of the facility due to lack of proper planning and budgeting which make the facility not sustainable and subsequent reduction in the service quality delivered.

1.3 Objectives of Study

The main objective of this research is to determine the life cycle cost of sustainable WASH services; a case study of Bosomtwe-Atwima-Kwanwoma-District in Ashanti region.

The specific objectives are:

- to disaggregate the life cycle cost into investment, operation and maintenance, capital maintenance (replacement) and support.
- to determine the quality of service delivered by WASH facilities.

1.4 Justification of Study

The only way to sustainably reduce water, sanitation and hygiene related disease is through the provision of safe drinking water, sanitation and improved hygiene facilities. It is also important that facilities when provided will continue to function.

Thus, knowledge on real disaggregated life cycle cost of WASH projects is important for realistic planning and budgeting for sustainable services in rural and peri-urban areas. This research will therefore help policy makers, planners and donors to look beyond the investment cost and address the real cost of providing and sustaining WASH services.

1.5 Project Scope

To undertake the study, disaggregated cost information was obtained on the following water supply and sanitation facilities;

(a) Small Town Water Supply System in Kuntanase

(b) Boreholes with hand pump in three (3) selected communities

(c) Household latrine (VIP) in Kuntanase

The disaggregated cost considers the investment, capital maintenance (replacement), operation and maintenance and support costs. Sanitation facilities as used in this context refer to excreta disposal facilities.

1.6 Operational Definitions

Life Cycle Cost: This refers to the total cost of a project incurred at the investment (planning, preparation, design of systems, construction and installations), capital maintenance, operation and maintenance and support phases. For WASHCost Ghana it refers to the total cost of a facility including Investment, capital maintenance (replacement), operation and maintenance and support.

Unit cost: Cost of producing one unit of product or service, usually based on averages. The unit costs of a project are for example cost for overhead tanks/reservoirs, pipelines, standpipes, treatment plants, boreholes, pumps etc within a water supply project.

Disaggregated cost: This is the cost component resulting from the breakdown of the lump sum for a particular project.

Water Supply: The total amount of water available for human and other uses.

Sanitation: Is the hygienic means of preventing human contact from the hazards of wastes to promote health. In this report sanitation refers to the management of human faeces at the household, institutional and communal levels.

Hygiene: It is the study of rules for healthy living and the prevention of diseases and not merely the absence of diseases or infirmity.

Small Town: A small town is defined in the CWSA Act as 'a community that is not rural (more than 5000) but is a small urban community that has decided to manage its own water and sanitation systems'. The CWSA policy defines a small town water system as a piped system serving communities of between two and fifty thousand (2,000 and 50,000) inhabitants who are prepared to manage their water supply systems in an efficient and sustainable manner (CWSA, 2003).

Hardware: Hardware includes all civil works undertaken in providing improved water supply and sanitation facilities. It also includes the procurement and installation of equipment required for improved water supply and sanitation.

Software: Software includes all activities that are undertaken to complement the provision of facilities to the communities and to ensure the successful implementation, management and sustained utilisation of the facilities by the communities. It includes activities such as sanitation education, training, development of training materials and short-term consultancy form part of Software.

Sustainability: Is the capacity to maintain a certain process or system indefinitely.

1.7 Structure of the Report

This research sets out to determine the life cycle cost and disaggregated unit costs of sustainable WASH service delivery; a case study of Bosomtwe-Atwima-Kwanwoma-District in Ashanti region. The report is structured into five chapters. Chapter one provides the background to the study, problem statement, objectives of study, scope of research, justification and definition of key terms used in this research. Chapter two provides literature review to the study. Chapter three describes the study area and the methodology employed in carrying out the research. Chapter four contains detailed data collected. This data was further analyzed to achieve the set objectives. Chapter five presents conclusions and recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

This chapter provides literature reviewed on life cycle, life cycle cost analysis and its importance. It explains the disaggregated cost components such as investment, operation and maintenance, capital maintenance and support costs. The chapter further describes the various management options available within the WASH sector, cost recovery and financial sustainability of the small town water supply scheme.

2.1 Life Cycle

Life Cycle (LC) is a series of changes or form and activity that a system undergoes from its beginning through its development to disposal phase. LC is also the period during which a system is developed and used. It is essential to carryout life cycle assessment of WASH facilities to enable correct decision making process. Although the idea of a project life cycle is familiar in industry, the definition of separate components varies. However, it is possible to identify a generic set of components that are present in most project cycles. The life cycle of water and sanitation development facility can be divided into four components as shown in Figure 2.1:

1) Investment

2) Capital maintenance

3) Operation and maintenance

4) Support

The first life cycle component of WASH facilities is the investment. This component begins with needs assessment which determines the motivation for intervention and the extent of need. The result of this phase is a commitment to project action. This is followed by the development of conceptual designs and feasibility studies. A list of possible solutions is generated and evaluated during this phase. There is also the selection of an appropriate technology to implement. Implementation of WASH facilities includes resource procurement and construction. The second component is the capital maintenance which is carried out when the need arises throughout the life span of the facility. It involves the periodic replacement and rehabilitations that are carried out. The third component which is the operation and maintenance is the daily activities carried out to maintain the facility. The support is the last component which includes project monitoring and evaluation and also capacity building and skills training. Many life cycle approaches include an end-of- life stage involving the disposal or recycling of the product. However, in order to simplify estimations, end-of-life considerations are included in the feasibility studies rather than a separate life stage (McConville, 2006).

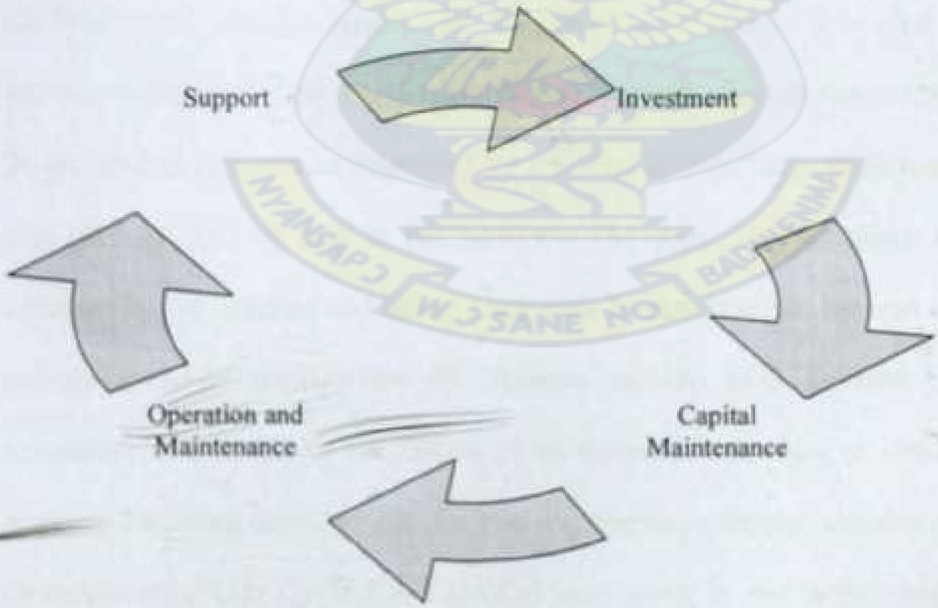

Figure 2.1: Four life cycle stages of water and sanitation facilities

2.2 Life Cycle Cost

Life Cycle Cost(LCC) is the total cost of a particular facility, including its cost of investment, capital maintenance and rehabilitation, operation, maintenance, support and/or decommission (SAE, 1999). It is also defined as the total of every cost estimate considered possible for a system from design phase through replacement with a new, more advanced system (Blank and Tarquin, 1998). LCC are summations of cost from inception to disposal for a facility. This is determined by an analytical study and estimate of total costs experienced in annual time increments during the facility's life with consideration for the time value of money. The objective of LCC analysis is to choose the most cost effective approach from a series of alternatives to achieve the lowest long-term cost. LCC is an economic model over the facility's life span (SAE, 1999).

2.2.1 Importance of Life Cycle Cost (LCC)

An integrated, process-centred, and disciplined approach to life cycle costing of facility provides real and tangible benefits to all facility stakeholders. Understanding the benefits of life cycle management for a facility leads to better understanding of the cost estimate and its role in the facility's life cycle. Understanding the type of estimate that is required and being conducted is important for the cost estimator to provide a useful estimate for the decision makers. LCC estimate provides an exhaustive and structured accounting of all resources necessary to identify all cost elements including development, deployment, operation, support and disposal costs. Overestimating Life Cycle Costs (LCCs) may result in the facility being deemed unaffordable and therefore risking not being funded. Underestimating LCCs will prevent decision-makers from allocating the proper funding required to support the facility. Properly estimating cost supports the budgeting and funding profile process. Life cycle costs also enhances economic competitiveness by working for the lowest long term cost of projects and helps identify the most financially attractive alternative.

