

CRANFIELD UNIVERSITY

YOLANDA CHAKAVA

“TRANSITION PHASE” WATER SUPPLY INTERVENTIONS IN  
LOW-INCOME URBAN SETTLEMENTS: KENYA

SCHOOL OF APPLIED SCIENCES  
GLOBAL WATER POLICY AND MANAGEMENT

PhD

Academic Year: 2010 -2013

Supervisor: Dr. Richard Franceys  
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## **ABSTRACT**

A multitude of transitional water supply and distribution interventions are continually piloted in Kenya's fast-growing urban settlements to meet national and global MDG targets, yet visible problems persist regardless of the investments made. This research evaluates the performance of four interventions led by public utilities and non-governmental organisations in the low-income settlements of Nairobi, Kisumu and Nakuru counties. To understand the service improvement received by the residents, this study used qualitative data from interviews and focus group discussions and quantitative data from 1,168 household surveys.

Service level analysis results showed making water more affordable using pre-paid technology reduced the effective price by 75% and increased consumption per household by 20 litres per day, resulting in the highest service progress. Improving water accessibility for the very poor via hosepipe door-step delivery reduced the burden on women carrying water by 43% although efforts failed to reduce the pricing structure, limiting the progress. Subsidised 'first-time' metered plot connections to increase the utility customer base experienced shortages in water supply and reluctance from landlords, restricting development. Despite showing no positive change, 81% of residents continued to rely on expensive self-supplied boreholes which were all contaminated.

Although the utilities have made positive strides in service improvement, in the context of universal service this study has shown that the very poor remain the most difficult to access, forming the target of discrete interventions that experience difficulties in influencing a reliable supply, sustained price reduction and/or good water quality – essentially what is needed most. In investigating the longer term supply and demand shortfall, this study concludes that the equitable supply and innovative distribution of point source groundwater, with a bias for the poorest, could be the most resilient transitional solution for the utility to promote in the foreseeable future, out of necessity rather than desire.

Keywords: groundwater; utility; urban poor.



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## LIST OF ABBREVIATIONS

CU	Cranfield University
DMM	Delegated Management Model
GoK	Government of Kenya
HH	Household
HWTS	Household Water Treatment Storage
jc	Jerrycan
JMP	Joint Monitoring Programme for Water Supply
KES	Kenyan Shillings
KES/jc	KES per 20 litre jerrycan
KIWASCO	Kisumu Water and Sewerage Company Limited
KPI's	Key Performance Indicators
L/c/d	Litres per capita per day
Li	Litres
LIS	Low-income settlement
MOs	Master Operators
MW&I	Ministry of Water and Irrigation
NAWASSCO	Nakuru Water and Sanitation Services Company Limited
NCWSC	Nairobi City Water and Sewerage Company Limited
NGO	Non-governmental Organisation
NRW	Non-Revenue Water
NWSS	National Water Services Strategy
PPIP	Pro-poor Implementation Plan
PPP	Public-Private Partnerships
SSP's	Small-scale Providers
SUWASA	Sustainable Water and Sanitation in Africa
UN-HABITAT	United Nations Human Settlements Programme
UFW	Unaccounted-for Water
UNICEF	United Nations Children's Fund
UNFPA	United Nations Population Fund
USAID	United States

WAB	Water Appeals Board
WASH	Water, Sanitation and Hygiene
WSB	Water Service Board
WSP	Water Service Provider
WASREB	Water Services Regulatory Board
WSTF	Water Services Trust Fund
WHO	World Health Organisation

### **NOTE ON CURRENCY**

1 USD\$ = KES 80

Prices for water are reported in Kenyan shillings in the denominations as follows:

KES 1.2 per 20 litre jerrycan = USD\$ 0.75 per cubic meter

KES 2 per 20 litre jerrycan = USD\$ 1.30 per cubic meter

KES 3 per 20 litre jerrycan = USD\$ 1.88 per cubic meter

KES 4 per 20 litre jerrycan = USD\$ 2.50 per cubic meter

KES 5 per 20 litre jerrycan = USD\$ 3 per cubic meter

KES 8 per 20 litre jerrycan = USD\$ 5 per cubic meter



**PART I: UNDERSTANDING THE URBAN POOR  
PLIGHT, LITERATURE REVIEW, THE STUDY  
AREA AND RESEARCH METHODOLOGY**



**The infamous Kibera slum in Nairobi, Kenya (Source: Franceys, 2011)**





# 1 UNDERSTANDING THE PLIGHT OF THE URBAN POOR

## 1.1 Introduction

The predicament of the urban poor, more commonly referred to as 'slum dwellers,' is a long-told story, with no happy ending. The basic definition of a 'slum' can be drawn from UNFPA (2007), as an area lacking an adequate form of at least one of the five amenities: safe water, sanitation (including solid waste), sufficient living space, durable housing and secure land tenure. Although the historic nature of slums has largely mutated, the challenges faced by the developed world from the 17<sup>th</sup> to the 19<sup>th</sup> centuries as humanity began living in cities has been well documented describing problems of inadequate services, unsanitary conditions and overcrowding (UN-HABITAT, 2003), conditions symbolic of the slums we talk of today. Slum dwellers are forced to adopt innovative and highly creative survival mechanisms, but at a high cost (UN-Habitat, 2004). At present, slums remain an almost accepted fate for majority of the world's population now living in urban areas (WHO/UNICEF, 2011).

Historically, there has been a clear correlation between rapid urbanisation and the expansion of slums. Reflecting on the past decade, the reported number of slum dwellers declined by 6 per cent, although in absolute numbers the proportion continued to grow to an estimated 828 million in 2011, compared to 767 million in 2000 and 657 million in 1990 (UN, 2011). In 2010, 72 per cent of the urban population in Sub-Saharan Africa were reported as living in slums (Jacobsen, Webster, & Vairavamoorthy, 2012), followed by 35 per cent in Southern Asia and 31 per cent South-Eastern Asia (UN, 2011).

With the highest urbanisation rate averaging at 3.9 per cent per year (Jacobsen et al., 2012), it is no surprise that the greatest prevalence of slum conditions was found in Sub-Saharan Africa (see Figure 1-1). Over the past 15 years, the urbanisation trend in Sub-Saharan Africa has been described as virtually synonymous with slum growth (UNFPA, 2007). By the year 2030, it is estimated that in both relative and absolute



Jakarta in Indonesia or Mumbai in India lack the expert and financial capacity to plan and manage the diverse demands for infrastructural service provision to meet ever growing economic and social needs (Ooi & Phua, 2007). However, in recognising the achievements of the region made by Hong Kong and Singapore, Ooi & Phua (2007) argue that the formation of slums need not be a necessary outcome of rapid urbanisation. Hong Kong and Singapore's highly successful planned urbanisation strategies encompassed planned economic development with urban housing provision and projected urban growth. This in turn led to a reduction in health problems and social issues from the provision of adequate potable water supply and improved living conditions.

Unlike Asia, Sub-Saharan Africa has made limited progress towards combating urban poverty. A UN-HABITAT (2008) study of 36 Sub-Saharan African countries suggested that high economic growth rates have not led directly to reductions in slum populations or urban poverty. Their study projections for 2020 indicated that due to rapid urbanisation, urban poverty will account for more than 40 per cent of the total poverty in several countries including Kenya, Tanzania, Benin, Cameroon, Mauritania, Mozambique, Nigeria and Senegal. Potts (2012) has strongly challenged these projections, boldly describing rapid urbanisation in Sub-Saharan Africa as a "fallacy" (Potts, 2012, p.1). Her findings contradict UN-HABITAT (2008) statistics, arguing that the evidence indicates a drop in urbanisation levels in 11 mainland countries, including Tanzania and Benin mentioned above. With the rising costs of city living and limited economic capacity, she reasons that the formation of slums is a deliberate move by private developers to exploit income generation opportunities from the urban poor and that growth in urban poor populations should not be confused with urbanisation (Potts, 2012). These findings build on Kessides (2006) perspective, that the primary reason Sub-Saharan Africa countries have not fulfilled their productive potential is because of widespread neglect and bad management relating to institutional failures that have perpetuated social exclusion and inequalities between the urban poor and non-poor. From the researcher's experience in urban poor dominated cities like Nairobi, where the ensuing inflation in early 2012 sparked nationwide protests (IMF,

2012), it is easy to relate how the perceived rapid urbanisation could simply be a reflection of rising urban poverty.

Clearly, the forces driving slum expansion and urban poverty are more intricate than urbanisation. Nonetheless, the existence of slums persists and fundamentally, human health risks arising from unsafe water and environmental degradation are exacerbated by the poverty and social marginalisation of people living in slums (Ali, 2010).

### **1.3 Public Health and Human Rights**

Typically, in many slums informal water distribution networks with intermittent or interrupted service encourages stagnancy of water and growth of microorganisms which has been inextricably linked to severe disease outbreaks in the developing world (Lee & Schwab, 2005). The negative hydraulic pressure draws pathogens from faecally contaminated material surrounding the piped network into the water supply, predominantly through leakages. Similarly, failure to disinfect or maintain a sufficient disinfection residual, as well as naturally ageing and corroding of infrastructure can create favourable conditions for bacterial growth (Lee & Schwab, 2005).

The most vulnerable to contracting water-related diseases include infants, young children, people who are debilitated and the elderly (WHO, 2011). A study undertaken in the urban slums of Dhaka, Bangladesh, determined that diarrhoea was the primary cause of child mortality among children aged 1 to 5 years. In Southern Asia, a similar study proved that diarrhoeal diseases alone accounted for a staggering 24 per cent of total child mortality (Alam, 2007). Through the good intentions of government policy to limit expansion of unplanned areas, by historically refusing to 'reward' slum dwellers with necessary access to basic services, the municipal utility providers are failing to meet public health objectives as sadly demonstrated by the water-related disease outbreaks in addition to the ongoing burden of diarrhoea (Franceys & Weitz, 2003).

On 28<sup>th</sup> July 2010, the UN General Assembly recognised safe and clean drinking-water as a human right, defined as the right to equal and non-discriminatory access to

adequate quantities of safe water for personal and domestic uses, i.e. drinking, sanitation, cooking and personal and household hygiene (Water Services Regulatory Board, 2011). In September 2010 at its 15<sup>th</sup> session the UN Human Rights Council affirmed that “the right to water was derived from the right to an adequate standard of living and inextricably related to the right to the highest attainable standard of physical and mental health, as well as to the right to life and human dignity” (WHO/UNICEF, 2012, p.36). The aim of the two resolutions was to firmly secure the right to water within the framework of the right to an acceptable standard of living and make it legally binding, similar to the other rights inscribed in UN treaties (WHO/UNICEF, 2012). In line with this, in August 2010, Kenya signed into law a new constitution enshrining a comprehensive Bill of Rights that includes the right to clean and safe water in adequate quantities for each person (Water Services Regulatory Board, 2011).

#### **1.4 National Research Context**

In Kenya, the provision of basic water services to all remains an urgent and necessary task. Recent trends show a pattern of urban demographic growth which public authorities are ill equipped to cope with. Migrants aspiring for a better life are often trapped in congested low-income settlements and lack access to basic services (Ruhii et al., 2009).

National statistics indicate an estimated 60 per cent of Kenya’s population living in urban settings have sustainable access to safe water, dropping to as low as 20 per cent in the low-income settlements (Ruhii et al., 2009). Residents are forced to rely on informal and/or illegal water sources with poor water quality, paying at between 10 and 20 times the volumetric price of the conventionally connected consumers. With a national population growth of up to 10 per cent in urban settlements, many ‘hot spots’ continue to develop in the fast-growing towns exacerbating the situation (Ministry of Water and Irrigation, 2009). The urban poor are significantly disadvantaged in terms of public health and the proportion of their incredibly scarce resources that have to be used to access water.

Literature suggests that the longer-term solution to this challenge commonly experienced in developing countries is undoubtedly the extension of the conventional water supply and distribution networks into the low-income settlements, managed by the public utility. For countries like Kenya to achieve this goal, institutional dimensions have to overcome the ever-present reluctance to serve very low-income households, as well as have the necessary funding to increase the supply and extend the distribution networks. Poor consumers have traditionally been seen to threaten the utilities' on-going efforts to break-even as a commercially viable water service provider, which increasingly has become a pre-condition of many funding agencies before they are prepared to advance additional finance.

The Government of Kenya (GoK) is taking steps to transform this situation by a combination of constitutional reforms, economic regulation and securing significant external funding for investments. The GoK published the eight year National Water Services Strategy (NWSS) incorporating a Pro-poor Implementation Plan (PPIP) prioritising the extension of water services to the fast-growing urban settlements, aiming to reach at least 50 per cent of the underserved urban population with safe and affordable water by 2015 in accordance with the Millennium Development Goal (MDG) targets, and thereafter move to access to all Kenyans by 2030 (Ministry of Water and Irrigation, 2009). However, until the long awaited pipe-dream goal is achieved, the poorest remain most disadvantaged and trapped in what the researcher defines as the "transition phase," subjected to a multitude of stop-gap interventions for the next one or two generations, whilst the utilities catch up with the demand.

During this transition phase, a mixed-bag of supply and distribution investments are continually being made in different settlements across Kenya by institutional stakeholders, civil society and third parties, in an effort to address the gaps in service provision. The impacts of these interventions remains to be determined, as visible problems continue to persist on the ground seemingly regardless of the nature of investments made. Very limited literature is available in the urban poor setting to capture and quantify the actual performance of these interventions over time, in providing lasting benefits for low-income residents.

There is a critical need to comprehensively evaluate the performance of discrete water supply and distribution interventions, to understand the mechanisms that drive project success and failure in complex urban settings and to inform the sector of priority investments in meeting the countries strategic goals to provide low-income residents with access to potable water for everyday uses of life at fair price, reasonable quality and in sufficient quantity for all.

## **1.5 The Study Area**

The research area is located in the low-income settlements of three main urban centres in Kenya, namely: Nairobi, Kisumu and Nakuru. Nairobi, the country's capital, is the most populous city in East Africa with a reported the population of 3,138,369 (Oparanya, 2010). An estimated 60 per cent of residents live in low-income settlements (Ministry of Water & Irrigation, 2009). Kisumu is Kenya's third largest city with a reported the population of 394,684 (2009 census). Similar to Nairobi, approximately 60 per cent of the inhabitants are said to live in the low-income settlements (Schwartz & Sanga, 2010). Nakuru is the fourth largest town in the country and one of the fastest growing towns in East Africa, with a population of 326,125 (2009 census). Approximately 40 per cent of the population live in low-income settlements.

## **1.6 Research Objectives**

The aim of this research is to interrogate the performance of discrete municipal and civil society water supply and distribution mechanisms implemented in low-income settlements, to quantify the improvement in service received by low-income residents over time.

The hypothesis assumes that "transition phase" interventions are viable and cost-effective pro-poor solutions, which deliver appropriate (desired and valued) levels of service improvement in low-income urban areas in advance of the roll-out of conventional household water connections.

The research objective is therefore is to develop a combined portfolio evaluating the performance of the transition phase interventions in the urban context through:

- 1) Assessment of the initial capital investment, revenue generated and operation and maintenance records where available in sustaining facilities provided.
- 2) An evaluation of the interventions in terms of number, user needs, coverage function, utilisation, drinking water quality and user perceptions.
- 3) An assessment of consumer satisfaction levels in relation to the service provided.
- 4) A comparative analysis ranking the performance of the interventions against a defined set of service criteria indicators.
- 5) An appraisal of the primary advantages and disadvantages of each intervention.
- 6) An assessment of the factors that drive demand for a particular service influencing the success or failure of the intervention.
- 7) An overview of the performance of the interventions in the context of achieving universal service.

## **1.7 Research Methodology**

This research adopts a descriptive multiple-case design, where the “case” is the water supply intervention. The key evaluation guidelines for improvement form the embedded units of analysis within each case, which allowed the researcher to evaluate the performance of discrete interventions in different low-income settlements, within the context of an overall improvement to water supply and distribution for low-income settlement residents.

The research is composed of both quantitative and qualitative data which was collected and analysed following a systematic conceptual framework. Desk studies, household surveys and water quality tests represented the quantitative data, whilst direct observation, interviews and focus groups formed the qualitative data.

## **1.8 Thesis Structure**

The structure of this thesis is sub-divided into three main parts. Part I of the thesis interrogates the research theory and background on both a global and national level, and details the planned approach to answer the research question in the four



chapters: Chapter 1: Understanding the Urban Poor Plight; Chapter 2: Literature Review; Chapter 3: The Study Area and; Chapter 4: Research Methodology.

Part II of the thesis describes the interventions undertaken at each location and the results, and presents an analysis of the research findings in the two chapters; Chapter 5: Description of the Interventions and Results and; Chapter 6: Comparative Analysis of Results.

Part III outlines the integrated discussions, research limitations, conclusions and recommendations of the study in the three chapters; Chapter 7: Discussing the Way Forward on “Transition Phase” Interventions; Chapter 8: Research Limitations and; Chapter 9: Conclusions and Recommendations.

The reader should note sections of Part I of the thesis have been duplicated from an unpublished report produced by the researcher following the first year of field work that was sponsored by an external bursary.



## **2 LITERATURE REVIEW**

The literature review explores the published research results on the different patterns of low-income settlements and the resulting implications as to the achieved levels of service and sustainability. It goes on to investigate the supply side of service delivery, considering the different management models and their implications for pro-poor services, primarily based on the availability of bulk, surface, water supply. It concludes by considering what the literature says about the use of groundwater in urban areas and the different ways of managing this type of service.

A comprehensive record of the researchers' critical analysis of journals and other studies developed as part of this literature review Chapter is included in Appendix A.

### **2.1 Slum Typology, Water Supply Challenges and Demand Segmentation**

#### **2.1.1 Global Terminology**

There are different global perceptions of slums and rightly or wrongly, the term is often used interchangeably with squatters, informal settlements and low-income settlements. Slums in the cities of many developing countries have become notorious for the extent and intensity of their deprivations, and yet living conditions for people in housing classified as 'slums' are not uniformly alarming (UN-HABITAT, 2008). The contested terms are also considered to identify stereotypes and mask more ambiguous realities (Dovey & King, 2012). A comparative study undertaken in Dakar, Nairobi, and Johannesburg revealed that the challenges facing 'slum' residents vary considerably from neighbourhood to neighbourhood and development, infrastructure, and living conditions differed dramatically across the three cities (Gulyani, Talukdar, & Jack, 2009). Generally the term 'informal settlement' is considered less disparaging and more representative of the complexity, ingenuity and creativity of everyday adaptations (Dovey & King, 2012). Dovey & King (2012), take an interesting approach to understand informal settlements within the urban field of the developing city as a place with negative symbolic capital. For local middle classes within the city, these are places to be ignored and the informality becomes essential to its identity, explaining

why 'informal' continues to signify 'slum' even if physical conditions and tenure are upgraded. For the purposes of this study, it is important to recognise and appreciate the varying types of settlements that display a range of topographies in which the urban poor live and resulting technical barriers faced by the utility, which the researcher has attempted to categorise.

### 2.1.1.1 Informal Inner City

Resulting from sporadic and rapid urbanization, these are the quintessential slums that comprise of unlawful structures, also described as very high density squatter/shantytowns. Included in this category are slums established illegally on pavements or rooftops (UN-HABITAT, 2003). Although these inner city slums may have been the result of local authorities turning a blind eye due to their illegal nature, particularly during the immediate post-independence influx of migrants to cities in Africa and Asia, UN-HABITAT (2003, p. 82) describes how these slums soon “became a large and profitable business often carried out with the active, if clandestine, participation of politicians, policemen and privateers of all kinds.”



**Figure 2-1 Dharavi, informal high density slum (Source: Jacobson, 2007)**

The areas are categorised by high density make-shift dwellings visually and functionally impenetrable (Dovey & King, 2012) constructed by residents in a haphazard layout, with no formal planning or service infrastructure (see Figure 2-1). These slums offer little or no security of tenure for occupants and are often

constructed on land with challenging topography and prone to events such as flooding or land slippage. Vehicular access is extremely limited and if possible is along uneven, unpaved, dirt roads (O'Regan et al., 2011).

Informal inner city slums vary in size from the sprawling, infamous Kibera in central Nairobi, Kenya and Dharavi in the heart of Mumbai, India (Meschkank, 2010); to

smaller more recent communities settling on vacant plots at the edge of towns and cities including individual pavement dwellers also seen in Mumbai (Kumar Karn & Harada, 2002). These high-density, illegal, unplanned slums represent the greatest challenges to utilities in the provision of 'temporary' water supply services to meet the bulging demand.

Although most people in slums or pavements rely on municipal water through vendors/carriers, the water supply is limited and generally contaminated with coliform bacteria (Kumar Karn & Harada, 2002). A study conducted in the slums of Mumbai showed significantly high incidence of water and sanitation related diseases in dense slum and squatter communities, than elsewhere (Kumar Karn & Harada, 2002).

### **2.1.1.2 Formal Inner City**

In some cases, the so called 'informal' settlements lie alongside and often within 'formal' settlement patterns. Historically, these slums generally constitute areas that were occupied by poorer residents as the rich moved out, resulting in higher densities and large population growth. Much of the existing buildings are legal and robust in nature, although infill buildings are sometimes constructed between the original structures creating terraces of uncertain legality, resulting in narrow and confined streets and consequent restricted vehicular access (O'Regan et al., 2011).



**Figure 2-2 Mukuru, formal high density slum (Source: Author, 2012)**

The planned nature of these settlements suggests closer proximity to existing conventional utility infrastructure serving the surrounding industrial and more affluent residential areas, as seen in Mukuru in Nairobi, Kenya (see Figure 2-2). In some cases limited existing utility infrastructure may

already exist in these slums, however the infrastructure is vulnerable to overloading due to rapid population growth and/ or sporadic layouts making it even more difficult for the utility to overhaul or extended water supply services (O'Regan et al., 2011).

Although this study categorises urban slums into 'informal' and 'formal,' the researcher also recognises that some of the larger formal slums may contain areas designated as informal within and vice versa; creating more complex challenges for utilities.

### **2.1.1.3 Vertical**

Vertical slums constitute of high rise tenements and housing blocks which ironically may have been originally constructed as a clearance solution to curb the expansion of urban slums, or as housing for industry workers that has since been neglected and fallen into disrepair (UN-HABITAT, 2003). Therefore although the buildings are legal, internal dwellings may be sub-divided and illegally sublet individually (O'Regan et al., 2011).

High rises are typically constructed in the inner cities, though some industry buildings may be built on the periphery of urban areas. It is likely some form of plumbing system was originally installed but is no longer operational through lack of maintenance or disconnection. In some cases, no internal plumbing may exist at all (O'Regan et al., 2011).



**Figure 2-3 Shanta, vertical slum  
(Source: Devarajan, 2011)**

In these slums, utility infrastructure should already exist and not present major access challenges. However, limited maintenance results in limited (often disconnected) water availability (WaterAid, 2011). Further difficulties are experienced in supplying water to individual households when there is inadequate plumbing requiring investments from residents and/or public institutions to upgrade the pipe work. This results in residents relying on alternative solutions, for example in Shanta slum in

Luanda, Angola (see Figure 2-3), some individuals earn a living by hauling water up floors (Devarajan, 2011).

#### **2.1.1.4 Peri-Urban**

Peri-urban slums typically exist on the edge of urban areas and are often built on land deemed unsuitable for urban development, such as floodplains or hillsides as seen in Kayole-Soweto (see Figure 2-4). These slums may be informal or formal in nature, although not distinctly pronounced as they are



**Figure 2-4 Kayole-Soweto (Source: Haki Water, 2011)**

generally less densely populated than inner city slums. Thus peri-urban slums are considered more semi-formal and less haphazard in nature. The buildings are generally constructed without any formal planning or regulation, however as the areas are less dense wider access routes exist (O'Regan et al., 2011). Expansion is mainly through existing structures being sub-divided or new plots emerging on the edge of the slum and develop into their own catchments.

Plots are typically demarcated and sub-divided into a courtyard type design with each room around the court containing a household (WaterAid, 2011). There is limited or no running water in the households, with some plots containing communal pumps. The semi-formal and semi-planned nature of peri-urban slums should allow for utility access to provide water supply infrastructure. However, challenges remain in managing the water supply to these areas as well as planning for future coverage expansion where development is unplanned or illegal.

#### **2.1.1.5 Absorbed Towns and Villages**

As an urban area expands it consumes surrounding satellite towns and villages. Though informal in nature, due to a lack of controlled planning, they may be located along main access roads categorised by greater dispersion of housing. The 'village style'

buildings can vary greatly from permanent for more established areas to ramshackle and insubstantial for newer villages (O'Regan et al., 2011).

Due to the low density housing, existing sources of water supply in village slums is likely to be self-served from community managed boreholes or tanker supplied water, from which customers access water via stand posts (WaterAid, 2011). Indeed, some absorbed towns and villages may already have a piped, public utility water supply. As villages and satellite towns are absorbed, utilities can decide whether to take over the running of these mini-networks or alternatively decommission and extend their own networks as per the case in Omdurman, Sudan (O'Regan et al., 2011).

In effect, absorbed slums could eventually become peri-urban, with the prospect of providing for future expansion. Although this poses an additional challenge for utilities, generally the more spread out nature of absorbed towns and villages should technically allow for easier utility access. Examples of village slums include Bandani in Kisumu, Western Kenya (see Figure 2-5).



**Figure 2-5 Bandani, Kisumu (Source: Author, 2012)**

### **2.1.2 Demand Segmentation**

Affordability of services has been quoted as a significant socio-economic barrier for the urban poor to access basic services (Foster et al., 2000; Gerlach & Franceys, 2010a). In recognising the different types of settlements in which the urban poor live and subsequent challenges faced by the utility in expanding coverage, the literature also attempts to profile the level of poverty among residents using different classifications, as an indication of demand for a particular service. As noted by Gerlach and Franceys (2010a), rarely do official statistics disaggregate the urban poor communities by socio-economic groups, masking the underlying inequalities and high levels of deprivation that exist.



Only consumers living in conditions of extreme poverty are likely to experience genuine affordability problems related to paying on-going consumption charges (Foster et al., 2000). In endorsing this point, Franceys and Gerlach (2010a) draw attention to the realisation that these most disadvantaged groups described as ‘very poor’ or ‘desitute’ often access a variety of water sources for different uses and are unlikely to be captured in any statistics at all, due to difficulties associated with reaching them.

On the other hand, the ‘coping’ poor are recognised and identified as a group unable to access the services due to the initial high up-front connection charges but who are able to afford ongoing consumption charges for an acceptable minimum level of service (Franceys, 2005). Therefore, the main disadvantage facing this group is overcoming the first-time connection barrier.

Although the poverty classifications of ‘very poor’ and ‘coping poor’ are relatively simplistic, the researcher considers this distinction an important factor in the context of the transition phase in identifying patterns relating the demand for the interventions studied to particular socio-economic groups, and potentially highlighting reasons for success or failure in the uptake of the interventions.

## **2.2 Monitoring Global Progress for Water Supply**

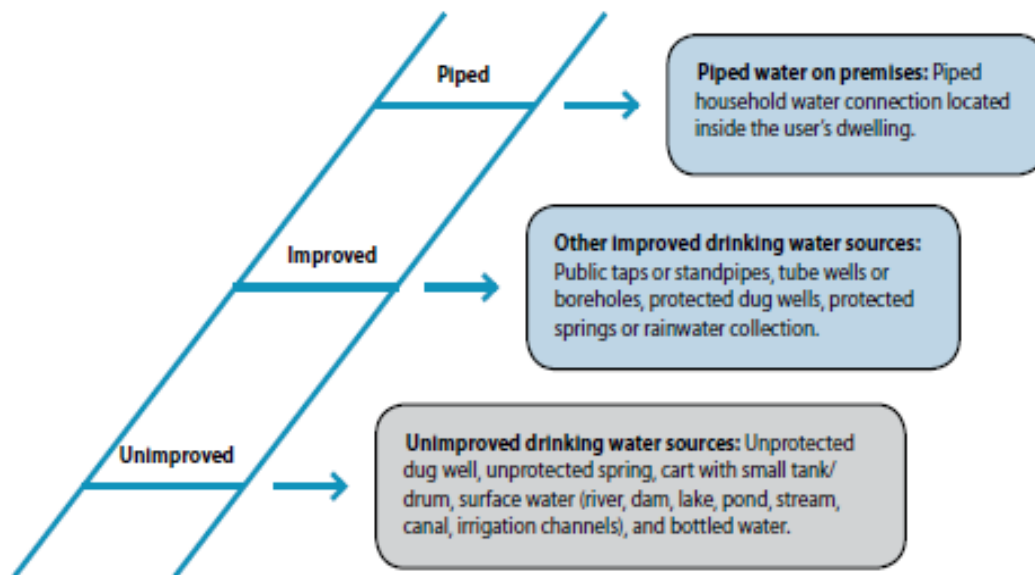
Through the Joint Monitoring Programme (JMP)<sup>1</sup> for Water Supply and Sanitation, the World Health Organisation (WHO) and the United Nations Children’s Fund (UNICEF), monitor global progress towards meeting the Millennium Development Goal (MDG) Target 7c to: “halve the population of people without *sustainable access* to *safe drinking-water* between 1990 and 2015.” JMP measure progress using proxy indicators for access broadly categorised as ‘*improved*’ and ‘*unimproved*’ sources, disaggregated by technology types representing progressive improvements in relative safety and sustainability. The current official definition of ‘*improved*’ relates to a source that is by

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<sup>1</sup>The official UN mechanism tasked with monitoring progress towards MDG Target 7c on drinking water supply and sanitation.

nature of its construction, adequately protected from outside contamination, particularly from faecal matter (WHO/UNICEF, 2012).

As illustrated in Figure 2-6 a 'drinking-water ladder' can be adopted to depict the notion of climbing up the service ladder as the source improves, with 'piped water on premises' classified as the safest and most sustainable improved source.



**Figure 2-6 The JMP “drinking-water ladder” (Source: Moriarty et al., 2011, p.9)**

The latest statistics are impressive with reportedly 89 per cent of the world's population using improved sources of drinking-water in 2010, thus the drinking-water target is reported as one of the first MDG targets to be met. Of the estimated 2 billion people who climbed up the service ladder to improved sources of drinking-water from 1990 to 2010, the most significant progress was reported in China and India, where more than half of the people who gained access in the developing world are represented. The report is however quick to clarify that despite this achievement, the work is far from over. By 2010, the remaining underserved global population who still lacked access to improved sources of drinking-water was estimated at 780 million people. Challenges remain in meeting the needs of this population that remains underserved, obtaining global monitoring data with regards to water safety and addressing coverage disparities in regions such as Sub-Saharan Africa, where only 61

per cent of the population are reported as using improved sources of drinking-water (WHO/UNICEF, 2012).

Only 19 out of 50 countries in Sub-Saharan Africa were considered on track to meet the MDG water target. The 10 countries reported with the largest underserved populations and not on track to meet the MDG target included Kenya, Tanzania, Sudan and Ethiopia in the East African region (WHO/UNICEF, 2012). Notably, regional and country coverage disparities across the continent were considered to mask gender inequalities and burdens of water collection experienced by the poorest. Therefore, despite growth in the population gaining access to the ‘other improved’ sources, reportedly the poorest population are largely denied the comforts and health benefits of piped water on premises. This suggests improvements are strongly correlated with wealth and that the richest households continue to benefit disproportionately (WHO/UNICEF, 2012). Table 2-1 summarises the reported Sub-Saharan Africa use of improved drinking-water Sources from 1990 - 2010 expressed as a percentage of coverage, although the results did not reflect the rural to urban disparities that represent different challenges.

**Table 2-1 Sub-Saharan Africa use of drinking-water sources (Source: Adapted from WHO/UNICEF, 2012)**

Sub-Saharan Africa Region	Year	
	1990	2010
<b>Use of Improved Drinking Water Sources in urban areas</b>		
Piped on Premises	15%	16%
Other Improved	35%	45%
<b>Total Improved</b>	<b>50%</b>	<b>61%</b>

The relevance of MDG targets to reflect improvements for the poorest urban populations has previously been questioned (Satterthwaite, 2003; Easterly, 2009). Using conflicting published statistics from Kenya as an example, Satterthwaite (2003), argues that the MDG target for safe drinking-water is based on inappropriate criteria and inaccurate statistics. The discussion describes the target as too narrow, led by ‘expert’ organisations disconnected from local populations, focused on measurable

outcomes and bias to developments that are not easily measured. The researcher considers this argument particularly relevant, as dependency on the MDG targets could depict false positive representation of outcomes that are short-lived and not sustainable in the long-term. Additionally, the so-called experts, with limited local exposure, run the risk of making critical assumptions with regards to the community priorities.

Easterly (2007) builds on this argument, focusing on Africa, to highlight the implications of inconsistencies in how the drinking-water target is set in relation to other MDG targets, to reflect the reduction in a negative indicator ('WITHOUT') as opposed to the increase in a positive indicator ('WITH'). Interestingly, the former tends to favour other regions, while the latter favours Africa. Although the researcher is in agreement with the basis of this argument, an element of uncertainty remains on whether the focus should be on how the MDG targets are set, or how they are applied at national and local level.

### **2.2.1 Drinking-Water Safety**

Predominantly, water-borne and water-related health issues occur as a result of microbial contamination (bacteriological, viral, protozoan or other biological) (Howard & Bartram, 2003). As mentioned earlier, diarrhoea represents the largest share of this health burden, causing an estimated 4 billion cases and 1.8 million deaths annually of children under 5 years, with most of all such deaths occurring in developing countries (Wright et al., 2004; Rosa & Clasen, 2010). Unsafe drinking-water also contributes to more than 25 million cases and 250,000 deaths annually of enteric fevers (typhoid and paratyphoid), as well as inducing cholera, poliomyelitis, dysentery and typhoid and hepatitis A and E (Clasen, 2010). A considerable number of serious health concerns can also occur as a result of the geogenic (natural) contamination of drinking-water (WHO, 2011), namely from fluoride. In its severe form, "fluorosis is endemic as a public health problem in at least 25 nations around the globe. Groundwater with high fluoride occurs in large parts of Africa, China, the Middle East, and southern Asia" (Godfrey et al., 2011, p. 569).

Access to a treated, piped water at source has proved to be crucial in the improvement of public health and decreased transmission of infectious diseases related to water (Lee & Schwab, 2005). Supplying water closer to home and convenient to access via household connections is said to double or triple consumption, with the belief that the additional water is used for hygiene purposes (Valdmanis & Cairncross, 2006). Although there are conflicting reports on public health benefits of household connections versus improved sources, with studies indicating the latter is less effective (Valdmanis & Cairncross, 2006), the benefit of improved water supply has been demonstrated through evidence based studies undertaken in 15 developing countries (UNDP, 2006). The findings analysed the change in the risk profile of households studied, illustrating the potential for improved water sources to reduce the risk of infant mortality by 23 per cent and reduce the incidence of diarrhoea by 21 per cent. Additionally, improvements in drinking-water quality such as point of use disinfection using relatively low cost methods, lead to a further reduction in diarrhoea episodes by 45 per cent (UNDP, 2006). This presence of a disinfectant residual is especially important in such developing countries due to the poor sanitary conditions and the high risk of recontamination during distribution (Lee & Schwab, 2005).

Arguments raised regarding the appropriateness of the MDG target to monitor access to safe drinking-water and the pace of improvement have brought into question inconsistencies in the interpretation of the word 'safe' (Clasen, 2010; Parker et al. 2010; Bain et al., 2012; Onda, LoBuglio, & Bartram, 2012). The United Nations (UN) define safe drinking-water as "water that is safe to drink and available in sufficient quantities for hygienic purposes" (Lenton, Wright, & Lewis, 2005, p.xiv). Howard and Bartram (2003, p.8) introduce a risk-based approach suggesting that a safe drinking-water supply is "one that does not represent a significant public health risk to the consumer, while acknowledging that a no risk approach is likely to be unachievable." The WHO definition builds on the health risk approach, but taken over a lifetime of consumption (WHO, 2011). The global indicator of an 'improved' source is considered ambiguous and has previously been referred to as 'improved access,' to encompass the three dimensions of water security, cited as: quality, proximity and quantity

(UNDP, 2006). The key concern lies in the use of 'improved' as a proxy indicator for water safety, although it has been acknowledged in several publications that the indicator does not include a measurement of drinking-water quality (Lee & Schwab, 2005; WHO/UNICEF, 2010, 2011, 2012). Critics have highlighted that the decision as to whether a source is classified as 'improved' or 'unimproved,' heavily relies on once again on 'expert' judgement of the likelihood that a particular type of source provides safe drinking-water, without adequately reflecting the type, quality and functionality of services available (Gerlach & Franceys, 2010; Godfrey et al., 2011; Bain et al., 2012; Onda et al., 2012).

The results of a comprehensive study conducted in India from 2006–2008 incorporating the use of WHO/UNICEF rapid assessment tools for drinking-water quality (RADWQ), demonstrated that “the inclusion of water quality data can reduce the JMP nationally reported water supply coverage levels by up to 40 per cent” (Godfrey et al., 2011, p.573). Similarly, using the RADWQ methodology additional studies were undertaken in five developing countries namely: Ethiopia, Nicaragua, Nigeria, Tajikistan and Jordan. The results supported the initial findings that taking water quality into consideration as a measure of drinking-water safety substantially reduced the estimated proportion of the global population with access to safe drinking-water at the 1990 baseline (Bain et al., 2012; Onda et al., 2012). Further challenging the current JMP Update (WHO/UNICEF, 2012) through accounting for faecal contamination as well as sanitary risks (i.e. risk of contamination), Onda et al. (2012) concludes that 1 billion people using piped or other-improved water sources receive unsafe water, and that by 2010, 1.8 billion people were without access to safe drinking water representing a shortfall of 10 percent in the global progress towards the MDG target. Overall, microbial contamination was the principal reason that improved water sources were ruled as unsafe. Chemical contamination had only a limited effect on the results (Bain et al., 2012).

Although the literature acknowledges that the calculated shortfall is imprecise (Onda et al., 2012), the researcher considers the importance of the exercise to demonstrate an existing association between water contamination and the presence of sanitary risk

factors and that due to lack of maintenance, some interventions classified as improved sources may not actually provide drinking-water that is 'safe'. However, as the methodology adopted groups together rural and urban populations, the results are also likely to falsely skew the magnitude of the estimate and extent of precautions needed in the two settings. The exercise also assumed that no contamination occurs between the source and the point-of-use, however extensive faecal contamination during collection, transport, unsafe storage and/or handling of water in the home is known to occur (Wright et al., 2004; Schipper, 2012). Investigating the potential recontamination of water from safe sources could potentially reduce even further the JMP nationally reported water supply coverage levels.

To better understand and manage drinking-water safety, alternatives that can accelerate the health gains associated with improved sources such as household water treatment storage (HWTS) together with improved transport and point-of-use water quality monitoring, have been considered for inclusion in the MDG target (Wright et al., 2004; Clasen, 2010; Godfrey et al., 2011). Although studies have shown an improved water transport and common HWTS practices in the home are effective in maintaining safe drinking-water quality compared from the source (Schipper, 2012), Clasen (2010) concluded that the evidence does not warrant counting these practices towards the MDG target. However, emphasis has been placed on the potential of these practices to make substantial contributions to health, particularly for the most vulnerable 'very poor' populations who in the context of this study remain trapped in the transition phase and are unlikely to benefit in the near future from a safe and reliable water supply (Clasen, 2010; Rosa & Clasen, 2010; Schipper, 2012).

### **2.2.2 Access to an Adequate Quantity**

Generally, "the quantity of water people use depends upon their ease of access to it" (WHO/UNICEF, 2000, p.3). A benchmark of 20 litres per person per day has been commonly cited as the minimum required quantity of water needed for drinking and basic personal hygiene (Gleick, 1996; WHO/UNICEF, 2000; UN-HABITAT, 2003; UNDP, 2006). "Below this level, people are constrained in their ability to maintain their physical well-being and the dignity that comes with being clean" (UNDP, 2006).

Totalling the water requirements for the daily domestic activities related to consumption, cooking, personal and household hygiene would raise the personal minimum threshold to 50 litres per person per day by some estimations (Gleick, 1996; UNDP, 2006).

For international reporting purposes reasonable access has broadly been defined as the availability of the minimum 20 litres per person per day from a source within one kilometre of the user's household (WHO/UNICEF, 2000; Valdmanis & Cairncross, 2006), that distance relating to rural considerations. UNDESA (2004), further clarify that to be considered reasonable, the source should be in the household or accessible within a walking distance not exceeding 15 minutes. For urban areas, a distance not exceeding more than 200 metres from the household to a public stand post was considered reasonable access. The surrounding environment was also taken into consideration, as if the route to the public stand post is perceived as “unsafe and therefore unlikely to be walked, it should not be considered as allowing access” (The Sphere Project, 2011, p.254).

Studies have shown that if access to water is readily available in the house or through a public stand post, people will use “large quantities for hygiene but consumption drops significantly when water must be carried for more than a few minutes from source to household” (WHO/UNICEF, 2000, p.3). This theory was proven from the results of household research data in Kenya, Tanzania and Uganda, which illustrated that households with piped water connections used on average 16 litres per capita per day (l/c/d) for washing and hygiene, while households without piped water on premises used less than 6 l/c/d for the same uses (UNDP, 2006). The literature also indicated that water availability and hygiene can also result in substantial reductions from other water related conditions such as trachoma and in the transmission of intestinal helminths (Valdmanis & Cairncross, 2006).

Howard and Bartram (2003) present a comprehensive assessment of past research exploring the relationship between proposed water quantity service levels, relative to health risks. The developed service levels that showed the strongest correlation used measures of water quantity in l/c/d in relation to the available access (distance and



time) (see Figure 2-7). Further evidence also suggests that increasing wealth leads to greater l/c/d consumption, as consumers pursue new water-consuming activities (Rural Water Supply Network, 2011).

Service level	Access measure	Needs met	Level of health concern
No access (quantity collected often below 5 l/c/d)	More than 1000m or 30 minutes total collection time	Consumption – cannot be assured Hygiene – not possible (unless practised at source)	Very high
Basic access (average quantity unlikely to exceed 20 l/c/d)	Between 100 and 1000m or 5 to 30 minutes total collection time	Consumption – should be assured Hygiene – handwashing and basic food hygiene possible; laundry/bathing difficult to assure unless carried out at source	High
Intermediate access (average quantity about 50 l/c/d)	Water delivered through one tap on-plot (or within 100m or 5 minutes total collection time)	Consumption – assured Hygiene – all basic personal and food hygiene assured; laundry and bathing should also be assured	Low
Optimal access (average quantity 100 l/c/d and above)	Water supplied through multiple taps continuously	Consumption – all needs met Hygiene – all needs should be met	Very low

**Figure 2-7 Water service level requirements to promote public health (Source: Howard & Bartram, 2003, p.i)**

Focusing on the ‘access’ criterion, critics have questioned the approach to streamline national monitoring programmes against the MDG target which lacks clear measurable outcomes (Bakker & Kooy, 2008; Kayaga, 2009; Gerlach & Franceys, 2010). Using Kenya as an example, Gerlach and Franceys (2010a) highlighted inconsistencies in published statistics affirming that the most disadvantaged, destitute and very poor urban communities who may be ‘difficult’ to reach or in ‘unsafe’ areas are unlikely to be represented in official monitoring global statistics. These findings echo previous publications indicating that the current estimates of the urban poor without access to an adequate provision of safe drinking-water, are “significantly underestimated by governments and international agencies” (Bakker & Kooy, 2008, p.1892).

Although quantity and access have been proven to provide important health and other gains (Clasen, 2010), the full benefits of ‘sustainable access to safe drinking water’ will not be realised unless interventions to improve water supply, distribution and quality are introduced in settings where both adequate water quantity and reasonable access are present. Therefore these findings indicate that to prove the hypothesis of this

study and provide services where there are needed most for lasting public health benefits, transition phase interventions will need to reflect dynamic service options accessible to the different types of settlements and poverty classifications, assuming that an adequate quantity of water is already available.

### **2.2.3 The Elusive Sustainability**

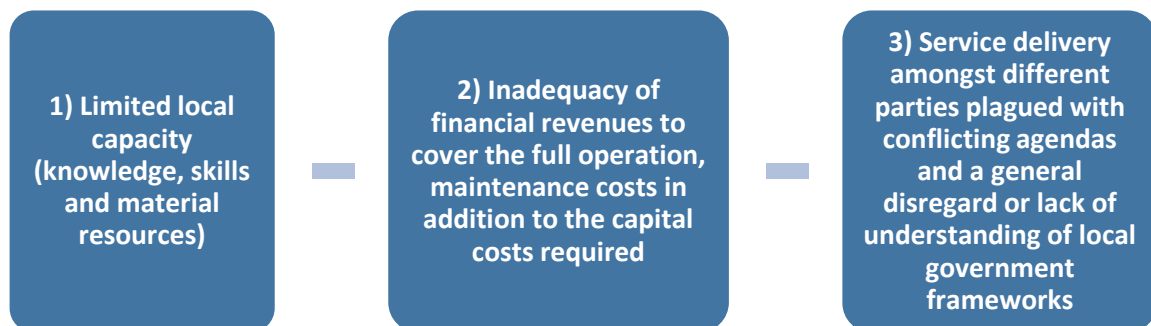
There are varying definitions of 'sustainability' that remain open to interpretation creating confusion in the application of the term. To first set the scene in the context of this study, sustainability is defined by the resilience of the intervention in providing appropriate levels of service improvement for the urban poor during the transition phase, although the researcher acknowledges the duration of this phase remains uncertain as the term 'transition' naturally assumes that ultimately everyone will be served conventionally by the utility within a specified timeframe (which is most desirable). Based on historic trends, this may not in itself be a realistic assumption for the fast growing urban cities in Kenya and Sub-Saharan Africa as a whole.

In general, the concept of sustainable development automatically assumes that the progression would be viable over the long term, even though clarification of what constitutes as 'long-term' remains elusive. Several studies have attempted to quantify the interpretation of sustainability in the context of water, sanitation and hygiene (WASH) through developing a framework. The Tornqvist et al. (2008) framework encourages user participation and emphasises the need for a comprehensive site specific analysis. The framework encompasses five sustainability criteria, namely: health, economy, environment, technical function and socio-cultural aspects. It is designed to be flexible for application by different users and in different contexts, and is intended to provide a suggestion of baseline supporting tools to inform planning decisions when selecting a technology and/or a system in a complex peri-urban environment (Tornqvist et al.,2008).

The WaterAid (2011) sustainability framework provides a focused definition of the term in the context of WASH development, as follows:

*“Sustainability is about whether or not WASH services and good hygiene practices continue to work and deliver benefits over time. No time limit is set on those continued services, behaviour changes and outcomes. In other words, sustainability is about lasting benefits achieved through the continued enjoyment of water supply and sanitation services and hygiene practices” (WaterAid, 2011, p. 11).*

The framework continues to highlight the main challenges experienced in rural areas of developing countries that hinder sustainable WASH development (see Figure 2-8).

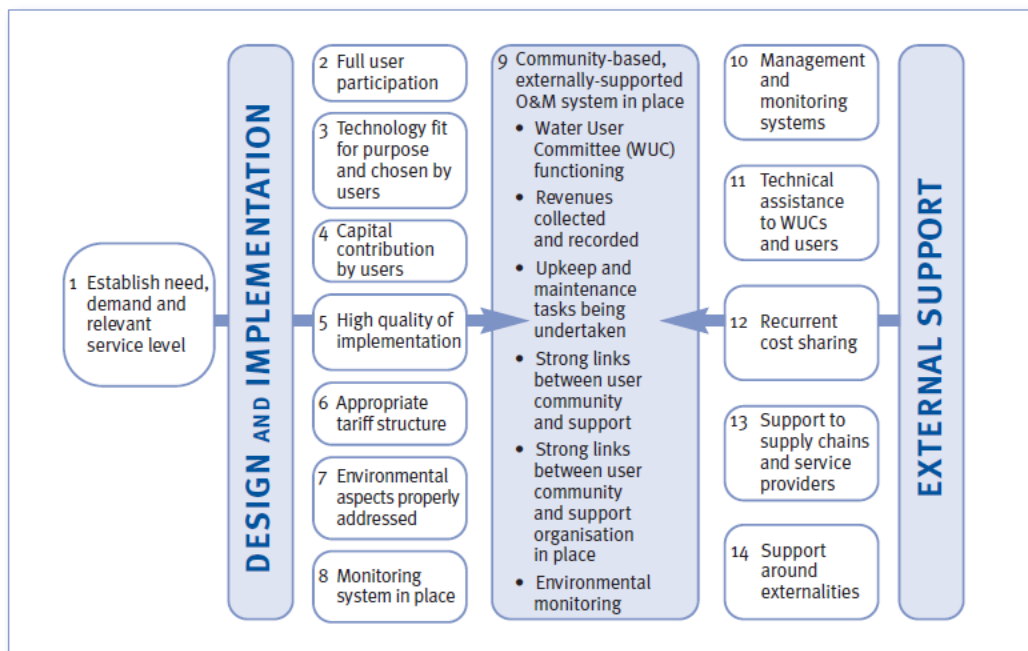


**Figure 2-8 Main WASH sustainability challenges (Source: Adapted from Carter, Casey & Harvey, 2011)**

Although this focuses on rural areas, the specific challenges highlighted could be transferrable to urban areas. The researcher expands on these reasons as follows: Reason 1) and 2) could be correlated in that skills and resources are lacking to not only maintain systems, but to develop sound business and management models to incorporate operational and maintenance costs. Consequently with high poverty levels, most people are forced to consider only the short-term economic implications for their own survival. Reason 3) highlights an important link that achieving sustainability relies on understanding and /or complying with the national government frameworks or strategic goals. In Kenya this would place scrutiny on the sustainability of the approach adopted in the eight year NWSS and PPIP prioritising the extension of water services to the fast-growing urban poor settlements, to meet the MDG 2015 and Vision 2030 targets.

WaterAid (2011) also developed a workable conceptual framework to represent the important factors considered necessary to ensure sustainability of an externally

supported community-based managed intervention providing water supply infrastructure. The framework shown in Figure 2-9 emphasises the level of external support to the community required for both the physical infrastructure and management arrangements from project inception, implementation, through to operation and maintenance. The researcher recognises that this framework is not a ‘one size fits all’ tool and has been largely developed for WASH interventions in rural areas (Carter et al., 2011). However, key factors for identified for an effective and sustainable approach such as setting an appropriate tariff structure and provisions for monitoring can be considered replicable in urban areas.



**Figure 2-9 WaterAid “conceptual framework for externally supported community-based management of rural water supply” (Source: Carter, Casey & Harvey, 2011, p.12)**

In taking into consideration the WaterAid (2011) definition of sustainability, the researcher noted that in the conceptual framework no attention had been given to the reliability of the water supply, which is particularly relevant in slums to guarantee sustainable or lasting public health and other benefits. This omission presents a shortfall in adapting this framework to urban areas. In this case, reliability can be defined as the “probability that a system does not fail, or conversely, it is the

probability of system failure subtracted from one” (Griffin & Mjelde, 2000, p.414). To achieve acceptable water supply reliability would mean an uninterrupted service which may not be achievable when water development costs are high. Therefore, designing a sustainable urban strategy requires an assessment of specific consumer needs pertaining to the reliability of water supply.

## 2.2.4 Standard Monitoring Indicators Post 2015

To monitor for sustainability on an international, national and sub-national level against the MDG target Shouten et al., (2011) move the focus from the type of infrastructure to the service experienced by the end users. This approach is considered particularly relevant for application in the context of this research, when attempting to aggregate the evaluation results of interventions involving different types of infrastructure implemented in different slum typologies in Kenya. As the literature has demonstrated, the more improved or expensive the technology does not automatically equate to a better service for the poor.

In developing the post-2015 monitoring landscape, an e-survey completed by respondents with primary experience in working in the sub-Saharan Africa ranked the primary service levels that should be measured in order of priority, to reflect the “human right to water”(Ward, 2012, p.8). The results are shown in Figure 2-10.

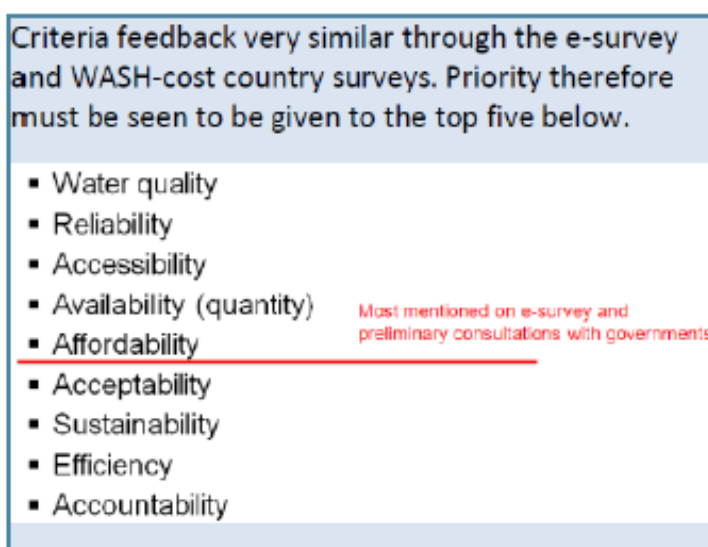


Figure 2-10 Prioritised service level criteria (Source: WaterAid & IRC, 2012, p.3)

The findings of this survey lead to the development of the definitions shown in Table 2-2 for the relevant priority service criteria specifically relating to the urban context, to explore the revised global level indicators post 2015.

**Table 2-2 E-Survey Definitions of Service Criteria (Source: Adapted from WaterAid & IRC, 2012)**

Service Criteria	E-Survey Definition
<b>Water Quality</b>	An overall measure of 95 per cent compliance “water quality” was considered appropriate.
<b>Reliability</b>	Anything less than continuous 24 hour supply with adequate pressure was considered undesirable, although it was acknowledged that many low-income cities in Sub-Saharan Africa are far from achieving that figure.
<b>Accessibility</b>	The ability to reach a safe-drinking water source without excessive time or energy. For an urban area a time based threshold of acceptable “accessibility” for one round trip was within 30 minutes.
<b>Availability</b>	Comprised of two components: 1) the quantity of water available and 2) the continuity of supply.
<b>Affordability</b>	The survey concluded at present there is no conclusive agreement on an acceptable baseline threshold for “affordability” at a global level and will require further consultation to become a post-2015 global level indicator.

Table 2-3 illustrates the service ladder concept developed to consider water quality, reliability, accessibility and quantity altogether, monitoring the status in relation to the prioritised and measurable post-2015 indicators JMP (Moriarty et al., 2011).

**Table 2-3 Prioritised water service level indicators (Source: Moriarty et al., 2011, p.12)**

Service level	Quantity (litres per person per day)	Quality	Accessibility (minutes/capita/day)	Reliability	Status (JMP)
<b>High</b>	>= 60	Good	Less than 10	Very reliable	Improved
<b>Intermediate</b>	Greater than 40	Acceptable	Less than 30	Reliable/Secure	
<b>Basic (normative)</b>	Greater than 20				
<b>Sub-standard</b>	Greater than 5	Problematic	Less than 60	Problematic	Unimproved
<b>No service</b>	Less than 5	Unacceptable	Greater than 60	Unreliable/insecure	

Monitoring against actual service provided and accessed allows not only for a more meaningful analysis of whether expectations are being met but, critically, also allows for the monitoring of improvement of service provision over time as consumers move up the service ladder (Moriarty et al., 2011). Emphasis is placed on long-term achievement of universal coverage and improvements in the quality of services post 2015, particularly for the poorest.

The formation of the service ladder framework is useful and for the first time considers more than two water supply service criteria together in one framework employing multiple thresholds. Nonetheless, similar to the WaterAid (2011) framework it is likely this will need to be adapted for application in the urban contexts, especially where piped water on premises is an important service (Ward, 2012) that is assumed to be obtainable in the transition phase context, but remains a particular issue for services to low-income settlements.

## **2.3 Investments in Dimensions of Water Supply**

### **2.3.1 An Uphill Task for Utilities**

For reasons best described as “beyond the technical, financial and institutional capacities,” (Gerlach & Franceys, 2010, p.6), urban water supply utilities<sup>2</sup> in developing countries have continually failed to provide adequate services to meet the rising urban poor population (Cross & Morel, 2005; Bakker & Kooy, 2008; Gerlach & Franceys, 2010). Despite significant and sustained investment by bilateral aid agencies and financial organisations, as summarised by Bakker & Kooy (2008, p.1894), the “institutional dimensions of water management simply do not effectively take into account the needs of poor households, creating disincentives for the public utility to connect poor households and/or for poor households to connect to the network.”

Over the years, this failure has been attributed to many reasons including: a historic culture of governance that does not prioritise the poor banishing them as ‘off-limits’ because they are ungovernable and unserviceable, shortage of water supply or water

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<sup>2</sup> In the context of this study, utilities are described as any public entity, either government department, municipal department, water company whose main shareholding is either in government hands or local authority.

resources availability to extend piped network connections, water utilities controlled by the tide of local government senior appointments who may be guided by political patronage rather than technical, infrastructure requirements and poor business models (Bakker & Kooy, 2008).

The main disincentives for utilities as highlighted in the literature can be summarised as: fears of low cost-recovery/ no revenue collection hindering plans for investment, operations and maintenance (Cross & Morel, 2005; Nyarko, Oduro-Kwarteng, & Adama, 2006; Kayaga & Franceys, 2007), the transient nature of residents as a high proportion of poor households are tenants and migrant dwellers (Cross & Morel, 2005; Jacobs & Franceys, 2008), physical constraints due to poor infrastructure planning and difficult topography associated with uncontrolled development, congestion and ramshackle housing (Cross & Morel, 2005; Kayaga & Franceys, 2007; Jacobs & Franceys, 2008) and difficulty of employing conventional management arrangements in the delivery of services due to their illegal status impacting social, economic and technical characteristics. The availability of the water supply is also a contributing factor in the decision not to connect to the utility supply. Particularly during the drought, non-network providers represent a more secure and reliable source of water for households (Bakker, 2007; Bakker & Kooy, 2008). Low pressure triggered by supply shortages is associated with poor water quality and also results in poor households relying on supplementary sources —usually shallow wells.

Conversely, the main disincentives identified for poor households can be summarised as: uncertainty of land tenure which creates significant disincentives for poor households to obtain official registration and associated permits required for networked connections (Cross & Morel, 2005; Bakker & Kooy, 2008; Jacobs & Franceys, 2008), the total costs (connection and transaction) to customers of networked water supply which may be higher than alternative sources (such as groundwater) and customer perceptions of water quality influencing households' decision-making. For example the results of a study revealed residents of Jakarta perceive groundwater to be of higher quality than either vended or network water (Bakker, 2007). Additionally long waiting times at utility offices to pay bills and address



queries associated with meter mis-readings raise transaction costs, compared to the ease of complaint handling and convenience of household visits by private vendors to collect bill payments (Bakker, 2007; Bakker & Kooy, 2008). Therefore, notwithstanding the above constraints, clearly urban water utilities in developing countries need to be innovative in order to create incentives for utilities both to perform better and to simultaneously draw the urban poor into a sustainable consumer base (Cross & Morel, 2005; Kayaga, 2009).

The lack of municipal provision for the urban poor has resulted in a defined gap in services being filled by a multitude of interventions such as those evaluated in this study, and has encouraged the use of illegal connections resulting in increased unaccounted-for water (UFW) for the water utility (defined as the difference in the quantity of water delivered to the network and the quantity of water sold to customers) (Lee & Schwab, 2005). UFW comprises of two components: commercial losses (illegal connections/water theft, unmetered public consumption, metering errors and unbilled metered consumption) and physical losses (leakages) from the system. For example, in Lagos, Nigeria, between 40 and 90 per cent of the piped supply is UFW (McDonald et al., 2011). In addition, since illegal or non-metered users are not held financially accountable for the service that they obtain, there is no incentive to conserve water (Lee & Schwab, 2005). This results in high levels of Non-Revenue Water (NRW) for the water utility (WHO & UNICEF 2000; Lee & Schwab, 2005; Water Services Regulatory Board, 2010). NRW results from a combination of physical losses (leakages) and commercial losses (illegal connections/water theft, unmetered public consumption, metering errors and unbilled metered consumption).

Interestingly, a benchmarking study carried out to evaluate utilities' performance across Africa concluded that "most utilities faced more inefficiency than ineffectiveness problems" (Mbuvi, De Witte, & Perelman, 2012, p.38). South African utilities (including South Africa, Malawi, Namibia, Mauritius, Zambia) were rated as the best performing (both efficiently and effectively) followed by the East African utilities (Kenya, Uganda, Ethiopia, Tanzania,) and then the West African utilities (Ghana, Mali, Nigeria, Benin, Cote d'Ivoire, Mauritania). Therefore if all the utilities would have been

performing as efficiently the research suggests, they would achieve their effectiveness targets with less resources.

### **2.3.2 Social Inequity**

Domestic water supply tariffs are generally linked to the cost of building, operating and maintaining drinking-water systems, but tariffs rarely recover the full cost of service. Economists define the financial water cost of service per cubic meter of water as the operations and regular maintenance costs, the longer-term capital maintenance costs (through the accounting charge of depreciation) and the cost of capital used in the capital investment (including interest on loans charges and any return to equity); the full economic cost of water further includes the opportunity cost of water (using urban water today instead of saving it for tomorrow or using it elsewhere) and the economic and environmental externality costs (Matros-Goreses & Franceys, 2008; Zetland & Gasson, 2012).

In Sub-Saharan Africa, as in much of the world, it is unknown to achieve economic cost recovery and extremely rare to achieve financial cost recovery, the state or donors having almost entirely subsidised the capital investment cost and the ongoing capital maintenance costs (where incurred) (Franceys et al, 2012). The regional average water tariff is approximately USD\$ 0.67 per cubic meter, which is considered relatively average by international standards (including developing countries) to cover recurrent costs only. In African low-income countries, on average operating costs are as high as USD\$ 0.60 per cubic meter (Foster & Briceño-Garmendia, 2010).

Perhaps the most significant sign of social inequity for the urban poor is visible in situations where the subsidised (by default) services are reserved for those privileged to have a network household connection (piped water on premises), while poor households are forced to rely on alternative poor quality, non-networked sources, often at high unregulated prices, or by innovative civil society involvement experiencing difficulties in scaling-up (Franceys & Weitz, 2003; Cross & Morel, 2005; Franceys, 2005; Hall & Lobina, 2007; Hadipuro & Indriyanti, 2009; Keener et al., 2010). In many cases the situation is further exacerbated by tariff design with widespread use

of minimum charges and rising block tariffs that, again by default rather than their intended design, provide overly large lifeline blocks of subsidised water to the rich with poor consumers, and especially poor multi-households, unable to take advantage of this intended subsidy (Foster & Briceño-Garmendia, 2010).

A study undertaken in Jakarta, Indonesia verified that the lower-income households on average spent more than 5 per cent of their household income on water supply, which is often still cited as an appropriate threshold by interventional aid organisations (Briscoe & Ferranti, 1998), in part because the choices of technology of water supply vary with income (Bakker, 2007). As quite a dated study, there is need to use caution when applying this benchmark as reasonable, particularly in reflecting on the differing poverty scale of Sub-Saharan Africa. Further studies have shown only 10 per cent of households in the lowest income bracket used piped networked household connections, as opposed to 30 per cent of those in the higher-income groups who did (Bakker & Kooy, 2008).

If all the piped water networks are accessible, connection charges (fees the utility charges for making a new pipe connection) when necessarily coupled with connection costs (the physical costs households have to pay for pipes, etc.) are often significantly beyond the ability to pay of urban poor users (Franceys, 2005; Kayaga & Franceys, 2007; Matros-Goreses & Franceys, 2008). As demonstrated by research conducted in Ugandan urban centres, the poorest consumers are unable to save up any reasonable amount of capital to invest in the initial one-off payments typically required for high connection charges, particularly where they are renting their accommodation. However the evidence suggests that many categorised as poor are more able to afford small on-going charges at a rate similar to the cost of supplying water, earlier referred to as the 'ordinary' poor (Franceys, 2005; Kayaga & Franceys, 2007). Therefore, addressing the affordability of connection charges and costs is critical to create a sustainable service for the poor in accessing convenience and health benefits of potable water, lower costs arising from economies of scale and in price terms cross-subsidies in the tariff structure, which the higher-income groups continue to benefit from (Kayaga & Franceys, 2007).

Increasing demand is perhaps the greatest threat to sustainable water service. Although demand can exceed supply because of natural causes, it is more often the result of poor management and failure to match investments in supply to increasing population (Zetland & Gasson, 2012). In water scarce environments, Gerlach and Franceys (2009) also emphasise that implications of rationed water supply should be taken into consideration in determining effective tariff structures paid by poor households. They consider “as a consequence of water rationing, high-income consumers are more obliged to install household storage facilities which mostly take the form of rooftop storage tanks, possibly backed up with ground level storage” (Gerlach & Franceys, 2009, p.434). In such cases whereby the privileged tend to be given 24 hour water supply rather than the poor, increasing tariff structures too quickly allied to storage coping strategies directly or indirectly cost lower-income households a disproportionate amount (Gerlach & Franceys, 2009).

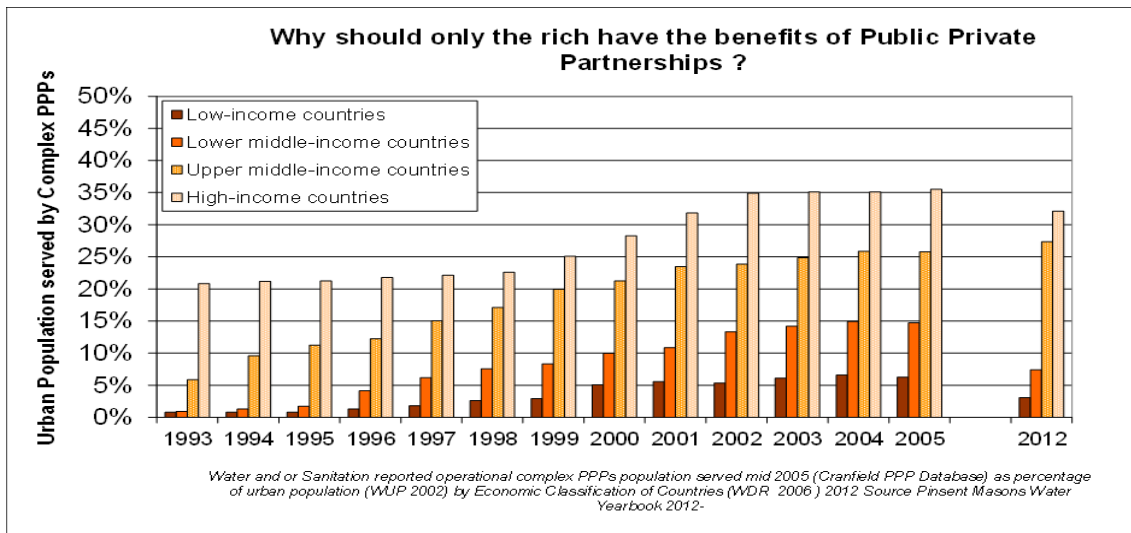
Evidently, there are clear financial and institutional challenges in getting connection charges ‘correct’ for urban poor users. The results of an analysis of water tariff data from around the world reveals that water prices are relatively low and that low prices are correlated with higher water consumption and greater risk of shortages (Zetland & Gasson, 2012). However, local governments have also typically been unable or unwilling to make politically unpopular decisions (such as raising tariffs to cost-reflective levels) or require water utilities to improve performance (e.g. through measurable performance targets) (Bakker & Kooy, 2008). An incentive should be the enhanced benefits for utilities in obtaining additional revenue from ‘new’ customers who might have traditionally been using utility water without paying for it (i.e. via the illegal connections).

### **2.3.3 Public Management or the Public-Private Partnerships (PPP’s) ‘Magical Formula’**

In considering the most effective approach to ensuring service to all, that is including delivering water to people in the low-income settlements, the overall structure of utility management is considered by some to be an issue, that is whether it should be public or private management – or the now, deemed to be more acceptable,

terminology of public-private partnerships (PPPs). Although some water utilities are financially self-sufficient, the majority struggle with insufficient revenues due to some of the reasons discussed in the previous section. Revenue shortfalls can be addressed in several ways, including: i) reducing spending on new infrastructure, maintenance, or even operations, resulting in a deterioration in service; ii) reliance on hidden or overt subsidies from politicians that can evaporate with a change of administration or financial crisis and iii) outsourcing the problem to private operators who bring finance and expertise in exchange for the political permission to raise prices, or in-source the problem by giving public utilities permission to raise prices (Zetland & Gasson, 2012).

Since 1990, more than 260 contracts have been awarded to private operators for the management of urban water utilities in the developing world (Marin, 2009). Figure 2-11 provides a snapshot of PPP coverage by country economic status over the stated period. At its peak, the global water privatisation market accounted for about 5 per cent of the total urban population in developing countries, dominated by the three French operators—Suez Environment, Veolia Water and Saur<sup>13</sup>; with varying inputs from UK operators such as United Utilities, Thames Water, Anglian Water and Severn Trent Water (Jacobs & Franceys, 2008).



**Figure 2-11 PPP coverage by country economic status (Source: Franceys & Weitz, 2003, updated 2013 KFW presentation)**

<sup>3</sup>Société d'Aménagement Urbain et Rural

Initially, hopes were high that private sector involvement would turn around poorly performing utilities by providing access to finance and bringing new operational skills (Jacobs & Franceys, 2008; Marin, 2009). Private companies were seen as being more innovative and results-oriented, and so able to deliver wider coverage more rapidly for poor households (Bakker, 2007; Hall & Lobina, 2007) which is the reason for a consideration of PPPs in this literature review.

Although a great deal of literature has been written on how service models can and should be designed to be pro-poor, there is limited conclusive documentation in comparison of actual experience in places where PPP's have been in place in developing countries for any length of time (Cross & Morel, 2005; Hall & Lobina, 2007; Jacobs & Franceys, 2008; Keener et al., 2010). Franceys & Weitz (2003, p. 1083) conclusions from early case studies suggest that a very limited number of PPPs "with international operators were found to be dramatically improving service to some of the poor with better quality at lower price, but often with long-term uncertainty over contractual stability." This is supported by case studies from Jakarta, Indonesia that revealed new connections over the period 1998–2005 were not found to be pro-poor, but preferentially targeted middle and upper-income households. The poor people who were served was usually only by default through the general overall improvement in performance (Bakker, 2007).

Proponents of private sector involvement highlight improvements through higher efficiency enabling additional sources of finance, or higher connection rates for poor households (Nickson & Franceys, 2003; Cross & Morel, 2005; Jacobs & Franceys, 2008). Examples of this were cited in El Alto, Bolivia, Casablanca, Morocco, Gabon, Manaus, Argentina and Manila, Philippines, where the introduction of payment options and flexible distribution facilities adapting to local circumstances promoted affordability, in terms of connection fees and consumption (Jacobs & Franceys, 2008). An interesting example of private sector innovation particularly relevant to this study was highlighted in Manila, where households were allowed to make their own connection to meter banks established on tertiary networks using a flexible hose. This distribution technique was designed to meet the challenges of lack of space and haphazard layouts

associated with some of the slum typologies seen in Kenya and from the locations of the interventions studied. Other examples from Buenos Aires and Manila, showed how private water companies sought new methods to involving the community deliver bills and thus collecting increased revenue, due to the “lack of infrastructure in poor communities (such as no street names or postal service)” (Jacobs & Franceys, 2008, p.252). Lessons learned from good practice in Buenos Aires, Manila and Casablanca also highlighted the need for a water utility to establish a separate, dedicated unit in-house to serve the poor, providing a proactive rather than reactive approach in dealing with contentious issues such as land tenure (Jacobs & Franceys, 2008). This approach seems to have been somewhat tentatively adopted in the study areas in Kenya. Nairobi has established a pro-poor department, while Kisumu and Nakuru have designated pro-poor coordinators, although the researcher can’t help but question if this has provided the necessary capacity to address the growing number of urban poor consumers.

Opponents argue that private sector involvement is not a reliable mechanism in the long-term to supply water services to the poor, “because private companies are unable to supply the poor on profitable terms” (Bakker, 2007, p.855). Private sector involvement is seen to negatively affect performance through raising the cost of capital, reducing long-term investment in infrastructure repair and replacement, increasing corruption, or reducing affordability for the poor due to tariff increases (Bakker & Kooy, 2008). Hall & Lobina (2007) also place emphasis on the lack of comparative evidence supporting the notion that the private sector is more likely to be innovative than the public sector.

In East Africa, one publication indicates that the introduction of an international private sector company in Dar-es-Salaam, Tanzania proved to be a costly affair with a disappointing contractual performance, which dramatically collapsed within two years of appointment (2003 - 2005). Interestingly, following the departure of the private operator the public utility that took over operation of the services and encountered many of the same constraints, despite new financial injections and an increase in the operator’s tariff (Triche, 2012). In Kenya there is increasing speculation regarding the

GoK's move towards privatisation of water services, even though the GoK indicates that privatisation does not constitute a policy component for the sector (Nyangena, 2008).

Effectively, the historic lack of data on the actual poor populations served and on the quality of services provided has made it difficult to conclude with some certainty the overall contribution of PPP projects (Marin, 2009). More recent studies are beginning to address this, for example a study undertaken to review the performance of private sector involvement of 35 main cities in China, concluded that participation of the private sector has had a positive effect on the integrated production capacity, an important indicator of urban water supply development. It also significantly increased the water coverage rate (Wang, Wu, & Zheng, 2011). The investment of fixed assets in water supply construction was also said to have shown great improvements. However, the findings made an important distinction between the performances of international versus private companies, as all the named improvements were solely associated with international private companies. The participation of domestic private companies showed little impact in improving the performance of the urban water supply sector, and in some cases even had a negative effect on indicators of industry performance (Wang et al., 2011), although this contradicts the findings from Tanzania.

Although the putative debate continues, the researcher acknowledges that PPPs are not the perceived magical formula to address all the multiple issues of failing utilities, but nonetheless private sector involvement still has much to offer in terms of reform and achievement of the MDGs (Marin, 2009). Evidence from the literature demonstrates that the most successful examples of good PPP practice are where well-designed partnerships are developed, recognising that institutions also play a critical role (Jacobs & Franceys, 2008; Bakker & Kooy, 2008; Marin, 2009). Other essential ingredients of good PPP practice are identified as flexibility, adaptability and innovation. The varied typology of the urban poor further demonstrates that there is no one-size-fits-all technological or management prescription.

The case of Uganda's urban water sub-sector provides perhaps a typical example of improved services through the public sector. Over the period 1998 to 2006, Uganda's



piped water supply service coverage in large towns rose from 48 per cent to 70 per cent. Prior to 1998, despite the engagement of an international private operator on a two-year contract to manage water distribution, billing and revenue collection, performance of the major urban utility in Uganda had deteriorated due to issues such as underutilisation of the system capacity, long distances (usually several hundreds of metres) to connect to the utility network, creating disincentives for the poor (an expenditure not affordable for many households) and non-payment of water bills (Kayaga, 2009). Instead, the use of cohesive and innovative managerial approaches not only to maintain high service coverage in planned areas, but also to extend services to unplanned, low-income settlements where water service provision is challenging, made the greatest strides in extending service coverage. This case study demonstrated that increasing coverage of water supply services requires integrated activities in various departments in order to overcome both 'hard' (physical) and 'soft' (social) barriers to sustainable access. However successful implementation of these change management initiatives was only made possible because of an enabling environment created through institutional reforms, accelerated capacity development of staff and strong corporate leadership (Kayaga, 2009).

Reflecting on what PPPs have to offer, this research considers the findings from the literature review in relation to the implementing partners of the interventions studied. In analysing the results, the researcher explores the significance (if any) of the management structures of the partners, comprising of both public utility and non-governmental organisations (NGOs), in affecting the overall performance and viability of the intervention in service improvement.

#### **2.3.4 'Informal' SSP Water Market**

Over the past decade, understanding of the role of the 'informal' private water market comprising of alternative non-network providers, commonly known as small-scale providers (SSPs), has gained more prominence in developing countries. SSPs can range from small network providers, household vendors and private entrepreneurs to cooperatives (Moretto, 2005), that distribute water from various sources which could also be part of the formal water sector via most commonly water kiosks, yard taps,

stand pipes, push carts etc. SSPs are commonly described as illicit or semi-licit actors who are unregulated and operating 'informally' in the sense of not being registered companies, not being authorised or recognised by the government and not paying taxes (Moretto, 2005; Bakker & Kooy, 2008; Keener et al., 2010). In the informal sector, such providers have previously been branded as small-scale independent providers, water vendors and resellers, informal operators and small water enterprises (Bakker & Kooy, 2008; Matsinhe, Juízo, Macheve, & Santos, 2008; Kacker & Joshi, 2012). The various forms of SSPs have long been accepted by donors and governmental authorities as a viable alternative to developing, managing and expanding service coverage in remote and underserved areas (Matsinhe, Juizo, & Rietveld, 2008). "There is now a growing literature base on the characteristics of SSPs and a lively debate on whether or not they should be formally included into public service provision regimes in order to improve access and quality of drinking-water for the poor" (Kacker & Joshi, 2012, p.27).

The informal water market is ubiquitous in low-income settlements and offers service distribution coverage in the context of the absence of the public utility. Water supply from SSPs is often problematic as the providers, out to recover costs and generate profits as quickly as possible (due to the high risks and uncertainties involved), exploit captive poor consumers and offer substandard services for unsafe water quality (Kacker & Joshi, 2012). Many of these SSPs are unable to access, for example, lifeline block subsidies to pass on water tariff reductions to the poor, due to the aforementioned high costs and charges associated with new network connections (Franceys, 2005). A study undertaken in India confirmed households relying on SSPs spent higher amounts (in absolute rupee terms), as well as higher relative proportions of income on buying water, with overall 43 per cent of households spending more than 5 per cent of their income on water bills (Keener et al., 2010).

Previous studies from countries like Mozambique in Southeast Africa have shown how SSPs were formally recognised as a valuable and reliable contribution to overcoming the problems with drinking water supply to peri-urban areas experiencing rapid growth (Matsinhe et al., 2008). In Maputo, the informal water market accounts for up to 80

per cent of the population of water resources for the urban poor (Matsinhe et al., 2008; Keener et al., 2010). As many as 45 per cent of residents were said to depend on SSPs supplying water from private boreholes through household connections, yard taps and standpipes, as opposed to 13 per cent who rely on the formal utility network (Matsinhe et al., 2008). The remaining household water resellers seek their own alternative sources by harvesting rainwater, drilling shallow private wells and collecting surface water runoff. SSP standpipes were considered more readily accessible to customers (particularly during the early morning hours or after work), “with roughly 90 per cent of them offering services for more than 8 hours per day as compared to 49 per cent of public standpipes offering the same level of accessibility” (Matsinhe et al., 2008, p.844). SSPs were also rated by many customers as the service that deals with requests and complaints more promptly than the utility. Overall the findings from Maputo demonstrated high customer satisfaction levels with SSPs, no over-exploitation of the aquifer system and good water quality, with majority of the private system virtually free from faecal contamination (absence of *E. coli* as well as faecal coliforms in more than 90 per cent of samples investigated) (Matsinhe et al., 2008). Despite any improvements being done to expand the formal utility network, due to the income households generate from selling water and rapid urbanisation, the literature anticipates SSPs will continue to play an important role in service delivery in Maputo for the foreseeable future (Matsinhe et al., 2008), although the researcher notes this situation is highly unpredictable and subject to change.

Similarly, the results from a study undertaken in Zambia demonstrate that kiosk distribution systems managed by professional SSPs with participation from the community in the implementation are an appropriate and effective solution to improve water supply distribution for the urban poor, as long as the service is properly operated (Devolution Trust Fund & GTZ, 2005). This was largely measured by a steady increase in revenue and customer base per kiosk.

In Ghana in West Africa, the gap between population demand for drinking water and its supply to urban residents is being exacerbated by water rationing and low quality adhoc storage systems. In Accra, connection rates average 90 per cent in high-income

areas and 16 per cent in low-income settlements where residents normally pay SSPs up to 8 times the formal public utility prices, escalating to up to 20 times during dry periods (Stoler et al., 2012). Consequently more people are becoming increasingly dependent on SSPs selling so-called 'pure' sachet water, when lacking a nearby connection or when rationing diverts water to higher-income neighbourhoods. The findings of a study revealed that: the individuals who depend on sachets as their primary drinking water source are generally the very poor or destitute, the extent of water rationing in a neighbourhood greatly influences choice of water supply and sachet uptake (with 67 per cent of the population interviewed more likely to use sachets) and that "there may be both a perceived and real health benefit linked to consumption of sachet water, as opposed to the vulnerability to faecal exposure from improperly stored water" (Stoler et al., 2012, p.261).

In most cases, the growth of SSPs and arrangements for the distribution of water do not have formal recognition or legal sanction. Therefore there is no oversight by the utility, or licensing arrangements (as a water service provider) to guarantee safe drinking-water, acceptable levels of service and conditions of operation (Kacker & Joshi, 2012). The ideal scenario for customers is one in which SSPs operate under the regulation of the state in terms of tariffs, water quality and meters (Hadipuro & Indriyanti, 2009) and customers have access to high-quality services at affordable prices, with transparent complaints systems built in (Kacker & Joshi, 2012). Yet there is limited academic literature that focuses on governance and politics issues underpinning the operations of SSPs (Kacker & Joshi, 2012). Kacker & Joshi (2012) consider that the existing alignment of various stakeholders is not naturally favourable to delivering the desired change, as local bureaucrats profiteer in collusion with SSPs at the expense of the poor.

This evidence in the literature therefore suggests that while SSPs fill the gap left by the formal public utility, in the context of the transition phase until the utility can keep up with the demand, the most disadvantaged residents are likely to remain trapped into unsatisfactory relationships with informal providers due to the lack of alternatives and, more importantly, the problems of collective action to influence service quality or

price. This research attempts to evaluate the satisfaction of the end user served by SSPs in relation to the public utility, in determining the effectiveness of different interventions in ultimately improving the quality of service for the poor.

### **2.3.5 Delegated Management Model (DMM)**

Adopting alternative models involving ‘delegated management’ to extend service provision to the informal settlements is increasingly promoted in Kenya, although the reports are conflicting regarding its sustainability. In essence, this model promotes the role of formal and recognised SSPs as an alternative to utilities, to meet the strategic goals for the urban poor and extend coverage to the informal settlements. “The principles of delegated management are considered similar, regardless of whether the SSP is a community group or private company” (WSUP, 2011, p.2). The different forms partnerships and relationships between utilities and SSPs that define the ‘delegated management model’ (DMM) have highlighted a number of ‘for’ and ‘against’ arguments that continue to heighten the debate. The concept has been applied in cities including Manila (Philippines) and Arusha (Tanzania)(Castro, 2009).

The DMM has been introduced in urban centres including Kisumu city (western Kenya) and Naivasha town (north west of Nairobi). In the Kisumu model, SSPs known as Master Operators (MOs) are contracted directly by the local water utility to manage the supply lines that take water directly from the bulk supply into the low-income settlements. The MOs are then responsible for managing the network distribution within the settlements via metered private connections (most desirable), shared standpipes or commercial kiosks, and are responsible for managing the billing, revenue collections and minor maintenance works (WSUP, 2011). The main advantages of this model are cited as decentralisation of services allowing for private investment (WSP, 2009), considerable service expansion and improvements for those not connected and additional revenue for the utility by selling bulk water to the SSPs (Schwartz & Sanga, 2010). However operational challenges were also identified including corruption, failure of the utility in up-holding the full end of the agreement and that in some locations customers of kiosks operated by the SSPs were paying “three times more for their water than households with in-house connections” (Schwartz & Sanga, 2010,

p.770). The shortfalls identified highlight there is yet work to be done in the justification of the model as a sustainable alternative to customers with in-house connections supplied directly by formal utilities. This model is discussed further in Section 3.5.2.

In Naivasha, a different framework agreement DMM has been developed to improve water supply and distribution through the construction of borehole-fed local water distribution networks supplying community water kiosks. As WSUP (2011, p.3) describes, the DMM involves improving water services through “extraction by private entrepreneurs, who sell untreated borehole water to the small private network operator, who then distributes the water to a series of kiosks where some is treated for the removal of fluoride, while the remainder is left untreated and sold at a lower price than the treated water.” This model is based on clearly defined contractual agreements between all parties namely: the asset owner, borehole owner, utility, private operator and kiosk attendants, and was reported to be operating with initial success (WSUP, 2011). The project appeared to be functioning well in June 2013 when the researcher made an informal visit to Naivasha. The more expensive treated water was primarily being used for drinking only and the cheaper untreated water for personal hygiene and cooking. The researcher considers this example particularly relevant in the context of the study, where a different PPP arrangement focused on supplementing the supply using borehole water. The regulated pricing structure addressed the associated water quality issues and allowed the customer to choose between treated and untreated water, based on affordability. The process appeared to be enforced by the kiosk operator and well understood by the end-users at the time of the impromptu visit.

### **2.3.6 Pre-paid Technology**

Pre-payment systems are regarded as one of the plausible solutions to tackle water access issues for the urban poor. The use of pre-paid technology to improve access to water is not a new phenomenon and had at one time been implemented in developed countries such as the United Kingdom. However the systems were declared illegal in a court case in 1997 (Laporte-Vergnes & Franceys, 2010).

In Africa, electricity companies have been successful in using this technology in improving cost recovery, money collection, cost savings and in minimising corruption and fraud. Pre-paid meters are also considered advantageous in aiding in eliminating bad debts and to recover costs of meter reading, disconnection and reconnection (Schnitzler, 2008; Berg & Mugadisha, 2010). However in the water sector the technology remains controversial, regarded by some as a violation of the right to dignity and human right to water. The example of the pre-paid water supply in Johannesburg, South Africa is commonly cited as discrimination against the poor where access to water via the pre-paid meters was unaffordable, forcing them to fetch from unsafe sources that allegedly caused the cholera outbreak in the area in 2002. This sparked to protests and outrage amongst poor communities and civil society advocacy groups, forcing the government to make some concessions. Opponents of the technology also raised questions regarding the sustainability due to the high installation and system maintenance costs that may outweigh the benefits and cost savings (Schnitzler, 2008). Nonetheless South Africa has become the Africa pioneers of pre-paid technology, exporting meters and expertise to the rest of the continent, touted as an effective distribution mechanism to allow poor consumers to manage their expenditure on water.

In Uganda, the public utility took bold steps to improve access to water for low-income areas in Kampala by installing pre-paid meters using technology from South Africa. A study investigating the performance of the meters revealed that the pre-paid meters system was generally appreciated by the user population and stakeholders. The main advantages of meters were cited as affordability and accessibility at all times (Berg & Mugadisha, 2010). However challenges and doubts remained regarding sustainability of the system, particularly due to the high investment costs and difficulties of maintenance at a distance from the manufacturer (Berg & Mugisha, 2010; Laporte-Vergnes & Franceys, 2010). Anecdotal evidence suggests that the initial pre-paid system in Kampala is no longer in operation, due to difficulties experienced in maintenance of the technology remotely (personal communication with Dr. Richard

Franceys, 13<sup>th</sup> June 2013). However a new experiment in pre-paid metering is now reported to be underway in Kampala.

## **2.4 Achieving Pro-poor Universal Water Service**

The underlying necessity of structural reforms demands a level of partnership between stakeholders that goes beyond the usual public provision by municipal utilities, to realise significant economic and health benefits in a manner which empowers poor communities in their struggle to move out of poverty has been echoed in the literature (Franceys & Weitz, 2003; Cross & Morel, 2005; Bakker & Kooy, 2008; Gerlach & Franceys, 2009). Targeted interventions and broader actions identified include: (i) offering households a menu of service options with differentiated costs that reflect their willingness to pay for service improvement; (ii) institutional arrangements to establish appropriate tariffs and subsidies enabling the poor access to household connections; (iii) expanding the choice of service providers focusing on pro-poor transaction design (including regulation and monitoring); and (iv) increasing hygiene awareness through social marketing, encouraging consumer voice and civil society engagement (Cross & Morel, 2005; Franceys, 2005).

It is also likely that the urban poor “do not have access to sufficient information to assess the cost differences between different water supply options” (Bakker & Kooy, 2008, p.1904), or cost comparisons between volumetric costs and alternative sources to determine the less expensive option. Evident from a study undertaken in Namibia, Matros-Goreses & Franceys (2008, p.353) consider that successful reform is also dependent on “knowledgeable / skilled people with integrity, independent operation (free from political influence), enforcement powers based on operation performance indicators” and the development of practical solutions.

Suggestions have been made that water utilities need to learn from the telecommunications industry who seem to have perfected the art of incorporating the voice of poor consumers in the design of pro-poor responses to segment their customer base and differentiate their services to cater for a broad and dynamic customer base (Kayaga & Franceys, 2007; Gerlach & Franceys, 2009). Gerlach and

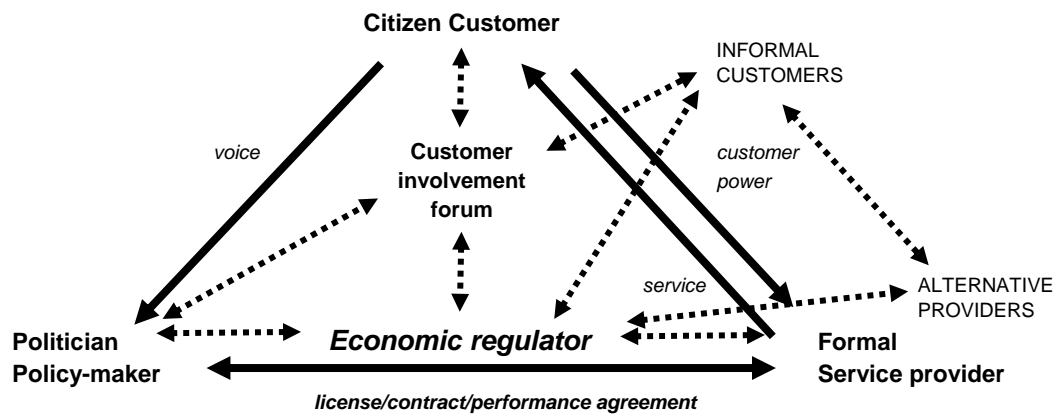


Franceys (2010) borrow concepts from this highly successful industry in recognising the benefits of offering a service that improves opportunities for revenue collection to sustain and extend services to the poor as a demand driven market, with room for local innovation and adaptation of available technological options.

#### **2.4.1 Economic Regulation**

“Like so many indicators that become targets, coverage figures can be manipulated to give the appearance of pro-poor service without achieving the reality” (Gerlach & Franceys, 2010b, p.1233). In acknowledging that PPPs have been unsuccessful in delivering all the desired benefits for the urban poor and that the literature does not offer concrete solutions for dealing with the informal SSPs, economic regulation became the latest focus in a series of attempts to balance politically sensitive issues in operational efficiency and meet public health objectives for the remaining millions of underserved (Gerlach & Franceys, 2010b; Franceys & Gerlach, 2011).

In formulating sustainable outcomes to address the significant investments required to upgrade and expand water supply infrastructure, Gerlach and Franceys (2010b, p.1299) bring to focus the need for greater cost-reflectivity of tariffs and the responsibility of the regulator to “negotiate, elucidate, make transparent and monitor the societal demand for water.” This will be evidenced through government policies and a water service provider’s ability to deliver those services efficiently and effectively through access to sufficient resources, based upon a reasonable balance of tariffs and economic support. Zetland & Gasson (2012), make the point that people concerned about water affordability assume that higher prices will harm the poor, which does not hold when higher prices are used to extend service to people relying previously SSPs. Regulating for the poor requires a thorough understanding of the obscure and unpredictable customer base of each public utility, knowledge of all the informal service providers (who may be competition for the utility with an estimated turnover that could exceed utility revenue collections), and customers’ differing demand for water services relative primarily to affordability and accessibility (Gerlach & Franceys, 2010b).



**Figure 2-12 Extended role of pro-poor regulation (Source: Franceys & Gerlach, 2010b, p.1230)**

There is a general view that economic regulation operates between the water service provider and the customer or end-user for the protection of the customer (Franceys & Gerlach, 2011), although the elusive and unrecognised poor customers are often forgotten. Figure 2-12 illustrates the perspective taken by the literature that pro-poor regulation in effect mediates between government as policy-makers setting the standards of service and the monopoly service providers, “who both need to be incentivised for efficiency gains, funded through appropriate tariff adjustments and monitored for service performance” (Franceys & Gerlach, 2011, p.65). In a free-market customers purchasing choices would prompt providers to adjust service levels and options in correspondence with evolving user needs and preferences, which is absent in the water supply sector due to the natural monopoly characteristics of piped networked that by default is the most desirable service. However the reality is in many cases, the intentions of water sector reform and regulation do not engage the general public, let alone the poor customers (Franceys & Gerlach, 2011). As and when willingness to pay (or possibly affordability) by low-income customers increases and they start demanding for better services, regulators need to be paying attention “such that they can enforce (and support through price adjustments) the formal service providers to meet that need” (Franceys & Gerlach, 2011, p.69).

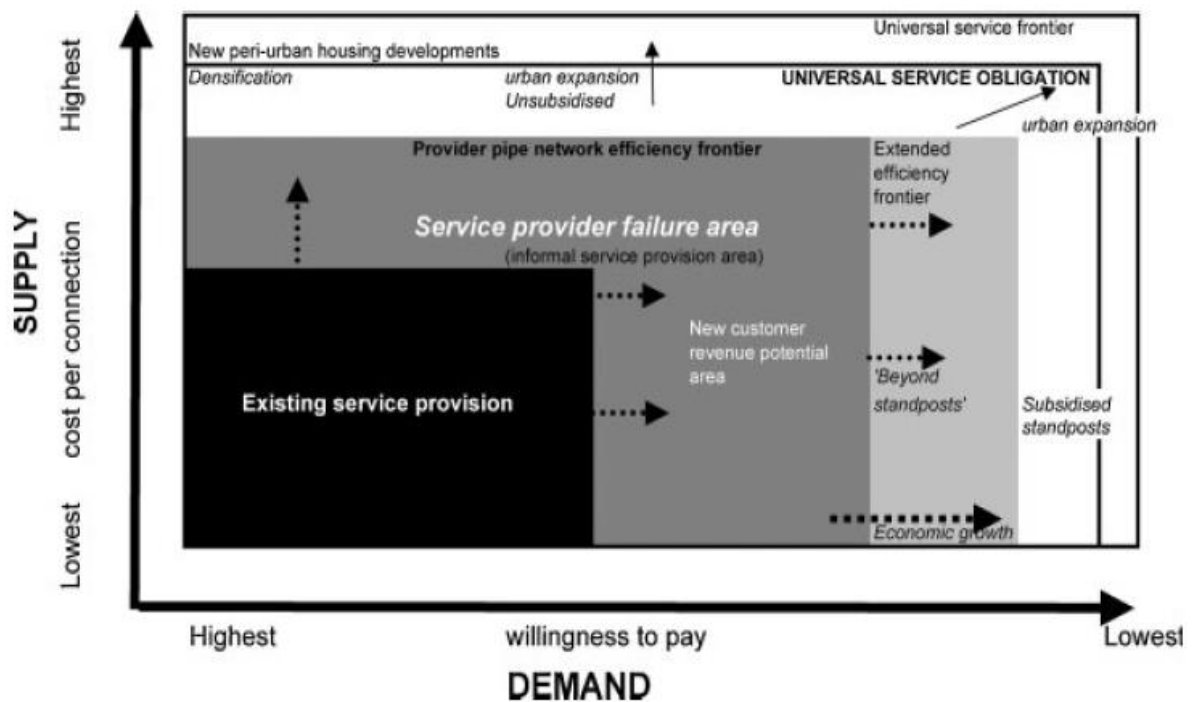
Ultimately, “the political voice of the poor is fundamentally constrained by their inability to connect with government, their absence of social and economic power and their consequent failure to represent their interests in devolved government

structures” (Beall, Guha-Khasnobis, & Kanbur, 2010, p.198). Therefore, promoting customer participatory development can “support citizen voice and customer power in addition to informing the regulatory mechanism” (Franceys & Gerlach, 2011, p.65). Although the literature recognises that to involve the very poor, marginalised, isolated and invisible customers who more often than not are not even customers, may encounter another set of challenging mechanisms (Beall, Guha-Khasnobis, & Kanbur, 2010; Gerlach & Franceys, 2010b; Franceys & Gerlach, 2011).

Regulation of water services can be an effective mechanism for the utility to institutionalise their commitment to universal water service for all and for consumer protection, while also promoting incentives for efficiency and effectiveness. “A dynamic definition of universal water service would not only have to account for objective needs but also for more subjective expectations of large numbers of low-income consumers at a time when the combined effects of environmental degradation, climate change, urbanisation and population growth are increasing the cost of water resource development, treatment, distribution and disposal” (Gerlach & Franceys, 2010a, p.464). Therefore, to achieve such a service regulatory mechanisms needed would require an in-depth understanding of the flexible and dynamic nature of service delivery over time to achieve a self-sustaining urban water supply close to the household (on premises being most desirable), delivering enhanced health and convenience benefits for all, particularly the most vulnerable poor women and children (Gerlach & Franceys, 2010a).

The ‘universal service dynamic,’ concept illustrated by Gerlach and Franceys (2010a) is shown in Figure 2-13. The model recognises and attempts to put into context the economic realities of the piped network efficiency frontier, where as housing density increases (e.g. transition from peri-urban to formal inner city) the service provider boundary must also extend. This model also recognises the potential for adopting flexible and dynamic mechanisms to extend the efficiency frontier through a range of differentiated service options allowing “acceptable compromises on service standards” (Gerlach & Franceys, 2010a, p.465) which are reflected in price reductions, although the researcher notes what is termed as ‘acceptable’ can in itself have several different

interpretations. Introducing services “beyond standpipes” (Gerlach & Franceys, 2010a, p.465) is considered a viable alternative to significantly improve the opportunities for the utility to collect revenue to sustain and expand coverage, with room for innovation (in technology or service levels) as demonstrated by the informal sector. For example “above-ground pipes, pre-paid meters, fixed-volume delivery mechanisms, yard taps, shared communal taps and kiosks all offer opportunities to introduce lower cost but improved quality and convenience through access to formal water supply,” (Gerlach & Franceys, 2010a, p.466), assuming the supply is adequate.



**Figure 2-13 Universal service dynamic frontier (Source: Gerlach & Franceys, 2010a, p.465)**

In considering the context of this diagram in relation to the findings from the literature review and in the context of the transition phase, the researcher notes that the increase in demand is based on the assumption of “willingness to pay” rather than their “ability to pay” or “affordability,” which is likely to be more representative when considering the defined slum typologies and poverty classifications of the urban poor identified in this study. Additionally the concept illustrated in the diagram fundamentally assumes that the public utility supply is adequate to meet the demand

for expansion and technical innovation within the service provider failure area highlighted, with groundwater becoming more relevant as peri-urban expansion occurs.

What remains to be determined is exactly where the transition phase interventions fit into this universal service dynamic concept, to illustrate the service gaps that are being filled by what interventions for different poverty classifications and which factors most positively or negatively influenced the performance.

#### **2.4.2 Dependency on Self-Supplied Groundwater**

Of particular interest to this study is the use of 'self-supplied' groundwater in urban areas as a means of evading the lack of an adequate conventional piped water supply. The concept of 'self-supply' is generally described as an approach whereby households are supported to make their own investments in water supplies (Carter, 2012). In the context of this study, self-supplied is the term used to describe boreholes constructed by NGOs, institutions and entrepreneurs which can be found in most urban poor settlements, due to the utility's inability to keep pace with the growing demand or failure to deliver it where it is most needed (Grönwall, Mulenga, & McGranahan, 2010; McDonald et al., 2011; Mulenga & McGranahan, 2011). Many government officials and water experts had wrongly assumed that as a developing city's infrastructure expands more and more residents will have access to the public water supply network, leaving behind the simple wells used in rural villages. However this was not to be the case as an estimated 30 per cent of the urban poor in Asia and Sub-Saharan Africa are said to still rely on groundwater via shared wells, boreholes, public taps and standpipes, or purchased from private vendors abstracting from groundwater (Foster, Tovey, & Tyson, 2011).

While there are relatively limited research studies on urban self-supplied groundwater, this approach has increasingly been promoted in rural Sub-Saharan Africa (Grönwall et al., 2010). The use of shallow wells and boreholes has traditionally been one of the most common technologies used by NGOs and third parties to provide a source of water supply for the most marginalised and vulnerable rural communities where no

formal municipal infrastructure exists, thus leaving limited alternatives. However, in many rural projects across sub-Saharan Africa, less than 50 per cent of the pumps are reportedly still working properly after 3-5 years in operation (Riekkel, 2002). In Lagos, Nigeria, the state of water supply facilities in 43 communities revealed 86 per cent of boreholes fitted with electrical pumps had failed soon after project completion. Similar scenarios have been reported in Burkina Faso, Ghana, Mali and a number of other countries across the continent (Skinner, 2009).

Although it seems widely acknowledged, surprisingly limited literature has raised the alarm over the low levels of sustainability, mostly attributed to the lack of maintenance plans (Riekkel, 2002; Harvey, 2004; Skinner, 2009). Riekkel (2002) considers borehole maintenance at the local level virtually impossible without outside assistance in terms of information, funding and expertise, an aspect largely overlooked in the literature. In addition, Harvey (2004, p.339) highlights that implementing NGOs or third party operating staffs often have “limited technical knowledge and equipment to understand the hydrogeological conditions within which they are working. There is also a distinct lack of effective regulation or supervision.” Consequently, the quality of workmanship varies considerably and is generally poor, as is the ability to locally identify, predict and mitigate against possible borehole failure (Harvey, 2004; Longe, Omotoso, & Sodamade, 2009). Longe et al.(2009) also considers the attitudes of the communities as a barrier.