2.2.2 Life Cycle Cost Analysis

Under Life Cycle Cost Analysis (LCCA), facility management outlays are future expenses; costs incurred after the facility has been placed in service (Mearig, et al., 1999). The facility management costs incurred include Capital Maintenance Expenditure (CapManEx), Operation Expenditure (OpEx) and minor Maintenance Expenditure (ManEx). Therefore, it is essential to use robust assumptions when using LCCA to compare series of alternatives. Reliable LCCA is possible by using historical facility management costs from similar projects. LCCA is a management tool that can help minimize the cost of providing water and sanitation facilities. LCCA is a useful aid for comparing lifetime cost of series of assets to determine which asset provides the best value per dollars spent (Ashworth, 1996; Mearig et al., 1999; Robinson, 1996).

2.2 3 Cost Breakdown Structure

In order to conduct a LCCA it is necessary to create a structure that facilitates the identification of facility costs in each of the life cycle phases (El-Haram et al., 2002). El-Haram et al. noted that the British Standard 5760, part 23, has a cost breakdown structure (CBS) that identifies all relevant costs categories in all appropriate life cycle phases.

The life cycle cost of WASH facilities can be disaggregated into investment, capital maintenance, operation and maintenance and support costs. Each of these cost components can further be subdivided into its cost elements. For instance in the construction of community piped water scheme, an investment cost includes the construction (hardware) and software costs, which can be disaggregated into the costs of borehole works, pipe works, stand pipe, storage tank, community sensitization. Likewise capital maintenance cost includes replacement, rehabilitation, extension costs. Also the operation and minor maintenance cost includes the cost of operating and maintaining the facility. This cost can further be disaggregated into administration, energy, personnel, transportation, minor repairs, board allowance. The support cost includes cost incurred at the national, regional and district levels. This can further be disaggregated into the costs of allowances to the Water and Sanitation Teams (WSTs), monitoring and supervision, capacity building and skills training.

Total facility cost

Total facility cost is composed of total acquisition cost, total facility management (operation and support) costs, and total disposal cost (CT = CA + CFM + CD). Jones (1994) and El- Haram and Horner (2003) indicated that, over time, the major costs of a system are facility management costs rather than acquisition cost. Therefore, they stressed the importance of designing systems that minimize total project cost rather than acquisition cost. It is also important to note that the ability to influence total project cost is highest in the acquisition phase of a project and lowest in the facility management phase. Thus, project cost minimization must be embedded in the acquisition phase, particularly during the definition requirements process.

However in the WASH sector total facility cost is composed of total investment cost, total capital maintenance cost, total operation and minor maintenance cost and total support cost.

Investment Cost

Investment cost is the initial facility cost and it is the outlays incurred prior to putting the facility in service. The investment phase determines the reliability, maintainability and effectiveness of a facility and its components (Chao and Ishi, 2004). Mearig, Coffee and Morgan (1999) noted that choices that planners make determine the initial and future costs. For instance, choosing PVC pipe instead of asbestos pipe or concrete tank over steel tank determines initial and subsequent operation, maintenance and capital maintenance costs.

The total investment costs may include items such as borehole works, pipe works, stand pipe, electrical installations for water supply and setting out, pit excavation, reinforced concrete slabs, superstructure for sanitation facilities. These costs flow from preliminary studies which are conducted during the pre-investment (e.g. Planning) stage and involve the study of the technical, economical, social, environmental and health aspects in the construction of the facility.

Capital Maintenance Cost

The capital maintenance cost is the cost of replacement and rehabilitation of facility. This may include replacement of pumps, servicing of boreholes and rehabilitation of deteriorated pipe lines. In any particular period, capital maintenance expenditure and depreciation can differ. When the facility base is relatively new, depreciation is likely to be higher than capital maintenance expenditure because the new facility will not require a great deal of maintenance. When the facility is old, capital maintenance expenditure might exceed depreciation. When the facility is in a steady state one would expect depreciation and capital maintenance expenditure to be broadly equal.

Operation and Minor Maintenance Cost

Operation and minor maintenance cost outlays are future expenses; costs incurred after the project has been placed in service (Mearig, et al., 1999). The operation and maintenance cost comprise all expenditures (personnel, energy, minor repairs) that are required to keep a system operational and in good condition (maintenance) after its installation is complete. This cost is recurrent in that they are continuous over time and are part of the operation and maintenance of a water supply or sanitation system.

Support Cost

The support cost include institutional capacity building and skills training at local, regional and national levels and also include built-in incentives to prevent a local 'brain drain' once technical and administrative staff are trained and until a critical mass of people is trained. This category also includes the cost of developing and maintaining monitoring and assessment information systems which are critical for gauging the effectiveness of programs as part of a broader development strategy (IRC, 2003).

2.3 The Total Costs of Service Delivery, IRC Definition

According to IRC definition, the following costs are included when calculating the total cost of a facility or service:

- Financial costs
- Economic costs
- Costs of sustaining service (Support costs)

The total costs of service delivery are summarised in the Table 2.1;

Table 2.1: Identifying Costs of Service Provision

TOTAL COSTS OF SERVICE PROVISION		
FINANCIAL COSTS	**ECONOMIC COSTS**	**COSTS OF SUSTAINING THE SERVICE**
Operation and maintenance costs	Environmental costs	Institutional capacity building and skills training
Capital costs	Opportunity costs	Monitoring and assessment
Servicing capital costs		Policy and enabling environment

Source: Cardone and Fonseca (2003)

2.4 Quality of Service

Quality of service of water supply and sanitation facilities has many dimensions: affordability, reliability, adequacy, water quality and the degree of responsiveness of service providers to customer complaints. Three significantly levels of service can be distinguished from Water Supply Systems. These are House connection, Yard Connection and Public/Community stand pipe. With the house connection, water flows through laid pipes to individual households. The level of service with the house connection is highest. With the yard connection water flows through laid pipes to a stand pipe on the compound of a household. The level of service with yard connection is lower compared to house connection. With the communal connection, people fetch water from a central stand pipe point. Service level with the communal connection is lower compared to the yard connection.

Also, the levels of service derived from sanitation facilities are Household, Institutional and Public or Communal. With the household and institutional services, individual households and institutions have access to their own latrine whiles with the communal; the entire community is provided with a common latrine. The levels of service for household, institutional and communal are highest, higher and high respectively.

Service quality needs to be sufficiently good to encourage payment and that water suppliers are seen to be responsive to the demands of consumers. It has been shown that consumers are willing to pay for good quality services and are prepared to pay increased costs for improved services in terms of water quality and supply continuity. However, consumers are willing to be disconnected from water supply whose service quality is poor and whose costs are high. This will inevitably lead to greater health risks as unprotected water sources are used for water supplies.

2.5 Management Arrangement STWSS

For Water supply and sanitation facilities to be sustainable and high quality of service levels maintained, there should be a management board to monitor the activities and performance of the facility.

The Water and Sanitation Development Board (WSDB) manages the Water and Sanitation Systems in rural and peri-urban communities (TREND, 2006). It devolves upon the Board to put in place a strong and effective management system that ensures that the Water and Sanitation Systems is being run efficiently to avoid the complete breakdown of the installed system much to the health detriment of the community. The Board has three management options to choose from. These are the:

- **The Direct Management System** - In case of direct management, the Water and Sanitation Development Board (WSDB) directly supervises the day to day operation of the system. Again, the WSDB directly employs all the workers for the system and either pay them salaries or commissions (TREND, 2006).
- **The total Indirect (Delegated) Management System** – In the case of indirect management system the community through the WSDB hands over the entire operation and management of the community's water supply system either on contract or on lease to a private operator (TREND, 2006).
- **Partial Delegated Management** – In the case of partial management the community through the WSDB hands over some parts of the management and or operation of the communities' water system either on contract or on lease to a private operator (TREND, 2006). The responsibility of the Board is reduced with this option; however the extent of supervision is still relatively strong.

It is also possible to choose a combination of both and to delegate only parts of the system to some specialised agency for management. These, for instance, might include delegating accounting to an accounting company, maintenance to a maintenance company and technical operation to a skilled technical operator. Where you have such situations, the system is still managed in Direct Management while the selected components are managed in Indirect Management. The Companies appointed for the delegated management of the components of the system are paid for their services.

2.6 Cost Recovery and Financial Sustainability

Tariffs are set primarily to recover costs and ensure financial sustainability depending on the cost which is to be recovered. Cost recovery increases the numbers of people that have access to sustainable water and sanitation services (IRC, 2003). Costs of WASH facilities are mainly recovered through tariff setting, subsidies, micro credit, social funds, and community funds (IRC, 2003).

As defined by Brikke, 2002 as cited in Financing and Cost Recovery by Cardone and Fonseca, WASH service is sustainable when:

- It is functioning and being used
- It is able to deliver an appropriate level of benefits (quality, quantity, convenience, continuity, health)
- It continues to function over a prolonged period of time
- Its operation, maintenance, administrative and replacement costs are covered at the local level.

Sustainability of a service is achieved when the community wants and accepts the level of service provided, is able to pay for it and the skills are available locally to service the system (Cardone and Fonseca, 2003). It makes sound economic sense if the scheme can be managed locally, as it does not only reduces the cost of running the scheme but also ensures that money is retained in the local area (WHO-IRC, 2003).

Unless all of the costs related to providing and maintaining a service are identified and covered in a coherent manner with sources of funds, a system cannot be considered to be sustainable (IRC, 2003). Costs related with operating and maintaining a water supply and sanitation scheme and certain percentage of capital costs in many community tariffs alone are not sufficient to recover cost and hence make the system to be sustainable. Sustainable system must be able to recover cost on system construction (Investment), operation and maintenance, capital maintenance and support.

CHAPTER THREE

3. STUDY AREA AND METHODOLOGY

This chapter describes the study area and method used in carrying out the study. The study area gives a description of the Bosomtwe-Atwima-Kwanwoma District (BAKD). It explains the location and size, population of the district and other relief features. The methodology explains how sampling was done, procedure for data collection, sources of data and questionnaire formulation and administration.

3.1 Study Area

The BAK district map below shows the areas selected for the study. These communities are shown with red rings in figure 3.1.

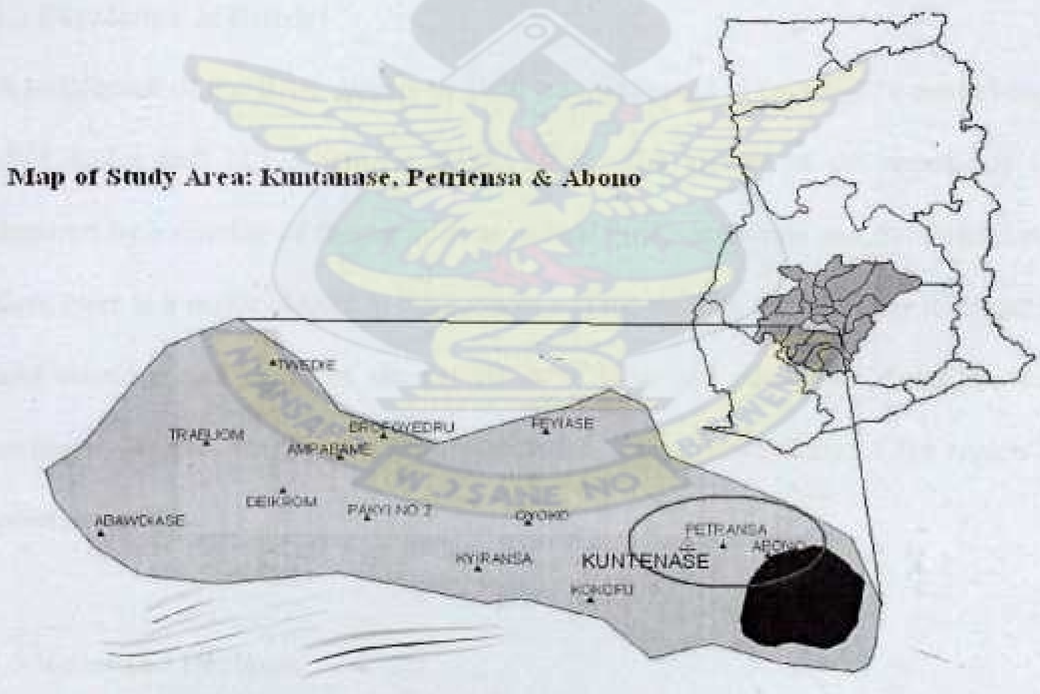

Figure 3.1: Map of Bosomtwe-Atwima-Kwanwoma District Assembly showing the Study Areas

3.1.1 Location and size

Bosomtwe-Atwima-Kwanwoma (BAK) District is among the newly created districts which were established when the District Assembly concept was introduced in 1989. Until then it was part of the Ejisu-Juaben district.

The district is located at the eastern part of the Ashanti Region and covers an area of approximately 718 square kilometers. It lies within latitudes 6’24° N and 6’43° and longitudes 1’15° and 1’46° W. The district is bounded on the north by Atwima, Ejisu-Juaben and Kumasi Districts and on the east by Asante-Akim North District. The southern section is bounded by the Amansie East and Amansie West Districts. The BAK has Kuntanase as district capital.

3.1.2 Population of District

The population of the BAK district in 2000 was estimated to be 146,028 comprising 71,904 males and 74,124 females (GSS, 2000). The growth in the population is influenced by a number of factors such as natural birth, death rate and out migration. Unless there is a major change in the economy of the district, the tendency to migrate would continue and therefore the net effect of birth and death rate would be the contributory factors to the growth of population. The district share of the region's population is 4%.

3.1.3 Relief and Drainage

With the exception of the Lake that has an outer ridge that maintains a constant distance of 10 km from the centre of the lake and stands at an elevation of 50 to 80m, the rest of the district cannot boast of any unique topographical features. The drainage pattern of Bosomtwe District is dendritic. The rivers flow in a north- south direction. Around Lake Bosomtwe, there is an internal drainage where the streams flow from surrounding highlands into the lake. The rivers are perennial. They also form a dense network due to the double maxima rainfall regime. Notable rivers in the district are rivers Oda, Butu, Siso, Supan and Adanbanwe.

3.1.4 Climate

The district falls within the equatorial zone with a rainfall regime typical of the moist semi- deciduous forest zone of the country. There are two well- defined rainfall seasons. The main season occurs from March to July with a peak in June. The minor season starts from September to November with a peak in October. August is cool and dry. The main dry season occurs in December to March during which the desiccating harmattan winds blow over the area.

Temperature of the area seems to be uniformly- high and throughout the year with a mean of around 24°C. The highest mean occurs just before the major wet season in February as observed in Kumasi 27.8°C. The mean minimum occurs during the minor wet season.

Relative humidity (RH) is generally high throughout the year. The morning relative humidity (RH) is highest during the minor dry season and start of the minor wet season (95%) whilst the lowest is towards the end of the main dry season. The afternoon at 1500 hrs has the highest in August (71.6%) and the lowest in January where it is around 42.5%.

3.1.5 Vegetation and Water Resource

The vegetation of the district is semi-deciduous forest. Intensive agricultural activities have led to the reduction in the change of forest cover to secondary forest. The secondary vegetation consists of climate, slumps and soft wood plants. The major rivers in the district are Oda, Busu, Siso, Supan and Adanbanwe.

3.1.6 Hydrological Conditions

The geological formation of the district consists of Upper, Lower Birimian rock and granite rock formation (IDA, 1998). The upper Birimian consists of metamorphosed lavas and pyroclastic rocks, hypabussal basic intrusives phylites and grey wackes, whilst the Lower Birimian is made up of phylites schists tuffs and grey wackes. The granite consist of brolite and muscorite granite, granodiorite pegmatite aplite with brolite schists pendants. As regards its groundwater potential, the lower Birimian rocks have a higher groundwater potential and the discharge could be as high as 200l/min (IDA, 1998). However, in the case of the granites, where there have been weathered rock fractures, groundwater potential is high where as in the areas where weathered granites exist the potential for groundwater is low. Against the background of the hydrological conditions and the experience of ongoing project in areas with similar characteristics, the probability of hitting underground water is estimated to be 70% (IDA, 1998).

3.2 WASH facilities available in BAKDA

The Bosomtwe-Atwima-Kwanwoma District (BAKD) has 130 communities. The WASH technologies mainly available in the district are hand dug well, borehole with hand pump, small town water supply scheme, household latrines, public latrines and institutional latrines. The Table 3.1 below shows the existing WASH facilities available in the Bosomtwe-Atwima-Kwanwoma District.

Table 3.1: Wash facilities available in BAKD

TECHNOLOGY OPTIONS	NUMBER OF COMMUNITIES
WATER SUPPLY	
Hand dug Well	28
Borehole + Hand pump	112
Small Town Water Supply	4
SANITATION	
Household latrine	51
Public/Communal latrine	28

3.3 Methodology

3.3.1 Sampling

In carrying out this research, the life cycle cost and service quality of small town water supply scheme, borehole with hand pump and household latrines were considered from three communities namely Kuntanase, Abono and Petriensa in the BAK. Only three communities were selected because of financial and time constraints. The sampling technique adopted was Purposive where systems which were expected to have the same level of record keeping of their operations were selected. Further criteria for the selection were based on population, contractor, funding agency and age of facility. Details of the number of systems considered are shown in the Table 3.2.

Table 3.2: Sampling Matrix

System	No.	Location	Population (2008) using the facilities	Year of construction
Small Town Water Supply Scheme	1	Kuntanase	3884	2002
Borehole with Hand pump	1	Kuntanase	1942	1985
	1	Abono	1467	1998
	1	Petriensa	356	1998
Household Latrine	3	Kuntanase	3884	2002

3.3.2 Procedure for Data Collection

Data required for the study were obtained through desk study, field survey to the selected water supply and sanitation facilities, questionnaire formulation and administration and structured interviews.

3.3.3 Desk study

Literature and other relevant documents were reviewed with respect to this study in order to fully understand the issues involved in the costing of water supply, sanitation and hygiene services. Literature were reviewed on life cycle cost analysis and its importance, cost breakdown structure, WASH management arrangements, cost recovery and financial sustainability of WASH facilities.

3.3.4 Field survey

After reviewing literature and other relevant documents, field visits were carried out to collect data from the following stakeholders;

- Structured interviews with Heads of CWSA, DA and Community Water and Sanitation Team.
- Collection of data from CWSA, DA and Community.