Borehole construction was also found to be more expensive in African countries, compared to China and India. This was attributed to “lack of any economy of scale or competition in the field, the absence of a large private-sector market, high excise duty on imported drilling equipment, corruption and inappropriate well design including drilling to excessive depths” (Grönwall et al., 2010, p.60).

Disappointingly, despite the significant capital investments made in the water sector by governments, NGOs, bilateral and multilateral agencies and donor organisations have remained disengaged when it comes to conceptualising the importance of maintenance costs for a sustainable supply (Riekkel, 2002) though this has been challenged by Fonseca et al (2012). The importance of this failure cannot be

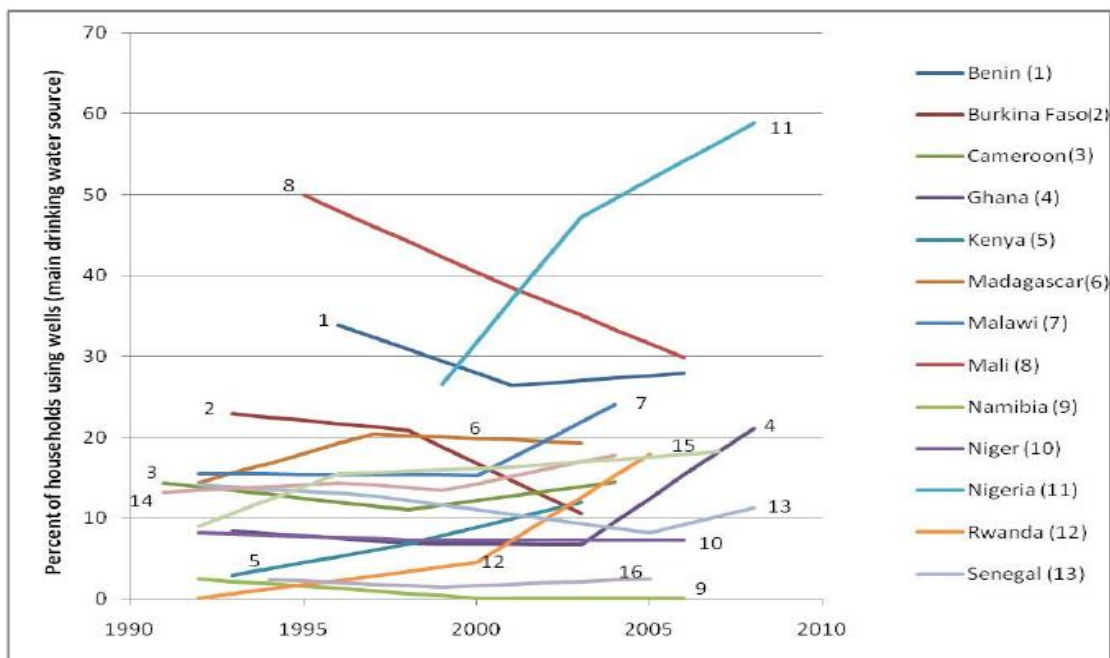
understated in economic and social terms. A study undertaken in Botswana proved that if the boreholes were properly maintained, this would sharply reduce annual operational costs for all borehole installations by at least 40 per cent. When boreholes are not working people return to walking long distances for other contaminated sources or stop farming or other income generating activities altogether (Riekkel, 2002). Although Skinner (2009) estimates a failed investment of anything from USD\$ 215-360 million, he states this figure could be far worse in areas less accessible. “To be sustainable direct investment in water supply infrastructure also needs to address the issue of who will maintain it, and where the money and skills to do so will come from” (Skinner, 2009, p.1).

### **2.4.3 Groundwater and Urbanisation**

Considering the role and function of self-supplied groundwater in urban areas, the relationship between groundwater and urbanisation has been described as “one person’s solution which becomes the other’s problem” (Foster, 2008, p. 5). Although groundwater resources have proved vital to the economical provision of water supply in many developing urban centres, the literature has echoed that investment in governance of the resource has typically been neglected (Foster & Tuinhof, 2005; Foster, Tovey, & Tyson, 2011; Mulenga & McGranahan, 2011; McDonald et al., 2011). In the continually evolving dynamics of urbanisation processes, indiscriminate resource exploitation of this finite supply can lead to serious water-table decline (locally causing aquifer saline intrusion and land subsidence), accompanied by pollution of shallow groundwater (also sometimes due to natural contaminant mobilisation), all of which impact human livelihoods and public health (Foster, 2008b; Foster et al., 2011; Mulenga & McGranahan, 2011). This is becoming of even greater concern for policy-makers with climate-change effects becoming more pronounced each year of the past decade (Grönwall et al., 2010; Foster et al., 2011).

The growing dependency on groundwater in urban environments is explained by the key advantages that it may be conveniently available close to where it is required, can be developed at relatively low cost (compared to the alternative self-supply approach of tankering) and in stages to keep pace with rising demand and financial ability to self-

finance (Kilanko-Oluwasanya, 2009; Grönwall et al., 2010; McDonald et al., 2011). Additionally small-scale self-supply of groundwater “offers the choice of technology, progressive upgrading and replicability” (Grönwall et al., 2010, p. 67). Examples shown in Figure 2-14 include Sub-Saharan countries such as Nigeria, where in 2011 more than 60 per cent of the urban dwellers relied on nearby wells, up from 27 per cent in 1999. Kenya maintained a steady 10 per cent increase from 1993 to 2003. Over a comparable period, Mali experienced a comparable shift in dependence in the opposite direction, from 50 per cent in 1995/96 down to 30 per cent in 2006.



**Figure 2-14 Positive and negative “changes in urban household well use over time in Sub-Saharan African countries” (Source: Grönwall et al., 2010, p.21)**

In Lusaka, Zambia, unofficially many of the urban poor depend on shallow wells for drinking-water, despite government warnings that such wells are easily contaminated (Grönwall et al., 2010; Mulenga & McGranahan, 2011). In the Central African Republic, only 10 per cent of the wells and boreholes are reported to provide safe water, in spite of these being the main supply for urban dwellers (Jacobsen et al., 2012). However, as case studies have shown in Bangalore for example, excessive uncontrolled abstraction leads to localised water-table decline and aquifer depletion (Grönwall et al., 2010). Similarly in Bangkok, excessive abstraction caused subsidence, damaging the



foundations of valued historic buildings as well as producing localized flooding (McDonald et al., 2011).

Generally groundwater is assumed to be a relatively safe drinking-water source due to the protection and filtering effect of the soils and sediments over the waters (Kilanko-Oluwasanya, 2009; Parker et al., 2010). However, Kilanko-Oluwasanya (2009, p.35) highlights a key issue in the use of aquifers as a drinking-water source, stating that “particular attention is needed to determine whether the general assumption of groundwater being safe to drink is valid in individual settings.” Other studies undertaken to compare different groundwater source types concluded that boreholes (defined as machine drilled wells and typically 30–90m deep) are “significantly better than protected springs, covered hand dug wells, open hand dug shallow wells and open water” (Parker et al., 2010, p.554).

It is known that groundwater is highly vulnerable to contamination in urban environments (Grönwall et al., 2010; Mulenga & McGranahan, 2011). It appears likely that the major water quality problems (whether microbial or chemical) will be greater in areas with higher upstream population density (McDonald et al., 2011). The poor are particularly vulnerable to microbiological contamination from faecal matter containing pathogens discharging straight into open wells, exacerbated during the rainy season. This contaminated water, including wastewater from latrines, may also pollute aquifers by seepage through the ground. “The resource can also deteriorate due to inadequate source protection and poor resource management” (Kilanko-Oluwasanya, 2009, p.35). In-depth studies focusing on both Bangalore and Lusaka’s urban self-supply groundwater consumed by slum dwellers found that in Bangalore, 77 per cent of the children less than five years old were affected by diarrhoea and 80 per cent of the residents were affected by intestinal worms. In Lusaka, regular fatal cholera outbreaks attributed to poor water quality abstracted from the aquifers, especially during the rainy season, accounted for nearly two-thirds of the overall country’s cholera cases in 2009 (Mulenga & McGranahan, 2011). The results indicated that regardless of the source, very few slum dwellers bothered to treat their drinking-water

before consumption, considering this unnecessary and too expensive (Grönwall et al., 2010).

Mulenga & McGranahan (2011), argue that researchers have focused on the statistics surrounding disease and contamination from urban self-supply groundwater to criticise this option, without providing feasible alternatives. They emphasise that it is not the actual use of groundwater that presents a public health risk but the vulnerability to pollution from latrines located close by, or the lack of roofs on latrines during the rainy season. Suggestions have been made for water treatment at point-of-use (or consumption) and encouraging hygiene measures such as hand-washing to reduce the health burden of groundwater, particularly during seasonal fluctuations (Grönwall et al., 2010; Foster et al., 2011; Mulenga & McGranahan, 2011). However this literature notes the argument does not discuss the potential long-term knock-on health impacts from aquifer depletion.

Without the possibility of a household connection, an overall review of previous studies and the academic literature concludes that self-supply from groundwater has been a major benefit in improving access to water for neglected and underserved groups of the urban poor, proving beneficial for development, health and their overall well-being resources (Foster, 2008a; Grönwall et al., 2010; Mulenga & McGranahan, 2011). “Conversely, there are situations where increasing dependence on groundwater is a symptom of problems that need to be addressed” (Grönwall et al., 2010. p.20). Studies undertaken in urban centres of Aurangabad in India and Abeokuta in Nigeria illustrated that large-scale domestic self-supply can distort utility water-supply operations with significant implications for investment. These studies illustrated lack of economic and environmental sustainability, in addition to the potential public health hazards, calling for better management of groundwater resources (Foster, 2008a). From the perspective of the urban public utilities, groundwater may play a strategic role in supplementing supply seasonally, largely depending on geographic and other environmental conditions. However recent studies have also emphasized the risks for the utility associated with unregulated high-income and/or commercial consumers over-abstracting groundwater to meet demand. Although private self-supply can

essentially 'free-up' utility water production capacity to meet the needs of low-income consumers, this simultaneously reduces the utility revenue collection and makes it more difficult to introduce or maintain pro-poor tariff structures (Foster & Vairavamoorthy, 2013). "From the city planners' perspective however, groundwater resources may not seem prominent enough to be given special management consideration. This may in part be because the groundwater is not accounted for properly their statistics due to insufficient monitoring" (Grönwall et al., 2010, p.2) and difficulties in distinguishing customers who are accessing a mixture of the utility's surface water and groundwater supply by private means. Without better information on groundwater use, it is hard to know how many millions of people are in cities that are essentially abstracting groundwater in an unsustainable fashion (McDonald et al., 2011). Under-reporting on groundwater consumption undermines the potential for an informed international debate on groundwater sustainability in the short as well as the long-term. "However, interpreting what sustainable groundwater development means is a complex issue which depends on a multitude of environmental, social and economic factors" (Grönwall et al., 2010, xiii). These include local hydrogeology, climate change, scale and purpose of withdrawals, alternative water sources, potential for accurate monitoring and modelling and political will to enforce measures (Grönwall et al., 2010; Foster et al., 2011). What remains certain, though, is that to ensure groundwater use remains sustainable and continues to sustain life in urban poor settlements, city planners' must take this source of water supply into account (Mulenga & McGranahan, 2011). For example Bangkok in Thailand is cited as making promising strides to regularise urban groundwater by using time-limited licensing for all larger multi-residential, industrial, and commercial groundwater abstractors in critical areas (Foster & Vairavamoorthy, 2013).

Particularly in Sub-Saharan Africa, it is unlikely that a majority of the urban poor will be properly served by a network household connection in the foreseeable future (Grönwall et al., 2010). Studies from urban poor settlements in Kisumu city in Kenya also revealed that even if piped water was accessible to everyone with a reliable supply and at a consistent price people, in particular the vulnerable poor, would

continue to use self-supply sources for at least part of their water needs (Philip & Stevens, 2013). Promoting the existence of self-supply of groundwater is cited as an option, or rather a necessity for survival for many urban poor dwellers not served in a reliable way and/or at an affordable cost by public water utilities. As the gap between demand and supply grows, consumers from all income-levels may find that they need to self-supply from a range of sources, however poor the quality or uneconomic that might be.

Notwithstanding this the growing dependence on boreholes in urban environments to serve the urban poor prevails. The available published academic literature does not focus on the East Africa region with limited evidence-based evaluation studies of the sustainability of urban boreholes in economic, environmental and social terms.

## **2.5 The Lessons Learned**

The literature to date has outlined the challenges in providing universal service coverage to the growing urban poor population when the varied typology and poverty classifications are not equally uniform, presenting unique settings. In the context of the transition phase, although significant investments have been made in developing technological and/ or management models to fill the service gap left by the public utility in distribution and supply mechanisms, sustaining the effectiveness and utilisation of services has added another dimension of complexity even less well understood by policy makers.

In summary, the literature suggests that very few evidence-based studies have been undertaken to adequately investigate the performance and viability of the multitude of interventions undertaken to improve water supply services for the urban poor. Knowledge gaps remain in understanding the factors that influenced their performance over time, with respect to driving demand for a particular service among the different socio-economic groups of the urban poor, and to what extent these transition phase interventions contribute to the overall aspiration to provide universal services; all of which are addressed in this research.

The next section describes the study area in detail to familiarise the reader with the local urban poor landscape in relation to the findings from the literature review and put into context the interventions undertaken at each location. The section also highlights the existing surface and groundwater supply sources in relation to the demand, to recognise the specific service challenges facing fast growing urban centres in Kenya.



## 3 THE STUDY AREA

### 3.1 Background to Water Services Provision in Kenya

“Kenya is classified as a water-scarce country. This means that the combined surface water and groundwater renewable resource potential amounts to less than the global standard of 1,000 cubic metres per capita” per annum (IEA, 2007, p.12). This is evidenced by the steady decrease in the water per capita recorded over the 40 year period from 1969 to 1999: starting at 1,853 cubic metres in 1969, 704 cubic metres in 2000, 612 cubic metres in 2005 and 534 cubic metres in 2009 (Mumma, Lane, Kairu, Tuinhof, & Hirji, 2011). By the year 2015, the scarcity is expected to continue declining to about 235 cubic metres (IEA, 2007), primarily due to rapid population growth.

The provision of basic water services to all Kenyans remains a necessary and urgent task (Ruhii et al., 2009). Regional water shortages and drought are unrelenting and contentious issues frequently discussed and featured in the local (and sometimes international) news. “In addition to the rapidly growing and increasingly impoverished population, the decrease in surface water levels has also been attributed to under-investment in water infrastructure and ineffective financial and commercial management structures of public utilities. Inadequate water supply to meet demand has been identified as a factor hindering socio-economic growth in Kenya and threatening the integrity of national ecosystems” (IEA, 2007, cited in Chakava, 2011, p.6).

When it comes to consumption, the relatively little water that is available is not managed efficiently. The average national consumption per capita (domestic consumption) in 2009/10 was 52 l/c/d, including NRW. Excluding NRW, this figure goes down to 36l/c/d, which is significantly below levels of around 100 l/c/d in developed countries (Water Services Regulatory Board, 2011). Considering the 2009/10 average tariff of KES 53 (USD\$ 0.66) per cubic metre, the amount of water lost due to NRW in monetary terms can be valued at a significant KES 8.6 billion (~USD\$ 107.5 million<sup>4</sup>).

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<sup>4</sup>Exchange rate USD\$1 = Kes 80, best estimate at time of writing

Although the marginal cost is much less, this valuation represented approximately one third of the annual sector development budget for 2009/10 (Water Services Regulatory Board, 2011).

Groundwater is considered important, more so than it might seem given that on record it only constitutes about 5 per cent of the Kenya’s natural renewable water resources. The last census (2009) revealed that 24 per cent of the urban population rely on boreholes, shallow wells or springs as their primary source of water (compared to 43 per cent of the rural population) (Oparanya, 2010). Dependence on groundwater does come with unique advantages including the ability to abstract quickly, the relatively low capital cost of development, its unparalleled resilience during droughts and meeting the demand, making it a vital component in rural water supply and a supplementary water supply solution for small (and sometimes large) towns. Despite its importance, the management of groundwater resources in Kenya has been described as weak and ineffective, largely due to the perception that groundwater is an infinite resource. Consequently “the value of the resource is not appreciated, nor is its vulnerability understood” (Mumma et al., 2011, p.xiv).

### 3.1.1 Coverage

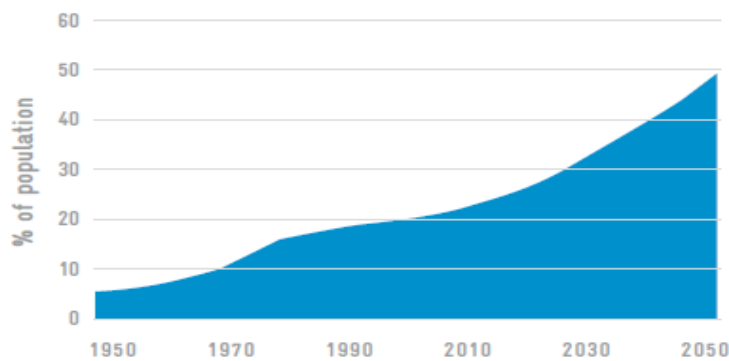
With over half the total population (53 per cent) accessing water from sources considered unsafe, Kenya’s water coverage falls well below the required standards (Oparanya, 2010). Table 3-1 below summarises Kenya’s water coverage statistics in 2009.

**Table 3-1 Kenya national WASH statistics (Source: Adapted from Oparanya, 2010)**

KENYA	
Capital	Nairobi
Population	38,610,097
No Water	16.8 million (44%)
No Sanitation	22.6 million (59%)
Infant Mortality	5%



In urban settings, national statistics indicate that an estimated 60 per cent of the country’s population have sustainable access to safe water, dropping to as low as 20 per cent in the low-income settlements (Ruhio et al., 2009). The 2009 Population census revealed that Kenya is currently adding 1 million people yearly to its already high population (see Figure 3-1) which is more concentrated in urban low-income settlements. This rapid rate of population growth has adverse effects on spending in infrastructure, health, education, environment, water and other social and economic sectors. Sources of grey literature describe the situation in Kenya as an ‘urban crisis’ due to the growing gap between the rich and the poor and the disproportionate focus on rural areas by politicians and donors (GIZ et al., 2013).



**Figure 3-1 Kenya’s urban population growth (Source: GIZ et al., 2013, p.4)**

### **3.2 The Institutional Framework**

“The Water Act 2002 provides the structure for reform in Kenya for implementation, addressing the three main aspects: (i) the management, conservation, use and control of water resources. (ii) the acquisition and regulation of rights to use water, and (iii) the regulation and management of water supply and sewerage services” (IEA, 2007, p.8)

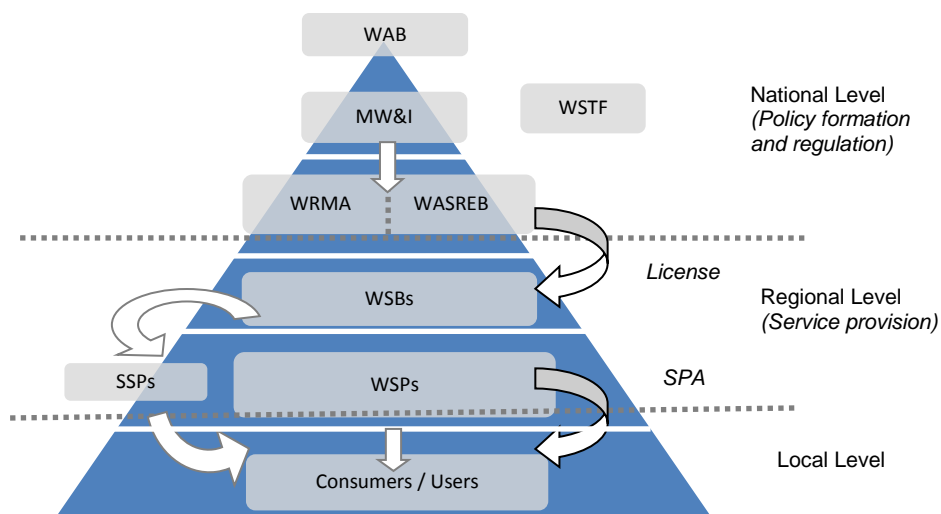
The reform process redefines the key sector roles, formally separating policy-making, service delivery and regulatory roles in a pyramidal framework (IEA, 2007). The sole function of the Ministry of Water and Irrigation (MW&I) at the apex is to “plan and mobilise resources for the sector and develop policies, specifically including: Water

and Sanitation Services Policy, Water Resources Management Policy, Water Quality and Pollution Control Policy and Water Schemes and Community Water Projects” among others (IEA, 2007, cited in Chakava, 2011. p.4).

“The Water Services Regulatory Board (WASREB) and Water Appeals Board (WAB) are independent institutions to regulate and deal with disputes respectively. In view of the large investments required to address the problems of inadequate infrastructure, decaying resources and a growing population, the Act established a Water Services Trust Fund (WSTF) to facilitate and assist in water service provision to areas currently without adequate water services by disbursing public funds and donor contributions to projects benefitting the poor” (Gerlach, 2006, cited in Chakava, 2011. p.5).

“Regional Water Services Boards (WSBs) are entrusted with the ‘efficient and economical’ provision of water services. The service obligations are to be met by contracting Water Service Providers (WSP’s) reducing WSBs’ functions to asset management and development as well as supervisory control of contracted operators. The primary regulatory instruments are the licences granted to the countries WSBs by the WASREB. The WASREB is specifically responsible for monitoring and enforcing the WSBs’ compliance with conditions attached to their licences, though the scope for subsequent regulatory interventions is vaguely defined in the legislation. The Water Act 2002 also does not clearly define WASREB’s powers and responsibilities with respect to the individual WSPs, however, the contractual arrangements between WSBs and WSPs, termed Service Provision Agreements (SPAs) are subject to WASREB approval. The foundations of the regulatory system, such as the guidelines and regulations envisaged under the Act 2002, are also a responsibility of WASREB” (Ministry of Water and Irrigation, 2007, cited in Chakava, 2011. p.5).

Figure 3-2 summarises the institutional framework for water service provision in Kenya.



**Figure 3-2 Institutional framework for water supply in Kenya (Source: Adapted from NCWSC, 2011)**

In August 2010, Kenya signed into law a new constitution enshrining a comprehensive Bill of Rights that includes the right to clean and safe water in adequate quantities for each person. The domestication of this law represents the Government of Kenya (GoK) commitment to scale up efforts to ensure access to water that is safe, clean and available in adequate quantities (Water Services Regulatory Board, 2011). The GoK service criteria adopted for good practices fulfilling human rights obligations related to access to safe drinking water is summarised in Table 3-2.

**Table 3-2 WASREB service criteria definitions (Source: Adapted from Water Services Regulatory Board, 2011)**

Service Criteria	WASREB Definition(1-5 Normative criteria; 6 – 10 Cross cutting service criteria)
1) Water Quality	Water must be of such a quality that it does not pose a threat to human health.
2) Availability	Refers to sufficient quantities, reliability and the continuity of supply or service.
3) Accessibility	Water facilities must be physically accessible for everyone within, or in the immediate vicinity, of each household, health or educational institution, public institution and the workplace.
4) Affordability	Access to water facilities and services must be accessible at a price that is affordable for all.

<b>5) Acceptability</b>	Water facilities and services must be culturally and socially acceptable.
<b>6) Non Discrimination</b>	Discrimination on prohibited grounds including race, colour, sex, age, language, religion, political or other opinion, national or social origin, property, birth, physical or mental disability, health status or any other civil, political, social or other status must be avoided, both in law and in practice.
<b>7) Participation/ Empowerment</b>	Processes related to planning, design, construction, maintenance and monitoring of water services should enable participation by users including representatives of all concerned individuals, groups and communities.
<b>8) Accountability</b>	The State and numerous other actors in the water sector also should have accountability mechanisms, including participation and access to information.
<b>9) Impact</b>	This criterion aims at capturing the impact of practices and the progress achieved in the fulfilment of human rights obligations related to water.
<b>10) Sustainability</b>	Good practices have to be economically, environmentally and socially sustainable, with continuous and long lasting achieved impact.

Although the GoK has confirmed its commitment to essential long-term investment in water infrastructure in order to achieve the MDG target, universal access to safe, adequate and affordable drinking-water is still lagging behind. Prompted by the new constitution (promulgated in 2010), a Draft Water Bill 2012 has been published and pending enactment by parliament to repeal the Water Act 2002. This bill segregates the key sector roles and functions by regulation, water services, financial provision and dispute resolution as follows: Water Resources Regulatory Authority (WRRRA) to regulate the management and use of water resources (transfer WRMA), including powers to issue permits, monitoring and control of groundwater abstraction; new Basin Water Resource Boards (BWRB) for the management of water resources within the basin area; new Water Resource Users Association (WRUA) for collaborative community management of water resources and conflict resolution; Water Works Development Boards (WWDB) to formulate county development and investment plans (transfer WSBs); Water Services Regulatory Commission (WSRC) to protect the interests and rights of consumers (transfer WASREB); Water Service Providers (WSP's)

to operate on the basis of an agreement established by county governments (providers can be a company, NGO or other person or body as approved by the WSRC); Water Sector Trust Authority (WSTA) to assist in financing water resources management and development of water services for the poor (transfer WSTF); Water Tribunal to adjudicate on disputes (transfer WAB) (Ministry of Water & Irrigation, 2012).

### **3.2.1 Strategic Goals for the Urban Poor**

In September 2007, the GoK through the MW&I adopted the National Water Services Strategy (NWSS), complimented with a Pro-poor Implementation Plan (PPIP). This is an eight year programme that has a main goal to ensure sustainable access to safe water and basic sanitation to all Kenyans by 2030 (Ministry of Water and Irrigation, 2009), in accordance with Kenya's new development footprint referred to as 'Vision 2030.'

This approach places emphasis on prioritising investments to ensure the maximum number of people access safe water and basic sanitation in the shortest time possible (Ministry of Water and Irrigation, 2009). This means extending services to the fast-growing settlements where investments would reach the highest number of beneficiaries. The mid-term goal in urban areas is by 2015, for 8 million more people to have access to safe water (increase from 60 per cent to 80 per cent) and for 7.2 million more people to have access to basic sanitation facilities (increase from 55 per cent to 76 per cent) (Ministry of Water and Irrigation, 2009).

### **3.2.2 Kenya's SSPs**

Under the Water Act 2002, the right to provide water services relevant to SSPs is regulated by the provisions of Clause 56. (1). The Clause stipulates that that no person shall: "a) provide water services to more than 20 households; or supply (i) more than twenty-five thousand litres of water a day for domestic purposes; or (ii) more than one hundred thousand litres of water a day for any purpose, except under the authority of a valid licence" (Ministry of Water & Irrigation, 2012, p.51). Subsection (2) further states that it is an offence to provide water services in breach of the regulatory licence requirement (Ministry of Water & Irrigation, 2002). The role of Small-Scale Providers (SSPs) such as private borehole operators and water kiosk vendors has been commonly

overlooked in the institutional framework. The above Clause confirms they too are (or should be) subject to regulation and licensing requirements, to manage efficient and affordable services to the customers.

Under the Draft 2012 Bill, notably, the provision of water licence requirements relating to SSPs is no longer descriptive per number of households served and quantities sold, suggesting that a license issued by WSRC would become mandatory to all services providers whether operating as an organisation or individual, regardless of coverage.

### **3.2.3 WSP Performance Indicators**

The performance of WSPs in fulfilling the Gok's human rights obligations is assessed on an annual basis by WASREB. The WSP are categorised into 'urban' and 'rural' as different scoring criteria is applied to both. This is attributed to the significantly different operating environments and constraints. WSPs are scored against nine key performance indicators (KPIs) (Water Services Regulatory Board, 2010) namely:

1. Water coverage
2. Sanitation coverage
3. Non-Revenue Water (NRW)
4. Water quality
5. Hours of supply
6. Metering ratio
7. Revenue collection efficiency
8. Operation and maintenance (O&M) cost coverage
9. Staffing (per 1000 connections)

The WSPs are then assigned scores in relation to the three sector benchmarks defined as 'good,' 'acceptable' and 'not acceptable.' However the researcher notes that the KPIs do not reflect specific 'pro-poor' progress made by the WSP's in meeting the PPIP strategic goals.

### **3.3 National Urban Poor Landscape**

The urban poor population in Kenya is stated to now exceed 3.9 million (5.2 million including areas with slum pockets within) and is set to almost double in the next 15 years (GIZ et al., 2013). “City authorities categorise informal and/or low-income settlements as areas that lack access to basic services and infrastructure provision. These settlements contain urban residents who earn low incomes and have limited assets. Employment is largely low skill (domestic house-helpers, waiters, bar maids, security guards etc), often on a casual / part-time basis (construction labour), small business owners (kiosk owner or newspaper seller) and other income-generating activities. Discrimination, especially along ethnic lines exists, with most ethnic groups living in (sub) communities of their own ethnic background. The settlements constitute areas with a higher concentration of crime, ethnic clashes, violence and victimization, and are a major source of urban unrest associated with post-election violence every five years. The accommodation structures are mainly let on a room-to-room basis and the majority of households occupy single rooms. Several studies indicate that 56 to 80 per cent of the households rent from private-sector landlords (who, in the past, often had the political connections that helped them to protect their investments)” (UN-HABITAT, 2003, cited in Chakava, 2011. p.11).

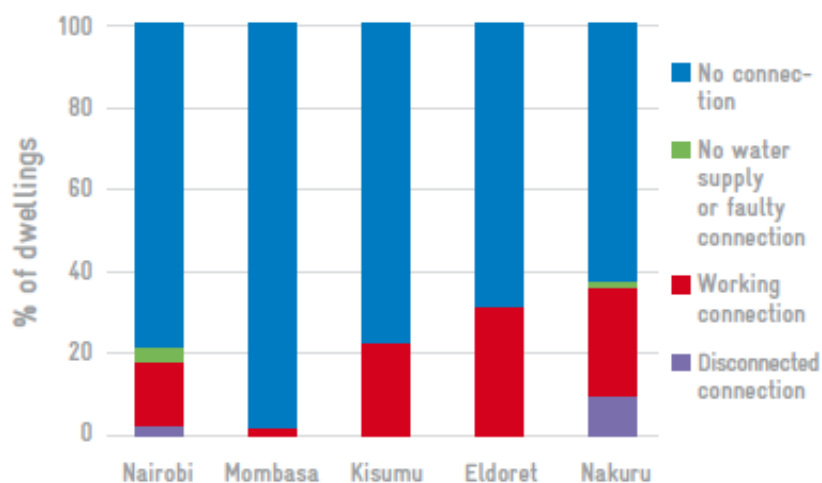
As the appalling living conditions do not allow for acceptable hygiene practices, the urban poor population in Kenya has the worst health outcomes in the country, with women and children suffering the most. The rate of child mortality is higher in the settlements than the national average, with flying toilets and open defecation commonly seen in the larger slums such as Kibera causing a devastating effect on public health and human dignity (GIZ et al., 2013).

Despite the known challenges, “the word ‘slum’ is less commonly used in Kenya due to the connotation that the areas are un-inhabitable, which causes apprehension amongst the local residents. For the purpose of this study, the term ‘low-income settlement’ (LIS) has been adopted to categorise the areas studied. This is because the broad definition of ‘slums’ suggests that the areas are largely unplanned and very

densely populated, when as demonstrated in Section 2.1 this is more likely to be characteristic of only a few. All the areas studied lacked basic services to water, however not all were as densely populated and some were fairly well organised in terms of visible allocated plot demarcations. The informal / unplanned areas tended to be scattered within the settlements. Therefore the term ‘LIS’ is considered a more representative description for the combination of all the informal and formal settlements studied” (Chakava, 2011. p.11).

### 3.3.1 Access to Water

Figure 3-3 below shows the current status of municipal water connections in the LISs of the main urban centres in Kenya.



**Figure 3-3 Status of water connections in LISs (Source: GIZ et al., 2013. p.5)**

Water has historically been a bone of contention and cause for dispute between the urban poor and local authorities. The GoK’s historic attempts to provide water to LIS residents have at best been sporadic and reactive to potential social unrest, manipulative as a vehicle for political campaigns intended to acquire votes (e.g. in Mathare and Kayole-Soweto settlements in Nairobi) and in response to potential health threats to the general public from the unsanitary living conditions. For example, after a cholera outbreak in some settlements in Kisumu in April 2008, the GoK provided 40 litres of free water per household per day (Mudege & Zulu, 2011), which proved to be a short-lived and unsustainable solution.



Although the GoK reports efforts to improve water supply LISs have been hampered by the ‘illegality’ of the land-tenure complexities and the associated water stealing and vandalism of water pipes, previous studies have highlighted that although water scarcity is a ‘real’ problem associated with the physical unavailability of the resource. Mudege & Zulu (2011, p.222) also reflect how it is possible for it to be “manufactured in a way to serve the interests of powerful actors such as politicians and bureaucrats” leaving the poor most disadvantaged.

### 3.3.2 Tariff Structure

Prior to 2009, the water sector had not seen a tariff adjustment for almost 10 years. The published national 2009/10 tariff structure is shown in Table 3-3. The sustainability of the entire water value chain is entirely dependent on payment by customers with household-level metering.

**Table 3-3 Approved tariff structure for the year 1<sup>st</sup> June 2009 to 31<sup>st</sup> May 2010 (Source: Water Services Regulatory Board, 2011)**

Customer Category (Monthly Consumption)	Consumption block (m <sup>3</sup> )	Tariff	
		KES/m <sup>3</sup>	USD/m <sup>3</sup> [ <sup>1</sup> ]
<b>(Domestic/Residential, Commercial/Industrial, Government Institutions and Schools)</b>	Up to 10m <sup>3</sup> 'Lifeline block'	18.71	0.23
	11 to 30	28.07	0.35
	31 to 60	42.8	0.54
	over 60	53.8	0.67
<b>Water Kiosks</b>	Up to 10m <sup>3</sup>	15	0.19
	11 to 30		
	31 to 60		
<b>Water Kiosks per jerry can</b>	KES 2 per 20 litre jerry can	100	1.3

As shown in Table 3-3, the WASREB nationally approved tariff per jerrycan (jc) equates to about KES 100 per cubic meter. This price is well above the average 2009/10 domestic tariff of KES 36 per cubic metre, which includes a lower block tariff of KES 18.71 per cubic meter, applicable to households consuming under 10 cubic meters per month (Water Services Regulatory Board, 2011). SSPs in LISs tend to add their own margins to the nationally approved tariff and this rate is not always accurately billed. WASREB currently has no means to enforce the provisions of the Water Act 2002 or resale prices (Gerlach, 2006). Consequently, LIS residents are the highest-paying consumers in the city per cubic meter. On average poor non-connected households spend a significantly higher share of their limited income to buy expensive water, which is a contributing factor to poverty.

Water kiosks are the main distribution points of the formal piped water (though the final lengths of pipe may well be informal) and usually consist of a tap stand with or without a water tank from which customers collect water in 20 litre yellow jerry cans (23 litres when full) (see Figure 3-4). Residents are forced to spend long hours queuing for and carrying water which is not tested for subsequent potability, paying 5 to 20 times more than the tariffs charged by formal providers through metered household connections (Ministry of Water and Irrigation, 2007). Water supply in the settlements is also highly unreliable, a few hours per day on average, and water shortages are common increasing the health burden.

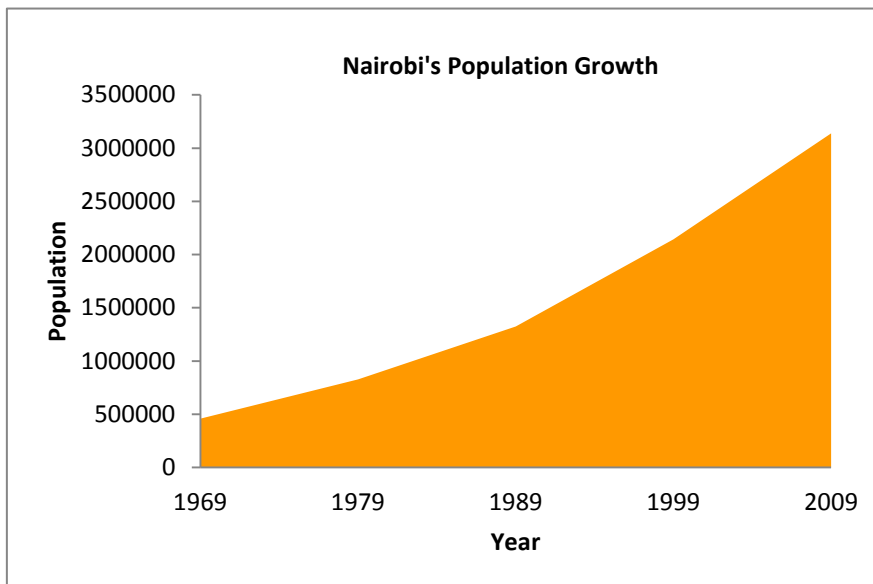


**Figure 3-4 Residents in Mukuru, Nairobi queuing for water at a tap stand (Source: Haki Water, 2011)**

### 3.4 Nairobi City

Nairobi, the country's capital, is the most populous city in East Africa and hub of trade in the region. The city and its surrounding area also form the Nairobi County. Water provision in Nairobi has been struggling with an overall supply deficit since its early beginnings more than a century ago, at times holding the city hostage to restricted public water supply (Mumma et al., 2011). The most recent 2009 census reported the Nairobi's population at 3,138,369 (Oparanya, 2010). Unofficial figures estimate that 60 per cent of residents live in areas interchangeably described as slums, informal and LISs, which constitute only 5 per cent of the residential land and do not have adequate access to affordable, safe drinking water (Gerlach, 2006). This not only impacts the health and welfare of the millions of residents (rich and poor), but also relates to a huge cost for the nation's economic base, including its industrial and service sectors (Njoroge, 2011).

As shown in Figure 3-5, the population of Nairobi has grown steadily over the years. Population growth and the increasing demand for land is one of the main forces driving the city's overwhelming number of settlements.

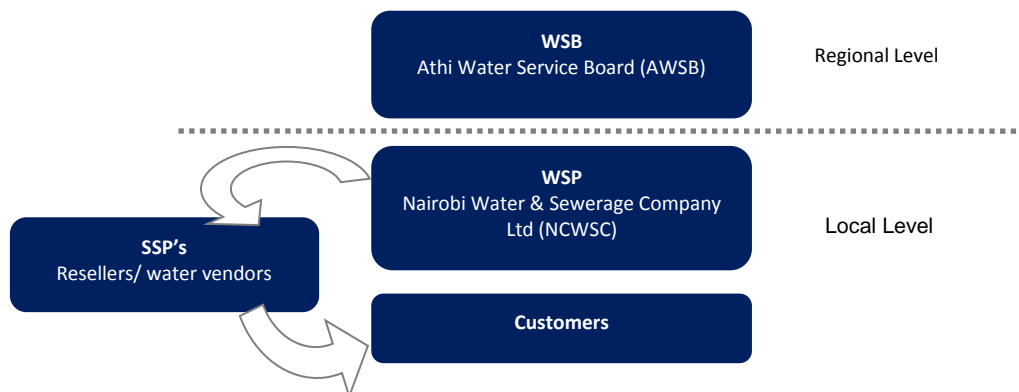


**Figure 3-5 Nairobi's population growth from 1969-2009 (Source: Adapted by author from census data)**

### 3.4.1 Key Stakeholders

“Prior to the water sector reform, the responsibility for water service provision rested with the Nairobi City Council (NCC). The municipality belonged to the local authorities that provided services independently of the MW&I and the National Water Conservation and Pipeline Corporation (NWCP). In accordance with the Act 2002, a Nairobi Water Services Board (NWSB) was formed as a corporate body and gazetted in March 2003. The existing Water and Sewerage Department (WSD) was transformed into an autonomous entity. Incorporated under the Companies Act (Cap. 486) as Nairobi City Water and Sewerage Company Ltd (NCWSC) in December 2003, NCWSC remains wholly owned by NCC” (Ministry of Water and Irrigation, 2007, cited in Chakava, 2011, p.5).

As per the institutional set-up discussed earlier, “the initial five-year SPA between operator NCWSC and asset holder Athi Water Services Board (AWSB) was not signed until 5th April 2004, when the Board was awarded its water service provision licence by the then established national regulator, WSRB. The SPA formally appoints NCWSC as Nairobi’s WSP, and specifies the terms and conditions of service provision to customers, as well as the applicable performance targets. The transfer of assets and customer contracts previously managed by NCC is governed by a tripartite agreement between NCC, AWSB and NCWSC. This agreement, in conjunction with the SPA, specifies the terms of remuneration of the three parties and allocates a small revenue share to the WSRB” (Gerlach, 2006, cited in Chakava, 2011, p.5). NCWSC officially commenced operations in summer 2004. A summary is shown in Figure 3-6.



**Figure 3-6 Nairobi key stakeholders for water supply (Source: Adapted from NCWSC, 2011)**

The domestic consumption for Nairobi in 2009/10 is reported as 80 l/c/d, including 42 per cent NRW and 57 l/c/d excluding NRW (Water Services Regulatory Board, 2011). Many domestic, commercial, and industrial water users rely on their own private boreholes as a coping strategy in the face of inadequate municipal supply (Mumma et al., 2011).

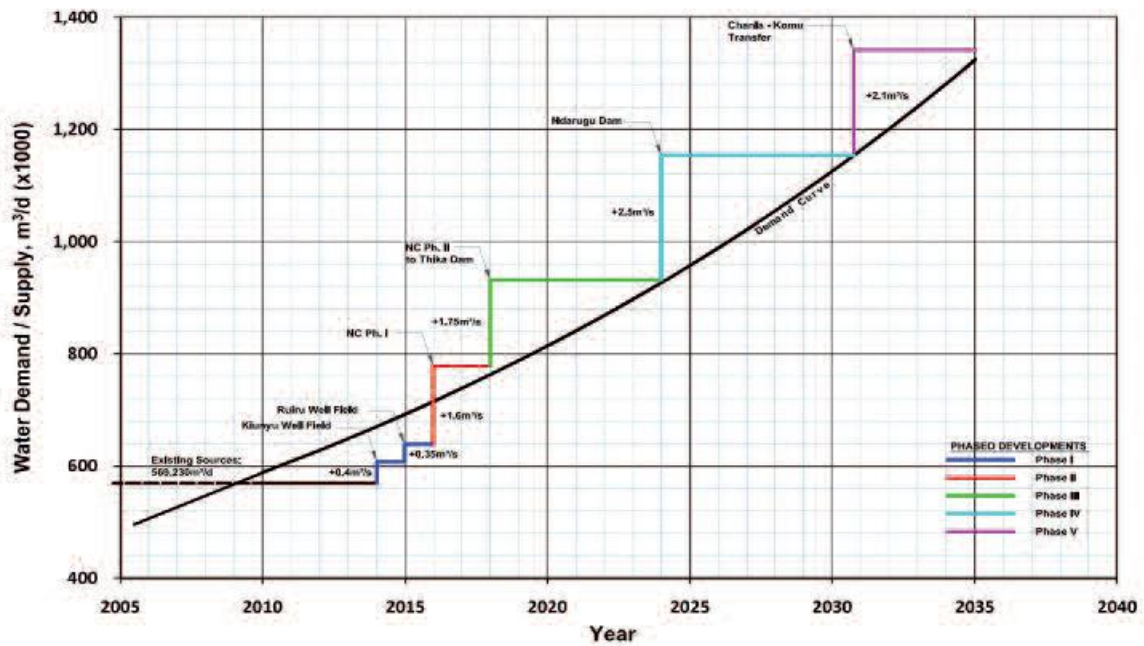
### 3.4.2 Surface Water Supply Resources

NCWSC is reported to supply about 554,900 cubic metres per day of water into the city from four main surface water sources and groundwater (Egis et al., 2012), as shown in Table 3-4. This bulk water-supply is especially unreliable during periods of drought and is also endangered by reservoir siltation associated with catchment deforestation. The supply problem is further aggravated by the poor state of the distribution system resulting in the high per cent of NRW (Water Services Regulatory Board, 2011).

**Table 3-4 Nairobi's main surface water sources (Source: Nairobi City Water and Sewerage Company Limited, 2011)**

Source	Output in cubic metres per day (m <sup>3</sup> /day)
Thika Dam - Mwangi Intake System	415,000
Sasumua Dam	68,400
Ruiru Dam/ Kabete Water Works	21,700
Kikuyu Springs	4,000
Self-supply boreholes (estimate)	45,000

Although the vast majority of Nairobi residents directly or indirectly depend on the public utility, the city is reported to endure a shortage of 200,000 cubic metres per day (Njoroge, 2011), which is currently managed through water rationing (Water Services Regulatory Board, 2011). A USD\$ 1 billion dollar water Master Plan presented in 2011 provides a 24-year blueprint from 2011-2035, (see Figure 3-7) to alleviate the current water problems in Nairobi county and 14 surrounding satellite towns. Ultimately, the Master Plan seeks to deliver over 750,000 cubic metres per day additional capacity of water supply, to mostly benefit the city's LISs (Njoroge, 2011).



**Figure 3-7 Nairobi water supply and demand Master Plan (Source: Njoroge, 2011, p.29)**

With Kenya’s decentralization of government since the new constitution, scrutiny has been placed on the resilience of Nairobi’s water supply to serve the growing population, considering 80 per cent of the existing surface water sources comes from other counties (Jacobsen et al., 2012).

### 3.4.3 Urban Poor Access to Water

Nairobi’s LISs “have a history as long as that of the city itself” (Chakava, 2011.p.11). Throughout much of the colonial period, “most Africans were barred from the city’s designated residential areas as these were reserved for Europeans and Asians. Africans who came to the city in search of work therefore had to create informal residential settlements outside of the central business district and the planned residential areas. The local authorities did not provide essential services for the settlements and did not construct roads to link them to other areas of the city. As a result, Nairobi developed along segregated lines” (Amnesty International, 2009, cited in Chakava, 2011.p.11).

“The city’s 1948 Master Plan and other major urban development plans continued to neglect the settlements. Kenya’s Independence in 1963 did not lead to improved

conditions in the settlements. The immediate post-independence government considered 'slums' an "eyesore" and an indication of government failure" (Amnesty International, 2009, cited in Chakava, 2011.p.11). As a result, it first introduced control measures to reduce population movement into the city and then, under the pretext of enforcing law and order, adopted an extreme and radical policy of 'slum' clearance. The clearance policy did not, however, halt the proliferation of settlements. Instead, displaced residents moved to other areas in and around the city, creating new settlements and slums faster than the authorities could keep count (Amnesty International, 2009).

"In the 1970s and 1980s the government's approach shifted away from clearances towards efforts aimed at improving living conditions in the settlements. Projects undertaken as part of bilateral or multilateral donor initiatives reflected this new approach, as did projects developed by NGOs, churches and 'slum'-dweller alliances. Between 1971 and 1995, the number of informal settlement areas within the Nairobi divisional boundaries rose from 50 to 134, while the estimated total population of these settlements increased from 167,000 to over 1million individuals. In terms of percentage of the total Nairobi population, the share of LIS residents reportedly rose from one third to the estimated 60 per cent today" (Gerlach, 2006, cited in Chakava, 2011.p.11). "The involvement of NGOs and international development agencies in informal settlement improvement projects increased in the 1990s. However due to the distinct lack of a clear policy that would facilitate and guide urban development in Kenya, these adhoc urban interventions have had mixed results" (Chakava, 2011.p.11).

A map of Nairobi's showing the city boundaries and locations of the significant settlements is shown in Figure 3-8. However as the city continues to grow, so does the number of settlements.



**Figure 3-8 Nairobi city boundaries and LIS areas (Source: UN-HABITAT, 2007. p.152)**

Presently the designated LIS residents predominantly consume piped water however service delivery varies. Approximately 22 per cent of residents have a legal NCWSC household connection, while an estimated 75 per cent purchase their water from SSPs at water kiosks operated by NGOs, CBOs (community based organisations) or individual entrepreneurs and in some cases from pushcart vendors (Ruhui et al., 2009). The quantity NCWSC water supplied to the settlements is unknown due to lack of metering and illegal connections, however studies indicate per capita water consumption is as low as 23 litres (Ruhui et al., 2009).

A study in Nairobi’s Korogocho settlement revealed an interesting insight into LIS residents’ perception of the water problem, as not one of water scarcity but of unequal distribution. The study concluded that although the government subscribes to the rights-based approach to water, the manner in which water is distributed suggests “that economic and political preferences supersede the needs of individuals from poor communities” (Mudege & Zulu, 2011, p.227).



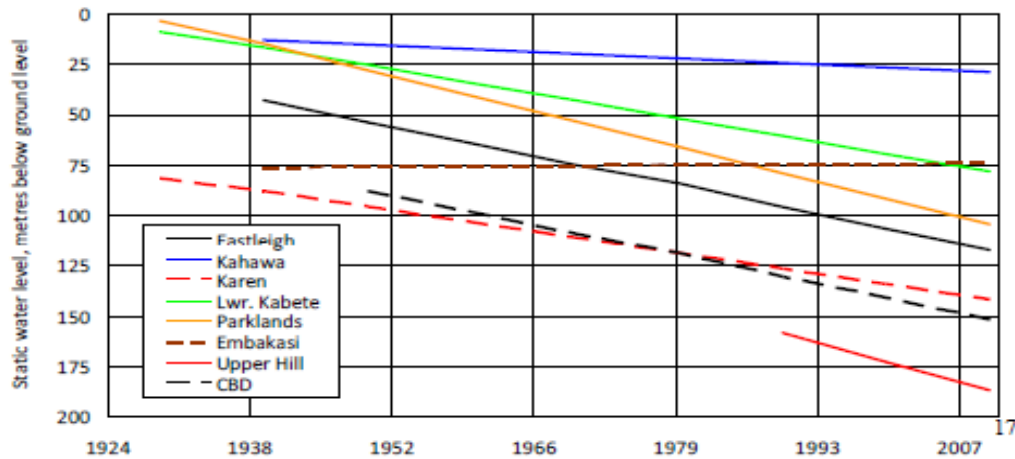
### **3.4.4 Prominence of Groundwater Self-Supply**

In economic and scale of abstraction terms the Nairobi Aquifer System (NAS), the most significant in the country, occupies 5,462 square kilometres, and is under increasing pressure as a result of population growth combined with the inadequate municipal supply to meet the demand (Water Resources Management Authority, 2011a). The principal aquifer unit, the Upper Athi Series, is entirely confined, and is found at depths of 120 to 300 metres below ground level. “The natural quality of groundwater is considered good, with the exception of fluoride” (Foster & Tuinhof, 2005, p.5). Notwithstanding this, many domestic, commercial, and industrial water users are increasingly relying on private boreholes as a coping strategy to supplement the NCWSC supply (Foster & Tuinhof, 2006; Mumma et al., 2011).