3.3.5 Sources of Data

It was initially decided that the investment cost data would be based on accepted bill of quantities, project completion reports and payment certificates of projects. However the project completion reports and payment certificates did not contain costs of various components of the facilities and also final costs were not usually available. Therefore the investment costs were based on accepted bill of quantities where completion reports and payment certificates did not exist. The operation and maintenance costs were obtained from WATSAN committee, Water and Sanitation Development Board, District Water and Sanitation Team in the district. Capital maintenance costs were also collected from Water and Sanitation Development Board, District Water and Sanitation Team. Support costs were obtained from WSDB, District Water and Sanitation Team (DWST), Community Water and Sanitation Agency, Donor Agencies and NGOs. The Table 3.3 below shows the type of data and the sources from which they were obtained.

Secondary sources of information included CWSAs Strategic Investment Program report, Ministry of Works and Housing Operation Manual and relevant technical journals.

Table 3.3: Data Source Matrix

DATA	SOURCE
Investment cost	▪ BOQ ▪ Project completion report ▪ Payment certificates of Projects
Capital Maintenance cost and Operation and Maintenance cost	▪ WATSAN ▪ WSDB ▪ DWST
Support Cost-National Level -Regional Level -District Level	▪ Donor Agencies, ▪ CWSA ▪ NGOs/Das

3.3.6 Questionnaire Design and Administration

Questionnaires were designed and administered to households using various types of water and sanitation facilities within the study area. The questionnaires were aimed at seeking information regarding the quality of service derived from the facilities.

Forty (40) questionnaires each were administered to people who fetch water from stand pipe and households with house connections in Abono, Petriensa and Kuntanase to assess the quality of service they get out of the Water supply facilities.

3.3.7 Structured Interviews

Heads of CWSA, DA's, WSDB's and WATSAN Committee were interviewed on issues regarding the cost of some water and sanitation facilities, the quality of service and reasons for providing a particular system for a particular community.

Some of these stakeholders were interviewed regarding the quality of service derived from household latrine.

3.3.8 Data Analysis

The components of life cycle cost were made of the investment, actual operation and minor maintenance works, actual replacement and estimated support costs. Disaggregated data collected were analysed under the headings with their various activities below in Table 3.4.

Table 3.4: Activities considered under various cost components

ACTIVITY	COST			
	INVESTMENT	CAPITAL MAINTENANCE	OPERATION AND MAINTENANCE	SUPPORT
1.	Construction	Major rehabilitation	Routine maintenance	▪ DWST/RWST Allowance ▪ Utility ▪ Communication ▪ Fuel & vehicle Maintenance
2.	Software	Replacement	Administration*	▪ WSDB and WATSAN support ▪ Monitoring activities by DWST/RWST ▪ Feedback on reporting
3.		Extension*	Energy *	Monitoring activities by CWSA*
4.			Personnel*	Project Administration*
5.			Transportation*	Subsidy***
6.			Board Allowance*	
7.			Miscellaneous*	

*Small Town Water Supply only, **Borehole with HP only, ***Household Latrine only.

(i) The disaggregated costs of investment, operation and maintenance, capital maintenance and support costs were estimated using cash flow diagram and basic principles of Engineering Economy to convert historical cost to their annual costs and per capita costs.

(ii) The quality of service of WASH facilities were analyzed using questionnaires based on the quantity, characteristics (water quality), reliability and affordability of the water supply facilities.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

The chapter four present results on disaggregated cost of WASH services and quality of service delivered. The per capita and annual cost components of the WASH services are discussed in this chapter. The costs were determined for the facilities listed below;

- Small Town Water Supply Scheme
- Borehole with Hand pump
- Household (VIP) latrine

4.1 Kuntanase Small Town Water Supply Scheme

Kuntanase, the capital of BAKD has a population of 3,024 (2000, Population and Housing census) and hence falls under the category of small town. The population in the service area is expected to grow at an annual rate of 3 percent, slightly above the national average, due to natural growth and immigration from rural areas.

The Kuntanase Small Town Water Supply scheme was constructed in 2002. This system was funded by the Government of Ghana in partnership with the European Union. It started operation in June 2002. The water supply scheme serves the entire Kuntanase population. The community manages its own Water Supply scheme with the mandate given to the WSDB. Water is pumped from the borehole to an overhead concrete tank of capacity 30 m^3. The water is treated and distributed under gravity to various water points. The pump is expected to be replaced every six years.

Previously the community relied on two boreholes with hand pump. This supply was very inadequate for the entire population. There were often long queues during the early mornings when most households had to fetch water. These boreholes often got spoilt since the pressure on it was too much. This resulted in many water related diseases since some of the population resulted to other sources such as streams and rivers.

Since the inception of the Small Town Water Supply, the acute water shortages have been a thing of the past and most reported water related diseases has drastically been reduced. The community now has adequate and reliable water supply. The facility has a design life of twenty (20) years.

4.1.1 Investment cost

Investment cost was the initial facility cost incurred prior to and putting the facility in service. The total Investment cost comprised of the software and hardware component. The software component is the community sensitization and hygiene education component of the project. The hardware cost comprised the construction cost which had various units. Borehole works was made up of the Hydrogeological investigations and the drilling works. Pipe works comprised of the transmission and distribution mains with dimensions 50mm, 75mm and 100mm. Reservoir/Storage tank made of concrete has a capacity of 30m^3. Also it comprised of pump house and electrical installations and treatment of the water which were part of the construction cost. The disaggregated costs of investment for these components are presented in Table A3.1 in Appendix 3.

The total investment cost as shown in Table 4.1 was estimated to be GH¢ 115,524.98. The annual cost and the annual cost per capita estimated for the Kuntanase Small Town Water Supply Scheme were GH¢18,456.27 and GH¢3.38 respectively.

All these costs were incurred before and during the construction of the small town water scheme. This cost was paid by Government and Partner Agencies.

4.1.2 Capital Maintenance Cost

The capital maintenance cost is the cost of replacement and rehabilitation of infrastructure. The results revealed the CapManEx incurred on rehabilitation works on the pipe lines and rehabilitation of the office of WSDB, cost of servicing of pump and borehole, cost of blowing and cleaning of borehole and the cost of replacement of pump. It also included the cost of extending water from Kuntanase to Toamfom which is a nearby community. The costs of capital maintenance was calculated based on the actual replacements and works that had been carried out over the five year study period and these are presented in Table A3.2 in Appendix 3.

The Net Present Value (NPV) as summarized in Table 4.1 for the capital maintenance for the five (5) year study period from 2003 to 2007 was GH¢ 2,781.03 using 2002 as base year. The annual cost and the annual cost per capita estimates for the CapManEx were GH¢ 829.64 and GH¢ 0.15 respectively.

Capital maintenance works were carried out when there was the need for replacement and rehabilitation works. This cost varied from year to year. In the year 2003, there was no Capital Maintenance Expenditure (CapManEx) due because the system had just been put into operation and hence it was very new. In the year 2007, there was a drastic increase in cost. This was because the WSDB bought a new pump of specification SP 8A 21 which was intended to replace the old pump which was not functioning. This cost was paid by the users of the facility.

4.1.3 Operation and Minor Maintenance costs

Operation and minor maintenance cost outlays are future expenses; costs incurred after the project has been placed in service (Mearig, et al., 1999).

The operation cost included energy cost, personnel cost, transportation cost, administration cost, hospitality cost, water quality tests and board allowance cost. The energy cost was the cost of electricity bill. Personnel cost was the salaries given to the five (5) workers of the board. Transportation cost was the cost incurred for the to and fro movement of the board in carrying out their activities efficiently. Administration cost was the cost of stationeries, printing works and cost of running the WSDB office.

The hospitality cost was the cost for assisting members of the board when they are sick (hospital assistance) or losses a loved one. Board allowances were incurred as salaries and per diem to WSDB. Water quality test was carried out at the KNUST Environmental Engineering Laboratory to check the quality of the water produced. The study was done for five (5) years from 2003 to 2007. The disaggregated costs for operation and minor maintenance are presented in Table A3.3 in Appendix 3.

Minor maintenance costs were incurred on minor and regular works carried out on the water supply scheme. They included the costs of clearing and weeding along the pipe lines, cleaning of washout, repair of WSDB bicycle, repairs on pipe meters etc.

Operation and minor maintenance cost increased from the year 2003 to 2007. The cost was highest in the year 2006. This was due to the fact that there were series of minor repair works carried out on the pipelines and the other components. Generally operation and minor maintenance cost increased with time.

The NPV as presented in Table 4.1 for operation and minor maintenance for the five (5) year study period was GH¢ 24,221.93. The annual cost and the annual cost per capita estimates were GH¢ 7225.89 and GH¢ 1.32 respectively. These costs were calculated based on the actual Operation and minor maintenance records within the 5 year study period with 2002 as the base year.

4.1.4 Support cost

Support costs are obtained from the National, Regional, District and Community levels. The support costs included the allowances for four (4) DWST staffs, communication and utility (electricity and water bill) cost. Fuel and vehicle maintenance costs were also captured as part of the support cost. The variable costs included WSDB and WATSAN support, monitoring and evaluation.

From the national level, money was given to the DWST to buy computer, printer and other stationary for administrative works. Also from the regional level, cost was in the form of capacity and skills training that were organized for the DWST. It also included the cost of monitoring the activities of the DWST by Community Water and Sanitation Agency (CWSA). At the district level, the cost included the allowances given to the four (4) DWSTs and the cost of fuel for monitoring the operation and minor maintenance works of the water scheme by the WSDB.