Historical records indicate that the drilling of boreholes within the NAS commenced in the 1930s, increasing from less than 10 reported in 1940 to almost 2000 in 1997. The reported number further increased to 2,250 in 2001. In 2002, when severe drought reduced NCWSC supply by 67 per cent water supply from boreholes became critical in the metropolitan area for a few months (Foster & Tuinhof, 2005). Beyond this, very sketchy information is available. The most recent ‘door to door’ exercise conducted to establish the number of boreholes drilled and the distribution patterns within the NAS found over 4,130 boreholes, of which at least 456 (11 per cent) were abandoned (Water Resources Management Authority, 2011b), although the number is considered a gross underestimation. At present, an estimated 133,300 cubic meters per day is abstracted from the NAS. The projected abstraction by the year 2015 is 184,000 cubic meters per day, from an estimated 5,000 boreholes (Water Resources Management Authority, 2011b; Mumma et al., 2011).

Within Nairobi county, the number of boreholes is reported as 2,139 (the highest number within the NAS), with current abstraction at 72,541 cubic meters per day. Over 20 per cent of boreholes were identified within 100 metres of each other and 52 per cent were non-compliant with licensing regulations (Water Resources Management Authority, 2011b). The explosive rate of urban borehole drilling over the years has led

to significant water level decline within the metropolitan as shown in Figure 3-9, averaging at 3 metres per year. In several 'hot spot' locations, such as Langata, the rate of water level decline is as high as 7 metres per year (Water Resources Management Authority, 2011b).



**Figure 3-9 Water level decline within Nairobi (Source: Water Resources Management Authority, 2011b, p.17 unpublished report)**

Unregulated and adhoc groundwater abstraction has been mainly attributed to: overlaps in the perceived responsibilities between key sector roles of the institutional framework, lack of available technical or financial resources to develop and sustain the right structure to manage aquifers and poor understanding amongst both water sector staff and the public about the specific characteristics of groundwater connectivity between surface water and groundwater (Mumma et al., 2011). Consequently, legal provisions are not enforced for controlling abstractions, pollution and borehole drilling. “In practice, groundwater management is strongly influenced by common law perception of groundwater as a private resource belonging to the land owner” (Mumma et al., 2011, p.xvi). Therefore, unless the landowner comes forward to declare their intent to abstract groundwater out of free-will, there is no mechanism in the system to notify institutional stakeholders that a borehole has been drilled, reflecting the potentially disastrous inaccuracies in the numbers reported. Consequently the majority of groundwater users exploit it for short-term gains and ignore the long-term consequences of unregulated use (Foster & Tuinhof, 2005;

Mumma et al., 2011). Although there is growing evidence that domestic water use will need to increase substantially to help move people out of poverty and that groundwater provides an important buffer to climate variability and change (MacDonald, Bonsor, Dochartaigh, & Taylor, 2012), evidently much work remains to address significant shortfalls in the current institutional framework to manage and protect this critical resource.

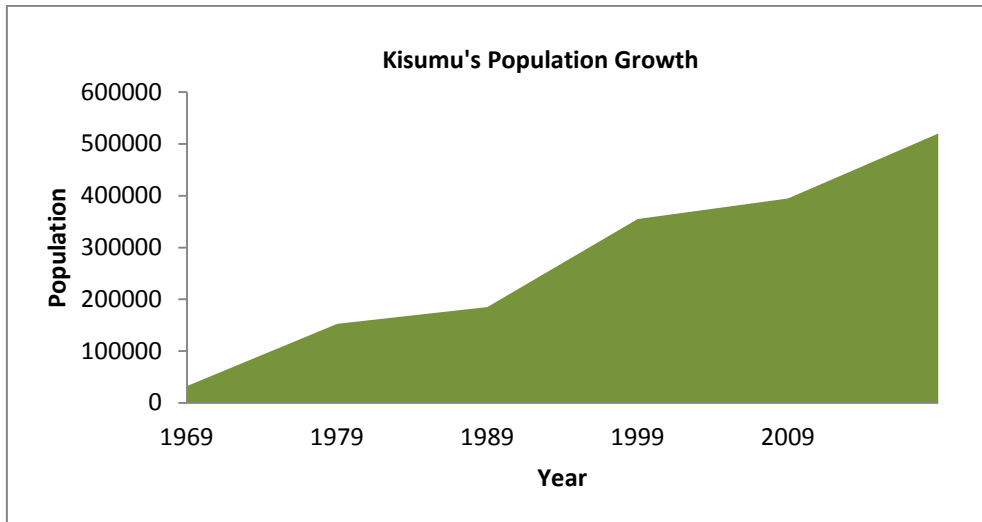
### **3.5 Kisumu City**

Kisumu is Kenya's third largest city located in western Kenya and the headquarters of Kisumu County. The city is highly influenced by its location on the eastern shore of Lake Victoria and is the leading commercial/ trading, fishing, industrial, communication and administrative centre in the region, occupying an area of 297 km<sup>2</sup>. The 2009 census reported the population of Kisumu at 394,684 (Oparanya, 2010), however current information suggests the population is about 520,000<sup>5</sup> people. Similar to Nairobi, approximately 60 per cent of the inhabitants are said to live in informal settlements with inadequate supply of basic water services (Schwartz & Sanga, 2010). The city has not benefitted from economic developments felt in other parts of the country, and the LIS areas in particular were very badly affected during the 2007/8 post-election violence (Philip & Stevens, 2013).

As one of the fastest growing cities in Kenya, the rapid population growth in Kisumu (see Figure 3-10) is typically exacerbating the pressure for land in the LIS areas.

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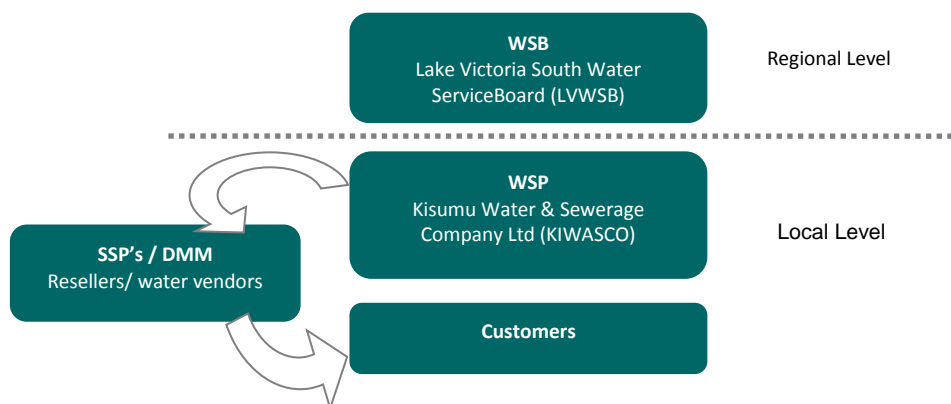
<sup>5</sup>Source: Presentation given by Frank David Ochieng, Acting Head of Commercial Services, Kisumu Water and Sewerage Company Limited, 16<sup>th</sup> May 2013)



**Figure 3-10 Kisumu’s population growth from 1969-2009 (Source: Adapted by author from census data)**

### 3.5.1 Key Stakeholders

Kisumu Water and Sewerage Company Limited (KIWASCO) is the Water Service Provider (WSP) appointed by Lake Victoria South Water Services Board (LVSWSB). Under the Water Act 2002, KIWASCO was established in 2003 and is officially mandated to operate water and sewerage services in Kisumu Municipality (Onyango, 2012). “Prior to the establishment of KIWASCO, Water and Sewerage services were carried out by Kisumu Municipal Council. LVSWSB is responsible for supervising activities carried out by KIWASCO” (Schwartz & Sanga, 2010, p.767), in accordance with the signed SPA. A summary is shown in Figure 3-11.



**Figure 3-11 Kisumu key stakeholders for water supply (Source: Water Services Regulatory Board, 2011)**

The domestic consumption for Kisumu in 2009/10 is reported as 22 l/c/d, including 50 per cent NRW and 15 l/c/d excluding NRW (Water Services Regulatory Board, 2011). In that year reporting period, KIWASCO ranked in top 10 best WSP performers in the country (Water Services Regulatory Board, 2011).

### **3.5.1 Surface Water Supply Resources**

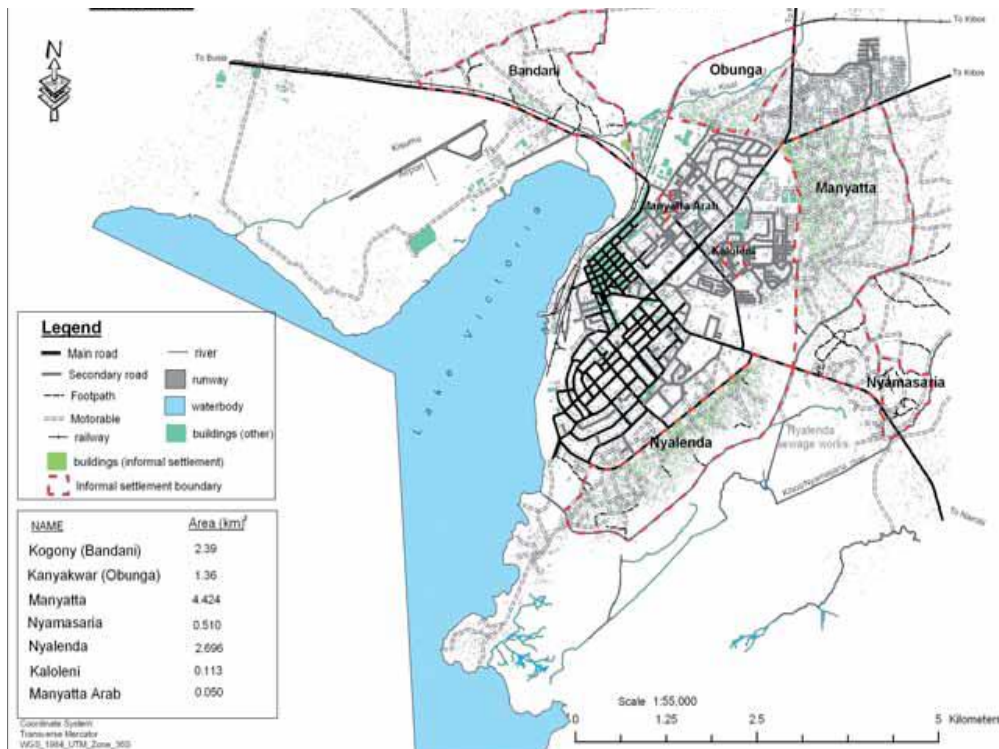
The main source of water supply in Kisumu is Lake Victoria, with a small percentage extracted from the Kibos River. Other rivers include Kisian, Nyamasaria, Mamboleo, Kajulu, Luanda and Lidango. The water from Lake Victoria is treated at the Dunga Water Treatment Plant located 0.6 km from the intake, and is then pumped to a storage tank in Kibuye, while the water from the Kibos River is treated and then flows by gravity to a reservoir. Due to shallow water tables, groundwater is also available, with levels ranging from 2-5 metres from the surface level. Efforts to improve water supply in Kisumu have nonetheless focused on bulk surface water, mainly because groundwater is susceptible to contamination by inadequate drainage, poor wastewater management and overflowing pit latrines (Maoulidi, 2010).

A 2008 study reports that Kisumu's water supply facilities had a design capacity of 22,700 cubic metres per day, but was operating below capacity at only 18,700 cubic metres per day, with Kajulu supplying 1,700 cubic metres per day and the Dunga Water Treatment Plant producing 17,000 cubic metres per day. The study estimated that water demand in 2007 was 47,700 cubic metres per day, leaving Kisumu with a supply deficit for that year of over 29,000 cubic metres per day (Maoulidi, 2010). As part of Kenya's Vision 2030 development footprint, a project is currently underway to provide an additional 48,000 cubic metres per day water supply at Kajulu to ease the water supply deficit. This project is due to be completed in 2014.

### **3.5.2 Urban Poor Access to Water**

The formation of settlements in Kisumu has been associated with the rapid growth of urban population caused by migration in circumstances that do not favour rapid rates of absorption and acculturation (UN-HABITAT, 2005). Nyalenda is the biggest informal settlement in Kisumu with a population of about 50,000 inhabitants. Only 30 per cent

of the residents have formal employment, while the remaining 70 per cent work in informal sectors such as selling fish, mandazi, second hand cloths, charcoal, and vegetables (Schwartz & Sanga, 2010). Other existing settlement areas include Bandani, Kamenya lower, Kibos, Lumumba, Makasembo, Mamboleo, Milimani, Migosi, Manyatta, Nyamasaria, Nyawita, Obunga, Ondiek and Tobert Ouko (Maoulidi, 2010). A location plan of the main settlements is shown in Figure 3-12.



**Figure 3-12 City boundaries and LIS areas in Kisumu (Source: UN-HABITAT, 2005, p.x)**

As previously explained in Section 2.3.5, the Water and Sanitation Program Africa (WSP-AF) and the French Embassy through its Social Development Fund, Agence Française de Développement (AFD), developed the DMM in Nyalenda in 2004 as a mechanism to increase service coverage to the urban poor. The contractual arrangement is such that a Master Operator (MO) pays KIWASCO for bulk water delivered to the master meter. The MOs then takes responsibility for water distribution from the master meters and sells the water to either connected domestic customers or to kiosk operators within the settlements. The kiosk operators then in

turn sell water to unconnected consumers (Schwartz & Sanga, 2010). The domestic and kiosk tariff structure for all MO's versus KIWASCO regular customers is shown in Table 3-5. With this model, KIWASCO is guaranteed a volumetric price for the bulk water it delivered to the MOs. It is estimated that at the moment the levels of NRW for the MOs lies at approximately 6 per cent (Schwartz & Sanga, 2010).

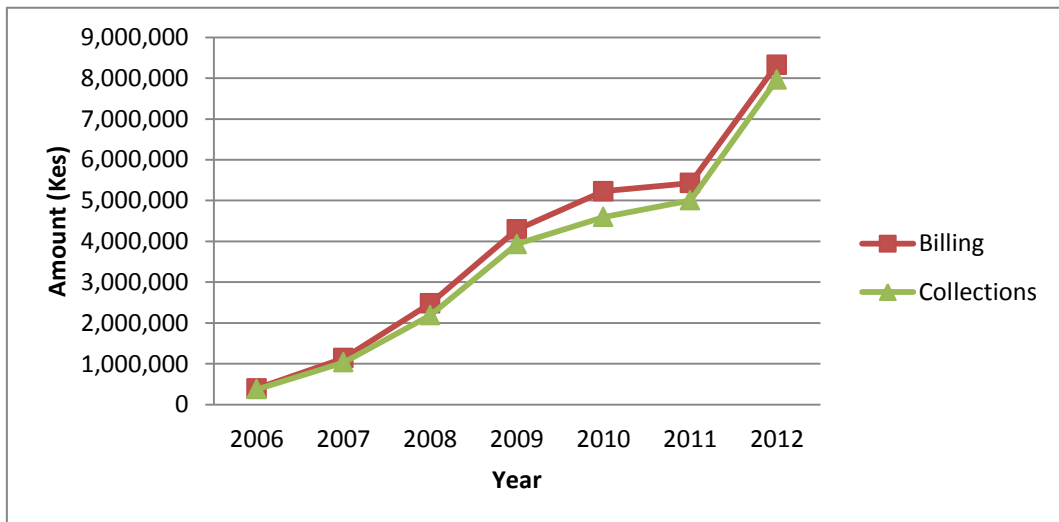
**Table 3-5 MO versus KIWASCO Tariff Structure (Source: Onyango, 2012)**

<b>Domestic Tariff</b>				
<b>Consumption</b>	<b>MO</b>		<b>KIWASCO</b>	
	<b>KES</b>	<b>USD<sup>6</sup></b>	<b>KES</b>	<b>USD</b>
0-6m <sup>3</sup>	180 (min flat rate)	2.25	200 (min flat rate)	2.50
7-20m <sup>3</sup>	35 per m <sup>3</sup>	0.44	50 per m <sup>3</sup>	0.63
21m <sup>3</sup> & above	50 per m <sup>3</sup>	0.63	65 per m <sup>3</sup>	0.81
<b>Kiosk Tariff</b>				
<b>Consumption</b>	<b>MO</b>		<b>KIWASCO</b>	
	<b>KES</b>	<b>USD</b>	<b>KES</b>	<b>USD</b>
0-10m <sup>3</sup>	400 (min flat rate)	5	400 (min flat rate)	5
11m <sup>3</sup> & above	45 per m <sup>3</sup>	0.56	45 per m <sup>3</sup>	0.56
<b>Other Associated Costs</b>				
<b>Item</b>	<b>MO</b>		<b>KIWASCO</b>	
	<b>KES</b>	<b>USD</b>	<b>KES</b>	<b>USD</b>
Meter Rent	70/month	0.88	150/month	1.88
Connection Fee	1,500	18.75	4,000	50
Deposit (Domestic)	1,000 (refundable)	12.50	1,800 (refundable)	22.50
Deposit (Kiosk)	5,000 (refundable)	62.50	10,000 (refundable)	125

The benefits of the DMM for the utility are clearly reflected in KIWASCO revenue collection records over the seven year period shown in Figure 3-13. KIWASCO collections for 2012 were reported at KES 7,968,000 (~USD\$ 99,600).

<sup>6</sup>1 USD = 80 Kes

For the MOs who come from the local community, the DMM model has provided employment opportunities as well as income generation for the established groups such as Katuoro and Wamalanda (Schwartz & Sanga, 2010).



**Figure 3-13 KIWASCO billing and collections (Source: Adapted by author from community field records)**

The literature outlines the benefits of the DMM model which has clearly improved water service coverage for the urban poor in Kisumu, though this has come at a considerable cost to the end consumer. In attempting to gauge the effectiveness of this model in relation to the service gaps in Kisumu, the researcher’s observations, following a field visit to Nyalenda and Obunga, are captured as shown.



**Researcher Observations 15/05/13**

*Katuoro MO is a registered Community Based Organisation (CBO) operating in Nyalenda. The Group comprises of 15 members. The MO has greatly exceed KIWASCO targets of 120 connections and now manages a customer base of 353 connections, out of which 333 are active served via 24 water meter chambers. The average population reached by the MO is 4,000. In 2012, the revenue collected by KIWASCO from Katuoro was KES 1,759,838 (~USD 22,000), the highest revenue from all the MO's, and the average NRW for the year was an impressive 3.5 per cent.*

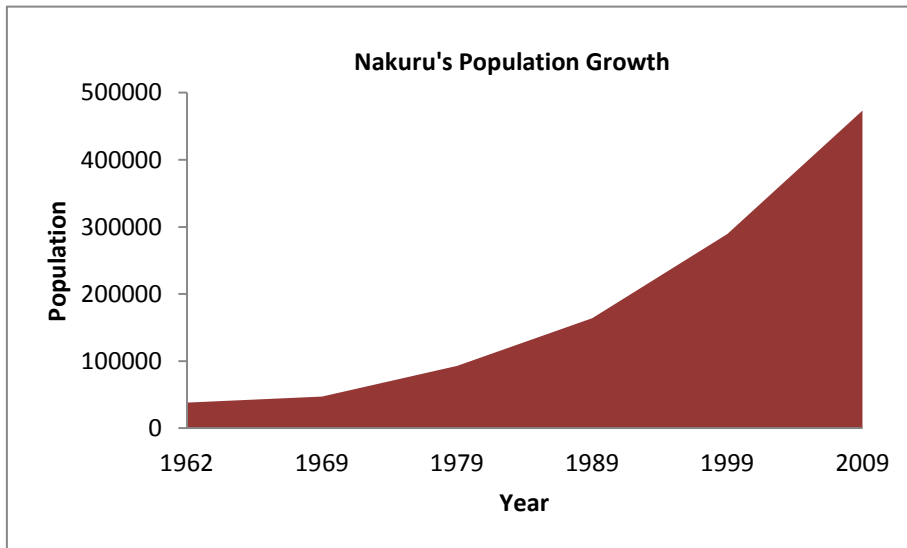
*Improvements to the service received by customers in Nyalenda and Obunga via the DMM were difficult to determine, as in Obunga customers were being charged higher tariffs than the DMM, which KIWASCO claimed to be unaware of. High tension was also noted between the MO's and KIWASCO, with the MO's expressing frustration that KIWASCO does not recognise their investments in chamber constructions, pipeline extensions and maintenance, as per the contract. This has resulted in lack of motivation for the MO to continue extending the provision of water supply services.*

The reliance on shallow wells and boreholes is prominent in the LISs but is problematic. As mentioned earlier due to the high water tables in Kisumu shallow wells are easily contaminated contributing to dangerous outbreaks of such diseases as diarrhoea, cholera, typhoid, dysentery and malaria (UN-HABITAT, 2005).

### **3.6 Nakuru Town**

Nakuru town located in Nakuru County is the fourth largest town in the country. The town is located in the heart of the Great Rift Valley and lies approximately 1,859 metres above sea level. The town occupies a municipal service area of 270km<sup>2</sup> (of which 50km<sup>2</sup> includes peri-urban areas outside of Nakuru Municipal Council) (Municipal Council of Nakuru, 1999). Located along the main national road and railway network, Nakuru serves as an administrative industrial, commercial and service centre that has attracted an ethnically and socio-economically diverse population.

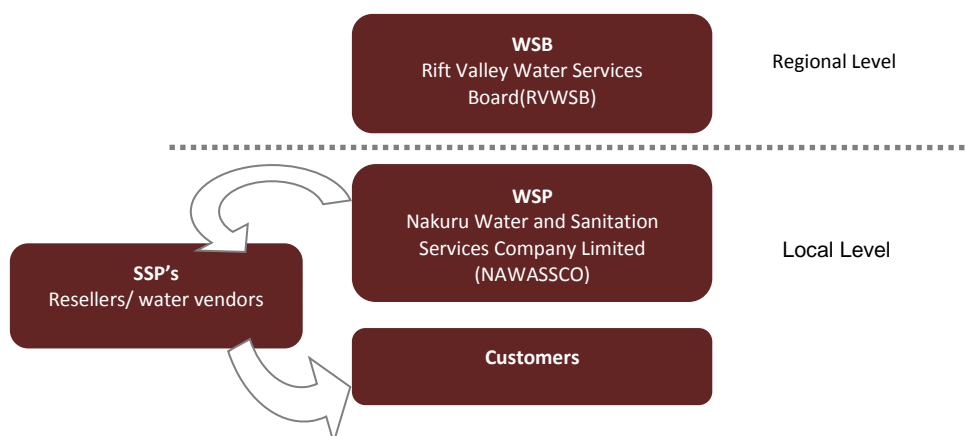
The 2009 census reported the population of Nakuru at 326,125 (Oparanya, 2010) although current estimates are closer to 500,00. Within the town, 207,843 people live in 40 LISs, which equates to approximately 40 per cent of the urban population. With an annual average population growth rate of 13 per cent (see Figure 3-14), Nakuru has been named as one of the fastest growing towns in East Africa due to the high rate of rural-urban migration (Acolor & Adams, 2013).



**Figure 3-14 Nakuru’s population growth from 1962-2009 (Source: Adapted by author from census data)**

### 3.6.1 Key Stakeholders

Nakuru Water and Sanitation Services Company Limited (NAWASSCO) is the Water Service Provider (WSP) appointed by Rift Valley Water Services Board (RVWSB). Under the Water Act 2002, NAWASSCO was established in 2003 and is officially mandated to operate water and sewerage services within Nakuru Municipality and its environs (NAWASSCO, 2013). Prior to the establishment of NAWASSCO, Water and Sewerage services were carried out by the Municipal Council of Nakuru (Municipal Council of Nakuru, 1999). RVWSB is responsible for supervising activities carried out by NAWASSCO in accordance with the signed SPA. A summary is shown in Figure 3-15.



**Figure 3-15 Nakuru key stakeholders for water supply (Source: Adapted from NAWASSCO, 2013)**

The domestic consumption for Nakuru in 2009/10 is reported as 45 l/c/d, including 53per cent NRW and 29 l/c/d excluding NRW (Water Services Regulatory Board, 2011).

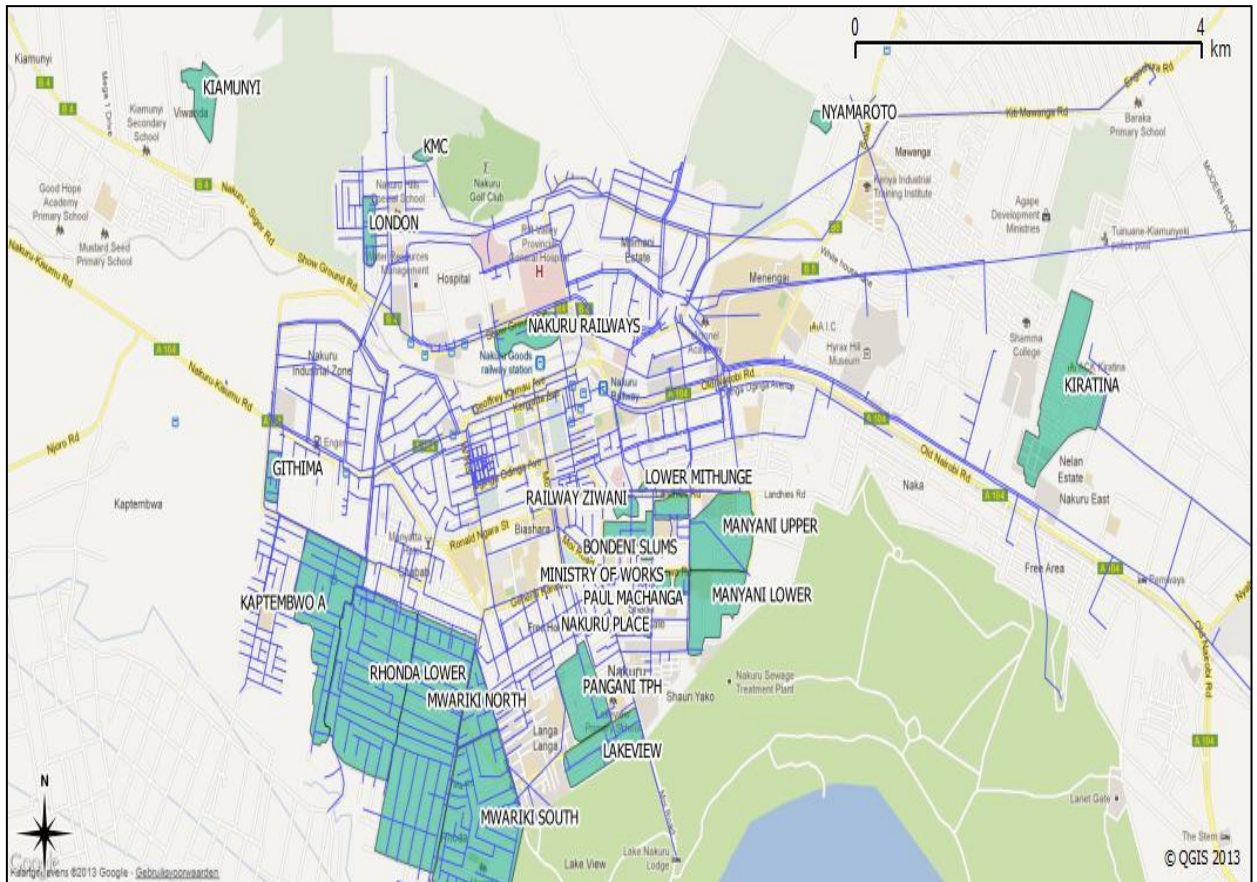
### 3.6.2 Surface Water Supply Resources

NAWASSCO is reported to supply about 40,000 cubic metres per day of water into the town. Groundwater is currently the main source, with 80 per cent of the supply abstracted from 24 boreholes. The remaining 20 per cent is abstracted from rivers within the basin and neighbouring basin. The treated surface water not only boosts the quantity of water available, but also helps in blending the groundwater supply to reduce fluoride levels to drinkable standards. Reports indicate this supply does not meet the current and future water demand for Nakuru (NAWASSCO, 2013). Consequently, Nakuru residents are set to benefit from a multi-billion shilling dam project, set to increase the water supply in the town to 100,000 cubic metres per day (Kariuki, 2013).

### 3.6.3 Urban Poor Access to Water

Nakuru has approximately 40 planned and unplanned LISs. Water supply to these areas is rationed, and hygiene and sanitation facilities are substandard. The most populated settlements (>10,000 people) are Kaptembwo A and B (28,812), Rhonda Upper (24515), Rhonda Lower (25,141), Mwariki South (18,402), Freearea (16,596),

Lakeview (10,312), Kiratina (11,391)(NAWASSCO, 2013). A location map is shown in Figure 3-16.



**Figure 3-16 Nakuru LIS areas (Source: NAWASSCO, 2013)**

Presently the designated low-income residents consume piped water however service delivery varies. The majority, 66 per cent rely on yard tap connections, 26 per cent purchase their water from water kiosks operated by community groups or individual entrepreneurs and in some cases from pushcart vendors, 6 per cent have a household connection and the remaining 2 per cent rely on pre-paid meters. Kiosk vendors typically sell water at the national tariff of KES 2/jc, however other vendors exploit the situation and sell water to their customers at KES 10/jc - KES 20/jc, up to 10 times the regulated tariff (NAWASSCO, 2013).

This Chapter clearly demonstrates that Nairobi, Kisumu and Nakuru are all facing similar challenges in serving the bulging urban poor population, with the water supply continually struggling to meet the demand. As evidenced in the literature review, the poor and vulnerable consistently continue to suffer the most in the quality and cost of services received, despite the different structures adopted in the three urban centres to supplement the supply and manage the extension of the public utility network.

The next Chapter outlines the researcher's methodology and approach to conduct the study in the three locations and collect the data required from the interventions.

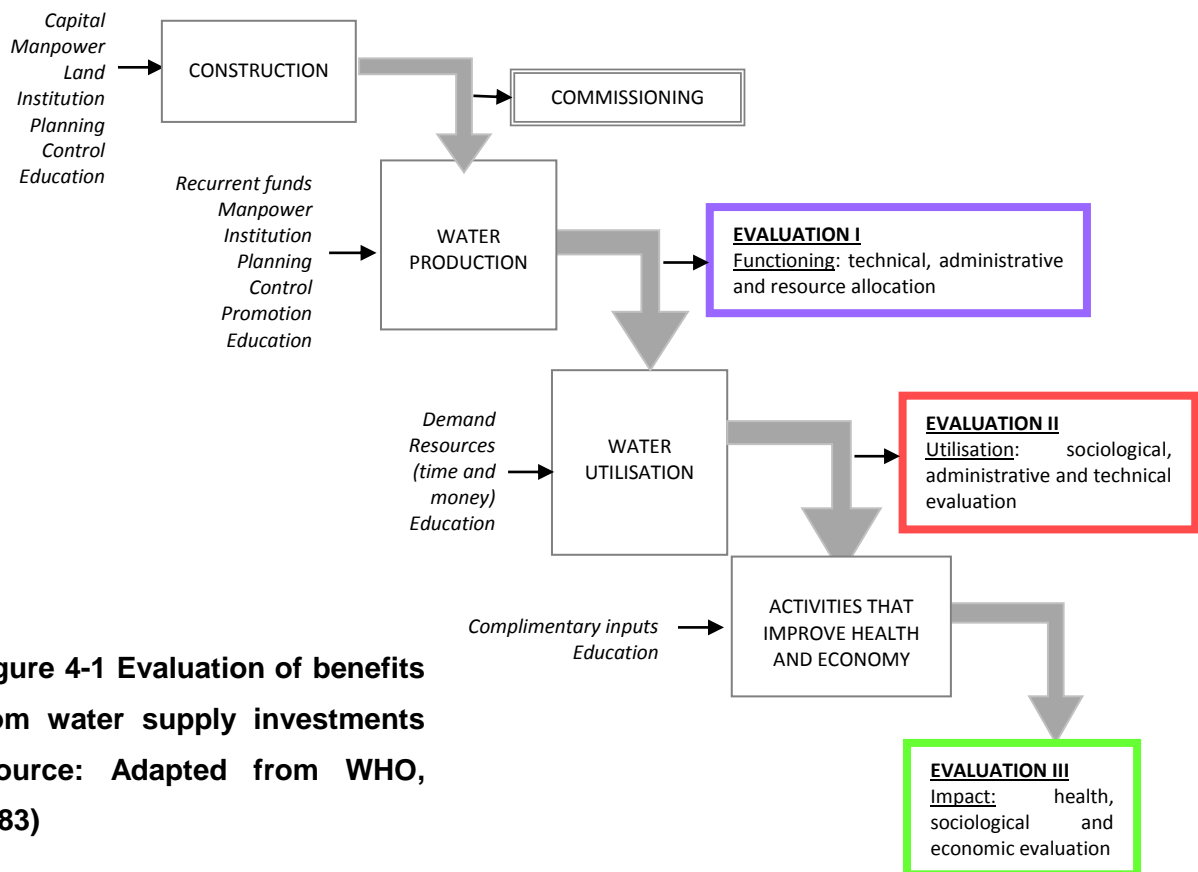
## **4 RESEARCH METHODOLOGY**

The literature review and the introduction to water supply in urban Kenya, indicates that although there is growing recognition of the challenge of serving the urban poor there has been no systematic investigation of the results achieved by the various interventions. This chapter describes the approach used in this study to understand to what extent the interventions are meeting the needs of the low-income urban population during the transition.

### **4.1 The Evaluation Procedure**

WHO (1983) describes the purpose of evaluation as a systematic way of learning from experiences and using the lessons learned to improve both future planning and existing functioning, utilisation and impact of projects. Robson (2002) describes evaluation as a procedure to assess the effects and effectiveness of an intervention. Both these definitions continue to emphasise that an evaluation should not just be a list of problems and causes, but should include recommendations and / or corrective actions to improve.

In the water sector, monitoring and evaluation has gained much importance to address concerns around the lack of accountability in the allocation of resources and management of projects. The WHO (1983) guidelines summarise the steps shown in Figure 4-1, to evaluate the benefits from a typical water supply intervention. Although this document may appear to be somewhat dated, these guidelines provide a relatively simple and quick starting point to develop a comprehensive evaluation methodology.



**Figure 4-1 Evaluation of benefits from water supply investments (Source: Adapted from WHO, 1983)**

Evaluations can sensibly address the impact of a project on the participants, through introducing a ‘control group,’ described as a group of non-participants in the project. This control group should be very similar to the target group (those who do receive the intervention), but for the fact that its members do not receive the intervention. An estimate of impact can then be derived by comparing the levels of well-being between the target group and the control group (Shuttleworth, 2008). Using a control group can help to gather the most credible evidence to strengthen your evaluation that a project is making a difference in the lives of its participants (Boyd, 2002). However in reality, there are reportedly often severe problems in finding an appropriate control group, achieving random allocation to the different groups, and in securing effective isolation between groups to avoid cross contamination (Robson, 2002). There are also more fundamental critiques of the use of control group methodology in evaluation research (Pawson and Tilley, 1997), although it still has strong advocates (e.g. Oakley and Fullerton, 1995). Evaluation research can adopt fixed or flexible design strategies, with either qualitative or quantitative methods, or combinations of both types.

## **4.2 Research Design Strategy**

### **4.2.1 Flexible Design**

A flexible design is extremely useful when the topic is too complex to be answered by a simple 'yes' or 'no' hypothesis (Shuttleworth, 2008). Of particular relevance to the nature of this study, a flexible design allows for the detailed framework to evolve and develop during the data collection process.

Typically, the data collected is predominantly non-numerical in the form of words, often referred to as a qualitative data. In principle this design can also include the collection of numerical data, referred to as a quantitative data (Robson, 2002). Both methods are discussed on more detail in this section. The broader scope covered by this design ensures that some useful data is always generated and, ideally, should be open to replication (Shuttleworth, 2008). This flexibility, together with the fact that most evaluations are concerned with the effectiveness and appropriateness of an innovation (i.e. as a 'case' not as a 'sample'), make the case study strategy appropriate for many evaluations (Robson, 2002).

### **4.2.2 Case Study Strategy**

Defined by Yin (1994), a case study is "an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and the content are not clearly evident" and "it relies on multiple sources of evidence" (Yin, 1994, p.13). As a popular strategy, case studies are often applied to test the hypothesis of an existing theory that may be important, but subordinate to the understanding of the case (Stake, 1978). The results of the case study data collection and analysis either validate the theory, or find it to be untrue in some way and may be further redefined on the basis of the findings (Darke, Shanks, & Broadbent, 1998).

Case studies should especially be considered when the focus of the study is to answer 'how' and 'why' questions and where the researcher cannot alter or influence the behaviour of the participants (Yin, 2004). There are single or multiple-case designs (Darke et al., 1998; Robson, 2002) and case studies based on a mix of quantitative and



qualitative evidence (Yin, 1994; Verschuren and Doorewaard, 1999; Robson, 2002). Single-case (holistic) study is appropriate where it represents one unique/extreme/critical case that meets all necessary conditions for testing a hypothesis (Yin, 1994; Baxter & Jack, 2008). Multiple-case designs allow for cross-case analysis and comparison, and the investigation of a particular hypothesis within each setting and across diverse settings (Darke et al., 1998; Baxter & Jack, 2008). A strong advantage of multiple-case design is that the evidence created is considered more robust than a single case study and, depending on the results, can strengthen the external validity (Yin, 2003). The disadvantage is “it can also be extremely time consuming and expensive to conduct” (Baxter & Jack, 2008, p.550).

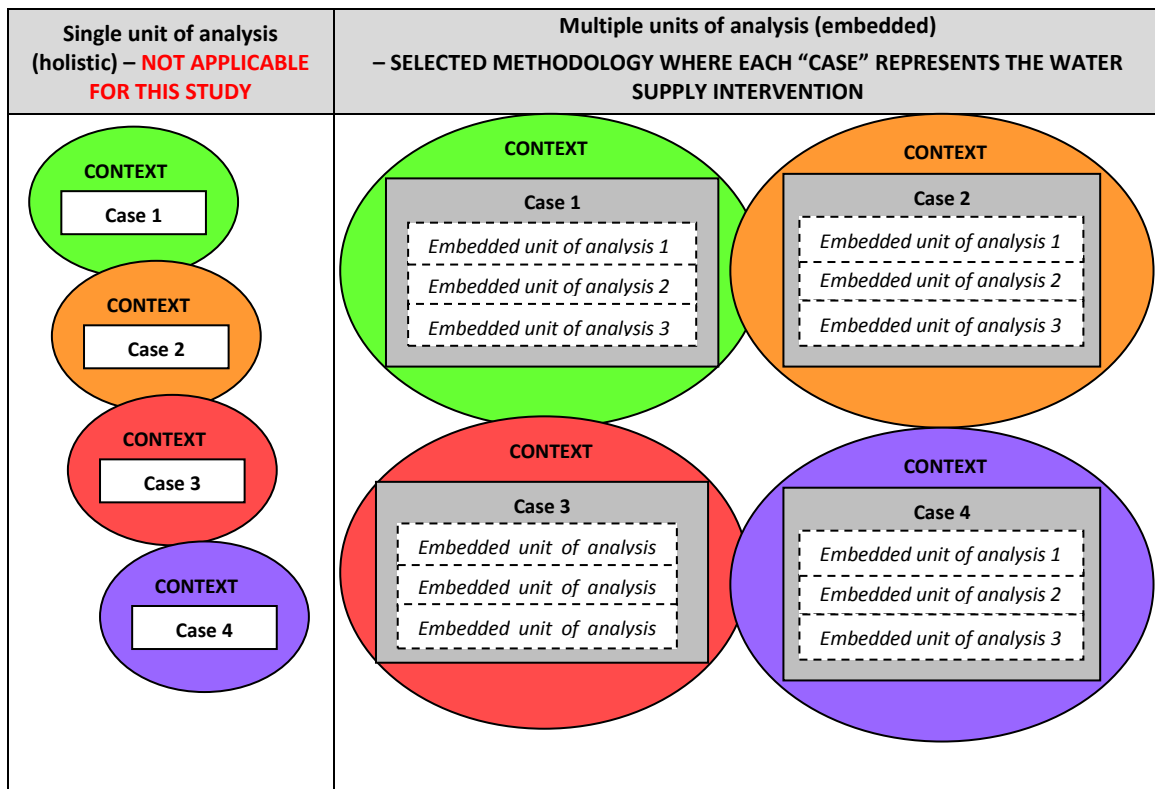
Proponents consider the best application of case study strategy is to add intuitively and empirically to existing experience and human understanding of the research context, which is especially well suited as a method of learning to produce context-dependent knowledge (Stake, 1978; Flyvbjerg, 2006). If one assumes that case study research, “like other learning processes, can be described by the phenomenology for human learning, it then becomes clear that the most advanced form of understanding is achieved when researchers place themselves within the context being studied” (Flyvbjerg, 2006, p.236). The proximity to reality allows the researcher to understand the viewpoints and behaviour as a prerequisite for advanced understanding (Flyvbjerg, 2006). Opponents have argued that this approach is too subjective, giving much scope for the researcher’s own interpretations and bias (Darke et al., 1998; Flyvbjerg, 2006). In addition, poor researcher skills when attempting to summarise large and mutually exclusive case studies can result in lost contextual value of the study (Peattie, 2001). Problems can also be experienced in finding suitable sites for a rigorous and effective study, as organisations are not always willing to participate in case study research (Darke et al., 1998).

This research adopts a descriptive multiple-case design, where the “case” is the intervention. The cases have been selected on the basis of expectations about their information content (Flyvbjerg, 2006). The key evaluation guidelines for improvement form the embedded units of analysis within each case, which allows the researcher to

evaluate the performance of varied interventions in different LIS, within the context of an overall improvement to water supply and distribution for LIS residents. Application of a descriptive methodology requires that the researcher begins with a descriptive theory, or face the possibility that problems will occur during the study. “Thus what is implied in this type of study is the formation of hypotheses of cause-effect relationships” (Tellis, 1997, p.4). The approach fits into the multiple-case design strategy shown in Table 4-1.

The goal of this design strategy is to discover patterns across cases, establish meanings, build theory and construct conclusions (Kohlbacher, 2006). It is crucial that the cases are carefully selected as comparisons will be drawn by the researcher in an effort to predict similar or contrasting results across cases, based on a hypothesis (Yin, 2003). The only flexibility of case study design is in selecting cases different from those originally identified and not in changing the overall objectives of the study to match the cases (Baxter & Jack, 2008).

**Table 4-1 Basic multiple case study designs (Source: Adapted from Yin, 2009)**



### **4.3 Answering the Research Question**

The research methods and subsequent activities are driven by the question *"what do you need to know about the performance of water supply interventions to evaluate the improvement for low-income urban consumers?"*

As shown in Figure 4-1, the performance indicators for water projects have been adapted to answer the three key questions: 1) *Are the facilities functioning as intended?*; 2) *Are the facilities being utilised as intended?*; and; 3) *Are notable social and economic impacts being achieved?*. Identification of these core knowledge areas has been used to inform the necessary activities and data collection methods. It is important to note that the methodology does not attempt to collect and evaluate data relating to direct health effects. The full list of water related diseases is extremely large and varied (Valdmanis & Cairncross, 2006). An evaluation exercise of direct health effects would require an in-depth understanding and site-specific knowledge of the relationship between the water supply interventions and disease transmissions routes in varied and complex urban environments, which is beyond the scope of this study. The main objective of this study is to provide evidence to evaluate the performance of discrete water supply and distribution interventions in Kenya's LISs in relation to function, utilisation and defined social and economic impacts.

#### **4.3.1 Data Collection Methods**

"Case studies do not imply the use of a particular type of evidence and can be done using either qualitative or quantitative evidence (or both)" (Kohlbacher, 2006. p.8). As outlined earlier the main simplified distinction between the two categories is that quantitative involves collection of data in form of numbers while qualitative collects data in the form of words and pictures (Neuman, 2003; Kohlbacher, 2006). Qualitative research methods have often faced acceptance problems and academic and disciplinary resistances, termed as unscientific, or too exploratory, or subjective. Efforts made to reconcile this notion emphasise that qualitative methods should be viewed as complementary to quantitative methods, rather than competitive. Kohlbacher (2006) considers the combination of mixing quantitative and qualitative

methods in case study strategy bears an enormous potential for the advancement of social research.

The methodology adopted for this study comprises of both qualitative and quantitative data collection methods. Table 4-2 below provides a summary of the qualitative and quantitative data collection methods used in this study under the identified categories, and indicates the relevance of each category to the research.

Complete copies of the researchers' qualitative and quantitative data collection tools developed as part of this research methodology Chapter is included in Appendix A.

**Table 4-2 Features of qualitative and quantitative data collection methods and relevance to study (Source: Adapted from Neuman, 2003)**

FEATURES OF DATA COLLECTION METHODS	RELEVANCE TO STUDY
<b>QUALITATIVE</b>	
<ul style="list-style-type: none"> <li>➤ Data in form of words and/or pictures.</li> <li>➤ Centred on interactive processes.</li> <li>➤ Involves in-depth detail knowledge of the cases.</li> <li>➤ Based on non-causal or inductive theory.</li> <li>➤ Process of analysis starts with themes extraction, to description, interpretation and generalisations from evidence to present fluid and consistent scenarios.</li> <li>➤ Researcher is often an integral part of the process.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Direct observations to collect evidence.</li> <li>➤ Key informant interviews with project stakeholders.</li> <li>➤ Focus Group Discussions (FGDs) with target and control groups.</li> </ul>
<b>QUANTITATIVE</b>	
<ul style="list-style-type: none"> <li>➤ Data in form of numbers.</li> <li>➤ Measure observable facts.</li> <li>➤ Analytical processes discusses how.</li> <li>➤ Theory is largely causal and deductive.</li> <li>➤ The researcher is removed from the research process.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Data collection of relevant reports (literature review).</li> <li>➤ Detailed work plans for the four projects outlining: ongoing and planned interventions, project descriptions, durations, baseline parameters and intended impacts.</li> <li>➤ Technical documents on operation and maintenance requirements and costs.</li> </ul>

	<ul style="list-style-type: none"> <li>➤ Financial records on re-sale tariffs and revenues.</li> <li>➤ Water quality test results.</li> <li>➤ Household surveys for impact assessments.</li> </ul>
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## 4.4 Qualitative Methods

### 4.4.1 Direct Observations

The participant style of direct observation is more widely used in flexible research designs (Robson, 2002). In this study, the researcher adopted two roles: as participant-as-observer where the researcher played an active role in implementation of the intervention and observer-as-participant where the researcher acted purely as an observer.

The participant-as-observer style used the researcher's 'self' as the main instrument of research, to infiltrate situations and learn about the culture and processes of the groups being investigated (Denscombe, 1998). This allowed the researcher to be openly recognised by the groups, thus having the advantage of gaining consented information from those involved (Robson, 2002). However, Denscombe (1998) regards the dependence on the researcher's 'self' interpretations a significant disadvantage, as this causes difficulties in verifying the reliability of data collected and leaves it open to doubt. The observer-as-participant approach was adopted where the researcher took no part in the activity, but whose status as a researcher was known to the participants during the data collection process. Although this is the aspirational state for many researchers, questions have arisen on how realistic it is for a known researcher to not be a part of the activity (Robson, 2002).

Observation was employed in this study to develop an understanding on the varying classifications of poverty among different typology settlements, document institutional challenges in water supply and distribution at each location, record the different sources of water, and observe the different types of supply and distribution mechanisms, management practices and cultural behaviour change pre-intervention and throughout the monitoring period. Monthly field visits were conducted in Nairobi

over the monitoring duration due to ease of accessibility and visits to Kisumu and Nakuru were conducted three times in one year. Information was recorded systematically by the researcher through hand-written site record notes and pictures.

#### **4.4.2 Semi-structured and Unstructured Interviews**

Qualitative interviews allow interview questions to draw information more freely, with the interviewer guiding the discussion to the appropriate topic. Robson (2002) classifies the interview styles into three commonly used types: fully-structured (predetermined questions with fixed wording), semi-structured (predetermined but wording can be changed and questions omitted) and unstructured (informal, open ended discussions around the area of interest).

Semi-structured and unstructured interviews are widely used in flexible designs, either as the sole method or in combination with others (Robson, 2002). Semi-structured interviews allow the researcher to be more flexible in terms of which the order topics are considered, and more significantly, let the interviewee develop ideas broadening the scope of interview to discuss any issues that may be raised by the researcher (Denscombe, 1998). In unstructured interviews, the interviewee takes the opportunity to engage in discussions with someone in the research setting about anything which seems relevant. It is not appropriate as the main data collection method but, used in conjunction with other methods can provide invaluable information (Robson, 2002). Denscombe (1998) describes the relationship between semi-structured and unstructured interviews as on a continuum, and that in practice it is likely the interviews will slide back and forth along the scale.

The researcher carried out semi-structured and unstructured interviews with key project implementation and operational stakeholders, including funding/ donor institutional stakeholders and project beneficiaries where applicable to obtain information on the water challenges within the area, management structures and perceived impacts from the water supply and distribution interventions within the settlements. Interviews were captured by the researcher through hand-written field notes, questionnaires and digital voice recordings of discussions with the consent of

participants. The researcher mainly used this interview style in the initial trial questions with adults and children at an early stage of the research, to aid the preparation of the key informant interview tools and to set the scene for the quantitative data collection methods e.g. household surveys.

#### **4.4.3 Key Informant Interviews**

“These are interviews with individuals who have significant amounts of knowledge” (Chakava, 2011, p.21). Casley & Kumar describe “the main difference of key informant over general respondents, in that whereas general informants describe information about themselves, key informants provide information on other people and other things” (Caseley & Kumar, 1988, cited in Chakava, 2011, p.21). In highlighting the benefits of key informants, Blumenthal & Manderson state that “discussion with a person knowledgeable in the area of study can help one to gain a good overview of the situation at the start of the project” (Blumenthal & Manderson, 1997, cited in Chakava, 2011, p.21). Denscombe (1998) considers the advantages to the researcher in the straightforwardness of the approach to locate specific ideas from specific people, while taking little effort to control and arrange. Simpson-Herbert took the perspective that “key informants were most reliable in providing information relating to physical geography and public buildings, institutions and institutional roles and the dates of important community events; but with regards to information relating to more evaluative questions, research has found such information to be less useful” (Simpson-Herbert, 1983, cited in Chakava, 2011, p.21).

The researcher carried out key informant interviews with: water vendors, representatives from the institutional stakeholders at each case study location (Nairobi, Kisumu and Nakuru) e.g. the WSP’s and WSB’s, the implementing project team members, knowledgeable members of the community and any other participants identified through consultations. Discussions were recorded by the researcher through hand-written field notes and digital voice recordings with the consent of informants. Table 4-3 provides a sample of the main questions asked by the researcher. The complete questionnaire template is included in Appendix B.1.

**Table 4-3 Sample key informant questions**

<b>KEY INFORMANT QUESTIONS</b>
1. What are the general water-related problems in this community/area?
2. How many customers do you serve per day?
3. How much is the average income from selling water in this area (monthly)?
4. Does the number of customers change during periods of drought and/ or heavy rains?
5. Have you experienced challenges providing the water supply service in this area?

#### **4.4.4 Focus Group Discussions (FGDs)**

FGDs are “more commonly used in urban and peri-urban areas, involving discussions with people who are deemed particularly relevant to the study” (Denscombe, 1998, cited in Chakava, 2011, p.21). The groups are typically small, comprising of between six and nine people who are brought together by the researcher to explore attitudes, perceptions, feelings and ideas about a specific topic or theory (Denscombe, 1998).

“Casley & Kumar highlight the main strengths of group interviews as being that information can be drawn from a wider number of people, group participation can reduce individual inhibitions which may exist and in some instances and information obtained from a group can be more reliable than information obtained by an individual” (Caseley & Kumar, 1988, cited in Chakava, 2011, p.21). Robson (2002) places emphasis on the efficiency of the technique for a relatively inexpensive and flexible set up and that the participants tend to enjoy the experience. “The limitations raised by Casley & Kumar are the dominance of certain individuals in discussions, peoples’ reluctance to express their true opinions in the company of others and a greater susceptibility to interviewer bias” (Caseley & Kumar, 1988, cited in Chakava, 2011, p.21). Denscombe (1998) discusses the difficulties experienced in recording the discussions that take place, as speakers interrupt one another and talk simultaneously. “Pratt & Loizos suggest that collective and individual opinions should be noted and advise on interviewing mainly homogeneous groups, as different social status standings, genders etc. may result in some group members not voicing their opinions due to feelings of discomfort, inhibition, fear, respect or uncertainty” (Pratt & Loizos, 1992, cited in Chakava, 2011, p.21).



The researcher designed the FGD questions and carried out the discussions in person with beneficiaries in Nairobi and Kisumu to obtain customer feedback and verify the data collected by household surveys in the area. A representative from the local implementing organisations accompanied the researcher at all times and was present during the discussions. The discussions were predominantly conducted in English and Kiswahili (the two national languages in Kenya). In one instance, a translator from the group was required as some of the women were more comfortable expressing themselves in the Luo language (the local dialect in Kisumu). Due to limited resources, the researcher was not able to conduct FGDs in Nakuru to independently verify the household survey data provided by third parties. The discussions were recorded by the researcher through hand-written field notes, questionnaires and digital voice recordings with the consent of participants. Table 4-4 provides a sample of the main FGD questions asked by the researcher. The complete questionnaire template is included in Appendix B.1.

**Table 4-4 Sample FGD questions**

<b>FGD QUESTIONS</b>
<ol style="list-style-type: none"> <li>1. What is your main source of water in the household?</li> <li>2. How many days per week is water available from your main source?</li> <li>3. What are other alternative available water sources for local residents living in this area?</li> <li>4. How many jerrycans were you using before the service, and now?</li> <li>5. What are some of the advantages and disadvantages this service has had over the other water sources you mentioned above?</li> </ol>

## **4.5 Quantitative Methods**

### **4.5.1 Desk Studies**

Desk studies conducted by the researcher involved collecting and reviewing documents from each intervention covering a wide range, including for example: published reports, income and expenditure record books, minutes of meetings, receipts, cash-flow records etc. Studies also included analysing relevant documentation and literature available in the public domain and in the documents provided by the project stakeholders.

A particular desk study investigated the state of water resources and bulk water availability in Nairobi to understand better the likelihood of early extension of piped network supply into the low-income settlements and therefore the possible length of the “transition.”

#### **4.5.2 Household Surveys**

Surveys are commonly linked to questionnaires, largely or wholly composed of fixed choice questions (Denscombe, 1998). Although it is difficult to determine a precise definition due to the wide range of studies that have been labelled as surveys, Robson (2002) summarises the typical central features as: fixed quantitative design, a collection of data in standardised form and the selection of representative samples of individuals from known populations. Many, probably most surveys are carried out for descriptive purposes.

The use of household surveys is popular to provide a relatively simple and straightforward approach to the collection of standardised information on the attitudes, values, beliefs and motives of a study (Robson, 2002). Some critiques regard the large amounts of data generated by household surveys as falsely prestigious because of their quantitative nature, whose findings are seen as a product of uninvolved and disinterested participants (Robson, 2002). Another disadvantage Robson (2002) identified relates to the reliability and validity of the data, as this largely depends on the proficiency and characteristics of the interviewer.

Baseline household surveys were carried out with target and control groups in Nairobi, Kisumu and Nakuru, to understand the water resources and distribution challenges in the area pre-intervention. Where possible, the researcher participated in the design of the household survey questions in collaboration with the local implementing organisations to ensure key information required for the study would be captured. The researcher carried out the household surveys in Nairobi and Kisumu through face-to-face questionnaires in both English and Kiswahili languages, with consent from the local administration. Due to the resource intensive nature of household surveys, the researcher was supported by three to four field moderators from the respective

implementing organisations to collect the data. Prior to rolling out the surveys, the researcher ‘tested’ pilot questionnaires on a small sample size of five households to examine the robustness of the questions and skills of the interviewers. Following this exercise, the researcher conducted a short training session to review the questionnaire with the moderators as a measure to minimise bias and promote proficiency of the interviewers. Additional measures were also taken to minimise bias by refining the questionnaire to incorporate closed multiple choice questions in addition to open ended questions. It should be noted that in Nakuru the researcher had no involvement in the design of the household survey tool and did not participate in the data collection.

Monitoring household surveys were then conducted by the researcher in a similar style as the baseline, but over a period to obtain consumer feedback on the function, utilisation and satisfaction from the interventions within the settlements. As the interventions were implemented over varied timescales, monitoring household surveys were conducted over different periods largely influenced by the project stakeholders. The researcher considered interventions as ‘settled’ after three months for the first round of monitoring, however it was observed that although some interventions had been commissioned for more than three months, they had actually been operating for a shorter duration and could have been experiencing ‘teething’ problems when monitoring was undertaken, while others had an opportunity to settle for longer. Table 4-5 provides a sample of the main household survey questions asked by the researcher. The complete questionnaire templates for the baseline and monitoring surveys are included in Appendix B.1.

**Table 4-5 Sample household survey questions**

<b>BASELINE HOUSEHOLD SURVEY QUESTIONS</b>
1. How much is your monthly rent?
2. What is the daily water usage of the household (cost per number of jerrycans)?
3. Who in the household carries water?
4. Do you treat the water in your household before consumption?
5. What most concerns you when you purchase water from your main source? (cost/ time involved/ quality/ other)?

## MONITORING HOUSEHOLD SURVEY QUESTIONS

1. What is your main source of water in the household?
2. Do you collect and carry water to your water household daily or have it delivered?
3. Do you have a drinking water storage tank in your house?
4. Has the project in this area helped your household?
5. Are you satisfied with your current level of service?

### 4.5.3 Determination of Water Quality Parameters

The World Health Organisation “WHO produced international norms on water quality and human health in the form of guidelines that are used as the basis for regulation and standard setting, in developing and developed countries world-wide. In these guidelines, ‘safe’ drinking-water is defined as not representing any significant health risk over a lifetime of consumption” (WHO, 2008, cited in Chakava, 2011, p.22). The WHO (2008) standards are described as ‘guidelines,’ as they allow for countries to adapt the stipulated guideline values to suit the local socio-economic contexts. “The main reason for not promoting the adoption of international standards for drinking-water quality is the advantage provided by the use of a risk–benefit approach (qualitative or quantitative) in the establishment of national standards and regulations. Further, the Guidelines are best implemented through an integrated preventive management framework for safety applied from catchment to customer. The guidelines provide a scientific point of departure for national authorities to develop a ‘framework’ for safe drinking-water regulations and standards, appropriate for the national situation. They are applicable to large metropolitan and small community piped drinking-water systems and to non-piped drinking-water systems in communities and in individual dwellings” (WHO, 2008, cited in Chakava, 2011, p.22).

Research studies tend to use total coliforms, faecal coliforms or *E. coli* as an indicator of faecal contamination, due to the availability of this water testing technology in most developing countries. It should be noted total coliforms can originate from decaying vegetation in tropical areas and so do not necessarily indicate the presence of harmful bacteria in water. Similarly, faecal coliforms are often referred to as ‘thermo-tolerant’ coliforms as many may be non-faecal in origin. *E. coli* on the other hand can cause serious food poisoning in humans. The severity of the illness varies as it can be fatal to

young children, the elderly and those whose immune system has in one way or another been compromised. Therefore, of these indicator bacteria, *E. coli* are regarded as the most reliable measure of public health risks in drinking-water to be used as a key parameter for this study (Wright et al., 2004).

All the interventions studied were classified as improved sources of drinking-water. Reflecting on the findings from the literature review highlighting that improved sources may not actually provide drinking-water that is safe for consumption, water quality tests were conducted on all the improved groundwater supply sources studied. In evaluating the distribution side of service delivery, water quality tests were also conducted on interventions that incorporated multiple distribution mechanisms to assess the potential for contamination between the source and the point-of-use, which has been known to occur as described in the literature. Water sampling at each location could only be taken once, as limited resources were available to facilitate sampling all the locations over a prolonged duration for increased accuracy of results.

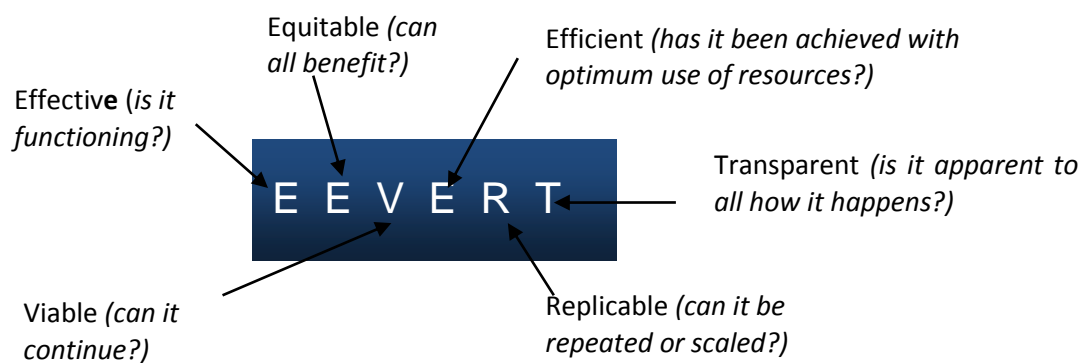
#### **4.6 Developing the Conceptual Framework**

One of the practical difficulties of analysing case study research is dealing with the overwhelming amount and variety of data collected (Darke et al., 1998). To manage this Yin (1994) recommends adopting an analysis strategy part of the methodology in the form of a conceptual framework, which will indicate what needs to be analysed and why, and help to ensure data collection activities are appropriate and support the manner in which evidence is analysed. The framework is considered a dynamic tool which should continue to develop and be completed as the study progresses, and the relationships between the proposed constructs emerges as data is analysed (Baxter & Jack, 2008).

In view of the nature and varied amount of data required for this study, the conceptual framework was designed to address three specific weaknesses highlighted in the literature regarding analysis of case study submissions: 1) the inability to extract significant patterns; 2) the inability to simplify from descriptive information and; 3) the in-ability to think laterally when exploring a phenomenon (Stuart, McCutcheon,

Handfield, McLachlin, & Samson, 2002). To create a personalised conceptual framework the researcher adopted the first and most preferred strategy to follow theoretical propositions (Yin, 2009) centred around interrogating the service received by low-income consumers for each intervention. This approach shaped the data collection plan detailing the relationships between the research hypothesis, objectives, reviews of literature, set of research questions and data collection methods to be applied, which ensured the data was converged and reported in a consistent manner in an attempt to understand the overall case, not the various parts of individual cases (Baxter & Jack, 2008).

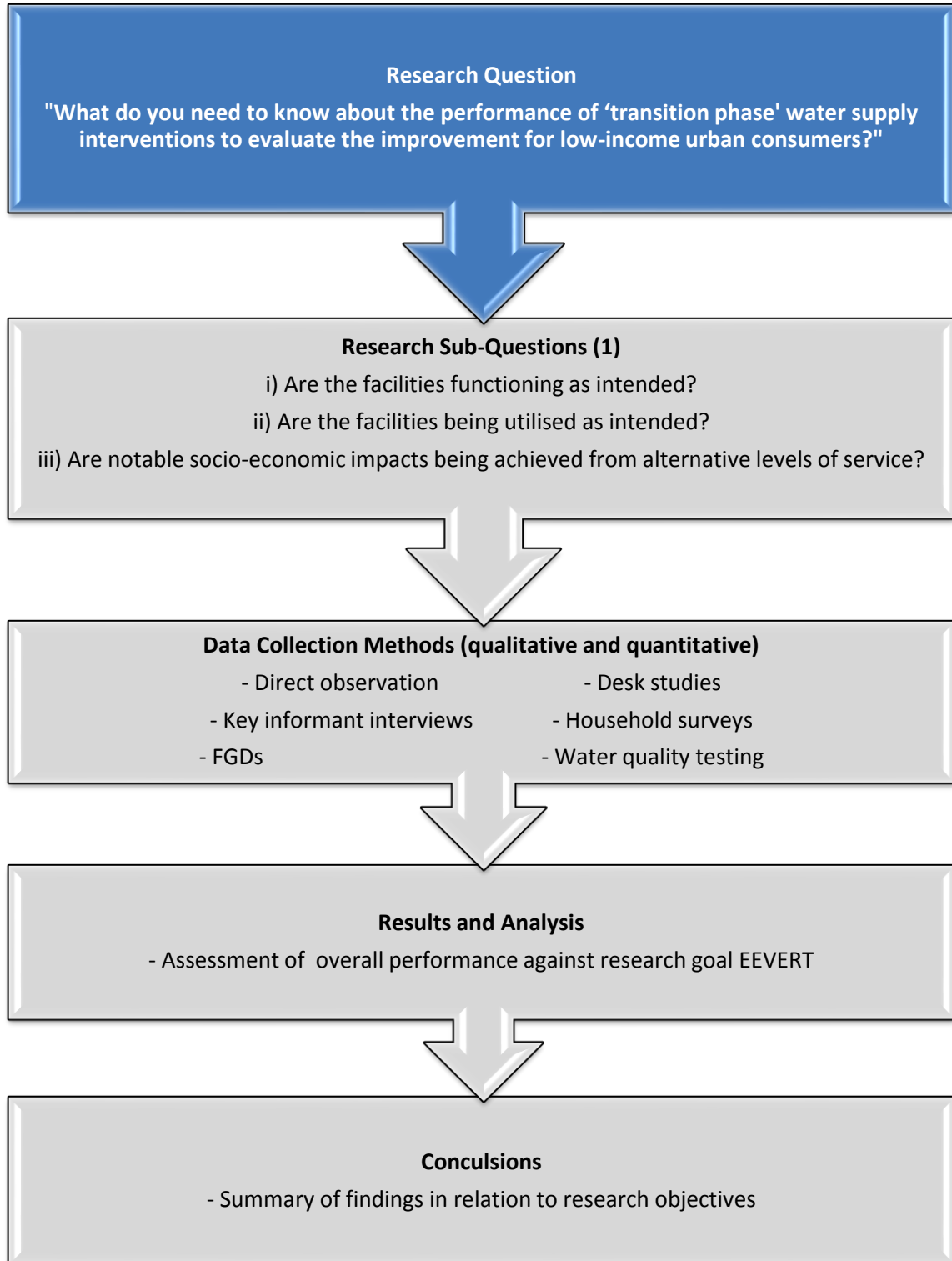
In developing a standardised basis of analysing the data collected for each intervention in relation to the performance, the aspirational goals or measures of success built into the framework were derived from the following six parameters: Effective, Equitable, Viable, Efficient, Replicable and Transparent; acronymed as 'EEVERT' (Franceys, 2011). Successful application of 'EEVERT' in the conceptual framework formed the basis of interrogating the results of the performance of the interventions under a variety of characteristics/ elements/ aspects and academic disciplines, which experience around the world has demonstrated must be considered in order to achieve lasting benefits, an approach first described in the definitions of 'sustainability.'



**Figure 4-2 'EEVERT' (Source: Adapted from Franceys, 2011)**

A master conceptual framework Microsoft Excel spreadsheet was setup to detail the template sub-set of research questions, data collection methods and evidence required to address each question, guiding the field research and formation of the

analysis strategy. The complete framework is included in Appendix B.2. A summary is shown in Figure 4-3.



**Figure 4-3 Conceptual framework overview of data collection method to answer research question**

## 4.7 Field Research

### 4.7.1 Multiple-case Site Selection

The original methodology has been adapted and developed over the duration of the research, in response to the conditions and resources available on the ground. Selection of the multiple-case sites for research was primarily governed by the following factors:

- The location of Umande Trust<sup>7</sup> (Cranfield University local partner) interventions.
- The location of Haki Water<sup>8</sup> interventions.
- Accessibility and availability of data for each site-specific intervention.
- The level of co-operation from local organisations and institutional stakeholders.
- The nature and duration of planned interventions.
- The researcher's access to manpower and financial resources on the ground.

Other factors included the researcher's knowledge on the ground and co-operation from LIS residents. These factors allowed access to the sites, not always a straightforward process with respect to researcher security, and ability to obtain relevant information. The main disadvantage noted by this approach is that the pre-selection of the LISs studied may not be representative of the water supply and distribution mechanisms in the sprawling settlements across the city.

The field research period was conducted in Kenya in two stages due to the varied start and completion dates of the interventions as mentioned earlier, and in response to the conditions and resources available on the ground. Monitoring of the interventions did not just take place immediately post-implementation but was tracked to understand the trend and demand over a period of time. During the Stage 2 research some cases

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<sup>7</sup>Kenyan Trust Registered in 2004.

<sup>8</sup>UK Registered Charity No. 1138556 founded by Yolanda Chakava.



selected were different from those originally identified in Stage 1 but still met the purpose and objectives of the study, which is applicable to every extent possible in a real-life research situation. All the initial sites identified for study during the two-stage research process are summarised in Table 4-6.

**Table 4-6 Stage 1 and Stage 2 research conducted in Kenya**

<b>Stage 1 Research Conducted in Nairobi from September 2010 – February 2011</b>			
<b>Project Stakeholders</b>	<b>The “Case” Intervention</b>	<b>Site Location/s</b>	<b>Comments</b>
WSTF (institutional)	Metered house-hold connections	Nairobi	Discontinued at the end of Stage 1 due to limited accessibility and availability of data
NCWSC (institutional) and Practical Action	Metered house-hold connections	Nairobi	Discontinued at the end of Stage 1 due to limited accessibility and availability of data
Umande Trust (Civil Society) and Cranfield University (academic institution)	WaterChoice s kiosks	Nairobi and Kisumu	Formed part of Stage 1 and Stage 2 research
Haki Water (Civil Society)	Self-supplied Boreholes	Nairobi	Formed part of Stage 1 and Stage 2 research
<b>Stage 2 Research Conducted in conducted in Nairobi, Kisumu and Nakuru from September 2011 – September 2013</b>			
NCWSC (institutional)	Social Connections	Nairobi	Stage 2 Research only
NAWASSCO (institutional), WSTF (institutional) and SUWASA (Civil Society)	Pre-paid meters	Nakuru	Stage 2 Research only (field data collected by WSTF)
Umande Trust (Civil Society) and Cranfield University (academic institution)	WaterChoice s kiosks	Nairobi and Kisumu	Formed part of Stage 1 and Stage 2 research
Haki Water (Civil Society)	Self-supplied Boreholes	Nairobi	Formed part of Stage 1 and Stage 2 research

The final cases studied comprised of three ‘distribution’ dimensions and one ‘supply’ dimension of the service received by LIS urban consumers. The distribution dimensions investigated the performance of innovative mechanisms used within the last 50 metres of service to LIS households. The supply dimension interrogated the performance of groundwater investments in filling and/or supplementing the water resource gap to meet the growing urban poor demand. All the final selected interventions which form the “cases” of study shown in Table 4-7, tested the overall hypothesis of investigating the performance of pro-poor interventions in meeting commercial or public health imperatives as “transitional stop-gaps” to utility provisions or “ultimate solutions” to conventional piped networks.

**Table 4-7 Final selected multiple-case study interventions**

Project Stakeholders	Dimension	The “Case” Intervention	Site Location/s	Researcher Role
NCWSC (institutional)	Distribution	Social Connections	Nairobi	Observer-as-participant
NAWASSCO (institutional), WSTF (institutional) and SUWASA (Civil Society)	Distribution	Pre-paid meters	Nakuru	Observer-as-participant
Umande Trust (Civil Society) and Cranfield University (academic institution)	Distribution	WaterChoices kiosks	Nairobi and Kisumu	Observer-as-participant
Haki Water (Civil Society)	Supply	Self-supplied Boreholes	Nairobi	Participant-as-observer

#### 4.7.2 Discussion of Sampling Selections and Sizes

The selected case studies were found to target a large range of beneficiaries from community groups to public institutions such as schools located in LIS areas. “The advantage of large samples is breadth, whereas their problem is one of depth” (Flyvbjerg, 2006, p.241). As the focus of the study was to evaluate the performance of specific water supply interventions a combination of purposive and snowball non-

probability samples were employed, which are acceptable when there is no intent to make a statistical generalisation to any population beyond the size of the sample surveyed by the researcher (Robson, 2002). This approach was selected to meet the research objectives quickly and efficiently, as sampling for proportionality was not the primary concern (Trochim, 2006).

Household survey areas were subjectively selected by the researcher based on the target intervention beneficiaries or defined service radius of each intervention. The settlements were divided into zones as per the number of interviewers in relation to the target beneficiaries and then a random selection of houses was performed in the ratio of nearly 1 in 3. A minimum sample size of thirty households was surveyed periodically over the monitoring duration, which was considered reasonable with the available resources to obtain information on the performance of the interventions over time and benefits to end users. In some cases, where information was received directly from the project stakeholders, the researcher had no influence over the sample size or locations selected for household surveys. The main disadvantage noted with a purposive sample is that although the opinion of the target population is likely to be obtained, the results are susceptible to overweighting subgroups in the population that were more readily accessible (Jacobs, 2012).

#### **4.7.2.1 Control Groups**

The researcher attempted to conduct household surveys with one control group in Nairobi. However as the study progressed expanding to LISs outside Nairobi, the researcher experienced difficulties in validating the appropriateness of the control group surveyed for all the LISs studied. Each LIS displayed unique characteristics and challenges that influenced the demand and performance of the interventions over time, therefore unless multiple control groups were established at each site-specific location where an intervention was piloted (regardless of whether it was the same intervention or not), surveying a control group in one location added limited value to the overall research and subsequently was not considered in the results.

In recognising the challenges of establishing multiple control groups with limited resources, the researcher adopted a different approach targeting higher-income consumers said to have access to safe and clean drinking water. Despite the fact that water is a national issue, rarely do research studies engage the higher-income consumers with conventional household water connections. The poor service provision to LISs has largely been attributed to the limitations faced by the utility in revenue collection, as discussed in the literature review (Cross & Morel, 2005; Gerlach & Franceys, 2010). The implication that higher-income consumers should pay more for their water to reduce the costs paid by the urban poor has been documented, however the awareness and willingness to pay from the higher-income consumers in Sub-Saharan Africa is rarely reported. In a high-income country setting, in response to a survey, the Consumer Council for Water found that participants were surprised and in some cases angry, to discover that they were already paying subsidies across a range of household bills, although perceptions of what is and what is not acceptable was underpinned by a number of factors, fairness being the main driver (Consumer Council for Water, 2010). Undertaking a somewhat similar study in Nairobi, case-snowball sampling was used to capitalize on social media networks to identify the higher-income respondents, who would otherwise have been hard to locate (Trochim, 2006).

Table 4-8 provides a clear summary and sample sizes of the data collected at household level both at baseline and at each monitoring interval periods for all the interventions, including sample sizes of the tentative control groups.

**Table 4-8 Summary of household survey sample sizes**

Intervention	Baseline Household Surveys (Period)	Total Baseline Sample Size	Monitoring Household Surveys (Periods)	Total Monitoring Sample Size	Total Sample Sizes
Social Connections	May 2012	110	May 2013 August 2013	60	170
Pre-paid meters	July 2012	45	November 2012 February 2013	192	237
WaterChoices	March 2012 –	144	August	245	389

kiosks	May 2012		2012, November 2012 May 2013, August 2013		
Self-supplied Boreholes	February 2011	240	May 2012, May 2013	161	401
Control groups	February 2011 October 2012	87	-	-	87

## 4.8 The Analysis Strategy

A common approach to document analysis is defined as content analysis, the qualitative analysis of what is in the document (Robson, 2002). Denscombe (1998) summarises the main strengths of content analysis as relatively easy and cost-effective access to vast amounts of data, which provides a clear, verifiable and replicable method for quantifying content. The disadvantages are in establishing the credibility of the source of documents and in misinterpretation by the researcher from biases or distortions (Robson, 2002). To minimise this, qualitative data was analysed using content analysis by applying a standardised systematic, theory-guided approach with the core and central tool being the aforementioned conceptual framework (see Appendix B.2). The strength in this form of qualitative content analysis is that it is strictly controlled methodologically and that the material is analysed step-by-step (Kohlbacher, 2006). The researcher collected and documented qualitative and quantitative data for import into the conceptual framework in the following formats:

1. Hand written notes of observations and interviews which were then transferred to Microsoft Word after each meeting and /or site visit conducted.
2. Digital voice recordings of interviews conducted and consumer feedback from FGDs which were transferred to Microsoft Word after each session.
3. Paper and electronic copies of case study documentation including reports, relevant literature and technical records relating to the operation and maintenance of infrastructure installed as part of the intervention.
4. Paper copies of vendor records and water quality analysis test results which were transferred into Microsoft Excel spreadsheets.

5. Paper copies of baseline and monitoring household surveys which were refined several times by first transferring into Microsoft Excel spreadsheets, then into IBM SPSS.
6. Electronic copies of Microsoft Excel baseline and monitoring household survey spreadsheets which were refined and transferred into IBM SPSS.
7. Refined baseline and monitoring household surveys already coded into IBM SPSS.

The quantitative data in the form of household surveys was gathered from multiple sources and comprised of different designs of household survey questionnaires and therefore the data was non-standardised. Additionally, interventions such as the 'WaterChoices' kiosks comprised of sub-sets of data from multiple locations where the experiment was piloted. The procedure of transferring all the data from paper copies to Microsoft Excel and then into IBM SPSS involved re-entering the survey questions and assigning numeric values for each response given. Where possible, any blanks, discrepancies or inconsistencies identified in the data were cross-checked and completed with the original paper copies of the household survey questionnaires and in consultation with the implementing project team representatives. Details that still required further clarification were verified during FGDs. Following this process, the most relevant data remaining in response to the research sub-research questions for each intervention was imported into the conceptual framework spreadsheet. Due to the non-standardised nature of the data and sub-sets of information, it took considerable time and effort to clean and standardise it all into a consistent and manageable format. Data analysis for each case study was conducted in IBM SPSS to compute the responses in relation to the research sub-questions as averages of the sampled household survey population.

To interrogate the actual service being delivered to end users, once all the subsets of information from each case study had been investigated and analysed in the conceptual framework, service level analysis was carried out to aggregate the results for each intervention, mapped against the key research questions and then shortlisted with the composite indicators that offered both most compatibility with Kenya's

current sector benchmarks and the JMP ‘Post 2015 Monitoring’ e-survey results highlighted in the literature. Essentially, the main service criterion adopted for this study has been developed from indicators that are either potentially prioritised as Post 2015 indicators or on the WASREB list and considered particularly relevant in the urban context.

A service framework was constructed with the introduction of suitable service level thresholds which were adapted over the lifecycle of the research as the data was collected, such that there can only be a single score per intervention for the service criterion (see Figure 4-4). As all the case studies focused on improved sources, five service level thresholds were selected and considered a reasonable number, starting with the most desirable service for the urban poor, progressing to an unsatisfactory level of service for an improved source. The number of service levels and the naming system used was informed by Franceys (2012), and adapted for use in this study. Service levels were analysed based on the average service level of the entire survey population per case study.

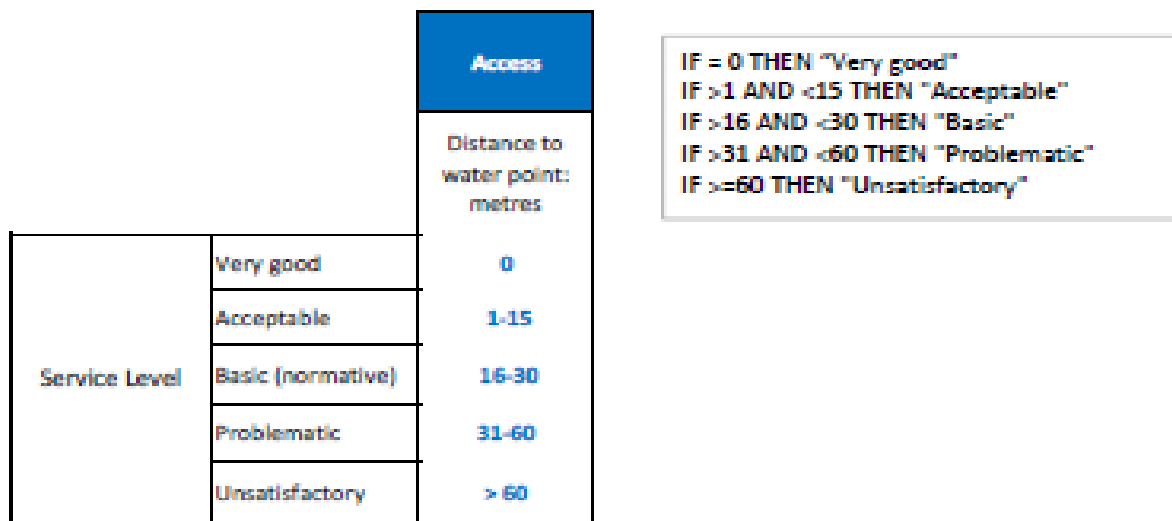
		Core						
		Access	Quantity	Reliability	Affordability	Quality	Acceptability	
	Descriptors	Score	Distance to water point: metres	Volume consumed per person per day: litres	Days of supply per week: number	Price paid per cubic meter of water: USD	Proportion of samples compliant with WHO Guidelines 3rd Ed.	Proportion of households satisfied with the service received
Service Level	Very good	4	0	>=50	7	<=1.25	100%	≥90%
	Acceptable	3	1-15	40-49	5-6	1.26-1.88	99-80%	≥70 <90%
	Basic (normative)	2	16-30	30-39	3-4	1.89-2.50	79-60%	≥50 <70%
	Problematic	1	31-60	20-29	1-2	2.51-3.13	59-50%	≥25 <50%
	Unsatisfactory	0	> 60	<20	<1	>=3.13	< 50%	≥0 <25%

Figure 4-4 Service level framework

The two main methods for carrying out service level analysis are by using nominal logic or indexing, both of which were applied and tested on the case studies.

### 4.8.1 Nominal Logic

Nominal data are items which are differentiated by using a simple naming system that renders indicators comparable (OECD, 2008). In this case the scores given for each of the service levels per service criteria are placed in order of a nominal scale. If a value is accredited to a particular nominal score on the scale, then it can be assumed to be in the associated service level as it belongs to that score. The assigning of a value to the appropriate nominal score on the scale requires the use of nominal logic “if” formulas found in Microsoft Excel, which are based on “higher than/lower than” statements with quantitative ranges (see Figure 4-5). After the service level has been calculated for each service criteria, then the overall service level score can be allocated (Ward, 2012).



**Figure 4-5 Nominal range**

### 4.8.2 Indexing

Difficulties experienced when attempting to aggregate large amounts of data comprising of different service level criteria can be overcome by using the indexing method. Three indexing methods were applied and tested using “arithmetic” means (adding up and dividing by the number of data series) of “ordinal” and “cardinal”



numbers and “geometric” means (multiplying together and taking the ‘n’ th root of the result where n is the number of data series) of “cardinal” numbers.

‘Ordinal’ refers to a scoring or ranking system (e.g. 1 – 5) that builds on nominal data by assigning each nominal range sequential numbers arranged in order to show their relative position in a scale (Franceys, 2012). For the purposes of this study, a 0 to 4 scale of ordinal scoring numbers has been used, with 4 representing the most desirable score assigned to ‘very good’ on the nominal scale and 0 the least desirable score assigned to ‘unsatisfactory.’ It was not necessary to normalise ordinal numbers before aggregation, as the range was already standardised for each underlying service level criteria. Each case study was assigned the appropriate ordinal number for that particular service level per criterion, depending on which nominal range its value fell within. For example as shown in Figure 4-5, under the access service criteria a distance to water point of 10 metres would be assigned an ordinal score of 3 within a service level threshold of ‘acceptable.’

‘Cardinal’ refers to “counting numbers” and are generally used to measure quantity (Ward, 2012). In this case it was necessary to normalise cardinal numbers to give indexed scores in an identical 0 to 1 range before aggregation, due to the different cardinal ranges for each service criteria. This has been carried out using a “Min-Max” approach employing the formula:

$$I = \frac{(X - X_{\min})}{(X_{\max} - X_{\min})} \quad (4-1)$$

For example using the same access service criteria, a distance to water point of 10 metres would be normalised within the cardinal range of the complete data set of 0 metres (minimum) to 100 metres (maximum), divided into quartiles as per the five service level thresholds. Therefore applying the Min-Max formula would produce an index score of 0.75 within a service level threshold of ‘acceptable.’

Once each of the underlying service criteria had been assigned ordinal scores or normalised cardinal index scores they were aggregated by averaging using an arithmetic and geometric mean. To equally weight the results, the ordinal index

arithmetic mean simply averaged the service level ordinal scores (0 to 4) from the five service criterion, and then translated the score on a 100 scale in quartiles. Similarly, the cardinal index arithmetic mean averaged the service level cardinal scores (0 to 1) and then translated the score on a 100 scale in quartiles. The same procedure was conducted on the service level cardinal scores (0 to 1) using the geometric mean. The 100 scale results for all the three methods are shown in Table 4-9. At this stage it was possible to introduce weighted averages to both ordinal and cardinal indices to influence the final score per case study either by rewarding or penalising selected criteria depending on performance.

**Table 4-9 Arithmetic and geometric aggregated ordinal and cardinal index**

Ordinal Index		Cardinal Index				Service Level	
<i>Equal weighting of components</i>	<i>Score</i>	<i>Equal weighting of components</i>	<i>100 scale</i>	<i>Equal weighting of components</i>	<i>100 scale</i>	<i>Brandings</i>	<i>Descriptors</i>
<b>Arithmetic mean</b>	<b>100 scale</b>	<b>Arithmetic mean</b>	<b>100 scale</b>	<b>Geometric mean</b>	<b>100 scale</b>	e.g.	
4.00	<b>100</b>	1.00	<b>100</b>	1.00	<b>100</b>	'a' % ≥85	Very good
3.00	<b>75</b>	0.73	<b>74</b>	0.77	<b>77</b>	'b' % ≥65 <85	Acceptable
2.00	<b>50</b>	0.46	<b>46</b>	0.51	<b>51</b>	'c' % ≥50 <65	Basic
1.00	<b>25</b>	0.23	<b>23</b>	0.28	<b>28</b>	'd' % ≥25 <50	Problematic
0.00	<b>0</b>	0.00	<b>0</b>	0.00	<b>0</b>	'e' % ≥0 <25	Unsatisfactory

### **4.8.3 Robustness and Sensitivity Analysis**

This exercise should be undertaken to interrogate the robustness of the defined composite indicators adopted for this study in relation to the mechanisms adopted for including or excluding an indicator, the normalisation, selection of weights and aggregation.

The nominal logic analysis was tested for sensitivity to changes for each service criteria to determine if there would be significant impacts on the intervention's final overall service level. This process involved carefully excluding one service criteria at a time from the analysis to measure and record any significant changes. The purpose of this exercise was to gauge whether any one service criteria, if left out, would consistently have no bearing on the overall service level originally assigned for each intervention and could be omitted from the final service framework. Additionally, if two criteria were consistently found to have a similar impact when excluded it might suggest that they were correlated to some degree and therefore inclusion of both in the final framework was unnecessary (Ward, 2012, p.20).

Indices were tested using weighted averages to varying degrees to gauge the effect on rankings between case studies. If the results showed a highly changed weighting did not reverse the rankings, "then the framework could be assumed to be robust for the particular case studies and method being tested" (Ward, 2012, p.20).

### **4.8.4 Statistical Analysis**

Statistics was used to interrogate results in relation to the research goal of 'EEVERT' and provide more information on the data collected for each intervention from patterns identified within the data. Statistical tests were used to describe the nominal data and explore the relationships using bivariate analysis between two categorical variables (*values cannot be sequentially ordered or differentiated from each other using a mathematical method*) and continuous variables (*numeric values that can be ordered sequentially*)(OECD, 2008). The statistical procedures shown in Table 4-10 apply to bivariate analysis:

**Table 4-10 Bivariate procedures (Source: Adapted from Maji Data, 2012)**

<b>Independent Samples T-Test</b>	Used to compare means of one continuous variable across independent groups, the samples are independent.
<b>One Sample T-Test</b>	Used to test whether a mean equals a predetermined value.
<b>Chi-Square</b>	Used to determine a relationship between two categorical variables
<b>ANOVA</b>	Used to compare three or more means on one dependent variable simultaneously, if $p < 0.05$ conclude that at least one population mean differs from the others. We cannot tell at this point which mean is different.

The concept model shown in Table 4-11 was adopted based on the data collected to select the correct statistical tests used as part of this study.

**Table 4-11 Statistical analysis concept model (Source: Adapted from Maji Data, 2012)**

		Dependent Variable	
		Categorical	<i>Continuous</i>
Independent Variable	Categorical	Chi Square	t-test

Following the application of the data collection approach and analysis strategy described in this methodology, the next Part II describes the interventions undertaken and the results.

**PART II: CHAPTER 5: DESCRIPTION OF THE INTERVENTIONS AND RESULTS AND; CHAPTER 6: COMPARATIVE ANALYSIS OF RESULTS**



**Mukuru-kwa-Njenga settlement in Nairobi, Kenya (Source: Haki Water, November 2010)**



## **5 DESCRIPTION OF THE INTERVENTIONS AND RESULTS**

Four interventions were investigated in order to understand their potential as viable and cost effective services during the transition to conventional household water connections. As explained in the research methodology section, they are named as: 1) Social Connections, 2) Pre-paid meters, 3) WaterChoices kiosks and 4) Self-supplied Boreholes.

As discussed earlier, the conceptual framework (see Appendix B.2) provided a standardised list of research sub-questions that were applied to the four interventions. The key evaluation sub-questions remained consistent across all the interventions studied. As a useful reminder to highlight the importance of the data collected and to avoid repetition throughout the document, Table 5-1 has been included. This clearly illustrates to the reader the breakdown of sub-questions asked by the researcher that informed the data collected methods and were used to gather the evidence required to answer the overriding research question.

The following sections continue to describe each intervention in detail, the actual data collected per intervention and summarise qualitative and quantitative results including descriptive statistics of the household surveys. The results present an overall picture of the performance of the interventions in investigating the improvement in service for LIS residents. Full details of the data collected are provided in Appendix C.

**Table 5-1 Summary of research sub-questions and data collection methods**

Research Sub-Questions (1)	Research Sub-Questions (2)	Research Sub-Questions (3)	Data Collection Methods
1) Are the facilities functioning as intended?	a) Did the project get non-functioning facilities into operation?	i) Is the quantity of water adequate to meet the demand?	<ul style="list-style-type: none"> <li>➤ Desk study of design and operational data</li> <li>➤ Direct observation</li> <li>➤ Key informant interviews</li> <li>➤ Household surveys</li> <li>➤ Water quality testing</li> </ul>
		ii) Is the water supply reliable?	
	b) Did the project improve the function of existing facilities?	iii) Is access to the water supply point convenient and reasonable?	
		iv) Is the water quality within regulatory requirements?	
2) Are the facilities being utilised as intended?	a) Is the infrastructure provided being utilised as intended?	i) What is the proportion of households using the facilities?	<ul style="list-style-type: none"> <li>➤ Desk study and mapping</li> <li>➤ Direct observation</li> <li>➤ Key informant interviews</li> <li>➤ Focus Group Discussions</li> <li>➤ Household surveys</li> </ul>
		ii) What volume of water is used and for what purpose?	
	b) Are the educational services provided being utilised as intended?	iii) What are the water storage habits?	
3) Are notable socio-economic impacts being achieved from alternative levels of service?	a) Have there been relative improvements in water quality?	i) What is the proportion of households using treated water as main source?	<ul style="list-style-type: none"> <li>➤ Desk study of design and operational data</li> <li>➤ Direct observation</li> <li>➤ Semi-structured and unstructured interviews</li> <li>➤ Key informant interviews</li> <li>➤ Focus Group Discussions</li> <li>➤ Household surveys</li> </ul>
	b) Have there been relative improvements in convenience?	ii) What is the time taken daily, to collect what quantity of water, from what source?	
	c) Have there been relative economic improvements?	iii) What is the return on investment relative to the service received?	
	d) Have there been relative improvements in consumer satisfaction?	iv) What proportion of households served by the facilities are satisfied with the level of service received?	



## **5.1 Social Connections**

### **5.1.1 Concept Description**

NCWSC, with support from AWSB, K-Rep Bank and the World Bank is implementing a 'Social Connections' intervention targeted at improving access to clean and safe water in Nairobi's LIS, starting in Kayole-Soweto. The main objectives of the social connection intervention are to: increase NCWSC customer base, increase revenue collection, increase access to affordable water for the urban poor, reduce poverty levels and reduce NRW (Nairobi City Water and Sewerage Company, 2011).

In development of this project the utility has finally acknowledged that the standard utility connection fee of KES 8,250 (about USD\$ 103) is a major barrier for urban poor consumers to access improved and regulated water services, a point made repeatedly in the literature. The standard fee comprises a non-refundable connection fee of KES 2,500 (~USD\$ 31), a non-refundable survey fee of KES 3,250 (~USD\$ 41) and a refundable fee of KES 2,500 (~USD\$ 31) as meter deposit (personal communication with Ken Owuocha, Senior Economist, AWSB, 8<sup>th</sup> May, 2013). This NCWSC intervention proposes to subsidise the one-off 'first-time' metered connections for the urban poor, which is considered preferable to tariff subsidies that would only be beneficial to people who are already connected and require recurrent funding, potentially straining the utility operations (Nairobi City Water and Sewerage Company, 2011). However despite the connection subsidy, the intervention justification has noted that the reduced connection fee alone is still almost 100 per cent of the average urban poor household income per month in Nairobi, although this research widely acknowledges that the city's urban poor landscape is not uniform. Nonetheless, to enable urban poor consumers to pay minimal and affordable fixed rates inclusive of consumption charges, the intervention requires LIS residents to repay the connection fee to NCWSC through a loan over 24 monthly instalments, which is agreed upon application.

To address affordability, the intervention is designed to facilitate access for LIS residents to pre-financed micro-loans to offset consumption water bills through a

financing and micro-credit scheme. This scheme allows the payments for water consumed to be made in instalments negotiated to suit the fluctuating incomes of self-employed and informal sector earners, who typically reside in the LIS (Nairobi City Water and Sewerage Company & World Bank, 2012).

A breakdown of the Social Connections approach is as follows (Orsola-Vidal, 2012):

- Upon application, the landlord (or plot owner) is required to pay KES 1,648 (USD\$ 21) as a 20 per cent down payment and commitment fee. This sum is then deducted from the total connection fee.
- The remaining balance of KES 6,602 (USD\$ 83) is then paid in instalments over a two year period via K-Rep Bank as agreed with the customer, starting upon receipt of the first water bill.
- The intervention intends to provide communal water connections for plots each containing approximately 5 – 10 households on average, as also observed by the researcher.
- The landlord is responsible for making the necessary arrangements of how the monthly water bill payment will be divided amongst their tenants. However the researcher noted the incentive for landlords to pass on the subsidy to the tenants was not clear.
- The monthly water bill includes the consumption and service charges as well as the loan repayment monthly connection fee payment that is due that month. The total water bill must be paid within 14 (fourteen) days of receipt. If payment is not received within the specified time-frame, then disconnection policies will apply to the entire plot connection. The researcher also noted scheme is not clear on whether reconnection fees will apply in this case, or how situations regarding multiple landlords per plot will be resolved.
- For every completed water connection, NCWSC can benefit from a subsidy from the World Bank Global Program on Output-Based Aid (GPOBA), subject to specific conditions.

- Consumers will be able to check their water bills via SMS and make payments using mobile money (Nairobi City Water and Sewerage Company & World Bank, 2012).

The intervention aims to install metered connections (see Figure 5-1) to 2,200 plots in Kayole-Soweto (equivalent to an estimated 15,000 households), aiming to increase access to clean drinking water for about 90,000 LIS residents who were previously underserved (Orsola-Vidal, 2012). According to the literature, in global terms Kayole-Soweto would best be described as a peri-urban settlement with courtyard type plots, which should allow for utility access to provide water supply infrastructure.



**Figure 5-1 Social connection within plot**  
(Source: Author, 2013)

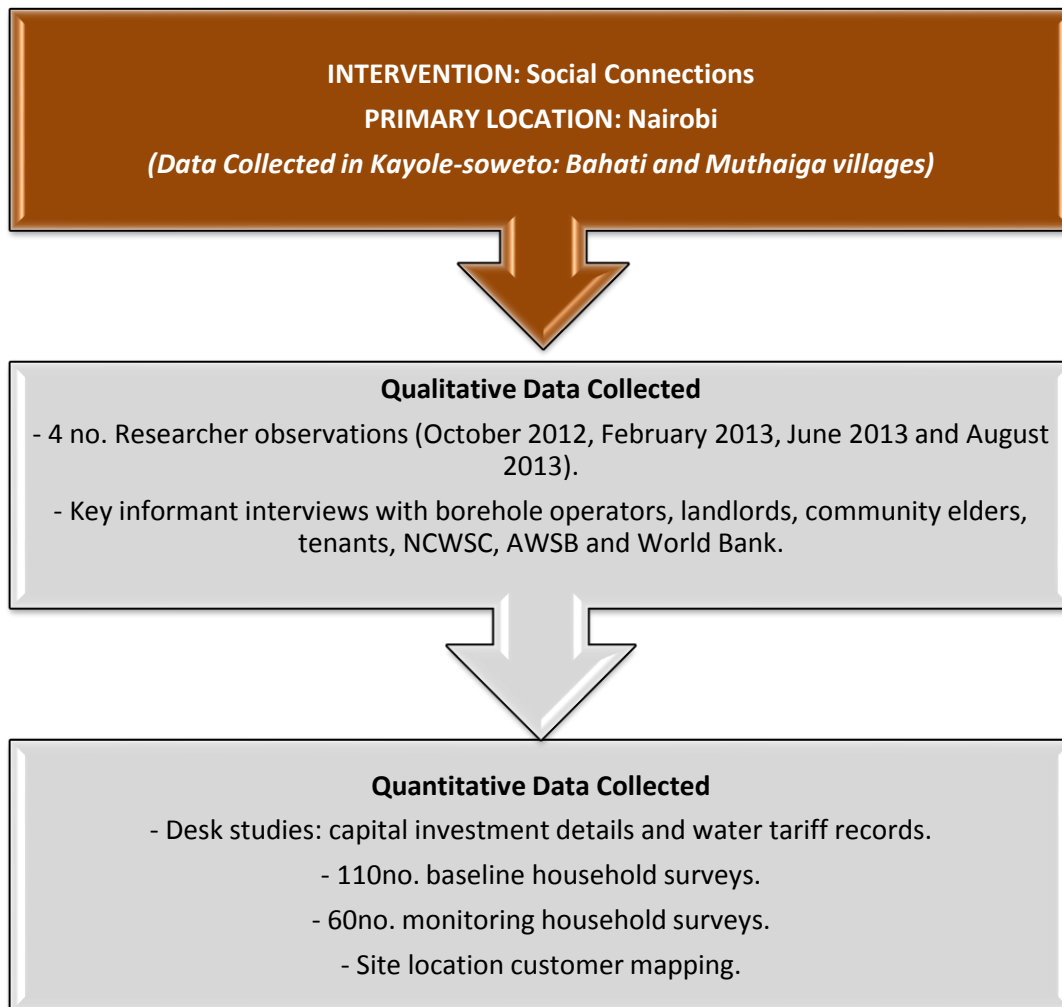


**Figure 5-2 Monitoring surveys in Kayole-Soweto**  
(Source: Haki Water, 2013)

### 5.1.2 Data Collected

The baseline and monitoring data was collected over the period May 2012 - August 2013 (see Figure 5-2). Detailed records of the qualitative and quantitative data collected and the complete set of results logged over the duration have been inputted by the researcher into the conceptual framework included in Appendix C.1. A summary of the data collected is shown in Figure 5-3.

The researcher analysed a total sample size of 170 household surveys in IBM SPSS to produce the results. Collection of the data was facilitated by NCWSC and Haki Water.