From the national level, support cost was incurred in the year 2002 when construction of the small town water scheme was being carried out. This cost is given to the DWST to enable them run the office efficiently. In 2003 the District Assembly organized three day training for the Water Board towards the maintenance of the scheme. The support cost excluded the salaries of District Water and Sanitation Teams (DWSTs), Regional Water and Sanitation Teams (RWSTs) and Ministry of Water Resource Works and Housing (MWRWH).

The NPV as shown in Table 4.1 for the support cost for the five (5) year study period was GH¢ 2,397.23. The annual cost and the annual cost per capita estimates were GH¢ 715.14 and GH¢ 0.13 respectively using 2002 as base year. The summary of activities that made up the support costs is listed in the Table A3.4 in Appendix 3. with detailed calculations in Appendix 7.

From the Table 4.1 it is seen that the total non investment cost for 5 years study period was 32%.

Table 4.1: Cost Per Capita for each component for Kuntanase Small Town Water Supply with Design life of 20 years for a study Period of 5 years

COST COMPONENT	COST (2002)/(GH¢)			
	INVESTMENT	CAPITAL MAINTENANCE	OPERATION AND MAINTENANCE	SUPPORT*
Total cost	115,524.98	2,781.03	24,221.93	2397.23
Annual Cost	18,456.27	829.64	7,225.89	715.14
Annual Cost per capita	3.38	0.15	1.32	0.13

Support Cost*-Does not include salaries of Staff from all the levels

4.2 Borehole with Hand Pump

Life cycle cost of boreholes with hand pump was considered in three communities namely Abono, Petriensa and Kuntanase. The life cycle cost data were collected for a period of five (5) years from 2003 to 2007. Abono is a community with a population of 1,467. It has one (1) borehole serving the entire populace. The borehole has a hand pump of make Nira. Water from this borehole is used for all domestic and other productive uses. The borehole was constructed in 1998 by the BAKD.

Petriensa is a community in the BAKD with a population of 365. It currently has one (1) borehole with Afridev hand pump installed and it is used by the whole community. The borehole was constructed in 1998 by a philanthropist called Owura Ben who later handed it over to the District Assembly.

Kuntanase is a community with a current population of 3,884. It has a small town water supply scheme and two (2) boreholes serving the entire population. The borehole was constructed by Government of Ghana in partnership with KFW from Germany. Since the inception of the small town water supply scheme in June 2002, the boreholes serve as an alternative source of water supply. The boreholes are thus used occasionally especially when the main source fails. There were lack of adequate and documented data on capital maintenance and operation and minor maintenance costs, hence these costs were estimated. The annual life cycle costs of these boreholes are summarised in the Table 8 below.

Table 4.2: Cost component data on boreholes with hand pump in the three communities for a study period of 5 years (2003-2007)

BOREHOLE	ANNUAL BOREHOLE COST (2003) (GH¢)			
	INVESTMENT	CAPITAL MAINTENANCE	OPERATION AND MAINTENANCE	SUPPORT
BH 1	506.67	102.92	87.44	12.47
BH 2	498.25	133.85	26.81	12.47
BH 3	506.67	53.14	19.25	12.47

BH 1-Borehole at Abono, BH 2-Borehole at Petriensa, BH 3-Borehole at Kuntanase

From the Table 4.2 above the investment costs (CapEx) included the software and construction costs. The construction costs were made up of Hydrogeological works (Drilling), borehole development, borehole concrete pad, capping, test pumping, supply and installation of pump. Comparing boreholes from various communities, it was observed that the investment cost were almost the same. This was due to the fact that all the three boreholes were constructed in the same year by the District Assembly.

Capital maintenance expenditure (CapManEx) for boreholes with hand pump was mainly the replacement of the PVC riser pipe. Others included the replacement of the PVC brass lined cylinder and the replacement of pipe centralizer. CapEx was highest in Petriensa and lowest in Kuntanase.

The operation and minor maintenance expenditure (OpEx) of the boreholes with hand pump included minor routine maintenances, greasing and oiling of movable parts, cleaning of the borehole and weeding around borehole area. It also included payments that were given to the vendors selling the water. OpEx was high in Abono and

Kuntanase and low in Petriensa. Petriensa recorded the lowest OpEx because the community do not sell water and hence do not have any cost incurred on payment to vendors.

The support cost included allowances that were given to four (4) DWSTs, utilities such as electricity and water bills. It also included communication, fuel and vehicle maintenance costs. The variable costs included capacity building and skills training that were given to two (2) DWSTs and also feedback on reports from both the regional and district levels. Support costs incurred from the national level was money for administrative and other logistics. Support cost for all the three (3) communities were the same. The support cost excluded the salaries of District Water and Sanitation Teams (DWSTs), Regional Water and Sanitation Teams (RWSTs) and Ministry of Water Resource Works and Housing (MWRWH). The support costs were estimated on the spending incurred on keeping the facilities working. Detailed support cost calculations are shown in Appendix 4.2.

Detailed calculations for life cycle cost for boreholes with hand pump are shown in Appendix 4.

4.3 Household Latrine at Kuntanase

The life cycle costs of three (3) household VIP latrines were considered in Kuntanase for different households. The study was done from the year 2003 to 2007. It was observed that almost all the households did not have consistent data on capital maintenance and operation and minor maintenance works. Table 4.3 summarizes the estimated life cycle costs of all the three household latrines.

Table 4.3: Cost component data on Household Latrines in Kuntanase for a study period of 5 years

HOUSEHOLD LATRINE	ANNUAL COST (2003)/ (GH¢)			
	CAPEX	CAPMANEX	O AND M	SUPPORT
HL 1	20.81	1.14	12.21	N/A
HL 2	20.81	1.89	12.19	N/A
HL 3	20.81	1.14	11.76	N/A

From the Table 4.3 investment costs were the same for all the three latrines considered. The reason was that all the three latrines were constructed in the same time under the same programme. The investment cost of the household latrines comprised of software, pit excavation, ring beam, reinforced concrete slab and superstructure.

Capital maintenance cost was mainly the replacement of vent pipe and the replacement of mesh which enhanced the effective functioning of the latrine. The capital maintenance cost was highest for HL2 than HL1 and HL3. This was due to the fact that sand barriers were erected to check erosion at the site of the latrine (HL2).

Operation and minor maintenance cost included the cleaning of latrine and minor repairs. Each of the latrines was cleaned everyday with water and detergent. The cost of cleaning the latrine increases with the years. Minor repairs were carried out on the roofing sheet of HL2 which was leaking.

There were no support costs incurred for the household latrine since it belongs to individual households. Subsidy of GH¢45.00 were given to households building the household VIP latrines by the government. This was to offset part of the cost incurred and also encourage more households to have their own latrine to improve the sanitation in the communities and the District as a whole. The support cost excluded the salaries of District Water and Sanitation Teams (DWSTs), Regional Water and Sanitation Teams (RWSTs) and Ministry of Water Resource Works and Housing (MWRWH). The support cost was estimated based on what needed to be done for the facility to be sustainable. Detailed support cost calculations are shown in Appendix 7.

The total annual costs of the three household (VIP) latrines are as presented in Table 4.3 above. Detailed calculations for life cycle cost for the household latrines are shown in Appendix 5.

4.4 Quality of Service in Relation to Cost

The quality of service derived from WASH facilities were measured through the administration of questionnaires to households enjoying house and/or public or communal stand pipe connections for the small town water supply scheme and borehole with hand pump. The variables that were used to measure the quality of service were quantity, characteristics (water quality), reliability and affordability. From the survey conducted all the respondents were willing to pay more for improved quality service.

4.4.1 Kuntanase Small Town Water Supply Scheme

The Kuntanase Small Town Water Supply Scheme has two service levels namely house connections and public/communal stand pipes. The pipe scheme is the main source of water supply and is used for all domestic activities such as cooking, drinking, washing and bathing.

Forty (40) questionnaires each were administered to households enjoying house connections and public standpipe connections.

House connections

The indicators used as a measure of the reliability and affordability are that questions were asked about how often the people get water, how often is the service interrupted and the general impressions of the people about the water price. Out of the 40 people interviewed, all of them attested to the fact that they get water every day for their daily activities and 27 said the service was reliable which accounted for 100% and 67.5% respectively. As to how often they get the interruptions, most of the people were of the view that the interruptions only occur at most once in a month for the purpose of repair and maintenance works to be carried out.

The cost for connecting water to a household is GH¢100.00. From the survey conducted, it was revealed that 46 households had connected water to their homes. The ability to have this type of service depended largely on the income status of the individual and the quest to have easy access to water at all times without much interruptions such as queuing and access to water at specific times of the day such as early mornings and evenings as in the case of that of the public stand pipe. The cost of one cubic meter is 50Gp which is charged through a metering system. Households responded that they are able to pay this amount hence it is very affordable.

The characteristics of water supplied were assessed based on the taste, smell and colour. Out of the number that was interviewed, 2 and 38 people responded that the taste was good and excellent respectively thus accounting for 5% and 95% of the total number interviewed. This is an indication that the people are satisfied with the taste of the water by judging it as excellent. The water supplied is also devoid of colour and smell as indicated by those interviewed giving a percentage of 100 for each of them. This makes the water supplied acceptable by the people.