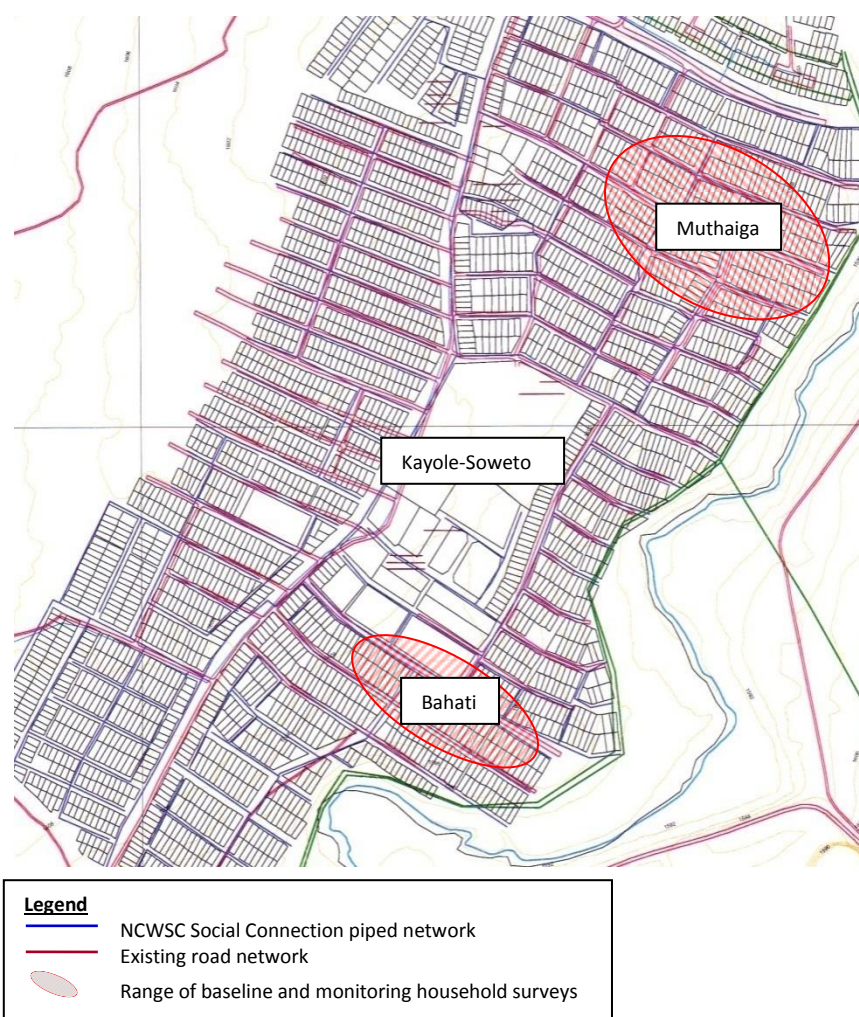
**Figure 5-3 Summary of social connections data collected**

## 5.1.3 Results

### 5.1.3.1 Function

#### 5.1.3.1.1 Access

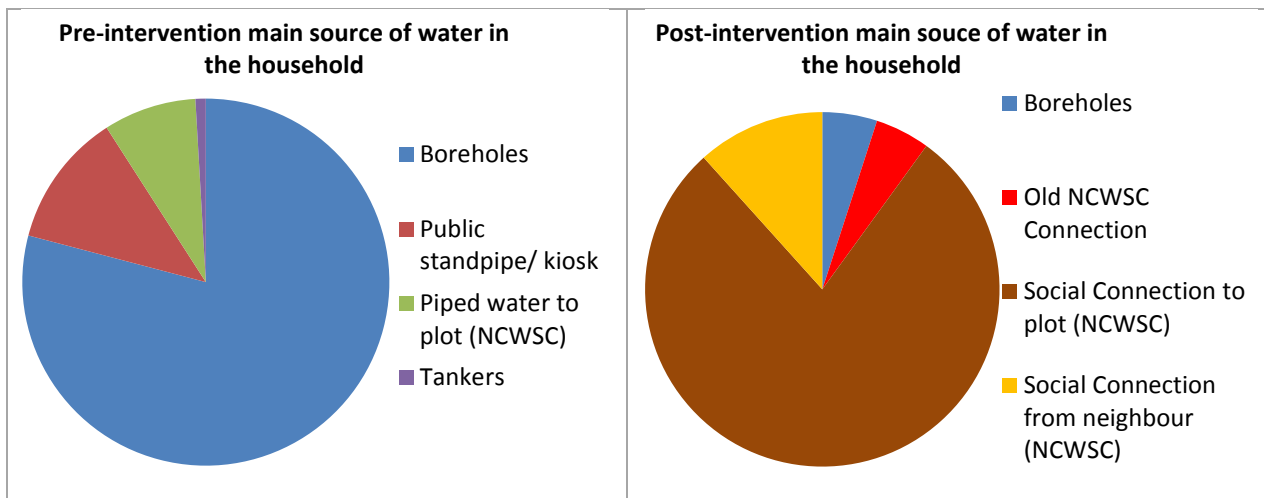
78 per cent of the total respondents (60 adults) within the areas shown in Figure 5-4 confirmed relying on the social metered connection within their plot as their main source of water. Plots with meters were measured at about 30 metres x 10 metres in size on average, resulting in a walking distance of less than 10 meters to access water.



**Figure 5-4 Social connections mapping (Source: Nairobi City Water and Sewerage Company & World Bank, 2012)**

Prior to the intervention, the majority 79 per cent of respondents relied on private boreholes as their main source of water (see Figure 5-5). Post-intervention, the results

showed a 70 per cent improvement in access, with majority of respondents referring to the social metered connection within the plot as their main source of water.



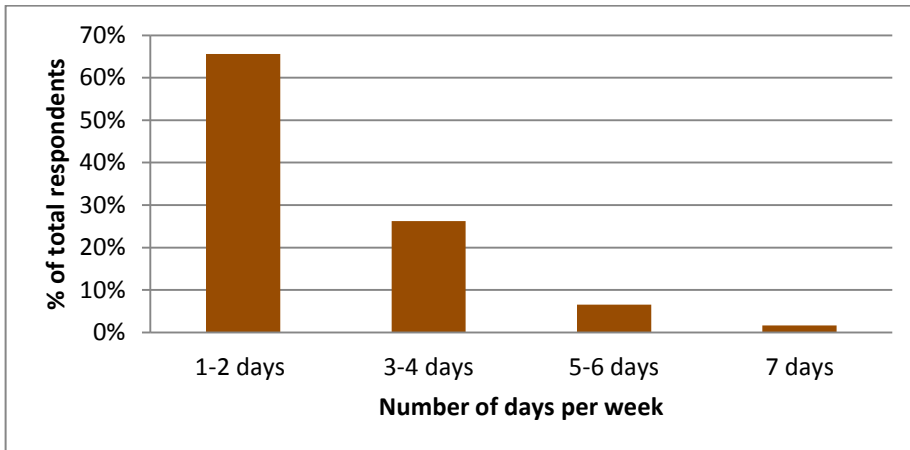
**Figure 5-5 'Pre' and post-intervention main source of water in the household (n=170)**

From observation, some social connection taps were located in close proximity to the toilets or entrance to plots, making it difficult to fill jerrycans and leading to visible leakages/ pools of standing water around the taps.

#### 5.1.3.1.2 Reliability

The main water source for the social connection intervention is from NCWSC. Monitoring surveys revealed the utility water supply was highly unreliable and inconsistent across different zones within Kayole-Soweto. The majority, 66 per cent of respondents, stated receiving the utility supply only 1-2 days per week (see Figure 5-6), enforcing the need to continue relying on alternative water sources.

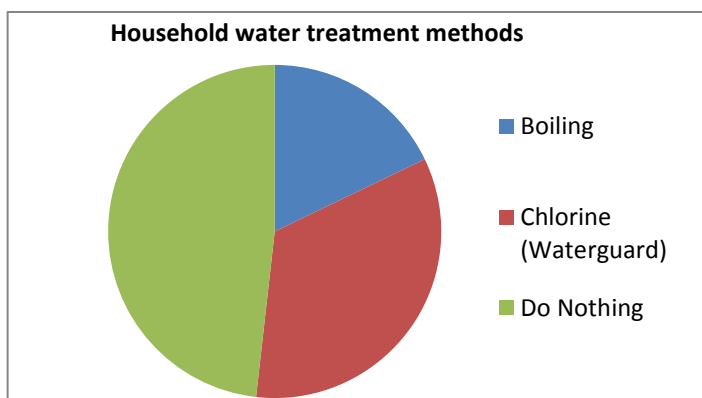
This was supported by daily water availability records kept by five members of the community living in different zones in Kayole-Soweto over the three month period from June 2013 – August 2013. The records, checked by the researcher at the end of each month, showed that water from the public utility was available on average 1-2 days per week.



**Figure 5-6 Average number of days per week water supply is available from Social Connections (n= 60)**

### 5.1.3.1.3 Water Quality

No water quality tests were conducted on the municipal supply, as the intervention did not impact the quality of water in distribution. 52 per cent of respondents confirmed treating their water prior to consumption, 48 per cent do nothing. From those who treat their water, the most common treatment method reported was Waterguard (Figure 5-7). One 150ml bottle retails at a fixed cost of KES 20 (USD\$ 0.25) in the settlements and can treat up to 420 litres of water (equivalent to 21 jerrycans).



**Figure 5-7 Social connection household water treatment methods (n= 60)**

Those who do nothing to treat their water prior to consumption stated this was unnecessary as utility water is already treated, although some residents complained that when there were long periods with no water flowing through the pipes, when the water became available at times it was contaminated.

### **5.1.3.2 Utilisation**

#### **5.1.3.2.1 Uptake of Intervention**

Despite having a social connection within the plot, rather disturbingly all respondents confirmed still relying on borehole water from outside the plot on a weekly basis, due to persistent water shortages and rationing with the utility supply. Results over the monitoring period showed residents taking 30 minutes or more on average to collect water from their main and alternative water sources, which did not reflect any improvement from the baseline. Therefore, although residents benefited from the water connection within their plot, this reduced but largely did not remove the need for women in particular to continue walking long distances every week in search of water.

As access to the social connection supply is solely through landlords, 51 per cent of tenants complained that resistance from landlords was significant barrier preventing more people from accessing intervention. Nonetheless despite the reports from tenants, only 1 in 4 landlords considered the application fee of USD\$ 21 too high, with a majority stating it was fair.

As shown in Figure 5-5 some residents were still relying on old 'illegal', or rather 'unregularised' connections described as "uhuru water" distributed as part of a previous political campaign, despite the utility stating that all such connections in the area had been disconnected. This created no incentive to connect to the metered intervention and start paying for water.

#### **5.1.3.2.2 Quantity**

Baseline surveys revealed that prior to the intervention, the average number of jerrycans per household filled daily was 6, for an average of 4 people per household. Therefore the average household consumption per person per day was 30 litres for all domestic purposes (drinking, cooking, washing clothes, general cleaning etc). The monitoring surveys were not conclusive on whether the intervention had resulted in higher consumption per day, as due to the irregular utility supply respondents confirmed filling all their jerrycans and/or water storage containers whenever water



was available for fear of missing out on water the next day, regardless of what quantity of water was needed at that specific time. This was evidenced by a 30 per cent increase in the number of residents with a water storage tank over the period, the most common size being 100 litres. As aforementioned, residents also supplemented their supply with borehole water which was mainly used for washing clothes and general household cleaning.

### 5.1.3.3 Socio-economic Impacts

#### 5.1.3.3.1 Management

The total investment in this intervention was reported as KES 280 million (USD\$ 3.5 million), which included laying 90 km of water pipes and 40 km of sewer pipes in the low-income areas of Nairobi. This equates to approximately USD\$ 27,000 per km. OBA is a development aid strategy that links delivery of public services (especially in developing countries) to targeted performance-related subsidies. Therefore this strategy is designed to improve accountability, transparency, value for money and economic distortions in utility-led pro-poor interventions (Owuocha, 2013). With this model, the provider largely pre-finances the service, receiving reimbursement mostly after the verification of successful delivery (see Table 5-2).

**Table 5-2 OBA financing arrangements (Source: Owuocha, 2013)**

Organization	During construction 'outputs' achieved (%)	After construction 'outputs' achieved (%)
Community contribution	20	20
K-Rep Bank loan	80	40
OBA subsidy	0	40
<b>Total</b>	<b>100</b>	<b>100</b>

Under this arrangement, NCWSC stand to benefit from a subsidy from successful execution based on specific conditions that: the subsidy per connection cannot exceed KES 3,965 (USD\$ 50), a total target of 2,200 connections should be completed by December 2012 and customers pay their total monthly water bill within 14 days of receipt (Nairobi City Water and Sewerage Company & World Bank, 2012).

As at August 2013, NCWSC had received 2,149 applications and 1,804 landlords had paid for connections. Based on an average of 8 houses per plot and 4 people per household, direct beneficiaries at the time of writing were estimated at 58,000, although the actual number of plots being supplied with water was not clear. Anecdotal evidence indicated approximately 20 km of pipe had been laid, at an estimated total investment cost of ~USD\$ 540,000. Therefore, the estimated connection cost per head has been calculated as USD\$ 9.

Key informant interviews revealed that majority of the landlords connected had not received a utility water bill and were unable to check their water bills via SMS and make payments using mobile money. This indicates the intervention was far from fulfilling the OBA conditions at the time of writing.

Key informant interviews with NCWSC revealed the main challenge is providing a reliable water supply to the area, which had resulted in hostility, anger and frustration towards the utility from the local community, which escalated when monthly bills were disseminated. Therefore to improve the effectiveness and efficiency of the intervention, a reliable water supply is essential.

#### **5.1.3.3.2 Affordability**

For those connected to the intervention the cost of water was generally included within the rent. Therefore, 56 per cent of respondents did not know what their last monthly water bill was in relation to their consumption. Despite the intervention being in operation for at least six months, as highlighted 82 per cent of landlords surveyed had not received a utility water bill creating a false sense of security for tenants. During FGDs landlords complained that bills were late and meters were not being read. The landlords that had received utility water bills claimed that the bills were estimated, too high and unaffordable, indicating the cost would need to be passed onto tenants. Landlords also complained that they did not understand the billing and subsidised connection details. Two landlords had carried copies of their utility bills to the FGD, hoping a member of the group could explain the billed amounts to them.

Apprehension was also expressed that although they had received bills they did not understand what the bills were for as water supply in the area had been scarce.

Surveys conducted with tenants who supplemented the supply by relying on other sources (mainly borehole water) outside the plot reported paying an average price of KES 4/jc for an average of six jerrycans per day. The average rent in the area was calculated as KES 2,024 (USD\$ 25). Therefore the additional monthly cost of water incurred in supplementing the utility supply at USD\$ 9, equates to approximately 36 per cent of the average rent in a typical 30 day month. Including this additional cost incurred monthly to access borehole water, tenants were actually paying twice to access the same rare commodity, with fears that the rent might increase once more landlords started receiving bills. As there appeared to be no incentive for the landlord to pass on any subsidies to tenants, the cost of water of water for the poor was likely to become even more expensive.

#### 5.1.3.3 Acceptability

Over the monitoring period Figure 5-8 shows the main benefits from the investment in the social connection intervention identified by the total respondents surveyed. The improvement in access to water from the intervention resulting in convenience and time savings from the reduced walking distance was most valued by 39 per cent of the respondents. Consumer satisfaction survey results revealed that 50 per cent of consumers were satisfied with the level of service received from the intervention, and 50 per cent were not.

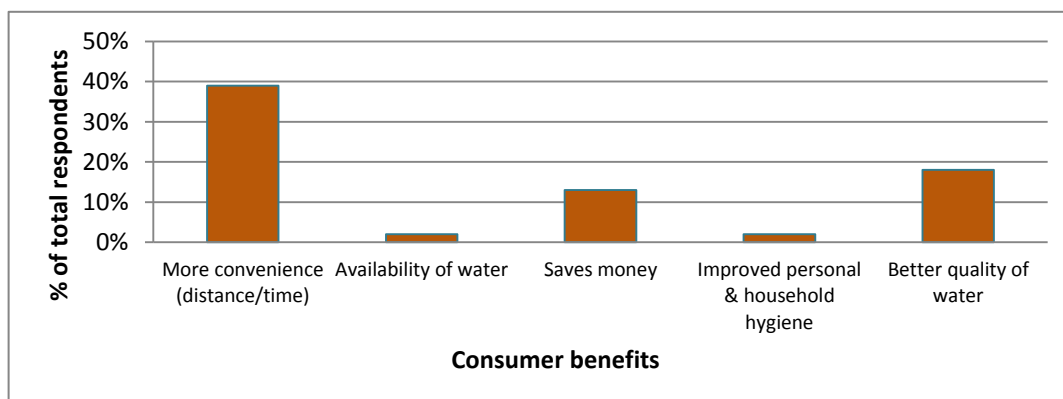


Figure 5-8 Main benefits of the social connection (n= 60)

## 5.2 Pre-paid Meters

### 5.2.1 Concept Description

Similar to the main urban utilities in Kenya, NAWASSCO in Nakuru has been faced with the immense challenges of attempting to deliver water to LISs through traditional, private household water connections. The high upfront connection charge of (~USD\$ 100) and transient nature of low-income families who do not want to make permanent investments have proven to be difficult barriers to overcome. NAWASSCO has advanced several initiatives to increase access to water in LIS such as the common yard tap set-up like private household connections registered in the name of the landlord and fully under his/her control, resembling the social connections intervention just discussed. With this set-up, NAWASSCO experienced reluctance from landlords in allowing unrestricted access to water for fear of abuse by tenants, which resulted in them locking and/or closely managing the taps. A high number of these connections were also disconnected due to payment default, continuing to present distinct challenges for the utility. In seeking more innovative alternatives NAWASSCO in partnership with Sustainable Water and Sanitation in Africa (SUWASA) and the United States Agency for International Development (USAID) developed and implemented the pilot pre-paid meter system in selected LISs of Nakuru, aiming to benefit up to 15,000 or more low-income residents (Acolor & Adams, 2013).

The pre-paid meter system is targeted at improving access to water for poor residents who often have difficulty meeting monthly bills and battle with disconnections and reconnection costs; and/ or are forced to rely on alternative poor quality sources, often at high unregulated prices. Under the pilot initiative, residents have been provided with prepaid meters at communal stand posts within the plot where they can purchase water at a regulated cost of KES 1.2/jc, previously KES 2/jc, using personal tokens which are allocated per household.

To connect to this system, the process is for customers to complete a registration form obtained from the nearest regional office and pay NAWASSCO a refundable deposit of KES 300 (USD\$ 3.75) for the electronic token (market price is KES 1,100 / USD\$ 13.75).

The forms should then be processed immediately and tokens ready for collection within one working day. To load the tokens, customers must visit the NAWASSCO regional office (see Figure 5-9). The average transaction value per day was reported as KES 3,000 (USD\$ 38). The minimum top-up value is KES 50 (USD\$ 0.63) per token. As part of the initial pilot efforts made to conduct household visits to top-up were not successful, as most people were not available during the day. The loaded token is then inserted into the pre-paid meter to access water. The system is designed to automatically discharge exactly 20 litres of water at KES 1.2/jc. The amount deducted is visible to the consumer, as well as confirmation of the available token balance upon completion of each transaction. Usage of the token is not restricted per plot, as access is allowed in any prepaid meter. The pre-paid meters currently serve plots containing 15 - 40 households. The first pre-paid meters were installed in Manyani settlement in Nakuru, which would best be described as a peri-urban settlement in the literature and should allow for utility access to provide water supply infrastructure.

The complete Elster Kent technology to operate the system has been imported from South Africa (see Figure 5-10). A local company called Nairobi Ironmongers is the local Contractor responsible for the supply of materials, installation, training of staff operatives and trouble-shooting. The construction cost of the prepaid meter is estimated at KES 70,000 (USD\$ 875).



**Figure 5-9 Pre-paid token being topped up at NAWASSCO regional office**  
(Source: Author, 2012)

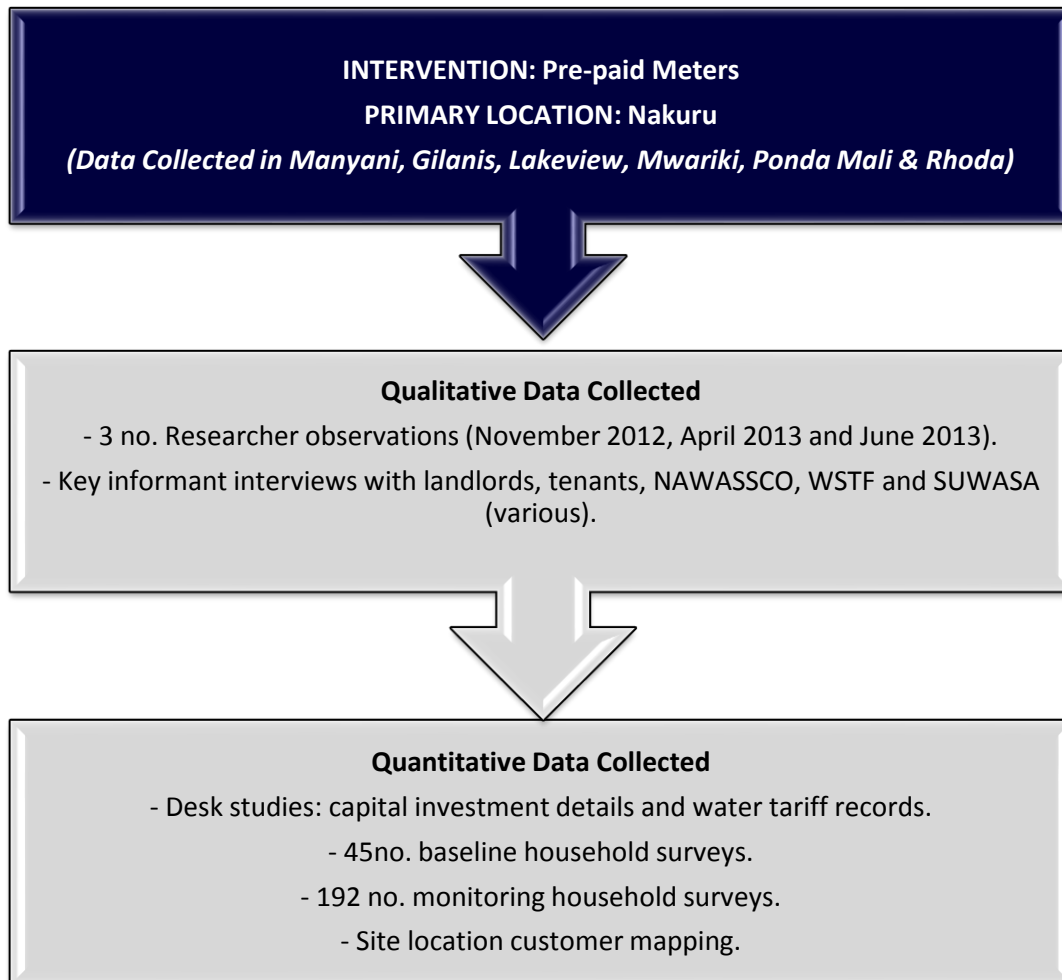


**Figure 5-10 Pre-paid meter within plot**  
(Source: Author, 2012)

## 5.2.2 Data Collected

The baseline and monitoring data was collected over the period July 2012 - August 2013. Detailed records of the qualitative and quantitative data collected and the complete set of results logged over the duration have been inputted by the researcher into the conceptual framework included in Appendix C.2. A summary of the data collected is shown in Figure 5-11.

The researcher analysed a total sample size of 237 household surveys in IBM SPSS to produce the results. Collection of the field data was undertaken by NAWASSCO, WSTF and SUWASA.



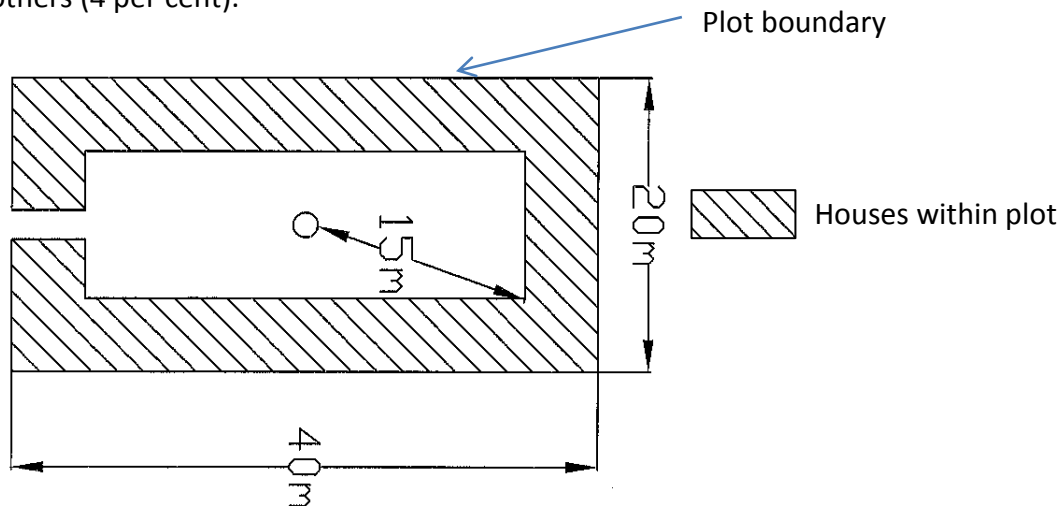
**Figure 5-11 Summary of pre-paid meters data collected**

## 5.2.3 Results

### 5.2.3.1 Function

#### 5.2.3.1.1 Access

100 per cent of the total respondents (191 adults) confirmed relying on the pre-paid system within their plot as their only main source of water. Plots with pre-paid meters were measured at about 50 metres x 100 metres in size on average, resulting in a walking distance of less than 15 metres to access water (see Figure 5-12). Prior to the intervention, 78 per cent accessed water from communal taps within the plot. Others accessed water from donkey carts (18 per cent) and private household connections of others (4 per cent).



**Figure 5-12 Walking distance within plot**

Mapping of all the locations where pre-paid meters were installed was not available at the time of writing. However, the researcher observed the long walking distance (approximately 1km) to the nearest NAWASSCO regional office where customers were required to top up the token. This was also noted by NAWASSCO and methods to make this process easier were under consideration.

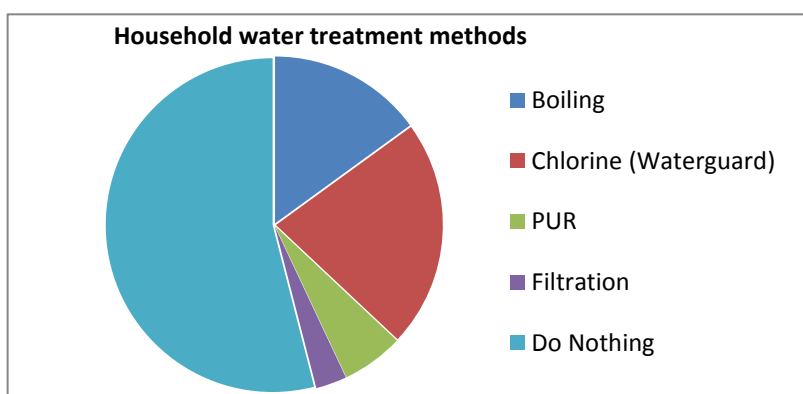
#### 5.2.3.1.2 Reliability

The main water source for the pre-paid intervention is from NAWASSCO. Baseline surveys revealed that water supply across the settlements studied is rationed and inconsistent, with 53 per cent complaining of unreliable supply and low water

pressure. The post-intervention monitoring surveys revealed mixed results with some settlements receiving water 7 days per week and others reported receiving water 3-4 days per week. Interviews with the utility confirmed that due to general supply and demand issues and the uneven topography in Nakuru, if the LIS did not receive a constant supply than water rationing was maintained with the introduction of the pre-paid system. Nonetheless, the number of complaints regarding water rationing and low water pressure decreased to 31 per cent after the intervention, with less confrontation from tenants as residents were generally more comfortable with the pre-paid system as long as they knew the specific days when water is available.

### 5.2.3.1.3 Water Quality

No water quality tests were conducted on the municipal supply, as the intervention did not impact the quality of water in distribution. The water quality was rated as good by 96 per cent, with confidence increasing post-implementation. The remaining respondents regarded their water quality as fair. The most common treatment method reported was Waterguard (Figure 5-13). One 150ml bottle retails at a fixed cost of KES 20 (USD\$ 0.25) in the settlements and can treat up to 420 litres of water (equivalent to 21 jerrycans).



**Figure 5-13 Pre-paid household water treatment methods (n= 237)**

### 5.2.3.2 Utilisation

#### 5.2.3.2.1 Uptake of Intervention

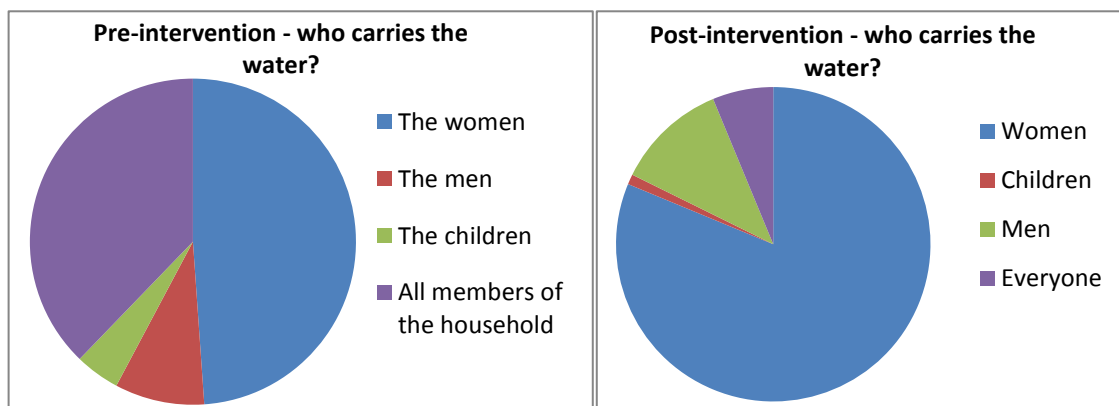
Prior to the intervention, 51 per cent confirmed having to fetch water from vendors outside the plot walking an average distance of 30 meters weekly due to persistent



water shortages and long waiting times when water was available. Therefore these tenants were often paying twice for water. Post intervention, no respondents stated the need to continue utilising water vendors outside the plot, therefore the prepaid system reflected a significant improvement in utilisation of public utility water supply for at least 73 per cent of the respondents.

A reduction in waiting times and reports of no more conflict at the communal taps was also recorded in the monitoring surveys and observed by the researcher. 92 per cent stated it now takes less than 15 minutes to fetch water daily, a significant improvement from the baseline surveys where 64 per cent had stated fetching water could take anywhere between 1 – 2 hours a day.

Figure 5-14 shows the pre- and post-intervention allocation of the responsibility for carrying water within the household. Interestingly, over the monitoring period the improved access seems to have increased the responsibility by 32 per cent for the women collecting water daily from the meters.



**Figure 5-14 Pre- and Post-intervention allocation of carrying water responsibilities in the household (n= 237)**

#### 5.2.3.2.2 Quantity

Baseline surveys revealed that prior to the intervention, the average number of jerrycans per household filled daily was 4, for an average of 4 people per household. Therefore the average household consumption per person per day was 20 litres for all domestic purposes (drinking, cooking, washing clothes, general cleaning etc). Over the monitoring period 73 per cent of respondents confirmed utilising larger quantities of

water, amounting to between two and three additional jerrycans per day. Additional quantities were mainly used for washing clothes, household chores and personal hygiene. During interviews the tenants said since the pre-paid system, they no longer had to pile heaps of clothes until the weekend which was the only time they could go out and look for more water. 23 per cent specifically highlighted their improved personal hygiene as a result of the intervention, implying that when water becomes more easily available people tend to increase their rate of personal and household hygiene.

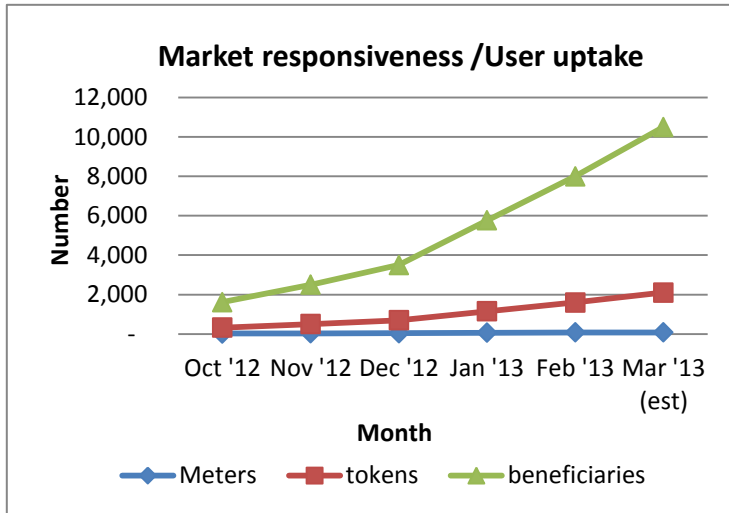
From observation, the stand posts were kept clean and well drained as no pools of standing water were visible around the taps, which were the conditions described at baseline. Key informant interviews with landlords indicated that since the intervention, tenants had become more careful about the amount of water they consume, reducing wastage.

### **5.2.3.3 Socio-economic Impacts**

#### **5.2.3.3.1 Management**

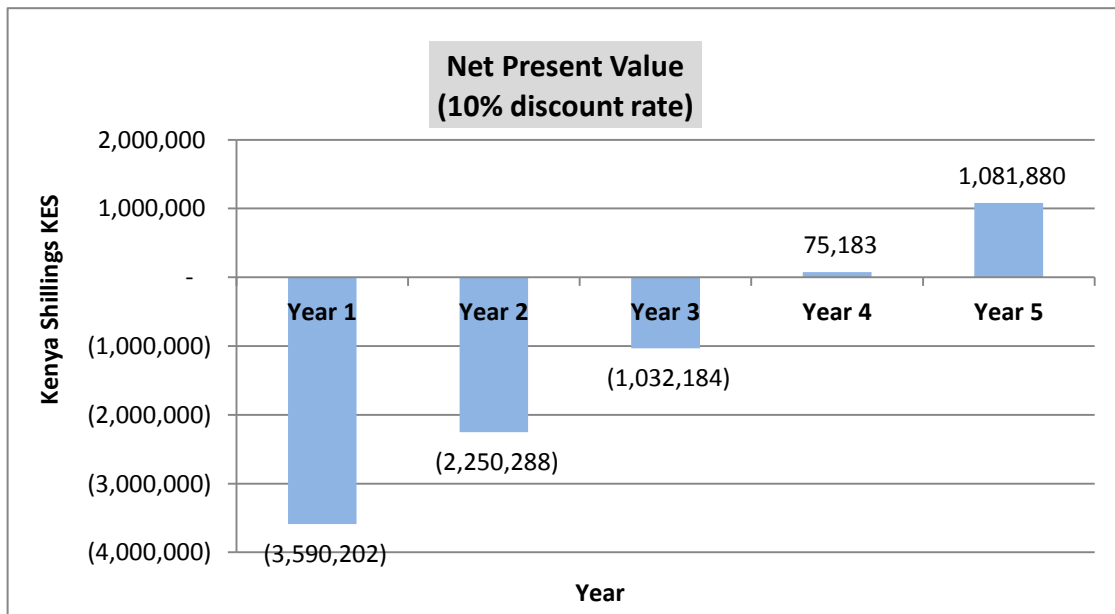
The total investment in the pilot intervention was reported as KES 17.64 million (USD\$ 220,500) financed as follows: USAID/SUWASA (USD\$ 129,789), NAWASSCO (USD\$ 22,890) inclusive of financing from Family Bank (USD\$ 11,445), community contribution as deposit for the pre-paid token (USD\$ 10,309) and a contribution from the WSTF (USD\$ 38,915)(Acolor & Adams, 2013).

NAWASSCO'S market research on the pilot performance suggested a positive view of the meters. This was demonstrated by a 220 per cent increase in the number of tokens distributed by in the two months of January and February 2013 reaching a total of 83 meters, 1,600 tokens and an estimated 8,000 beneficiaries (see Figure 5-15 (Acolor & Adams, 2013).



**Figure 5-15 Pre-paid meter growth from October 2012 – March 2013 (Source: Acolor & Adams, 2013)**

A Net Present Value analysis of the investment has been developed to show the cost recovery in year 3 of operation with 16 per cent profitability. In year 5 of operation, profitability reaches 72 per cent (Acolor & Adams, 2013). The profitability is based on the total investment and assumptions regarding the water consumption per household which was fixed at 7 jerrycans and anticipated savings for the company, taking into account all the administrative, overhead and production costs. Taking a pessimistic outlook on consumption, reduced to 6 jerrycans per household, staggers the cost recovery projection to year 4 of operation (see Figure 5-16).



**Figure 5-16 NAWASSCO Net Present Value (Source: Adapted from Acolor & Adams, 2013)**

As at August 2013, 92 prepaid meters were said to be in operation, with over 4,000 tokens in circulation (personal communication with Zaituni Kanneje, Pro-poor Manager, NAWASSCO, 20<sup>th</sup> August 2013). A precise number of beneficiaries was not available, however as one token per household caters for an average number of 5 people, it is estimated beneficiaries could be in the range of 20,000 people at the time of writing. Based on the total investment cost, the estimated cost of the pre-paid system per head has been calculated as USD\$ 11.

Key informant interviews revealed NAWASSCO's main challenge with the system related to inefficiencies with the local supplier – Nairobi Ironmongers. The service received by Nairobi Ironmongers was considered extremely disappointing and did not provide for the full scope services that were paid for, particularly with regards to adequate training for the technical team. Delays were experienced in obtaining spare parts for the meters and by the end of August 2013, 15 meters had broken down over the monitoring period (3 still remained to be repaired at the time of writing). Unresolved issues with maintenance are a recurring theme highlighted in the literature that threatens the long-term viability of water supply interventions.

#### **5.2.3.3.2 Affordability**

During key informant interviews, the landlords/ladies explained that prior to the intervention, the cost of water was generally included in the rent and tenants were not paying their water bills. The water bills were read from one single meter covering the whole plot, making it very difficult to confirm who pays for what consumption. Consequently the landlord/lady would be disconnected and left to pay utility bills ranging from KES 15,000 (USD\$ 188) to as high as KES 26,000 (USD\$ 325) per month. Tenants then resorted to other sources outside the plot reported paying on average KES 5/jc to supplement the daily supply.

With the pre-paid system, the landlord/lady is only responsible for paying for what he/she uses. One landlady revealed her water bill now averages at KES 900 (USD\$ 11) per month, representing a 95 per cent reduction in the water utility bill. The tenant respondents confirmed the token deducted the correct reduced flat rate price of KES

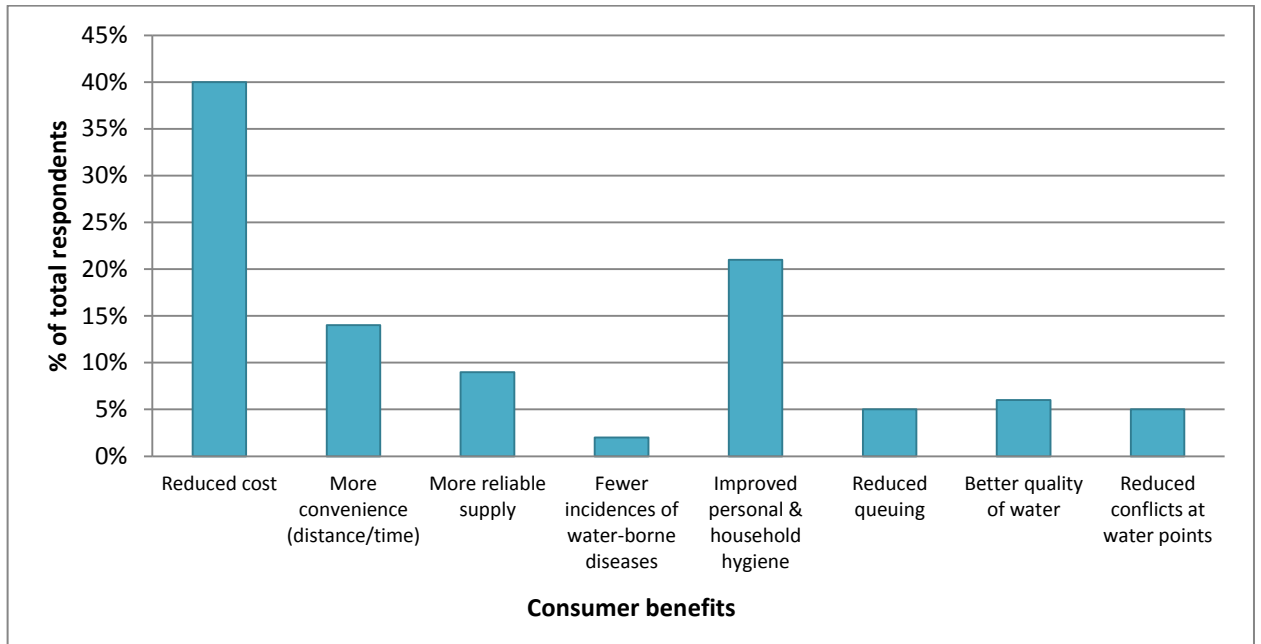
1.2/jc, which from observation was very transparent to the end user. From the tenant survey results the mean token recharge amount was calculated as KES 142 (USD\$ 1.78), almost three times the minimum top-up amount.

With the reduced price, customers are saving KES 190 (USD\$ 0.75) per cubic meter, which represents a 75 per cent reduction in the cost of buying water. Less conflict was also reported between tenants and landlords. The reduced cost of water was described as more affordable for community members, who no longer had to undergo the anxiety of disconnection and burden of reconnection costs.

The average rent per month in the area was calculated as KES 1,840 (USD\$ 23). Although tenants reported a minor deduction in average rent from the baseline, feedback obtained during interviews suggested most landlords had kept the rent the same which was inclusive of the water bill, despite tenants now paying for water using the new prepaid system. Notwithstanding this, with the reduced cost per jerrycan cost was consistently cited as a major improvement by on average 40 per cent of the total respondents over the monitoring period. The reduced cost of water at USD\$ 0.75 per cubic meter relates to approximately 12 per cent of the average rent in a typical 30 day month (based on an increased consumption of 6 jerrycans per day).

#### **5.2.3.3.3 Acceptability**

Over the monitoring period Figure 5-17 shows the main benefits from the investment in the prepaid system intervention identified by the total respondents surveyed, with the reduced cost most valued by 40 per cent. Overall the consumer satisfaction levels increased dramatically, with 94 per cent stating that they were satisfied with the pilot and had no complaints at the end of the monitoring period.



**Figure 5-17 Main benefits of the pre-paid meters (n= 192)**

The researcher noted external social factors also affected the uptake of the intervention. Customers required a national identity card in order for a token to be assigned to them, which proved to be a barrier for some transient low-income customers, possibly excluding the very poor and marginalised

## **5.3 *WaterChoices*' Kiosks**

### **5.3.1 Concept Description**

The theory behind the '*WaterChoices*' concept was to empower poor customers in decision-making through providing feedback on their purchasing choices, which can then be used to adjust service levels and develop options to match user needs and preferences (Franceys & Gerlach, 2008) mimicking, to whatever extent possible, a conventional piped supply. The initial research and pilot experiments were implemented by Umande Trust NGO through Cranfield researcher Jack O'Regan from June 2011 to September 2012. using simple technologies and delivery mechanisms (O'Regan, 2011).

The pilots were rolled out in LISs located in Nairobi and Kisumu, comprising of both 'informal' and 'formal' inner city settlements with different characteristics, ranging from densely populated to less dense and more dispersed peri-urban and absorbed village areas with different topographies and ground conditions. The systems were originally designed to deliver options to receive water through: a) a fixed but low-cost pipe supply direct to the household (metered at the kiosk), b) household supply to a fixed 200 litre daily filled tank through hosepipe, c) household supply through hosepipe to fill household jerrycans (metered) and d) conventional collection and carrying by the householder direct from the *WaterChoices* Kiosk – the different service levels being differentiated by price. In reality, it was found to be nearly impossible (one exception) to differentiate by price and the idea of a fixed household connection was not developed (a parallel study in Yaoundé, Cameroun did develop this option but to the exclusion there of the hosepipe daily roll-out). The option chosen by the NGO in Kenya (rather than the consumers) was developed on the basis that a water vendor could connect up to two or three hosepipes to one meter from a meter bank and roll out the hosepipe to a household or entrance to a plot using a device of their choice, such as a reel or wheelbarrow. Residents could then fill their own jerrycans and storage tanks at their doorsteps and the vendor collects revenues based on reading the meter at the kiosk. This system allowed a number of households and plots to be served

simultaneously with hosepipes of different lengths, while the option to collect and carry water from the kiosk still remained available. Where possible, a difference in price would be introduced between the services options described as ‘choices’ offered (i.e. hosepipe doorstep delivery vs. collect and carry). The results outlined in the following sections form two sub-sets of data collected from the pilot experiments undertaken in the study locations of Nairobi and Kisumu, in analysing the overall performance of the intervention.

Table 5-3 summarises all site locations of investments studied, nature of works undertaken and status of the experiment at the end of the monitoring period. It should be noted that Umande Trust had initially tried to develop *WaterChoices* Kiosks in two locations in Kibera which, although valued by consumers in early trials (O’Regan, 2012), were found to be unsustainable due to a mixture of social and institutional issues and hence could not be investigated under this study.

**Table 5-3 Locations of *WaterChoices* kiosk investments (Source: O’Regan, 2012)**

LIS	Sites	Works Summary	Total investment		Status
			KES	USD\$	
Sub-set 1 Mukuru- Ruben and Korogocho (Nairobi)	Heshima	Construction of new <i>WaterChoices</i> Kiosk (adjacent to existing Heshima bio-centre), external standard water meter bank, installation of 5,000litre water storage tank and provision of hosepipes.	295,940	3,700	Ongoing
	Top 1	Construction of external standard water meter bank, (attached to existing bio-Top 1 centre), external standard water meter bank and provision of hosepipes.	47,547	595	Ongoing
	High Ridge	Construction of new <i>WaterChoices</i> Kiosk, external standard water meter bank, and installation	285,362	3,567	<i>‘Choices’ not in operation at time of</i>

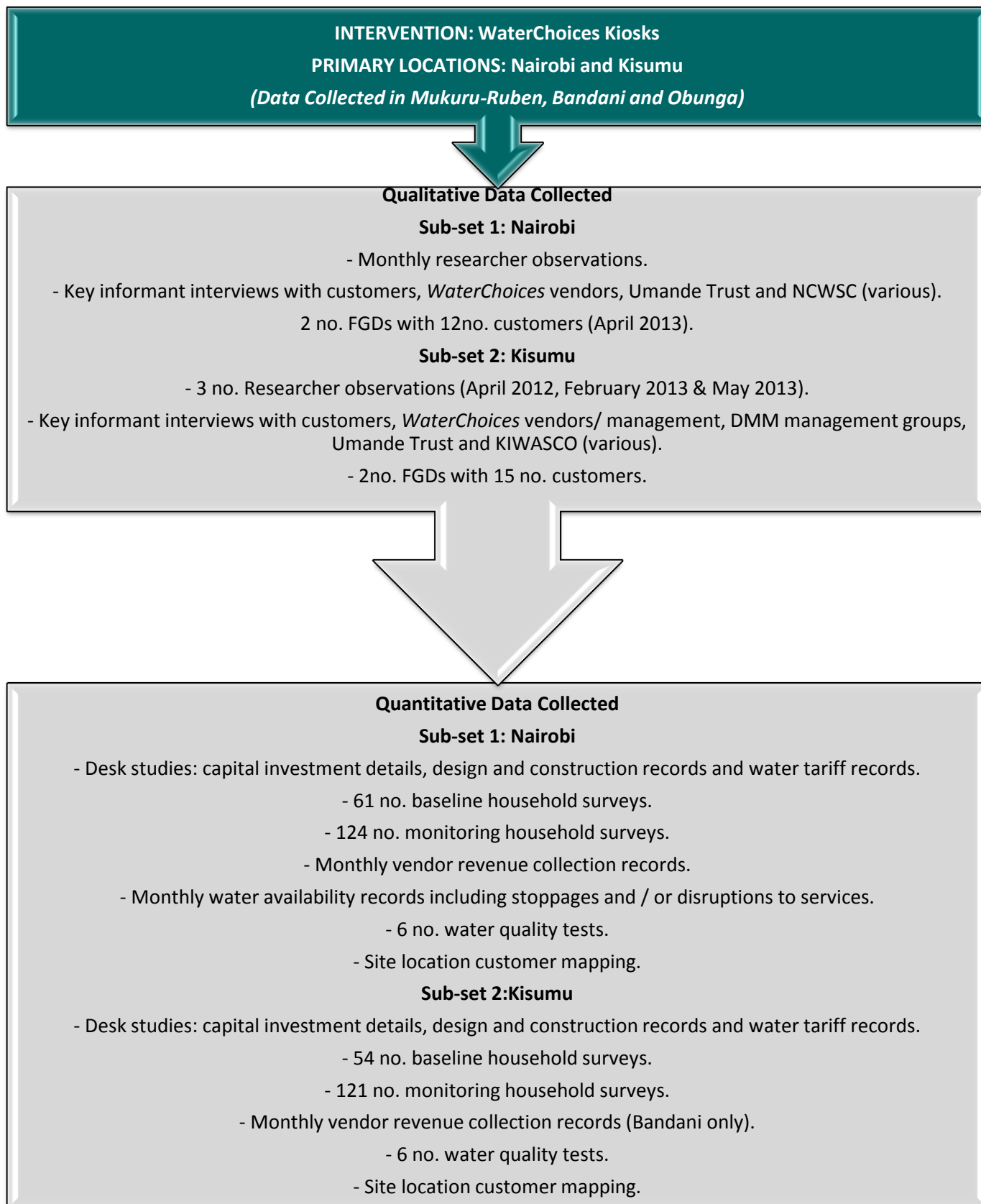


		of 5,000litre water storage tank.			<i>writing – no results included</i>
<i>Sub-set 2</i> Bandani and Obunga (Kisumu)	Bandani	New water connection, conversion of existing bio-centre kiosk to <i>WaterChoices</i> Kiosk, installation of 5,000litre water storage tank and provision of hosepipes.	225,935	2,824	Ongoing
	Obunga	a) New water connection to existing bio-centre with metered tee connection to existing kiosk and chamber and provision of hosepipes. b) Construction of a lightweight reel fixed to the frame of a wheelbarrow, provision of a standard portable water meter and hosepipe for existing vendor.	60,250	753	Ongoing
<b>Total</b>			<b>915,034</b>	<b>11,439</b>	

### 5.3.2 Data Collected

The baseline and monitoring data was collected over the period March 2012 - August 2013. Detailed records of the qualitative and quantitative data collected and the complete set of results logged over the duration have been inputted by the researcher into the conceptual framework included in Appendix C.3. A summary of the total data collected is shown in Figure 5-18.

The researcher analysed a total sample size of 360 household surveys from Sub-set 1 and Sub-set 2 in IBM SPSS to produce the results. As no monitoring surveys were undertaken from Korogocho settlement (Sub-set 1), the baseline data comprising of 29 household surveys has been excluded from the reporting and analysis. Collection of the data was facilitated by Umande Trust NGO.



**Figure 5-18 Summary of WaterChoices kiosks data collected**

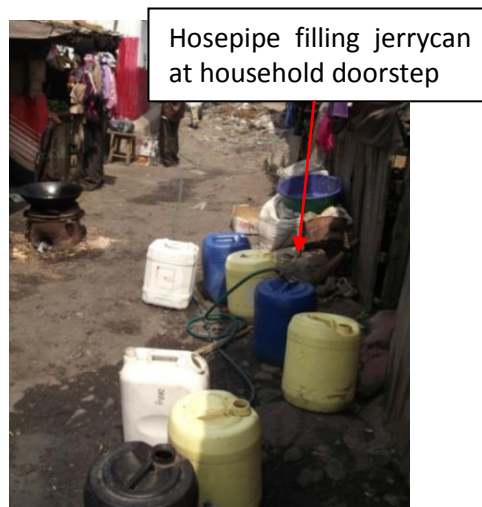
### 5.3.3 Sub-set 1: Mukuru-Ruben Results (Nairobi)

The complete Mukuru-Ruben data collected including site records notes and household survey results inputted into the conceptual framework are shown in Appendix C.3.1. Pilot experiments were implemented at two sites in Mukuru Ruben known as Heshima and Top 1 Bio-centres. The implementation period lasted approximately five months, with the hosepipe delivery service rolled out on a reel fully operational by July 2012 (see Figure 5-19 and Figure 5-20). At both sites it was not possible to introduce a different price for the different choices, due to reluctance from the management groups for fear that any price increases may result in a loss of their regular customers (O'Regan, 2012).

According to the literature, in global terms Mukuru-Ruben would best be described as a formal inner city settlement containing informal areas within, making the utilities job even more difficult.