As to whether the people subject the water supplied to any form of treatment, 62.5% of them said they do not treat water because they don't see the need since they perceive the water as clean and can be used for anything as it is fetched. The few who said they treat the water only said that the only form of treatment they do is to boil the water. This they do when they want to use it for drinking purposes because they are of the view that even though they see the water as good, they think it can't be 100% pure so there is the need to boil it to kill pathogens that may be present but are not visible to the eyes.

Public/communal stand pipe connections

During the interview it was revealed that 75% of the people spend 1-3minutes in a queue when fetching water. Also 25% of the people responded that they spend 4-6minutes in a queue when fetching water. In fetching water, 42.5% of the people interviewed use 1-3minutes to walk from their houses to the water point and back and also 57.5% make a round trip of 4-6minutes. There are nine (9) stand pipe locations within the community and it is placed such that one is not required to walk more than 500m to get to the stand pipe. This number is sufficient for the community. This conclude the fact that the service is reliable.

As to whether the community is able to get access to water every day in sufficient quantities, 100% responded that they get water every day and the water is sufficient for all activities. Since the inception of the public stand pipe, the mode of payment has always being pay as you fetch. The fee charged per bucket (18 litres) of water fetched is 2Gp. This amount collected is low as most confirmed accounting for 67.5% of the total number interviewed. 32.5% of the people were of the view that the amount charged is average hence concluding the fact that it is affordable.

Borehole with Hand pump

The quality of service derived from the borehole with hand pump was assessed based on the quantity, characteristics, reliability and affordability of water from the source. Forty (40) questionnaires each were administered to households using the facility in Abono, Petriensa and Kuntanase.

Abono

The main source of water supply to the community is borehole with hand pump and there is only one of such. There are about 245 houses with an average household size of about 6.0. The household type is predominantly room or compound type. The average water consumption per person per day in Abono was estimated to be 18 litres. This they said was not enough owing to the fact that the entire community of population of 1,467 have access to only one (1) borehole which should have been 300 people to a borehole based on the CWSA standard.

The characteristics of water were assessed in terms of taste, smell and colour. All the forty people interviewed said the taste, smell and colour were excellent and that they had no problem with the characteristics of the source of water.

With regards to the reliability, all the people interviewed were of the fact that there were frequent breakdown of the system due to the high number of people using the system. Breakdown of the borehole with hand pump occurs at least two to three times a month due to larger population using the borehole. Average queuing time was observed to be eleven (11) minutes. About 90% of the population store water in large plastic barrels for use with few treating the water by boiling for drinking purposes. The community charges 1Gp per bucket of water fetched and these monies are collected by a vendor. All the forty (40) people interviewed were of the fact that the tariff charged was very affordable.

Petriensa

The main source of water supply to the community is borehole with hand pump and there is only one of such. There are about 60 houses with an average household size of about six (6). The housing type of the community is predominantly room or compound type. The main occupation of the people is mainly farming. The average water consumption per person per day in Petriensa was estimated to be 36 litres. This they said was enough owing to the fact that the borehole was enough to serve the population of 356.

Characteristic of water quality was also assessed based on the taste, smell, and colour of the water supplied. From the community's point of view, the quality was excellent. About 78% of the people in the community store water in barrels for future use. Also 25% practice household treatment in the form of boiling for drinking purposes. When they were asked why they boil the water, they answered that though the water characteristic is good they boil it to kill any germs that may not be seen with the naked eyes.

Thirty eight (38) of the respondents were of the fact that there borehole was very reliable due to less breakdowns and quick response to these breakdowns. They use the borehole for all their domestic activities. The queuing time for getting water from the main source ranges from 1-10 minutes.

Affordability of the main source of water was assessed based on water price, willingness to pay and mode of payment. The price of water from the community's view was between low and average which clearly indicates their willingness to pay for the water supplied. The mode of payment of the price of water is monthly. This amount (20Gp) is collected per head of the service beneficiaries (normally of the SHS level and above) within a household.

Kuntanase

The Kuntanase community has two (2) boreholes which serve as an alternative source of water supply. The community uses these boreholes occasionally when there are breakdowns from the main source. The quantity during these periods is enough to serve the entire population. The average water consumption per capita was estimated to be 27 litres which is more than the CWSA standard of 24 litres per capita.

The characteristics of water were assessed in terms of taste, smell and colour. All the forty people interviewed said the taste, smell and colour were excellent and that they had no problem with the characteristics of the source of water.

The reliability was assessed to be good since the borehole was used occasionally hence less breakdowns.

The community fetches the borehole water for free because part of the money realised from their main source of water supply (Small Town Water Supply Scheme) was used to maintain the facility.

4.5 Mechanism For Cost Recovery And Financial Sustainability Of KSTWSS

The tariff for one cubic meter of water consumed was GH¢0.50. For sustainable service delivery there should be full cost recovery. The full cost recovery includes recovering the cost of investment, capital maintenance, operation and maintenance and support. Results of average tariffs per cubic meter of water for each of the cost components are shown in Table 4.4 below.

Table 4.4: Tariff for Cost Recovery for Cost Components

PARAMETER	COST COMPONENT (GH¢)				
	CAPEX	CAPMANEX	OPEX	SUPPORT	Total
Tariff for cost recovery/m^3	0.82	0.04	0.32	0.13	1.31

From the results above, the cost per cubic meter of GH¢0.5 can be used to recover the costs of only capital maintenance, operation and maintenance and support. The reason was that the WSDB had the thinking that the community should pay all of the costs related with operating and maintaining, replacement and rehabilitation (capital maintenance) and a certain percentage of the investment cost. Hence the tariff set was not enough to recover full cost which was essential for the sustainability of the system.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

The final chapter concludes on the unit cost of providing Small Town Water Supply Scheme, borehole with hand pump and household latrines to communities in the Bosomtwe-Atwima-Kwanwoma District Assembly. It also concludes on the quality of levels of service and cost recovery and financial sustainability of Small Town Water Supply Scheme.

5.1 Conclusions

The following conclusions are drawn from the analyses of the results;

- The Government of Ghana/Partner Agencies provides the investment cost and some aspect of the support cost leaving out the capital maintenance (replacement) cost and operation and maintenance.
- The capital maintenance, operation and maintenance costs are paid by the users of the facilities.
- The quality of service derived from the house connection is high compared to the communal stand pipe connection.
- The quality of service of water supply in Abono is relatively low compared to that of Petriensa and Kuntanase though the people are willing to pay for a better service.

5.2 Recommendations

Based on the results and discussion, the following are recommended;

- In providing sustainable WASH services focus should not be on only investment but operation and maintenance, capital maintenance and support costs.
- Capacity of Stakeholders (DWSTs/WSDBs/WATSAN/Committee members) involved in the WASH service delivery should be built to enable them keep accurate records of all cost incurred in providing the facility.
- Further research is recommended to enable the results and subsequent recommendations to be applied nationally.

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APPENDICES

APPENDIX 1: Life Cycle Cost Calculations

Design life (n) = 20 years
Average inflation rate from 2003-2007 = 14.82=15%

1. **Annual Investment cost (A)** = P $\left[\frac{i(1+i)^n}{(1+i)^n-1}\right]$

Annual cost for CapManEx, O & M and Support for each year I = A1, AI, A3, A4, A5

Step 1. $P_i = F\frac{i}{(1+i)^n}$

Step 2. $A_i = P_i\left[\frac{i(1+i)^n}{(1+i)^n-1}\right]$

Annual Cost Per Capita = $\frac{Annual\ cost}{Total\ ProjectedPop}$

Projected Population at the end of the design period

Kuntanase Small Town Water Supply Scheme = 5462

Standard for population using 1 borehole = 300

Households have average population = 10

Procedure for life cycle calculations applies to All the Systems.

APPENDIX 2: Summary of Disaggregated Cost Component

Table A2.1: Cost Component for Small Town Water Supply

COST COMPONENT	COST (GH¢)			
	INVESTMENT	CAPITAL MAINTENANCE	OPERATION AND MAINTENANCE	SUPPORT
Total cost	115,524.98	2781.03	24,221.93	2397.23
Annual Cost	18,456.27	829.64	7225.89	715.14
Annual Cost per capita	3.38	0.15	1.32	0.13

Table A2.2: Cost of Borehole

BOREHOLE	ANNUAL BOREHOLE COST (GH¢)			
	INVESTMENT	CAPMANEX	O & M	SUPPORT COST
BH 1	506.67	102.92	87.44	12.47
BH 2	498.25	133.85	26.81	12.47
BH 3	506.67	53.14	19.25	12.47

Table A2.3: Cost of Household Latrine

HOUSEHOLD	ANNUAL COST (GH ¢)			
	INVESTMENT	CAPMANEX	O & M	SUPPORT
HL 1	20.81	1.14	12.21	N/A
HL 2	20.81	1.89	12.19	N/A
HL 3	20.81	1.14	11.76	N/A

APPENDIX 3: Summary of Disaggregated Cost Data for Kuntanase Small Town Water Supply Scheme

Table A3.1: Investment cost Data for KSTWSS (Year 2002)

ACTIVITY	COST (GH ¢)	UNIT COST/ CAPITA (GH ¢)
General items	15,056.00	2.76
Borehole Works	7,287.29	1.33
Pipe Works	31,210.20	5.71
Stand Pipe (9)	8,764.47	1.60
Distribution Point For Private connection (9)	7,395.50	1.35
Pump House and Pump Installation	5,175.59	0.95
Storage Tank (30m^3)	36,479.81	6.68
Power Supply and Electrical Installations	2,706.12	0.50
Water Treatment	1,450.00	0.27
Software	4,475.02	0.82
Total	**115,524.98**	**21.15**

Table A3.2: Capital maintenance cost Data for KSTWSS

ACTIVITY	COST (GH ¢)				
	2003	**2004**	**2005**	**2006**	**2007**
Servicing of pump and borehole	0.00	66.00	0.00	0.00	0.00
Blowing and cleaning of Borehole	0.00	0.00	0.00	630.00	0.00
Extension Works	0.00	0.00	200.00	0.00	0.00
Rehabilitation Works at WSDB Office	0.00	0.00	230.00	0.00	0.00
Rehabilitation Works on Pipe line	0.00	0.00	0.00	0.00	400.00
Replacement of Pump	0.00	0.00	0.00	0.00	3,800.00
Total	**0.00**	**66.00**	**430.00**	**630.00**	**4200.00**

Table A3.3: Operation and Maintenance costs Data for KSTWSS

ACTIVITY	COST (GH ¢)				
	2003	**2004**	**2005**	**2006**	**2007**
Administration	129.47	222.82	202.15	259.85	597.73
Energy	1,216.15	1,531.50	2,967.50	1,504.70	1,262.09
Personnel	2,246.50	2,265.85	2,447.30	3,375.73	3,811.08
Transportation	97.00	92.57	110.25	66.08	50.00
Hospitality	10,00	15.00	0.00	0.00	0.00
Board Allowance	295.10	415.00	1,047.50	942.00	1,117.50
Bank Charges	0.00	82.00	0.00	0.00	0.00
Water Quality Test	0.00	135.00	0.00	0.00	315.00
SSNIT Contribution	52.80	368.55	462.08	501.39	552.83
PAYE	0.00	82.52	149.01	624.52	173.85
Maintenance	543.90	777.80	1,203.80	1,832.60	929.70
Miscellaneous	0.00	0.00	149.01	396.30	285.50
Total	**4,591.00**	**5,989.00**	**8,739.00**	**9,503.00**	**9,095.00**

Table A3.4: Support Cost Data for KSTWSS

ACTIVITY	COST (GH ¢)					
	2002	2003	2004	2005	2006	2007
District level	640.00	678.00	699.00	719.00	500.00	902.00
Regional level	686.00	739.00	758.00	987.00	869.00	1159.00
National level	3,000.00	0.00	0.00	0.00	0.00	0.00
Total	**4326.00**	**1417.00**	**1457.00**	**1706.00**	**1369.00**	**2061.00**

APPENDIX 4: Summary of Disaggregated Cost Data for Borehole

ABONO (BH1)-(2003-2007)

Table A4.1: Investment cost Data, BH1

ACTIVITY	COST (GH ¢)	COST/CAPITA (GH ¢)
General Items	191.82	0.13
Borehole Drilling	1,400.32	0.95
Borehole Construction	378.54	0.26
Borehole Development	75.08	0.05
Test Pumping	96.64	0.07
Water Quality Test	78.12	0.05
Borehole Capping	16.50	0.01
Borehole Concrete Pad	210.00	0.14
Supply and Installation of Hand pumps	421.55	0.29
Training of Pump Caretakers	52.33	0.04
Software	250.15	0.17
Total	**3171.44**	**2.16**

Table A4.2: Capital Maintenance Cost Data for BH1

ACTIVITY	COST (GH ¢)				
	2003	**2004**	**2005**	**2006**	**2007**
Replacement of PVC Riser pipe	25.00	0.00	0.00	38.00	45.00
Replacement Brass lined cylinder	35.00	0.00	80.00	58.00	65.00
Disinfection of borehole	9.00	0.00	13.00	0.00	15.00
Metal Stand	0.00	0.00	0.00	0.00	45.00
Black and White Rubber Bearing	22.00	34.00	11.00	19.00	44.00
Total	**91.00**	**34.00**	**104.00**	**115.00**	**214.00**

Table A4.3: Operation and Maintenance Cost Data for BH1

ACTIVITY	COST (GH ¢)				
	2003	**2004**	**2005**	**2006**	**2007**
Cleaning of borehole area	19.20	19.20	19.20	28.80	28.80
Minor repairs	10.00	10.50	15.00	10.00	17.00
Vendor's allowance	0.00	0.00	0.00	144.00	192.00
Total	**29.2**	**29.70**	**34.20**	**182.80**	**237.80**

Table A4.4 Support Cost Data for BH1, BH2 and BH3

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
District level	497.00	598.00	541.00	638.00	739.00
Regional level	632.00	679.00	768.00	865.00	952.00
National level	200.00	0.00	0.00	0.00	0.00
Total	1,329.00	1,277.00	1,309.00	1,503.00	1,691.00

PETRIENSA (BH2) - (2003-2007)

Table A4.5: Investment cost Data, BH2

ACTIVITY	COST (GH ¢)	COST/CAPITA (GH ¢)
General Items	191.82	0.54
Borehole Drilling	1,400.32	3.93
Borehole Construction	378.54	1.06
Borehole Development	75.08	0.21
Test Pumping	96.64	0.27
Water Quality Test	78.12	0.22
Borehole Capping	16.50	0.05
Borehole Concrete Pad	210.00	0.59
Supply and Installation of Hand pumps	421.55	1.18
Software	250.15	0.70
Total	**3118.72**	**8.76**

Table A4.6: Capital Maintenance Cost Data for BH2

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Dismantling and reinstalling of entire pump	0.00	0.00	400.00	0.00	0.00
Replacement of PVC Riser pipe	0.00	25.00	0.00	0.00	41.00
Replacement Brass lined cylinder	35.00	0.00	0.00	55.00	55.00
Disinfection of borehole	9.00	0.00	13.00	0.00	15.00
Repair of concrete pad	0.00	14.50	0.00	0.00	45.00
Total	**44.00**	**39.50**	**413.00**	**55.00**	**156.00**

Table A4.6: Operation and Maintenance Cost Data for BH2

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Cleaning of borehole area	12.80	12.80	12.80	19.20	19.20
Minor repairs	9.00	10.50	15.00	10.00	17.00
Total	**21.8**	**23.30**	**27.80**	**29.80**	**36.20**

KUNTANASE (BH3)-(2003-2007)

Table A4.7: Investment cost Data, BH3

ACTIVITY	COST (GH ¢)	COST/CAPITA (GH ¢)
General Items	191.82	0.10
Borehole Drilling	1,400.32	0.72
Borehole Construction	378.54	0.19
Borehole Development	75.08	0.04
Test Pumping	96.64	0.05
Water Quality Test	78.12	0.04
Borehole Capping	16.50	0.01
Borehole Concrete Pad	210.00	105/971
Supply and Installation of Hand pumps	421.55	0.22
Training of Pump Caretakers	52.33	0.03
Software	250.15	0.13
Total	**3171.44**	**1.63**

Table A4.8: Capital Maintenance Cost Data for BH3

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Replacement of PVC Riser pipe	25.00	0.00	0.00	38.00	45.00
Replacement Brass lined cylinder	35.00	0.00	0.00	58.00	65.00
Disinfection of borehole	9.00	0	0.00	15.00	0.00
Total	**69.00**	**0.00**	**0.00**	**111.00**	**110.00**

Table A4.9: Operation and Maintenance Cost Data for BH3

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Cleaning of borehole area	19.20	0.00	0.00	28.80	28.80
Minor repairs	10.00	0.00	0.00	10.00	17.00
Vendor's allowance	0.00	0.00	0.00	0.00	0.00
Total	**29.20**	**0.00**	**0.00**	**28.80**	**45.80**

APPENDIX 5: Summary of Disaggregated Cost Data for Household Latrine

HOUSEHOLD LATRINES AT KUNTANASE (2003-2007)

Table A5.1: Investment cost for HL1, HL2, HL3

ACTIVITY	COST (GH ¢)	COST/CAPITA (GH ¢)
Substructure		
Setting out	1.50	0.15
Excavation of Pit	16.73	1.67
Ring beam	15.00	1.5
Reinforced concrete slab	11.00	1.1
Superstructure		
Superstructure foundation	17.55	1.76
Door and door frame	11.20	1.12
PVC vent pipe	4.50	0.45
Roofing members and roofing sheet	17.55	1.76
Block work	13.21	1.32
Finishing	12.03	1.20
Software	10.00	1.00
Total	**130.27**	**13.02**

Table A5.2: Capital Maintenance Cost Data for HL1

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Replacement of Vent pipe	0.00	0.00	5.00	0.00	0.00
Replacement of mesh	0.15	0.15	0.15	0.20	0.20
Total	**0.15**	**0.15**	**5.15**	**0.20**	**0.20**

Table A5.3: Operation and Maintenance cost Data for HL1

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Cleaning of latrine	5.20	7.80	10.40	13.00	15.60
Minor repairs	0.00	0.00	5.00	0.00	8.50
Erosion control	0.50	0.00	0.00	1.00	0.00
Total	**5.70**	**7.80**	**15.40**	**14.00**	**24.10**