**Figure 5-19 Meter bank at Top 1**  
(Source: Author, 2011)

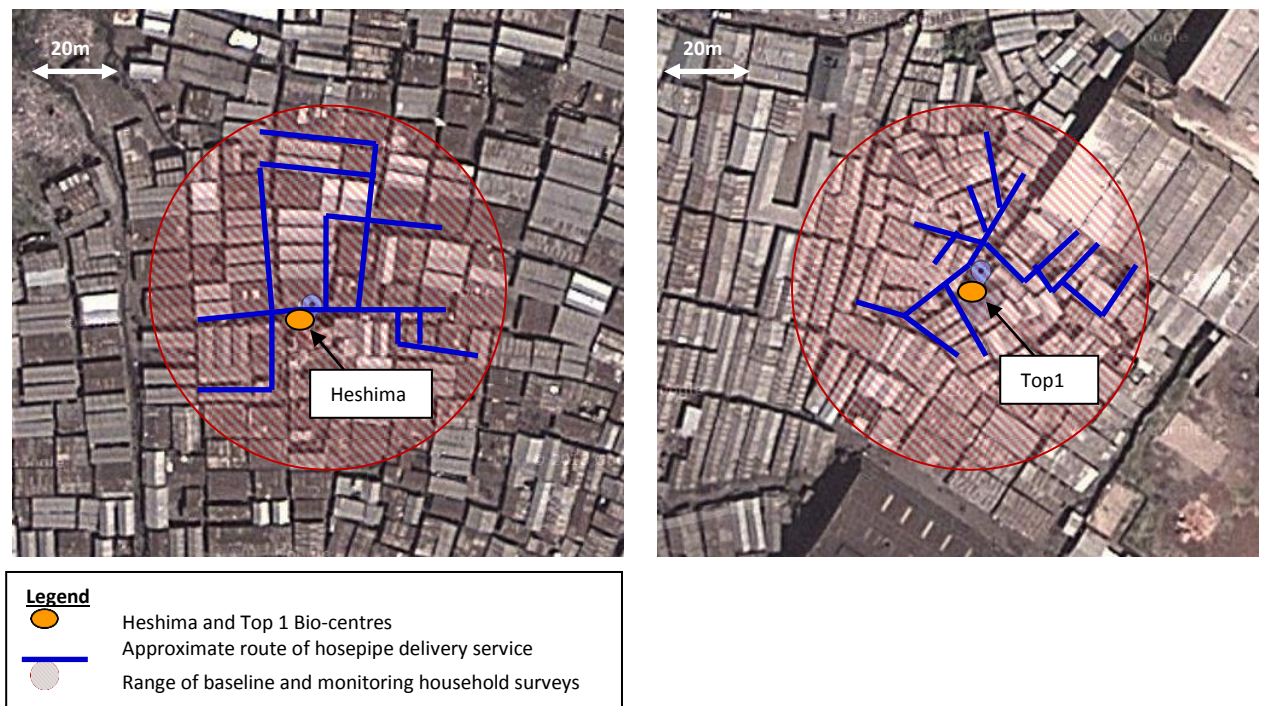


**Figure 5-20 Hosepipe 'door-step' delivery service in operation at Heshima**  
(Source: Author, 2013)

### 5.3.3.1 Function

#### 5.3.3.1.1 Access

The results showed that 67 per cent of the total respondents (124 adults) had benefitted from the 'door-step delivery' service over the monitoring period, reducing distances walked to the nearest water point down to 0 metres. At the end of the monitoring period for both Heshima and Top 1, approximately 125 households (~500 people) were mapped within a 100 metre radius as having used the service. At Heshima, coverage of the service was less, due to the presence of multiple water points representing stiffer competition from other water vendors (see Figure 5-21).



**Figure 5-21 Mukuru-Ruben mapping (© Google 2013)**

#### 5.3.3.1.2 Reliability

The main water source for the pilot intervention is from NCWSC. Over the monitoring period, 82 per cent of the total respondents regarded water from NCWSC as convenient with a reliable supply. Only 10 per cent of the total respondents stated that their water source was inconvenient due to water shortages. This was supported by daily water availability records kept by five members of the community living in Top 1 and Heshima zones in Mukuru-Ruben, over the three month period from June 2013 –

August 2013. The records, checked by the researcher at the end of each month, showed that water from the public utility was available on average 5-6 days per week.

### 5.3.3.1.3 Water Quality

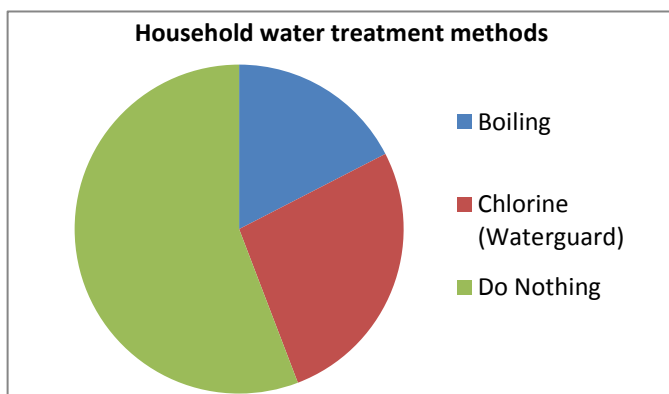
Water samples were taken to assess the quality of water from the collect and carry versus the hosepipe delivery service. Six water quality samples were taken from the following points at Heshima and Top 1: 2 no. from 20 litre jerrycans filled directly from the taps at the bio-centres (i.e. collect and carry), 2 no. directly from the end of the hosepipe and 2 no. from storage tanks filled directly via the hosepipe at the household door-step. Table 5-4 summarises the results for the faecal coliforms and *E. coli*, at concentration levels detrimental to health in accordance with the WHO guidelines on safe drinking water (WHO, 2008). The original test copies are included in Appendix C.3.2.

**Table 5-4 Mukuru-Ruben water quality test results n=6 (WHO Guideline 0 CFU/100ml)**

Location	Sample	Tested Results <i>E. coli</i> Organisms CFU / 100 ml	Tested Results Faecal Coliform CFU / 100 ml
Heshima	20 litre jerrycan	0	0
Heshima	Hosepipe	2.2	2.2
Heshima	Household storage tank (100 litres)	0	0
Top 1	20 litre jerrycan	0	0
Top 1	Hosepipe	0	0
Top 1	Household storage tank (75 litres)	>16	>16

The two samples that did not meet the WHO guidelines on safe drinking water from the hosepipe and household storage indicate that possibly the hosepipe and household storage containers were not being cleaned frequently. The majority generally rated their water quality as good, with a clear taste. 54 per cent confirmed treating their water prior to consumption, 22 per cent of whom had storage tanks with an average size of 100 litres. The most common treatment method reported was

Waterguard (Figure 5-22). One 150ml bottle retails at a fixed cost of KES 20 (USD\$ 0.25) in the settlements and can treat up to 420 litres of water (equivalent to 21 jerrycans).



**Figure 5-22 Mukuru-Ruben household water treatment methods (n= 124)**

### 5.3.3.2 Utilisation

#### 5.3.3.2.1 Uptake of Intervention

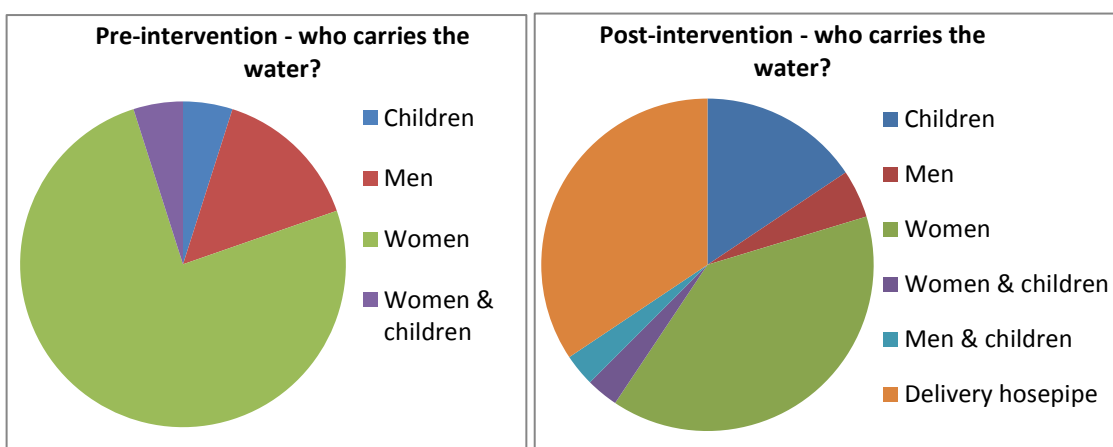
Despite no difference in price (see Table 5-5), the respondents who did not utilise the delivery service chose to continue walking and carrying water from their nearest water point (approximately 40 metres away), mainly due to low water pressure affecting the speed of the delivery service. Others also enjoyed the social aspects associated with meeting friends at the water points and did not mind walking and carrying water.

Of the 67 per cent (83 adults) who benefitted from the delivery service, a summary of the customer characteristics is shown in Table 5-5.

**Table 5-5 WaterChoices customers in Mukuru-Ruben (n=83)**

N=83 (67%)		Average no. of people in HH	Average Cost per 20 litre jerry can (KES)	Average Cost per 20 litre jerry can (USD\$)
Gender	% of beneficiaries			
Male	16%	4	4	0.06
Female	51%	4	4	0.06

Although the researcher noted that NCWSC was the main source of water in the area, semi-structured interviews revealed that most connections were likely to be illegal. Pre-intervention, from the 98 per cent of respondents who stated obtaining water from their main water point (kiosk/ tapstand) via collect and carry, 75 per cent confirmed it is mainly the women who shoulder this burden daily. Post-intervention, Figure 5-23 illustrates a significant 40 per cent reduction in the number of women still responsible for collecting and carrying water daily, as 34 per cent now made reference to the hosepipe delivery service as regular customers.



**Figure 5-23 Pre- and Post-intervention allocation of carrying water responsibilities in the household (n= 185)**

Of the total respondents, 31 per cent (mainly the women) stated that distance is the main factor in determining whether a water source is regarded as convenient or inconvenient.

### 5.3.3.2.2 Quantity

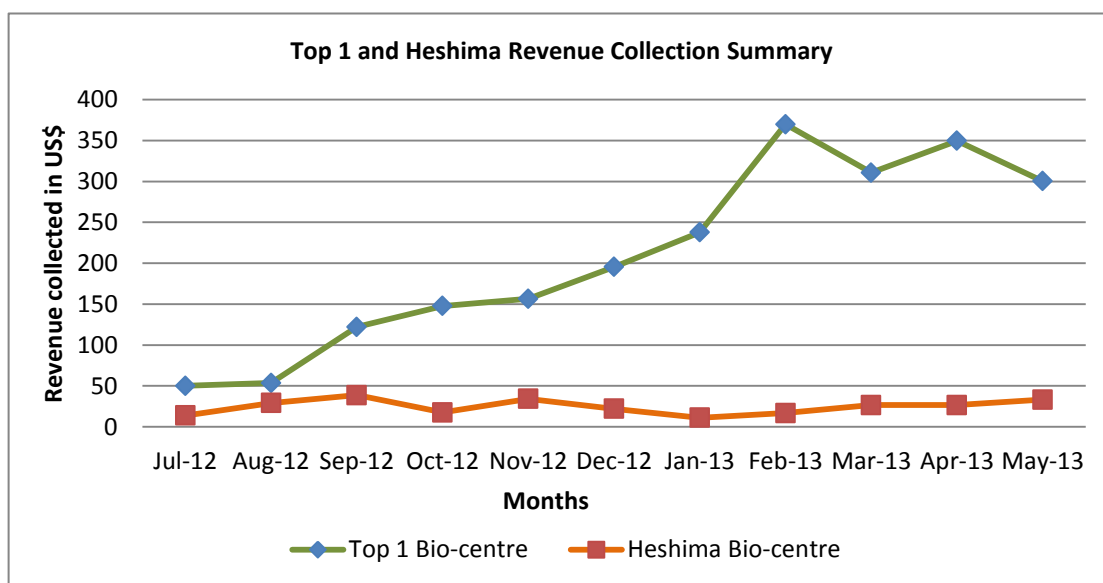
Baseline surveys revealed that prior to the intervention, the average number of jerrycans per household filled daily was 4, for an average of 4 people per household. Therefore the average household consumption per person per day was 20 litres for all domestic purposes (drinking, cooking, washing clothes, general cleaning etc). Over the monitoring period 73 per cent of respondents confirmed increasing the average consumption per person to 30 litres for all domestic purposes. During FGDs, the women confirmed that they enjoy the flexibility of purchasing more water via the

hosepipe delivery service. Additional quantities were mainly used for washing clothes and other household items that use large quantities of water such as bedding, personal hygiene and for businesses purposes to clean vegetables for sale.

### 5.3.3.3 Socio-economic Impacts

#### 5.3.3.3.1 Management

Steady records were maintained by the vendors over the monitoring period. Water sold per jerry can from Top 1 was more expensive than Heshima, at KES 5/jc and KES 3/jc, which was reflected in the revenue collected as shown in Figure 5-24.



**Figure 5-24 Mukuru-Ruben revenue collection records**

At Top 1, the graph clearly illustrates the steady increase in revenue from when the pilot came into operation in August 2012. Pre-intervention, the average monthly revenue generated by the vendor was reported at about KES 4,000 (USD\$ 50) and post-intervention the average monthly revenue increased to KES 20,000 (USD\$ 250), representing a staggering 400 per cent increase in revenue collection for the management group. The downside is the researcher was unable to determine if utility bills were being paid, creating no incentive for the utility to adopt the pilot as a long-term viable concept.



At Heshima the results were significantly lower and generally seemed to fluctuate within the same range averaging at KES 2,100 (USD\$ 26) per month, which was attributed to more competition in the area, the perception of 'dirty' water as some residents did not like the route the hosepipe passed to reach households and reluctance from the vendor in engaging new customers.

Notwithstanding the difficulties experienced, the results showed the pilot was able to: 1) generate increased revenue for the management group and the utility, 2) enable the management group to meet operation and maintenance costs and 3) continue operating at the end of the monitoring period, indicating a high level of empowerment of the local community.

#### **5.3.3.3.2 Affordability**

Pre-intervention, the baseline surveys showed that cost was the most commonly cited factor that was of most concern when buying water. The average price of water was calculated at KES4/j c, which is above the nationally approved tariff of KES 2/jc. During shortages, the average price per jerry can doubled to KES 8/jc. The average rent in the area was calculated as KES 1,300 (USD\$ 16). As new prices were not introduced with the intervention due to reluctance from the management groups, an increase in the household consumption (6 jerry cans per day), increased the average monthly cost of water in a typical 30 day month to KES 702 (USD\$ 9), which equates to 55 per cent of the average rent in the area.

#### **5.3.3.3.3 Acceptability**

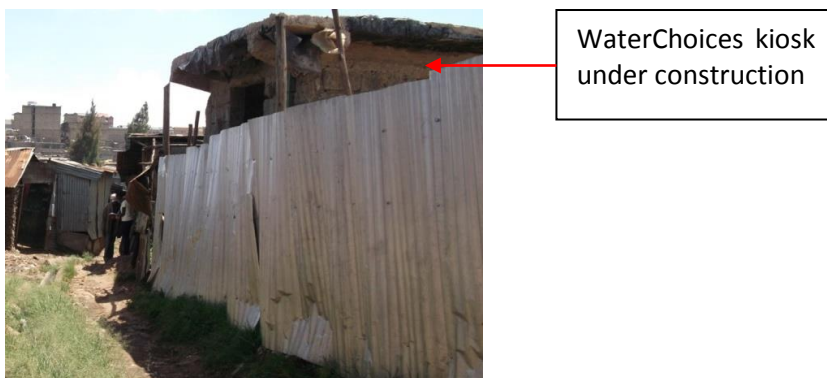
Over the monitoring period, 60 per cent of respondents confirmed that they were satisfied with the service, with the main advantages identified as time saved (50 per cent) and reduced effort (10 per cent). Residents also appreciated the accessibility of water at anytime especially in the evenings, with the women in particular expressing relief that they no longer had to leave their children unattended to fetch water.

The performance was also affected by external social factors which could not be quantified, such as the gender of the vendor. The female vendor at Heshima reported suffering from verbal abuse and in once instance physical abuse from men when

conducting the door-to-door delivery and attempting to collect payments, which had hindered the up-take of the intervention and affected her willingness to attract more customers.

#### **5.3.4 Sub-set 1: High Ridge, Korogocho Results (Nairobi)**

The initial investment was committed to the pilot at this location in July 2012. Despite this, when the researcher carried out baseline household surveys in November 2012, construction of the WaterChoices kiosk had not yet been completed (see Figure 5-25). Key informant interviews indicate the construction was not completed until June 2013. In summary, at the time of writing the WaterChoices kiosk had not been fully operational throughout the monitoring period.



**Figure 5-25 Korogocho WaterChoices kiosk (Source: Author, 2012)**

Key informant interviews with the project stakeholders suggests that the delays in implementing the pilot at this location during the specific timeframe was due to high-levels of insecurity in Korogocho and difficulties experienced in engaging the management group to adopt the pilot. The researcher was unable to access the site at the time of writing to verify the current status of the kiosk, however anecdotal evidence suggests that the management group had started selling water, but the WaterChoices aspect had not been introduced therefore the kiosk is was operating as per any other regular kiosk. For the purposes of this study, this pilot was considered as failed and no further monitoring surveys were undertaken. This result demonstrates the external factors that are difficult for an NGO to control and directly impact the success or failure of an intervention.

### 5.3.5 Sub-set 2: Bandani and Obunga Results (Kisumu)

The complete Bandani and Obunga data collected including site records notes and household survey results inputted into the conceptual framework are shown in Appendix C.3.3. Pilot experiments were implemented at two sites in Kisumu known as Bandani and Obunga bio-centres. At Bandani, the delivery service was implemented at the existing bio-centre via the management group. In Obunga the service was piloted using the two modes: 1) at the existing bio-centre via the management group and 2) via an independent water vendor in the same area, William Odera. Baseline data was collected in May 2012 and the implementation period lasted approximately three months, with the hosepipe delivery service rolled out on a reel fully operational by August 2012 (see Figure 5-26 and Figure 5-27). A price variation was introduced at Bandani for the different service levels i.e. KES 2/jc to collect and carry from the kiosk and KES 3/jc for hosepipe delivery. At Obunga it was not possible to introduce a difference in price due to resistance from the management group (O'Regan, 2012).



**Figure 5-26 Management group explaining hosepipe delivery service at Bandani (Source: Author, 2013)**



**Figure 5-27 Vendor William explaining hosepipe delivery service at Obunga (Source: Author, 2013)**

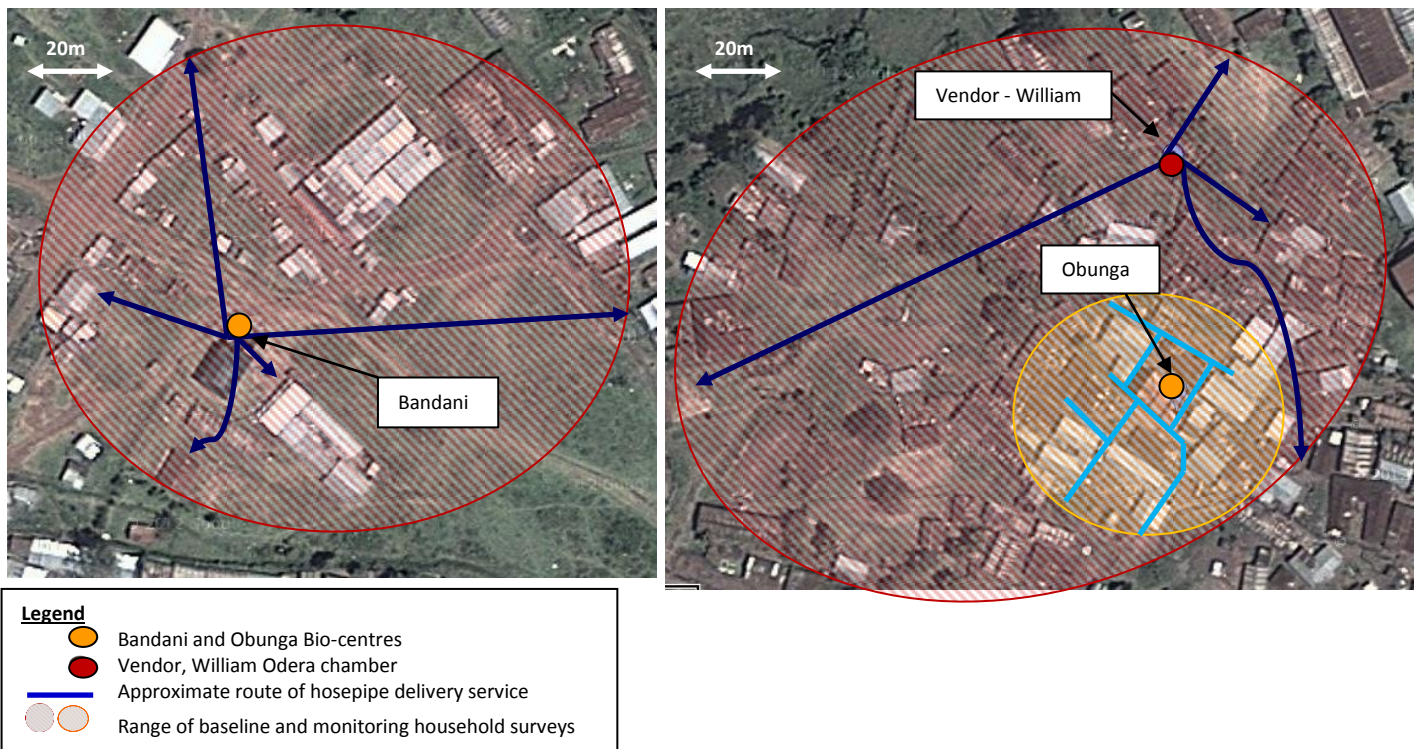
According to the literature, in global terms Bandani would best be described as an absorbed village and Obunga as a combination of peri-urban with formal inner city areas within. Generally the more spread out nature of absorbed villages and peri-

urban settlements should technically allow for easier utility access, however the integration of informal areas with varied typology presents challenges for the utility.

### 5.3.5.1 Function

#### 5.3.5.1.1 Access

The results showed that 80 per cent of the total respondents (120 adults) had benefitted from the 'door-step delivery' service over the monitoring period, reducing distances walked to the nearest water point down to 0 metres. At the end of the monitoring period for both Bandani and Obunga, approximately 175 households (~875 people) were mapped within a 150 metre radius as having used the service. At Bandani, coverage of the service was less due to the sparse population density and restricted length of the hosepipe to maintain pressure with the service (see Figure 5-28).



**Figure 5-28 Bandani and Obunga mapping (© Google 2013)**

#### 5.3.5.1.2 Reliability

In both Bandani and Obunga the main source of water was KIWASCO, however reliability of the public utility supply fluctuated heavily over the monitoring period. The

baseline surveys carried out in 2012 showed only 8 per cent of the total respondents regarded their water source as inconvenient due to water shortages, suggesting a fairly reliable supply. However in 2013, the new Kisumu-Busia bypass road was under construction, passing alongside both Bandani and Obunga which had a detrimental effect on the water supply and water pressure in both areas, crippling operation of the delivery service. During the FGDs residents stated that Bandani and Obunga had not received any water for the full months of March 2013 and May 2013. At the time of the FGD in May 2013, the researcher observed the dry taps and the delivery service was not in operation. At the end of the monitoring period in August 2013, although the water supply had returned, vendors complained that water was still scarce, available for an average of 2 days per week.

Residents openly discussed during the FGD that during such severe water shortages they resort back to using alternative expensive sources of water such as boreholes, and those who cannot afford to pay rely on a nearby river which was described as very dirty and unsafe resulting in stomach problems. Due to seasonal variations, if the river had dried up, residents were then forced to walk long distances in search of water. The researcher learned that previously, scarcity of water in the area brought about cases of cholera and typhoid.

#### **5.3.5.1.3 Water Quality**

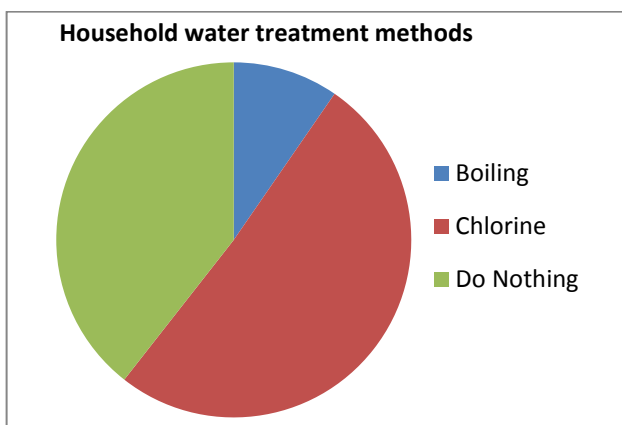
Water samples were taken to assess the quality of water from the collect and carry versus the hosepipe delivery service. Six water quality samples were taken from the following points at Bandani and Obunga: 2no. filled directly from the taps at the chambers (i.e. collect and carry), 2no. directly from the end of the hosepipe and 2no. from storage tanks filled directly via the hosepipe at the household door-step. Table 5-6 summarises the results for the faecal coliforms and *E. coli*, at concentration levels detrimental to health in accordance with the WHO guidelines on safe drinking water (WHO, 2008). The original test copies are included in Appendix C.3.4.

**Table 5-6 Bandani and Obunga water quality test results n=6 (WHO Guideline 0 CFU/100ml)**

Location	Sample	Tested Results <i>E. coli</i> Organisms CFU / 100 ml	Tested Results Faecal Coliform CFU / 100 ml
Bandani	From 'collect' tap	0	0
Bandani	Hosepipe	2.4	2.4
Bandani	Household storage tank (100 litres)	0	0
Obunga	From 'collect' tap	0	0
Obunga	Hosepipe	2.4	2.4
Obunga	Household storage tank (100 litres)	>18	>18

Similar to the Mukuru-Ruben results, the two samples that did not meet the WHO guidelines on safe drinking water were from the hosepipe and household storage that were possibly not being cleaned frequently. In Obunga, the vendor complained of occasional turbid water from the public utility supply, attributed to the bypass road construction works and following long periods of no water.

Over the monitoring period, 55 per cent confirmed treating their water prior to consumption, 45 per cent of whom had water storage tanks. The most common treatment method reported was Waterguard (Figure 5-29). One 150ml bottle retails at a fixed cost of KES 20 (USD\$ 0.25) in the settlements and can treat up to 420 litres of water (equivalent to 21 jerrycans).



**Figure 5-29 Obunga and Bandani household water treatment methods (n= 120)**

### 5.3.5.2 Utilisation

#### 5.3.5.2.1 Uptake of Intervention

At Bandani where a difference in price corresponding to service option was introduced, willingness to pay more for ‘door-step’ delivery service was realised by 45 per cent. Adoption of the ‘choice’ aspect was evident as customers recognised their ability to move between service options, depending on variable income, their immediate demand and a simple choice.

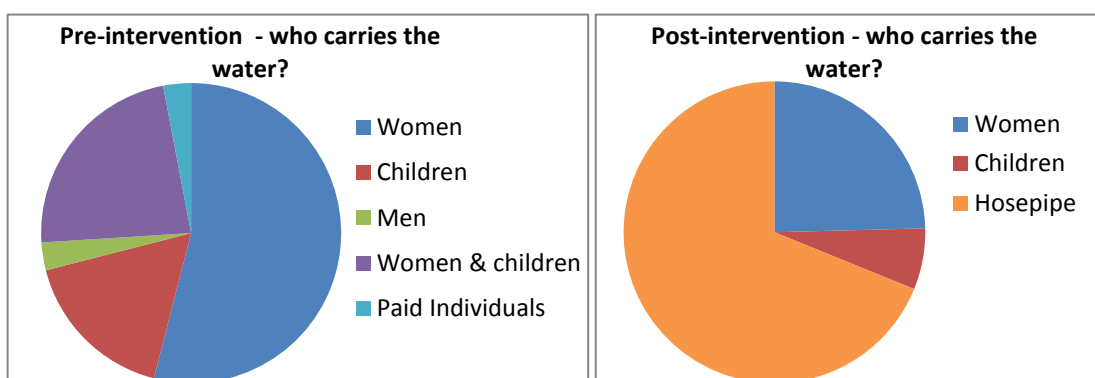
Respondents who did not utilise the delivery service (despite no difference in price in Obunga) stated this was mainly due to persistent water shortages and low water pressure with the public utility supply affecting the speed of the service, leaving customers in fear of missing out and opting to walk to the nearest kiosk/ waterpoint. Of the 80 per cent (96 adults) who benefitted from the delivery service, a summary of the customer characteristics is shown in Table 5-7.

**Table 5-7 WaterChoices customers in Bandani and Obunga (n=96)**

N=96 (80%)		Average no. of people in HH	Average Cost per 20 litre jerry can (KES)	Average Cost per 20 litre jerry can (USD)
Gender	% of beneficiaries			
Male	31	5	4	0.06
Female	49	5	4	0.06

Similar to the results from Mukuru-Ruben, pre-intervention 77 per cent confirmed the women (sometimes with children) are mainly responsible for obtaining water from their main water point (kiosk/ tapstand) via collect and carry. Post-intervention, Figure 5-30 illustrates a significant 52 per cent reduction in the number of women still responsible for collecting and carrying water daily, as 69 per cent now made reference to the hosepipe delivery service as regular customers.

During the FGDs residents confirmed the improved accessibility has saved time during the day which was generally used for household chores, resting and business.



**Figure 5-30 Pre- and Post-intervention allocation of carrying water responsibilities in the household (n= 121)**

#### 5.3.5.2.2 Quantity

Baseline surveys revealed that prior to the intervention, the average number of jerrycans per household filled daily was 6, for an average of 5 people per household. Therefore the average household consumption per person per day was 24 litres for all domestic purposes (drinking, cooking, washing clothes, general cleaning etc). Over the monitoring period 71 per cent of respondents confirmed increasing the average consumption per person to 36 litres for all domestic purposes. During FGDs, the women stated that since water had become more accessible, residents used between 2-3 additional 20 litre jerrycans per day for personal hygiene and household chores that used large quantities of water such as washing clothes. Key informant interviews with the vendors determined that during the rainy season the demand for the hosepipe delivery service dropped, as people tended to harvest rainwater. The researcher noted Western Kenya also experienced unseasonably high rainfall over the



Christmas period, which the vendor stated was reflected in sales. Additional beneficiaries of the delivery service were informal commercial traders who required large quantities of water such as local shops (selling vegetables etc.), bars and a local mini-brewery.

### 5.3.5.3 Socio-economic Impacts

#### 5.3.5.3.1 Management

In Bandani the management group is directly responsible for revenue collection and payment of the utility bills, and in Obunga, water is managed via the MO Obunga Watsan (under the DMM). Therefore any water vendors such as William Odera make payments based on consumption to the MO.

Steady records were maintained by the management group at Bandani over the monitoring period. The group confirmed there was demand for the service and that delivery continues when there is adequate pressure, which was supported by the vendor records. As illustrated in Figure 5-31 low water sales directly corresponded to the months that recorded a high number of days with no water. When water was available, the group stated revenue from water sales increased by over 100 per cent.

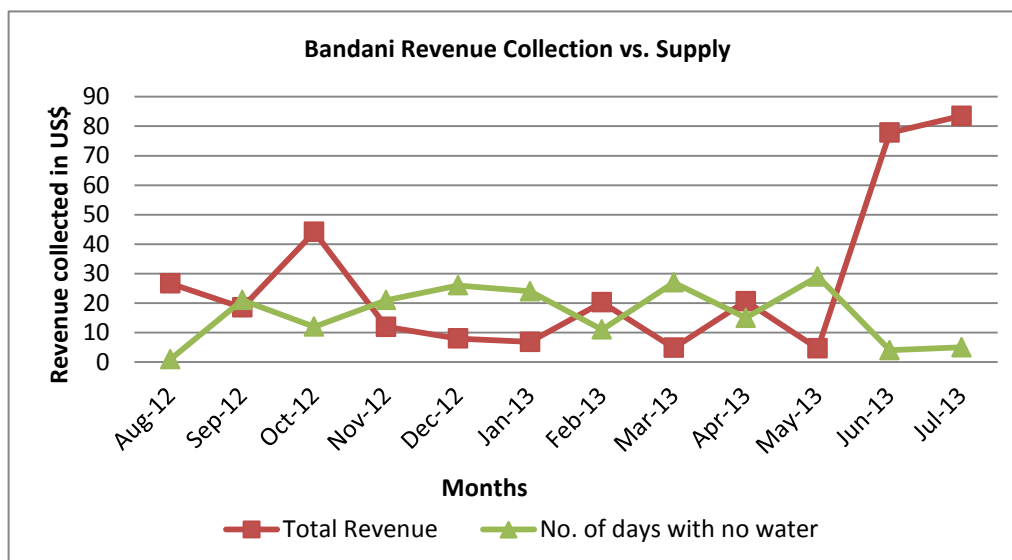


Figure 5-31 Bandani water records versus availability of supply

In Obunga, with the new WaterChoices equipment, vendor William Odera confirmed that he was able to move faster and consequently doubled his daily water sales to an average of KES 500 (USD\$ 6) per day, equating to KES 15,000 (USD\$ 188) in a typical 30 day month. Odera's self-reported average monthly utility water bill was ~ KES 5,000 (USD\$ 63) per month, therefore his monthly profit was estimated at KES 10,000 (USD\$ 125), demonstrating the viability (if not vendor 'profiteering') of the service. As discussed in the literature, William is effectively operating as a typical SSP unable to benefit from subsidies and passing the full cost of his service onto consumers at a premium, to guarantee the viability. Albeit his profit may be regarded as minimum, the price he sells water is still significantly higher than what urban poor consumers should and can afford to pay, hence the application of the term 'profiteering.'

Although steady records were not maintained by Odera, during key informant interviews he confirmed the high demand for his delivery service which operates from early morning hours and can continue late into the night, up to 11pm. The researcher observed that the service seemed extremely popular with customers calling him to secure deliveries for the day during the interview. William stated that with his increased revenue as a result of the intervention, he is able to educate his children.

#### **5.3.5.3.2 Affordability**

Pre-intervention, the baseline surveys showed the majority 57 per cent of respondents cited cost as the factor of most concern when buying water. Similar to Mukuru- Ruben, the average price of water was calculated at KES 4/jc, which is above the nationally approved tariff and escalated at the discretion of the vendor during water shortages. Although Bandani attempted to introduce new prices with the intervention at KES 2/jc for collect and carry and KES 3/jc for delivery, by the end of the monitoring period the price had increased to KES 3/jc and KES 4/jc respectively, due to persistent water shortages. In Obunga, despite the tariff being controlled by the DMM MO, the price remained fixed at KES 4/jc. KIWASCO stated that they were not aware of this set price in Obunga, as all MOs should not be selling water above the nationally approved tariff, bringing into focus the challenges faced by the utility in enforcing regulation (personal communication with Isaac Okoyo, Pro-poor Manager, KIWASCO, 17<sup>th</sup> May 2013).

The average rent in the area was calculated as KES 1,280 (USD\$ 16). Therefore, post-intervention an increase in the household consumption (8 jerrycans per day), increases average monthly cost of water in a typical 30 day month to KES 960 (USD\$ 12), which equates to a staggering 75 per cent of the average rent in the area.

#### **5.3.5.3.3 Acceptability**

Over the monitoring period, 55 per cent of respondents confirmed that they were satisfied with the service, with the main benefits cited time savings (43 per cent) and convenience benefits (12 per cent). Similar to Mukuru-Ruben results, the performance was also affected by external social factors including the gender of the vendor. Conversely in this setting, women complained that the male vendor was intimidating in the household and they had no privacy during the delivery, causing them to opt out of the service.

## 5.4 Self-supplied Boreholes

### 5.4.1 Concept Description

Privately owned boreholes have become a key water supply intervention for the urban poor, however the literature discussing dependency on self-supplied groundwater suggests that their cost is high and their regulation is not enforced. Typically, one would expect to find groundwater dependence where public utility supply is lacking. This research targeted LIS consumers of borehole water located in Nairobi, in a range of settings including churches, communal centres and schools. The boreholes were operated by various autonomous SSPs including community groups, entrepreneurs and institutional stakeholders. Where there was third party involvement, typically, the infrastructure capital investment had been provided by NGOs and management had been directly handed over to SSPs to operate and maintain. Water from boreholes was generally sold directly to consumers from kiosks and vendors within the settlement which are prominent, and/ or distributed via tankers. The results outlined are based on data collected from the three LIS: Kayole-Soweto, Mukuru-kwa-Njenga and Kawangware (Figure 5-32 and Figure 5-33).



**Figure 5-32 Borehole in Kawangware**  
(Source: Haki Water, 2011)



**Figure 5-33 Borehole in Kayole-Soweto**  
(Source: Haki Water, 2011)

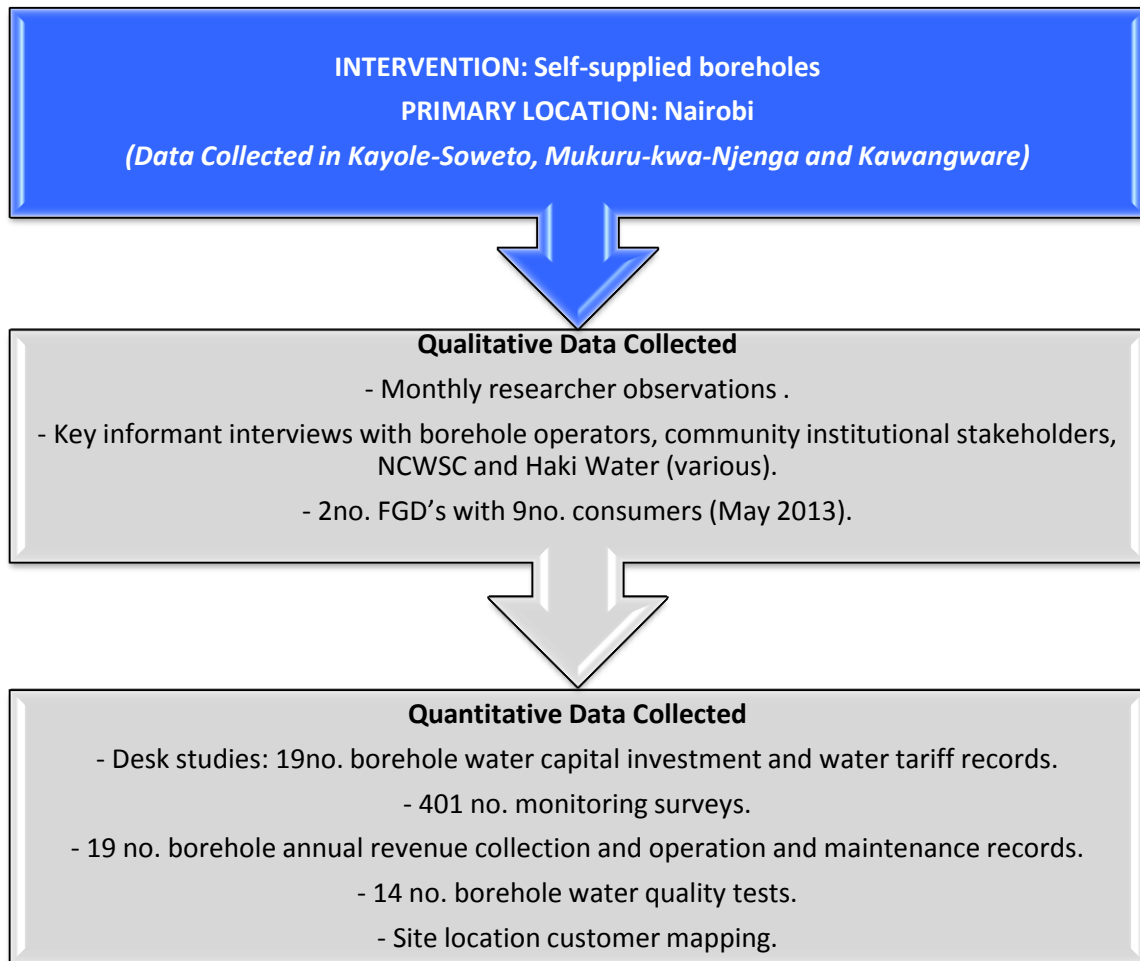
As mentioned earlier, Kayole-Soweto would best be described as a peri-urban settlement and Mukuru as a formal inner city settlement more difficult for the utility to access. Similar to Kayole-Soweto, Kawangware would be described as a peri-urban

settlement, although the researcher noted the settlement was less dense and less technically challenging for the utility.

#### **5.4.2 Data Collected**

The baseline monitoring data was collected over the period September 2010 - September 2013. As it was not possible to collect baseline data before the boreholes were drilled, the results reflect the prominence of groundwater supply in the LISs despite other ongoing municipal and civil society water supply interventions in the same locations. Detailed records of the qualitative and quantitative data collected and the complete set of results logged over the duration have been inputted by the researcher into the conceptual framework included in Appendix C.4.1. A summary of the data collected is shown in Figure 5-34.

The researcher analysed a total sample size of 401 household surveys in IBM SPSS to produce the results. Collection of the data was facilitated by Haki Water.



**Figure 5-34 Summary of self-supplied boreholes data collected**

### 5.4.3 Results

#### 5.4.3.1 Function

##### 5.4.3.1.1 Access

In Kayole-Soweto and Kawangware settlements, the distance between two boreholes was observed ranging from 100 – 200m and in some cases less than 100m, when statutory licences required to drill a borehole stipulate that one borehole should not be located within 800 metres of another (Water Resources Management Authority, 2011b). The deepest boreholes, at 300m+, were all found in Kawangware settlement, an area already identified as having 7-13 boreholes per square kilometre (Water Resources Management Authority, 2011b), suggesting the need to investigate further potential localised environmental impacts such as depleting groundwater levels due to excessive abstraction. Table 5-8 shows an increase in drilling depths from approximately 200m to 250m over the period. The extent to which this is due to reducing groundwater depths as opposed to over-drilling by contractors was difficult to ascertain.

**Table 5-8 Borehole depths (m) 1979 – 2010 (n= 19)**

Borehole No.	Year Drilled	Borehole Depths (m)
1	1979	120
2	2000	250
3	2004	200
4	2005	268
5	2006	200
6	2007	310
7	2007	300
8	2007	240
9	2007	180
10	2007	200
11	2007	250
12	2009	300
13	2009	180
14	2009	180
15	2009	250
16	2009	230
17	2010	240
18	2010	250
19	2010	250

When surveyed, 34 per cent of the total respondents (401 adults) reported boreholes provide an accessible source of drinking water to within 100m (or less) of households at best, also verified by observations. 26 per cent of respondents reported longer walking distances of 100-500m, while 13 per cent reported distances of 500-1000m. Interestingly, as shown in Table 5-9, although majority of the total respondents were women, majority of the men reported the longer carrying distances of over 100m. The remaining respondents who did not know have been excluded from the table.

**Table 5-9 Self-supplied borehole customers**

N=401		Average distance from HH to BH (m) % of total			Average no. of people in HH	Average Cost per 20 litre jerry can (KES)	Average Cost per 20 litre jerry can (USD)
Gender	Frequency %	100m (or less)	100-500m	500-1000m			
Male	36	7	13	7	4	4	0.06
Female	64	28	13	6	4	4	0.06

#### **5.4.3.1.2 Reliability**

The main water sources in the area are from boreholes and NCWSC. The results showed that eleven out of the nineteen boreholes were drilled in the years 2007 and 2009. Anecdotal evidence indicates in 2007, unusually low rainfall triggered a severe drought sending food prices soaring due to the shortage. The effects of this drought continued through late 2009, when another devastating drought swept the country leaving NCWSC taps in the LIS dry.



Table 5-10 also suggests that the pressure for additional boreholes lead to an increase in cost of drilling at the time of the drought, leading to a 10 year average drilling cost (nominal) of USD\$ 108 per metre but a likely real terms decrease in drilling costs, setting aside emergency drought drilling costs.

**Table 5-10 Drilling cost (USD\$) per metre 1979 – 2010 (n= 19)**

Borehole No.	Borehole Depths (m)	Drilling Cost USD	Cost (USD) per metre
1	120	15,000	125
2	250	20,000	80
3	200	18,750	94
4	268	22,500	84
5	200	20,630	103
6	310	25,000	81
7	300	25,000	83
8	240	22,500	94
9	180	18,750	104
10	200	22,500	113
11	250	37,500	150
12	300	22,500	75
13	180	20,000	111
14	180	25,000	139
15	250	37,500	150
16	230	50,000	217
17	240	18,750	78
18	250	20,449	82
19	250	25,000	100

#### **5.4.3.1.3 Water Quality**

Water samples were taken to assess the quality of water borehole water across the LIS studied. In total 14 water quality samples were taken over the period as follows: 9 in 2011, 2 in 2012 and 3 in 2013 (2012 and 2013 results were focused in Kayole-Soweto only).

Table **5-11** summarises the results for the faecal coliforms, *E. coli* and fluoride at concentration levels detrimental to health in accordance with the WHO guidelines on safe drinking water (WHO, 2008). The test results were provided by Haki Water and original test copies are included in Appendix C.4.3.

**Table 5-11 Borehole water quality test results (n=14)**

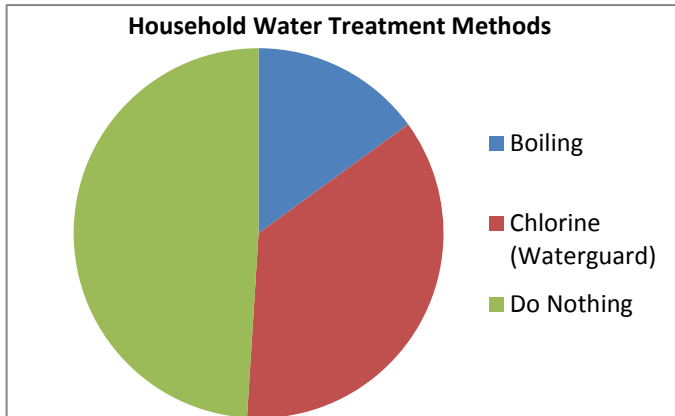
Tested Results	Replicate	Kayole-Soweto			Mukuru-kwa Njenga			Kawangware		
		Galilee school	Flomina CH	Kwa-watoto school	Kwa Patel	St. Mary's Church	Next to St. Marys Church	Sweet water	Deliverance Church	Emmanuel Church
Total Coliform	1	210	1	0	178	26	2,420	48	2,420	0
	2	0	16	-						
	3	0	0	5.1						
<i>E. coli</i>	1	0	0	0	137	0	0	36	214	0
	2	0	0	-						
	3	0	0	0						
Fluoride	1	2.05	2	2.03	9.4	7.4	0.42	2.3	3.5	5
	2	12	4.11	-						
	3	1.75	4.02	8.26						

- 1) Total Coliform WHO Guideline – Nil No/100ml
- 2) *E. coli* WHO Guideline – Nil No/100ml
- 3) Fluoride WHO Guideline – 1.5 mg/l

None of the water samples met the WHO guidelines on safe drinking water. Alarmingly total coliform levels over the set guideline (Nil no/100ml) were recorded in over half of the samples. *E. coli* levels were recorded in three of the samples that served community groups, when the WHO guideline is Nil no/100ml. The highest fluoride levels of 9.4 mg/l and 7.4 mg/l recorded in Mukuru-kwa-Njenga, greatly exceeded the WHO guideline of 1.5mg/l (WHO, 2008).

Poor drinking-water quality was repeatedly cited by 38 per cent of the total respondents as the factor of most concern when buying borehole water, with numerous complaints regarding the “salty” taste. Notwithstanding this, approximately half of the respondents (49 per cent) do nothing to treat their water, mostly due to the additional costs associated with treatment. From the 51 per cent who do treat their

water, the majority (35 per cent) had water storage tanks with an average size of 70 litres. The most common treatment method reported was Waterguard (Figure 5-35). One 150ml bottle retails at a fixed cost of KES 20 (USD\$ 0.25) in the settlements and can treat up to 420 litres of water (equivalent to 21 jerrycans).

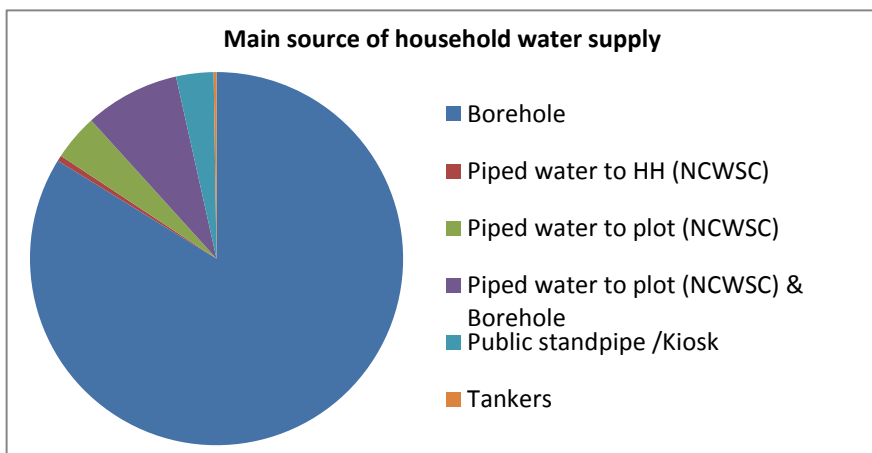


**Figure 5-35 Self-supply household water treatment methods (n= 401)**

### 5.4.3.2 Utilisation

#### 5.4.3.2.1 Uptake of Intervention

From the total respondents surveyed over the monitoring period, 60 per cent confirmed relying on borehole water only, while 21 per cent used a combination of borehole supply and NCWSC supply (see Figure 5-36).



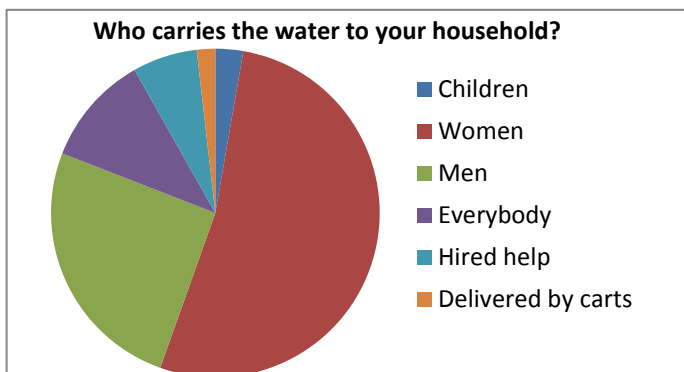
**Figure 5-36 Main source of household water supply (n=401)**

In total, 81 per cent of consumers of borehole water confirmed it is the only reliable supply in their location available 7 days per week. Those who used a combination of

both sources stated that this was due to unreliable NCWSC supply, therefore borehole water was a necessary supplement to meet their daily needs.