Table A5.4: Support Cost Data for HL1, HL2, HL3

ACTIVITY	COST (GH ¢)					
	2002	2003	2004	2005	2006	2007
District level	20.00	0.00	0.00	0.00	0.00	0.00
Regional level	0.00	0.00	0.00	0.00	0.00	0.00
National level	45.00	0.00	0.00	0.00	0.00	0.00
Total	**65.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table A5.5: Capital Maintenance Cost Data for HL2

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Replacement of Vent pipe	0.00	0.00	5.00	0.00	5.00
Replacement of mesh	0.15	0.15	0.15	0.20	0.20
Total	**0.15**	**0.15**	**5.15**	**0.20**	**5.20**

Table A5.6: Operation and Maintenance cost Data for HL2

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Cleaning of latrine	5.20	7.80	10.40	13.00	15.60
Minor repairs	0.00	7.00	0.00	0.80	4.50
Erosion control	0.50	0.00	0.00	1.00	0.00
Total	**5.70**	**14.80**	**10.40**	**14.80**	**20.10**

Table A5.7: Capital Maintenance Cost Data for HL3

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Replacement of door Hinge	0.00	0.00	0.50	0.00	0.00
Replacement of Vent pipe	0.00	0.00	5.00	0.00	0
Replacement of mesh	0.15	0.15	0.15	0.20	0.20
Total	**0.15**	**0.15**	**5.15**	**0.20**	**0.20**

Table A5.8: Operation and Maintenance cost Data for HL3

ACTIVITY	COST (GH ¢)				
	2003	2004	2005	2006	2007
Cleaning of latrine	5.20	7.80	10.40	13.00	15.60
Minor repairs	0.00	0.00	5.00	0.00	8.50
Total	**5.20**	**7.80**	**15.40**	**13.00**	**24.10**

APPENDIX 6: Quantity of Water Produced from 2003 to 2007

Table A6.1: Water production from 2003 to 2007

YEAR	PRODUCTION (m^3)
2003	18,575.42
2004	19,898.73
2005	21,409.37
2006	26,443.19
2007	25,694.00
TOTAL	**112,020.71**

Table A6.2: Income and Expenditure from KSTWSS

YEAR	INCOME/REVENUE(GH ¢)	EXPENDITURE(GH ¢)	SURPLUS (GH ¢)
2003	7,948.92	3,080.80	4,868.12
2004	9,512.55	6,761.11	2751.44
2005	9,452.60	14,164.45	-4,711.87
2006	13,1793.11	12,261.30	918.01
2007	10,950.36	9,102.58	1,847.78

APPENDIX 7: Support Cost Breakdown

FACILITY	LEVEL	DESCRIPTION	COST (GH¢)
Small Town Water Supply	**District**	Allowance for monitoring and evaluation 4 staff members each collects GH¢10.00 each month	4 x 10 x 12 =480.00
		Utility (Electricity Bill)	5 x 12 = 60.00
		Fuel and vehicle maintenance per year	50.00
		WSDB and WATSAN support	50.00
		Salaries for DWSTs	-
		Total support cost for 2002	640.00
	Regional	Allowance for monitoring and evaluation 4 staff members each collects GH¢11.00 each month	4 x 11 x 12 = 528.00
		Utility (Electricity Bill) = GH¢6.00 per month= GH¢ 36.00	6 x 12 = 72.00
		Fuel and vehicle maintenance per year	50.00
		DA support on feedback and reporting	36.00
		Salaries for RWSTs	-
	National	Computer	420
		Printer	970
		Photocopier machine	250
		Binding machine	30
		Air conditioner	410
		Refrigerator	120
		Office desk	400
		Book shelves	350
		Stationary	50
		Salaries of Workers of WRC	-
		Salaries of Workers of MWRWH	-
		Support cost for 2002 (for 4 Small Town)	**4326**

Borehole with Hand pump	**District**	Allowance for monitoring and evaluation 4 staff members each collects GH¢10.00 each month	4 x 10 x 12) =320.00
		Utility (Electricity Bill) GH¢5.00 per month	5 x 12 = 60.00
		Fuel and vehicle maintenance per year	50.00
		WSDB and WATSAN support	50.00
		Salaries for DWSTs	-
	Regional	Allowance for monitoring and evaluation 4 staff members each collects GH¢11.00 each month	2/3(4 x 11 x 12) = 352.00
		Utility (Electricity Bill) = GH¢6.00 x 12per month	72
		Fuel and vehicle maintenance per year	50
		DA support on feedback and reporting	36
		Three day training for one pump caretaker (Accommodation, food and transportation)	122.00
		Salaries for RWSTs	
	National	Administrative cost including stationary.	200.00
		Total support cost for (112 BH+HP) 2002	632.00
Household Latrine		There are no support costs for household latrines at all levels	-

APPENDIX 8: Sample Questionnaire

Table A7.1: Household survey and Public Stand pipe Questionnaire

HOUSEHOLD SURVEY QUESTIONNAIRE		
District: BAK	Date:	Community:
1. Family size		
2.Type of dwelling	☐ Separate House ☐ Semi-detached House ☐ Flat Apartment ☐ Room or Compound ☐ Huts/Tents/Kiosk/Attachment to shop	
3.Type of Household (from Well-being ranking)	☐ Poor ☐ Medium ☐ Better off	
4. Occupation	☐Government Worker ☐Farmer ☐Daily labour ☐Other(Specify)	
5.Income (Monthly)	☐ > GH¢ 50 ☐ GH¢50-100 ☐ < GH¢100	
6. Source(s) of water	Main source(s)	☐Small Town Water Supply ☐Borehole+Hand pump ☐River/ Stream ☐Rainwater harvesting
	Alternative source(s)	☐Borehole+Hand pump ☐Pond ☐Lake ☐River/Stream ☐Rainwater harvesting
7. Uses of source(s)	Main source(s)	☐Washing and bathing ☐Productive Uses..(Specify).......... ☐Cooking ☐Drinking

	Alternative source(s)	☐Washing and bathing ☐Productive Uses..(Specify)... ☐Cooking ☐Drinking
8. How regular is your source of water supply?	Main source(s)	☐Daily ☐Weekly ☐Monthly ☐Quarterly ☐Half yearly ☐ Yearly
	Alternative source(s)	☐Daily ☐Weekly ☐Monthly ☐Quarterly ☐Half yearly ☐ Yearly
9. When do you use the alternative source?	☐Always ☐Wet season ☐Dry season ☐When main source fails	
10. Where is the water source located?	Main source(s)	☐ In own dwelling ☐ In own Yard/Plot ☐ Elsewhere
	Alternative source(s)	☐ In own dwelling ☐ In own Yard/Plot ☐ Elsewhere
11. How far is water source from dwelling?	Main source(s)	☐ .... minute(s) ☐ ....metre(s) ☐ ....Kilometre(s)
	Alternative source(s)	☐ .... minute(s) ☐ ....metre(s) ☐ ....Kilometre(s)
12. How long does it take to go to source, get water and come back?	Main source(s)	☐ .... minute(s)
	Alternative source(s)	☐ .... minute(s)
13. How many times do you fetch water from main source?	☐1x ☐2x ☐3x ☐4x ☐5x ☐Other (Specify)..........	

14. How much water does your household use in a day?	☐ ....bucket(s)(34cm) ☐ ....litre(s) ☐ ....Gallon(s)	
15. Is water fetched sufficient for daily activities?	☐Yes ☐No	
16. Do you practice household treatment of water?	☐Yes ☐No	Type of treatment....................
17. What is your impression about the water quality?	Taste?	☐Excellent ☐Good ☐Fair ☐Poor ☐Very poor
	Smell?	☐Excellent ☐Good ☐Fair ☐Poor ☐Very poor
	Colour?	☐Excellent ☐Good ☐Fair ☐Poor ☐Very poor
18. Do you store water at home?	☐☐Yes ☐ No	
19. How much do you pay for water?	☐ ....per bucket ☐ ....per litre ☐ ....per container(Specify)	
20. What is the mode of payment?	☐Pay as you fetch ☐Monthly payment ☐Other (Specify)	
21. What is your impression about water price?	☐Low ☐Average ☐High	
22. Are you always willing to pay for water use	☐ Yes ☐ No	

STAND PIPE SURVEY QUESTIONNAIRE	
1. How do you transport water	□Animal □Wheel barrow □Vehicle □Physical carrying
2. At what times are water point opened	
3. How does opening times affect your daily activities	
4. How much do you pay for water	□ ....per bucket □ ....per litre □ ....per container(Specify)
5. What is the mode of payment	□Pay as you fetch □Monthly payment □Other (Specify)
6. What is your impression about water price	□Low □Average □High
7. Are you always willing to pay for water use	□ Yes □ No
8. How often do you get water	
9. How is the water point cleaned	
10. How often do you get interruptions in the piped water supply	
11. What normally causes the interruptions in your piped water	
12. In case of these interruptions, how soon are they rectified	□ a day □ a week □ a month □ 6 months □ Other (Specify)................
13. How do you rate the overall service quality of your system	□ Poor □ Good □ Very good