Only 15 per cent of respondents confirmed using borehole water because of the proximity to the household, suggesting distance is not the main driving factor in determining whether to access borehole water. There was no significant improvement in access to borehole water over the monitoring period, with the majority continuing to walk long distances of over 100 metres.

Not surprisingly, the results showed that the women shoulder the responsibility within the household for collecting and carrying water daily (reported by 53 per cent), which also remained unchanged over the monitoring period (see Figure 5-37).



**Figure 5-37 Allocation of carrying water responsibilities in the household (n= 401)**

The researcher mapped approximately 300 households (~1,200 people) per borehole up to distances of 500m that regularly rely on borehole water. However the researcher anticipated this number is likely to be much higher in droughts or water shortages as people walk longer distances in search of water.

#### **5.4.3.2.2 Quantity**

Over the monitoring period, the average number of jerrycans per household filled daily was 6, for an average of 4 people. Therefore the average household consumption from borehole water per person per day was 30 litres. During FGDs respondents confirmed borehole water is preferred for washing clothes and household chores which use large quantities of water, but similarly not for drinking due to a “salty” taste.

However the groups also stated that due to prevalent water shortages in the area, often there is no other option other than boreholes for drinking water.

### 5.4.3.3 Socio-economic Impacts

#### 5.4.3.3.1 Management

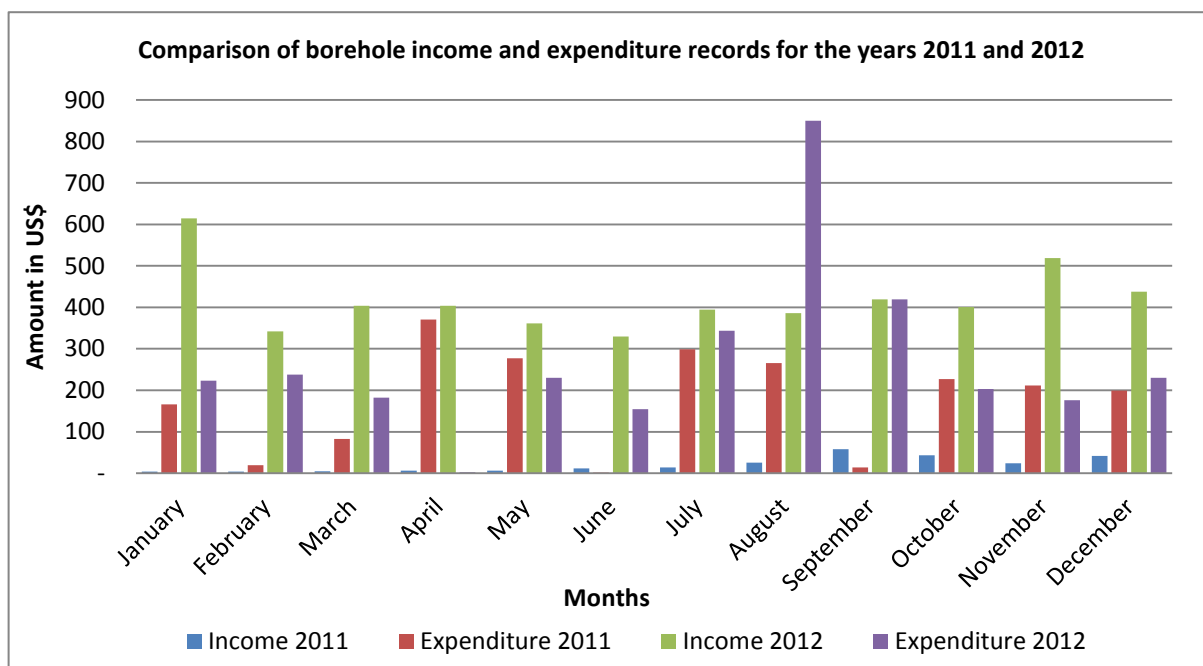
As shown in Table 5-12, data was obtained for a total of 19 boreholes in the three LIS: 3 from Kayole-Soweto, 4 from Mukuru-kwa Njenga and 12 from Kawangware. The average investment to drill a borehole was calculated as a KES 2.2 million (USD\$ 27,500), for an average depth of 230m. Appendix C.4.2 provides a detailed inventory and mapping of all the boreholes studied.

**Table 5-12 Summary of borehole data**

Borehole Location (Names)	Year Drilled	Depth	Drilling Cost (KES)	Drilling Cost USD	Stakeholder Ownership
Kayole-Soweto - Galilee school	2006	200	1,650,410	20,630	Community (financed by NGO)
Kayole-Soweto - Flomina childrens' home	2007	180	1,500,000	18,750	Community (financed by NGO)
Kayole-Soweto - Kwa-watoto school	2007	200	1,800,000	22,500	Community (financed by NGO)
Mukuru-kwa Njenga - Kwa Patel	1979	120	1,200,000	15,000	Entrepreneur (self-financed)
Mukuru-kwa Njenga - St. Mary's Church	2004	200	1,500,000	18,750	Community (financed by NGO)
Mukuru-kwa Njenga - Chiefs office	2007	240	1,800,000	22,500	Institution
Mukuru - Komedo	2010	240	1,500,000	18,750	Community (financed by NGO)
Kawangware – Deliverance Church	2000	250	4,000,000	20,000	Entrepreneur (self-financed)
Kawangware - Homestead	2005	268	1,635,899	22,500	Entrepreneur (self-financed)
Kawangware - Mosque (Muslim)	2007	250	1,800,000	37,500	Community (financed by NGO)
Kawangware - Sweet water	2007	310	2,000,000	25,000	Entrepreneur (self-financed)
Kawangware - Kwa Raila	2007	300	2,000,000	25,000	Entrepreneur (self-financed)
Kawangware - Kwa Njoroge	2009	300	2,000,000	22,500	Entrepreneur (self-financed)
Kawangware – Kwa Nguma	2009	180	1,600,000	25,000	Entrepreneur (self-financed)
Kawangware – Kwa Wacheke	2009	180	1,600,000	20,000	Entrepreneur (self-financed)
Kawangware - Emmanuel Church	2009	230	3,000,000	50,000	Community (financed by NGO)
Kawangware - International Management	2009	250	1,800,000	37,500	Community (financed by NGO)

Kawangware - Kabazi (Kwa Margaret)	2010	250	3,000,000	25,000	Entrepreneur (self-financed)
Kawangware - Girl Child School	2010	250	6,000,000	20,449	Community (financed by NGO)

Steady records were obtained for one borehole in Kayole-Soweto for the period 2011-2012, showing the income for water sold per jerrycan at KES 3/jc and the expenses in the electricity bills incurred pumping water (see Figure 5-38).



**Figure 5-38 Borehole income and expenditure for 2011 and 2012**

The results show a dramatic increase by 20 times in the income from selling borehole water from KES 1,618 (USD\$ 20) to KES 33,416 (USD\$ 418) in 2012. The expenditure on electricity bills also increased by 50 per cent from KES 14,233 (USD\$ 178) to KES 21,683 (USD\$ 271). However, due to the significant increase in income from water sales in 2012, with the exception of the month of August 2012, the income was adequate to meet the electricity bills – a significant difference from the previous year. This increase and empowerment of the institution to meet operational costs demonstrating the viability of the intervention could be attributed to initiatives by the project implementing partner around water treatment and training, increasing the ‘marketability’ of the water, coupled with ongoing water shortages.



#### **5.4.3.3.2 Affordability**

From the consumer surveys, the average price of water was calculated at KES 4/jc which is above the nationally approved tariff. During shortages, the average price per jerrycan increased to KES 8/jc. Surveys of the areas studied showed 74 per cent of the total respondents earn a monthly income of KES 10,000 (USD\$ 125) or less and pay monthly rent averaging at KES 1,800 (USD\$ 23). Therefore, in a typical 30 day month the average cost of buying water (6 jerrycans per day) can account for up to 14 per cent of their monthly income, which is equivalent to 60 per cent of the average rent. Despite the high costs, only 18 per cent of respondents cited cost as of most concern when buying borehole water, indicating other factors were more prominent.

Key informant interviews with the borehole operators consistently highlighted unaffordable electricity bills associated with pumping as a significant challenge. The average range of electricity bills recorded was around KES 20,000 (USD\$ 250) per month in normal conditions and up to KES 70,000 (USD\$ 875) per month during the drought season. Over the monitoring period, one community stakeholder was actively fundraising for a shortfall of KES 50,000 (USD\$ 625) to avoid disconnection. Due to persistent power shortages within the settlements, one in three stakeholders had found it necessary to purchase and/or fundraise for a generator estimated at a cost of KES 800,000 (USD\$ 10,000). The additional cost incurred to purchase the diesel also increased their monthly operational costs estimated at an additional KES 8,000 (USD\$ 100) for an 8 hour day. Those without generators reported power outages for periods of up to three weeks, leaving them forced to turn away consumers and revert to buying expensive and unsafe water from other vendors in the area.

#### **5.4.3.3.3 Acceptability**

Over the monitoring period, only 10 per cent of respondents confirmed that they were satisfied with the service. The majority, 40 were most concerned about the poor water quality of borehole water followed by 22 per cent who complained about the long walking distance, the high cost was identified by 20 per cent and the remaining 18 per cent complained about the time involved.

## 5.5 Conventional Consumer Group

### 5.5.1 Results

In an effort to understand the views of conventionally connected consumers, almost by definition higher-income groups, snowball sampling was undertaken via an online survey to gain knowledge from higher-income consumers who generally do not form the target of such research studies and are more difficult to access. The survey was completed by 61 male and female adults aged between 25 and 35 years, with an average family size of three. All respondents were permanently employed, with 64 per cent earning a net salary over KES 100,000 (USD\$ 1,250) per month.

The results revealed that 81 per cent of the respondents use NCWSC pipe supply as their main source of water, followed by 22 per cent who confirmed relying on private boreholes located within their compound as their primary source of water. The majority, 62 per cent, stated their average monthly bills range between KES 500 – 1,500 (USD\$ 6- USD\$ 18) for unrestricted usage and no associated maintenance costs. None of the respondents were aware of how much water they consumed for all domestic purposes on a daily basis. When asked if they would be willing to pay more for water in order to help Nairobi's urban poor gain access to clean water, 64 per cent said 'yes' they would be willing to pay more and 34 per cent said 'no,' with no reasons specified. Table 5-13 shows a comparison between the average monthly spend on water between the low-income consumers and higher-income consumers. The results clearly illustrate that higher income consumers spend less time, effort and money in accessing better quality water.

**Table 5-13 Average monthly spend on water (n= 61)**

Consumers	Regular		Drought	
	KES	USD\$	KES	USD\$
Low-income	630	8	3,000	38
Higher-income	500	6	1,500	18

However overall, the conventionally connected group results provided limited value to the research and proved relevant to Nairobi residents only.

## 5.6 Summary of Results for all Four Interventions

Table 5-14 summarises the results, demonstrating the advantages and disadvantages of each intervention. With the exclusion of the baseline data obtained for Korogocho (29 no.) and higher-income group surveys (61 no.), the final results presented are based on a total sample size of 1,168 household surveys.

**Table 5-14 Summary of results for all four interventions**

	Advantages	Disadvantages
<b>Utility-Led Interventions</b>		
<b>Social Connections</b>	<ul style="list-style-type: none"> <li>- Total sample size 170 households.</li> <li>- Investment cost per head estimated at USD\$ 9.</li> <li>- 78% benefitted from metered social connections within their plot.</li> <li>- 50% of customers satisfied most valued the convenience and reduced walking distance.</li> </ul>	<ul style="list-style-type: none"> <li>- Highly unreliable public utility supply, available 1-2 days per week threatens long-term viability.</li> <li>- 100% of total beneficiaries still relied on borehole water.</li> <li>- Despite connection subsidies, poor paying twice for unsafe, alternative sources of water.</li> <li>- Other indirect costs for the poor reflected by 30% increase in number of residents with a household water storage tank.</li> <li>- Resistance from landlords hindered uptake of the intervention.</li> <li>- Utility billing process not transparent to landlords.</li> <li>- Not on track to meet OBA targets.</li> </ul>

Pre-paid Meters	<ul style="list-style-type: none"> <li>- Total sample size 237 households.</li> <li>- Investment cost per head estimated at USD\$ 11.</li> <li>- 100% benefitted from pre-paid meters within their plot.</li> <li>- 73% increased water consumption per household; 23% reported improved hygiene.</li> <li>- Reduced waiting times at meters.</li> <li>- 95% reduction in the water utility bill for landlords/ ladies.</li> <li>- 75% reduction in the water cost for customers.</li> <li>- Less conflict between landlords and tenants.</li> <li>- 94% of customers satisfied most valued most valued the reduced price.</li> </ul>	<ul style="list-style-type: none"> <li>- Unreliable utility water supply, available 3-4 days per week.</li> <li>- 32% increase in burden on women carrying daily.</li> <li>- Operation and maintenance challenges threaten long-term viability.</li> </ul>
	<b>Civil Society-Led Interventions</b>	
WaterChoices	<ul style="list-style-type: none"> <li>- Total sample size 360 households.</li> <li>- Investment cost per head estimated at USD\$ 8.</li> <li>- 73% benefitted from 'door-step' delivery access.</li> <li>- 43% reduction in number of women carrying water.</li> <li>- 72% increased water consumption per household.</li> <li>- Over 100% revenue increase for one management group.</li> <li>- 4no. vendors gained employment.</li> <li>- 58% of customers satisfied most valued time and energy savings.</li> </ul>	<ul style="list-style-type: none"> <li>- Adjustment in prices not possible due to resistance from management groups.</li> <li>- Beneficiaries still paying higher prices, above the nationally approved tariff.</li> <li>- No improvement in water quality from introducing different distribution mechanisms.</li> <li>- Operation hindered by unreliable utility water supply.</li> <li>- Overall performance affected by the local management group threatens long-term viability.</li> </ul>

Self-supplied boreholes	<ul style="list-style-type: none"> <li>- Total sample size 401 households.</li> <li>- Investment cost per head estimated at USD\$ 23.</li> <li>- 81% of low-income residents relied on borehole water supply.</li> <li>- Reliable supply available 7 days per week, 24 hours a day.</li> <li>- 19no. vendors gained employment.</li> <li>- Increased revenue for one management institution by 30 times over 1 year.</li> </ul>	<ul style="list-style-type: none"> <li>- Long walking distances up to 1km to access borehole water.</li> <li>- 53% of women shoulder the burden for carrying water daily.</li> <li>- Not preferred for drinking due to “salty” taste.</li> <li>- Average price twice nationally approved tariff, escalating during droughts.</li> <li>- None of the 14 no. Water quality samples met WHO guidelines on safe drinking water.</li> <li>- Only 18% of customers satisfied.</li> </ul>
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The next Chapter aggregates the results in comparing the service received by the end-users for the four interventions.

## 6 COMPARATIVE ANALYSIS OF RESULTS

### 6.1 Service Level Analysis

#### 6.1.1 Results

The results for each intervention were aggregated to obtain an overall averaged result for insertion into the service level framework. Figure 6-1 and Figure 6-2 reflects the results under each service criterion at baseline and at the end of the monitoring period using a simple tabular two colour traffic light system. For simplicity, the results highlighted in green represent a positive improvement in the relevant service criterion, and the results highlighted in red represent a negative and/ or 'no change' scenario at the end of the monitoring period. Presenting the results using this system allows the reader to easily diagnose the service criteria progress between the case studies, illustrating which intervention made the most progress in the services received by the end users and which service criterion held back the overall progress. The selected service criteria were comparable against all the interventions with the exception of the water quality criterion which was not applicable to the two utility-led interventions where water quality samples were not taken. As shown, the two civil society-led interventions, struggled to progress affordability and the water quality criteria, while the utility-led interventions were penalised for unreliable water supply.

#### At Baseline

	Access (m)	Quantity (l/c/d)	Reliability (days of supply/wk)	Affordability (US\$ /m3)	Quality (% of samples-ve for E.Coli)	Acceptability (% of satisfied customers)
WaterChoices	50	22	4	2.50	No data	53
Self-supply BH's	100	25	7	2.50	67	35
Pre-paid Meters	30	20	3-4	3.13	No data	10
Social Connections	50	30	1-2	2.50	No data	24

	Access (m)	Quantity (l/c/d)	Reliability (days of supply/wk)	Affordability (US\$ /m3)	Quality (% of samples-ve for E.Coli)	Acceptability (% of satisfied customers)
WaterChoices	Unsatisfactory	Problematic	Basic	Basic	No data	Acceptable
Self-supply BH's	Unsatisfactory	Problematic	Very good	Basic	Basic	Basic
Pre-paid Meters	Basic	Problematic	Basic	Problematic	No data	Problematic
Social Connections	Unsatisfactory	Basic	Problematic	Basic	No data	Problematic

Figure 6-1 Baseline service criteria results versus service levels

**End of Monitoring Period**

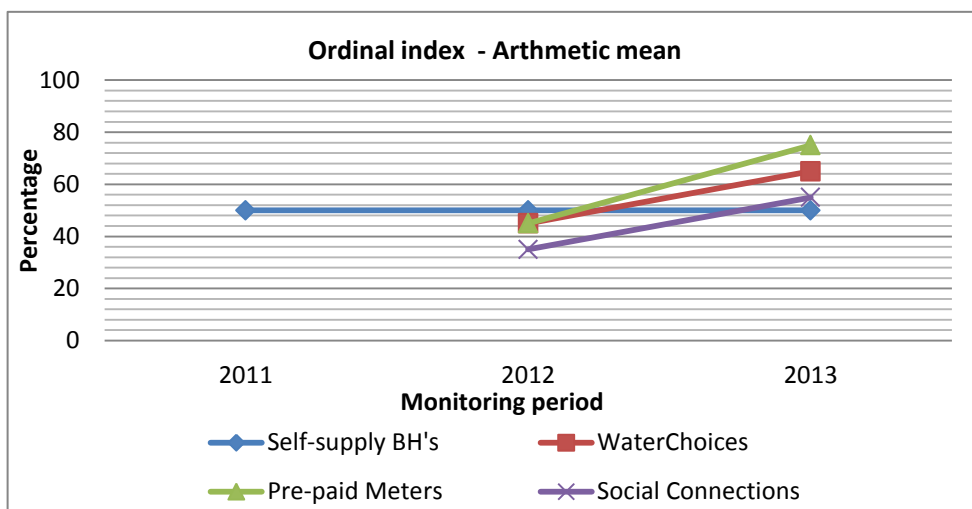
	Access (m)	Quantity (l/c/d)	Reliability (days of supply/wk)	Affordability (US\$ /m3)	Quality (% of samples-ve for E.Coli)	Acceptability (% of satisfied customers)
WaterChoices	0	35	4	2.50	58	58
Self-supply BH's	100	23	7	1.88	63	18
Pre-paid Meters	15	30	3-4	0.75	No data	94
Social Connections	10	30	1-2	1.88	No data	49

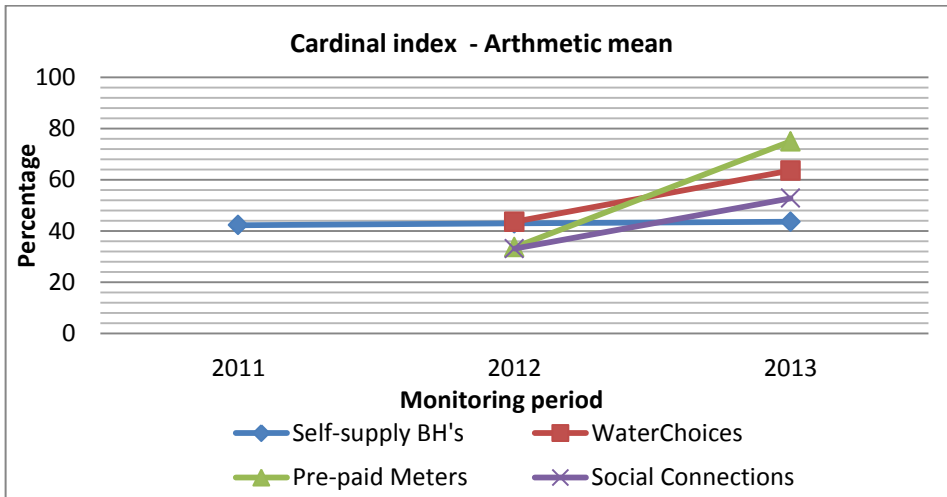
	Access (m)	Quantity (l/c/d)	Reliability (days of supply/wk)	Affordability (US\$ /m3)	Quality (% of samples-ve for E.Coli)	Acceptability (% of satisfied customers)
WaterChoices	Very good	Basic	Basic	Basic	Problematic	Acceptable
Self-supply BH's	Unsatisfactory	Problematic	Very good	Acceptable	Basic	Problematic
Pre-paid Meters	Acceptable	Basic	Basic	Very good	No data	Very good
Social Connections	Acceptable	Basic	Problematic	Acceptable	No data	Basic

**Figure 6-2 End of monitoring service criteria results versus service levels**

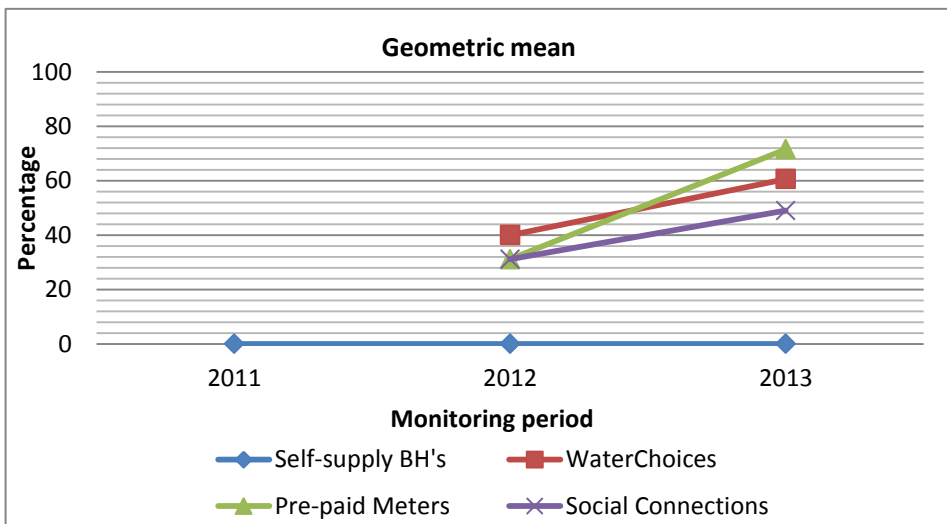
Of the three indexing methods tested, the indexing methods using the arithmetic mean of ordinal and cardinal numbers proved most effective in demonstrating the average service progress over the monitoring period. Use of the geometric mean was not fully effective, due to difficulties experienced in reflecting the lower service level descriptor for the Self-supplied boreholes, where multiple service criteria displayed negative progress. Notwithstanding this, the geometric mean still served as a helpful comparison of the service level descriptors for the other interventions, which proved to be in the same overall service level descriptors. The results are illustrated in Figure 6-3, Figure 6-4 and Figure 6-5.



**Figure 6-3 Ordinal index service level progression**



**Figure 6-4 Cardinal index service level progression**



**Figure 6-5 Geometric mean service level progression**

Overall, the highest service level progress was evident with the Pre-paid meters intervention, quantified in terms of access to public services closer to the household, leading to increased water consumption per household, reduced cost of water and high levels of consumer satisfaction. Although WaterChoices did not make any positive progress in the 'reliability' and 'affordability' service criteria, this intervention fared in second place scoring highly for being the only intervention able to provide door-step access to water for LIS residents and consequently, increasing the water consumption per household. However, WaterChoices just missed out on the 'acceptable' threshold, as the intervention was penalised for demonstrating the lack of progress in two service



criteria identified, representing a fairly balanced result. Although Social Connections showed progress in the access criterion, the progress was marginal and largely hindered by the unreliable water supply in the area, which had a knock-on effect in the quantity of water consumed and affordability, forcing LIS residents to continue relying on alternative unsafe and expensive sources of water.

With the exception of the Self-supplied boreholes intervention results from the geometric mean, the results from the three indexing methods were closely aligned. In reviewing the underlying values for each intervention the ‘Cardinal Index – Arithmetic mean’ appeared to provide the most sensible representative results falling in between the Ordinal Index – Arithmetic mean and the Geometric mean scales. Figure 6-6 summarises the weighted scale and service level descriptors of each intervention at baseline and at the end of the monitoring period ranked in order of progress, using the Cardinal Arithmetic method. The researcher considers the ranked progress results and corresponding overall service level descriptors a sensible representation of the performance of the interventions from observations and interviews conducted in the study area.

	At Baseline		At End of Monitoring Period	
	Cardinal Index - Arithmetic mean (100 scale)	Overall Service Level Brandings	Cardinal Index - Arithmetic mean (100 scale)	Overall Service Level Brandings
Pre-paid Meters	34	Problematic	75	Acceptable
WaterChoices	44	Problematic	64	Basic
Social Connections	33	Problematic	53	Basic
Self-supply BH's	42	Problematic	44	Problematic

Figure 6-6 Weighted scale and overall service level descriptors

### 6.1.2 Sensitivity Analysis

As part of the sensitivity, the removal of service criteria one at a time impacted the overall service level branding if the results fell in the ‘acceptable or ‘very good’ service

level thresholds by reducing the service level branding by one level. Typically there was at least one service criteria which met these thresholds in all the interventions, apart from the Social Connections. With no service criteria meeting the ‘very good’ service level descriptors, the Social Connections intervention was most sensitive to the removal of one service criteria at a time, as the results were just enough to make it to the ‘basic’ service level threshold but not convincing enough to maintain the level with any changes (see Figure 6-7). Although it is very difficult to draw conclusions based on the sensitivity analysis alone, this method is helpful to gauge the weighting and to understand which criteria were performing poorly or that were performing equally poorly over the monitoring period, hence why their omission does not bring about a change in service level holding back the overall service progress.

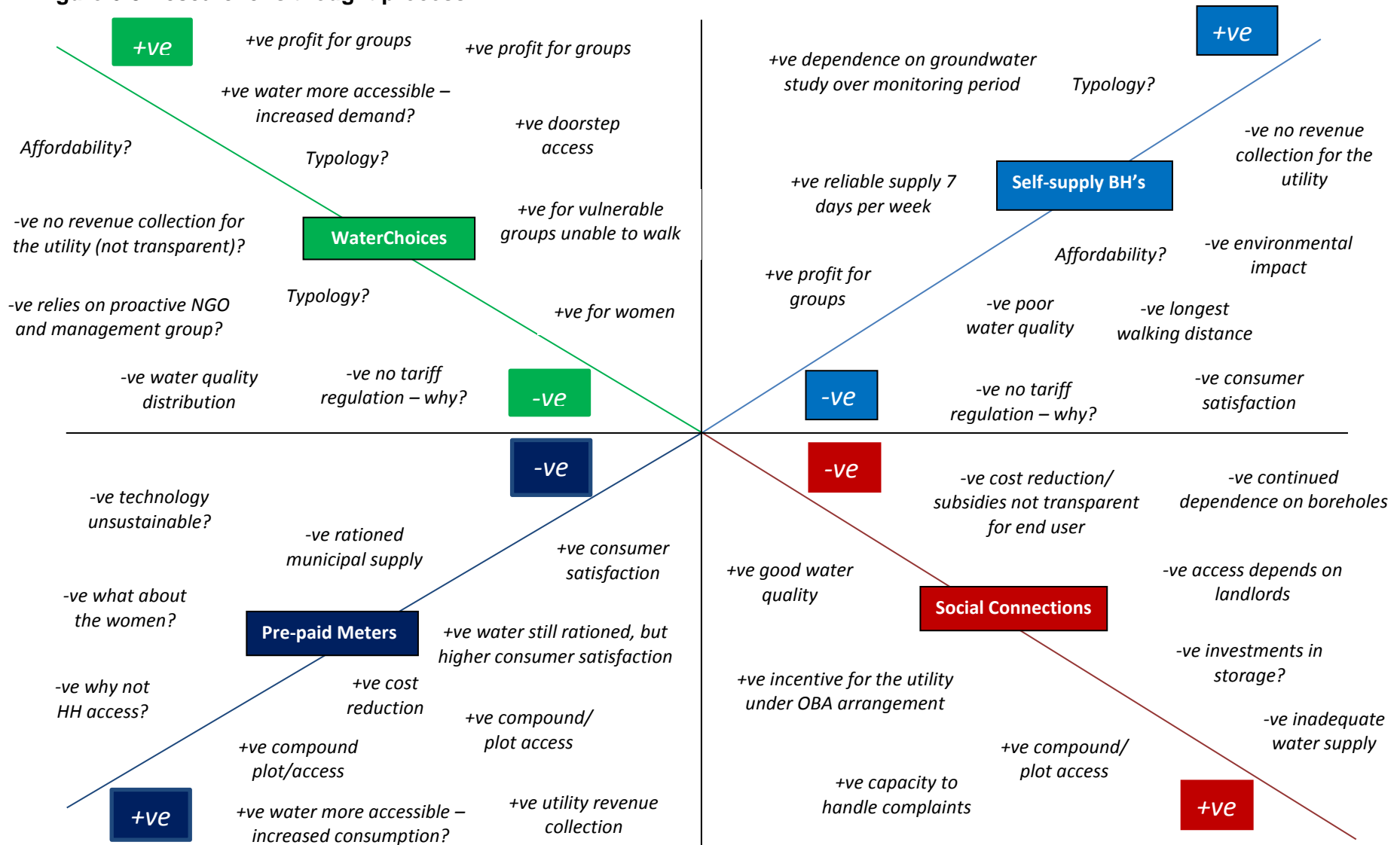
	Access (m)	Quantity (l/c/d)	Reliability (days of supply/wk)	Affordability (US\$ /m3)	Acceptability (% of satisfied customers)
WaterChoices	Y	N	N	N	Y
Self-supply BH's	N	N	Y	N	N
Pre-paid Meters	N	Y	Y	Y	Y
Social Connections	Y	N	Y	Y	Y

**Figure 6-7 Sensitivity analysis**

### 6.1.3 Researchers Thought Process

Figure 6-8 captures the researcher’s ideas and thought process in analysing the results of the service level analysis in relation to the overall research goal, used to inform the statistical analysis and integrated discussions around the performance of the interventions.

**Figure 6-8 Researcher's thought process**





## **6.2 Statistical Analysis**

### **6.2.1 Statistical Analysis Techniques**

Statistical tests were conducted to interrogate the service level results for each intervention under each service criteria, and statistically prove the differences after the interventions.

The analysis techniques adopted assumed that the target population for each intervention formed a normal distribution, regardless of whether the observed specific data-sets were normally distributed. This approach is considered acceptable for the commonly used robust parametric tests where normality is not a crucial pre-requisite, and any deviations to normality do not appear to have much effect on the outcome (Robson, 2002). Hence the parametric tests used were the one-sample and paired sample t-tests to compare the means of the data sets comprising of absolute numbers, and the Chi-square to test for association.

### **6.2.2 Access and Quantity**

Contrary to the literature, the service level analysis results demonstrated that the total water requirements for drinking, personal hygiene and household chores for low-income residents did not amount to 50 litres l/c/d, but averaged at 30 litres l/c/d at the end of the monitoring period (an increase of 6 litres from the baseline average). To understand whether an improvement in function under access (measured in distance to the water point) resulted in a statistical difference in the mean number of jerrycans utilised per household before and after the intervention, a one-sample t-test was used on the mean number of jerrycans used for all the WaterChoices monitoring data collected (both Nairobi and Kisumu) in comparison to the mean number of jerrycans collected at baseline. With the Pre-paid meters, it was possible to conduct a paired sample t-test using one set of monitoring surveys only, as the same individual provided a response on the number of jerrycans used before and after the intervention. The outputs are summarised in Table 6-1.

**Table 6-1 Quantity one-sample and paired t-tests**

Intervention	Monitoring Period	N	Sig. (2-tailed)	Mean Difference	95% CI of the Difference	
					Lower	Upper
<b>One-sample t-test</b>						
WaterChoices (all settlements combined)	August 2012	118	0.00	3.19	2.58	3.79
	November 2012, May 2013 & August 2013	114	0.42	0.26	-0.36	0.87
<b>Paired Samples t-test</b>						
Pre-paid meters	February 2013 (drinking)	115	0.00	0.56	-0.68	-0.43
	February 2013 (washing)	115	0.00	0.42	-0.54	-0.30

When assessing the WaterChoices outputs, the post-intervention monitoring surveys conducted after one month (August 2012) showed that the mean number of jerrycans increased by a mean of 3.13 from the baseline survey (April 2012). A one sample t-test showed that this increase was significant ( $p < 0.00$ ). Conversely, the results of the one sample t-test against the subsequent monitoring surveys conducted in the months of November 2012, May 2013 and August 2013 for both Nairobi and Kisumu provided evidence to conclude that there was no statistically significant increase ( $p = 0.42$ ) in the mean number of jerrycans used from the baseline survey (mean = 4.78) and post-intervention monitoring surveys (mean = 5.04). As such, no inferences can be made with this data that the door-step access resulted in increased demand and consumption of water over a period after the intervention, despite the initial increase immediately post- implementation. This initial increase could have been due to an initial excitement of ‘trying something new,’ however as time went on the results suggest that other factors other than access such as cost could have been more important in influencing a sustained increase in the average l/c/d consumption.

As predicted, the outputs from the Pre-paid meters intervention provided evidence to conclude that the mean number of jerrycans used for drinking increased from 2.50 to

3.06 between the baseline survey (July 2012) and the post-intervention monitoring survey (February 2013); an increase equivalent to 10 litres. The paired sample t-test showed that this increase was significant ( $p < 0.00$ ). The mean number of jerrycans used for other purposes such as washing produced the same results, increasing from a mean of 4.33 to 4.75 over the same period; a statistically significant increase ( $p < 0.00$ ) equivalent to 8 litres. Therefore in total we can conclude that the Pre-paid meters intervention increased the mean number of jerrycans used per household after the intervention by 1 (rounded off to 20 litres). The increase in consumption could be due to the improvement in accessibility which the literature has demonstrated has been known to occur, although the researcher considers that other factors associated with the intervention such as the reduced cost could also explain the increased consumption.

### 6.2.3 Reliability

In all three urban centres the functioning of the interventions suffered from unreliable water supply to meet the demand, resulting in persistent water shortages. Where information was available, the one-sample t-test was conducted at each settlement where the WaterChoices and Social Connections interventions were undertaken, to understand whether there was a statistical difference in the mean size of household water storage tanks in litres used per household before, during and after the intervention, as an additional indicator of persistent water shortages in the area. The outputs are summarised in Table 6-2.

**Table 6-2 Reliability one-sample t-tests**

Intervention	LIS	N	Sig. (2-tailed)	Mean Difference	95% CI of the Difference	
					Lower	Upper
WaterChoices	Mukuru-Ruben (Nairobi)	64	0.94	0.54	-14.80	15.89
	Obunga (Kisumu)	30	0.06	-23.460	-47.90	0.98
	Bandani	30	0.00	115.17	45.91	184.42

	(Kisumu)					
Self-supplied Boreholes	Kayole-Soweto (Nairobi)	30	0.00	57.68	29.99	85.24

In Mukuru, the mean size of household water storage tanks used slightly increased from 35.16 litres to 35.70 litres between the baseline survey (July 2012) and the post-intervention monitoring survey (November 2012), showing no statistical difference ( $p = 0.94$ ). In Obunga, the mean size of household water storage tanks used actually decreased from 72.17 litres to 48.71 litres between the baseline survey (July 2012) and the post-intervention monitoring survey (May 2013), although the decrease showed no statistical significance ( $p = 0.06$ ). This statistical evidence suggests that the supply remained fairly steady in both the settlements over the monitoring period corresponding with the community and vendor records, and did not lead to an increased investment in household storage.

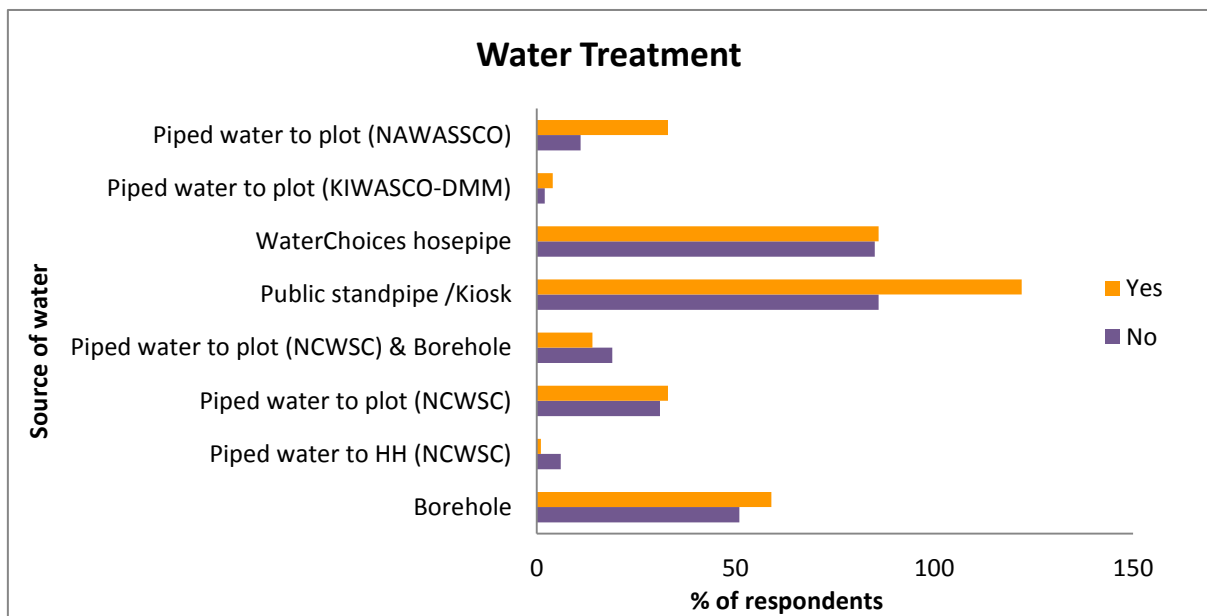
In contrast, for Bandani the mean size of household water storage tanks used dramatically increased from 20.50 litres to 135.67 litres between the baseline survey (July 2012) and the post-intervention monitoring survey (August 2013), a statistically significant increase ( $p < 0.00$ ). In Kayole-Soweto the mean size of household water storage tanks also increased from 63.55 litres to 121.17 litres between initial post-intervention monitoring survey (May 2013) and the subsequent monitoring survey (August 2013), a statistically significant increase ( $p < 0.00$ ). This statistical evidence supports the vendor sales and interview records from community members that both the settlements experienced severe water shortages over the monitoring period, forcing residents to make additional investments to increase their household storage capacity.

#### **6.2.4 Quality**

The household survey results showed that 82 per cent of consumers of borehole water were unsatisfied with the service and complained of a “salty” taste. As the service level analysis results reflected no functional improvement in water quality from introducing alternative distribution mechanisms and boreholes consistently produced poor water



quality, a chi-square test was conducted on the combined survey data to understand if the association between water treatment habits was independent from the main source of water (see Figure 6-9). Due to the non-standardised nature of the intervention, it was not possible to include all the monitoring surveys from the Pre-paid meters, where specific data was not available.



N = 643      Pearson Chi-Square  
 Value = 17.25  
 df = 7  
 p = 0.02

**Figure 6-9 Water treatment habits versus main source of water (n=643)**

The association between the main source of household water supply and water treatment habits reported a statistically significant dependence ( $p = 0.02$ ) with the Chi-squared test. However overall, although the majority sample that collected water from public standpipes and kiosks tended to treat their water, in studying the results there is no obvious association distinguishing the treatment habits from municipal supply or alternative sources.

### 6.2.5 Affordability

The service level results displayed an average price reduction per jerrycan with the Pre-paid meters (USD\$ -2.38), Social Connections (USD\$ -0.62) and the Self-supplied

boreholes (USD\$ -0.62), whereas the WaterChoices showed no change. To understand whether the socio-economic impact of this reduction, or status quo, resulted in a statistically verifiable difference in the mean cost per jerrycans filled before and after the intervention, a one-sample t-test was carried out on all four interventions using the available monitoring data collected in comparison to the mean cost per jerrycans at baseline. The outputs are summarised in Table 6-3.

**Table 6-3 Tariff one-sample t-tests**

Intervention	LIS	N	Sig. (2-tailed)	Mean Difference	95% CI of the Difference	
					Lower	Upper
Pre-paid meters	Manyani	72	0.00	-3.43	-3.47	-3.38
Social Connections	Kayole-Soweto	60	0.00	-1.03	-1.62	-0.44
Self-supplied Boreholes	Kayole-Soweto	60	0.00	-1.53	-1.89	-1.17
WaterChoices	Mukuru, Bandani, Obunga	124	0.01	0.21	0.05	0.37

The Pre-paid meters displayed the most staggering mean price reduction from USD\$ 4.67 to USD\$ 1.24 between the baseline (July 2012) and the post-intervention monitoring survey (February 2013); a statistically significant reduction ( $p < 0.00$ ) of almost three times the baseline value since the new technology was able to ensure the price remained fixed.

Self-supplied boreholes also demonstrated a mean price reduction from USD\$ 4.21 to USD\$ 2.68 between the baseline survey (February 2011) and the monitoring surveys (May 2012 and May 2013), a statistically significant reduction ( $p < 0.00$ ). As there was no significant change in the operation of the boreholes studied over the monitoring period, the mean price reduction could possibly be explained by the introduction of the public utility supply in the same area, posing as 'competition' for borehole vendors and forcing them to lower the price.

Social Connections showed the least price reduction from USD\$ 4.67 to USD\$ 3.64 between the baseline (May 2012) and the post-intervention monitoring surveys (May 2013 and August 2013), a statistically significant reduction ( $p < 0.00$ ). Despite this encouraging reduction, it is important to note that where supply was inadequate the actual savings were difficult to determine as people were still walking long distances to access unsafe and more expensive sources to meet their daily demand for water.

Interestingly, although the WaterChoices service level analysis showed no change, the combined outputs demonstrated that there was actually significant statistical increase in price ( $p = 0.01$ ) from USD\$ 3.67 to USD\$ 3.88 from the baseline survey (July 2012) and final post-intervention monitoring survey (August 2013). From this we can conclude that the mean price per jerrycan increased over the monitoring period, although the increase fell in the same overall service level descriptor. This increase could have been due to the water shortages experienced, escalating the prices.



**PART III: Chapter 7: DISCUSSING THE WAY FORWARD;  
Chapter 8: RESEARCH LIMITATIONS AND  
CHAPTER 9: CONCLUSIONS AND  
RECOMMENDATIONS**



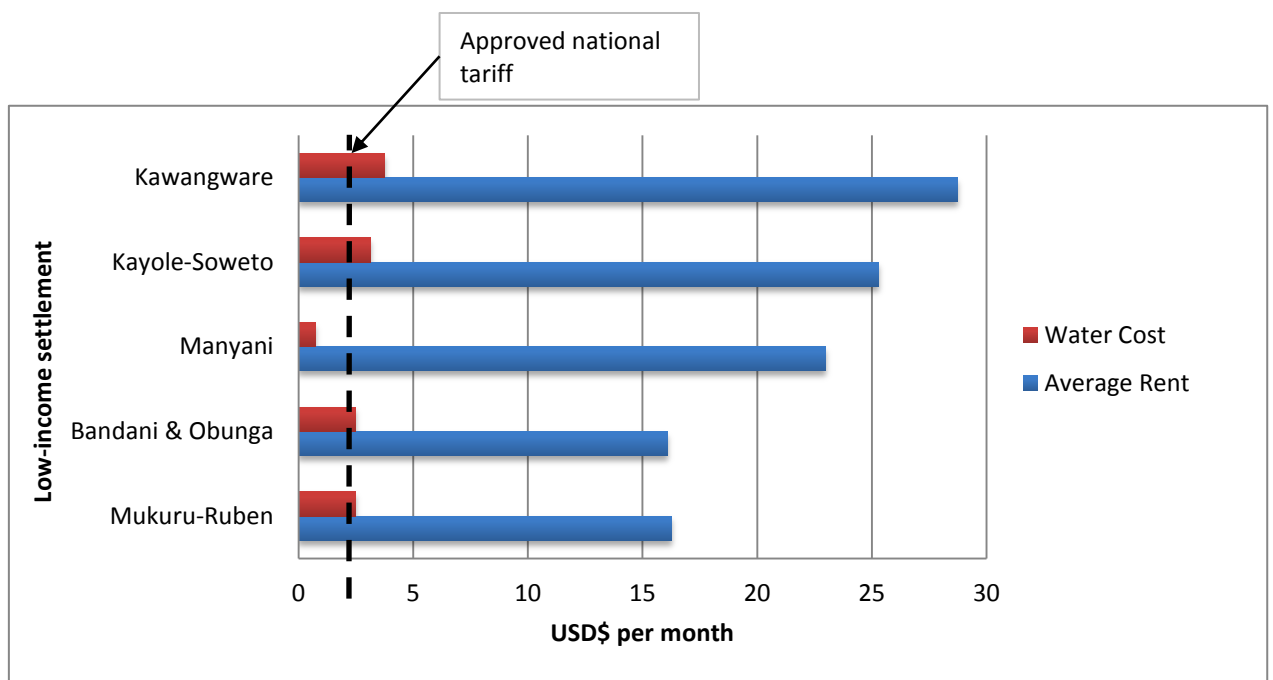
**Heshima bio-centre, Mukuru-Ruben, Nairobi, Kenya (Source: Haki Water, 2013)**



## 7 DISCUSSING THE WAY FORWARD ON “TRANSITION PHASE” INTERVENTIONS

### 7.1 LIS Categorisation versus Interventions

To understand better the socio-economic groupings of the main LIS studied and context in which the interventions were applied, Figure 7-1 shows the average rent per settlement in relation to the average post-implementation price of water per cubic meter. This is shown against the approved national tariff per 20 litre jerrycan, although it is important to note this is still at least 10 times more expensive than the flat domestic block tariff for customers with piped water on premises (USD\$ 0.23). The researcher observed it was very difficult to ascertain true income thresholds across all the LISs studied as most respondents were apprehensive about providing this information. Therefore their monthly rent payment was considered a more accurate benchmark where information was readily provided and could be verified to categorise the settlements.



**Figure 7-1 Average rent versus water price per LIS studied**

Bandani and Obunga (Kisumu) and Mukuru Ruben (Nairobi) settlements at the bottom range both have an average rent of USD\$ 16 and water cost of USD\$ 3 per cubic meter.

In the context of this study, and drawing from the broad socio-economic groupings identified in the literature, the researcher considers residents in these settlements are best described as the ‘very poor.’ In the middle range, Kayole-Soweto (Nairobi) and Manyani (Nakuru) have similar average rents of USD\$ 25 and USD\$ 23 respectively, although Manyani residents are now enjoying cost savings per cubic meter of water as a result of the pre-paid system. In the context of this study the researcher considers residents in these settlements could be best described as the ‘coping poor.’ At the top end of the range with a significant difference in rent from the bottom range, Kawangware residents pay the highest average rent at USD\$ 29, accessing groundwater supply and correspondingly highest average water cost of USD\$ 4 per cubic meter. Residents in these settlements can be described, by the researcher’s segmentation approach, as the ‘developing poor.’ Note the costs reflected do not include seasonal variations and escalated prices per jerrycans during droughts, as these prices are extremely unpredictable and fluctuate daily. Notwithstanding this, Figure 7-1 demonstrates that there are distinct differences in the scale of rent providing an indication of affordability across the settlements. However, the cost of water per cubic meter remains largely the same and exceeds the nationally approved tariff, with the exception of the pre-paid meters.

Table 7-1 reflects on the defined categorisations and interventions applied in relation to the settlement typology as described in the literature and assigned to the settlements in the results section.

**Table 7-1 LIS categorisation and intervention applied**

Study LIS Description	LIS	Global ‘Slum’ Typology	Intervention Applied	Implementation Partner/s	No. of beneficiaries
Very poor	Mukuru	Formal inner city	WaterChoices Kiosks	Umande Trust NGO and Cranfield University	~500
	Bandani	Absorbed village	WaterChoices Kiosks	Umande Trust NGO	~275



				and Cranfield University	
	Obunga	Per-urban/ formal inner city	WaterChoices Kiosks	Umande Trust NGO and Cranfield University	~600
Coping poor	Kayole-Soweto	Peri-urban	Self-supply borehole	Haki Water NGO	~1,200
			Social Connections	NCWSC	~58,000
	Manyani	Peri-urban	Pre-paid Meters	NAWASSCO, WSTF, and SUWASA	~20,000
Developing poor	Kawangware	Urban /pockets of formal inner city	Self-supplied borehole	NGO's / Entrepreneurs (various)	~1,200

Table 7-1 illustrates that the utility-led interventions defaulted towards the 'coping poor' living in plots / compounds of peri-urban type settlements (Kayole-Soweto and Manyani) where, one could argue, conventional piped networks could (and should) reach each household. The civil society-led interventions focused on the most difficult to reach 'very poor' by using innovative mechanisms to provide access to water at household level, however the number of beneficiaries was significantly less than the utility-led interventions. There is also an aspect to consider that has been highlighted in the literature that the 'very poor' are also the most powerless (an important aspect of poverty – not surprisingly linked to lack of income) and therefore the least able to take advantage of innovations. It is perhaps a truism that the poor are the most likely to be caught in the power of 'water mafia' and other exploiters and therefore least able to benefit from discrete improvements. It is also important to note that the Pre-paid meters intervention which displayed the highest progress in the service level analysis, was implemented by a combination of utility and civil society in relatively formal housing developments. This suggests a cohesive approach with strategic partners could be the best method for service progress, albeit the intervention focused on the easier to reach coping poor. The developing poor in Kawangware formed the

target of a combination of civil society and entrepreneurs recognising business opportunities in drilling boreholes to serve the poor within the public utility service provider area, where technically the utility bulk surface water should be available.

## 7.2 Understanding the Analysis Results

The following sections discuss possible reasons and explanations for the performance of each intervention in relation to the service level analysis cardinal-arithmetic scale and statistical analysis results, relative to the household segmentation and defined goal of 'EEVERT' discussed earlier.

### 7.2.1 Pre-paid Meters

In attempting to understand why the Pre-paid meters demonstrated the highest service level progress over the monitoring period, the researcher highlights the significant achievements of the intervention that the three other interventions failed to achieve, contributing to the overall 30 per cent increase on the Cardinal Index – Arithmetic mean scale.

- **Affordability:** The Pre-paid meters intervention reduced the price paid by the highest mean difference margin of USD\$ 3.43 (statistically significant) that was *transparent* to the end user; a reduction equivalent to 75 per cent. Despite the improvement in access, the statistical analysis results demonstrated that the price reduction resulted in a sustained positive knock-on effect on the quantity utilised, increasing (statistically validated) the number of jerrycans consumed by 20 litres per household and potentially was also reflected in the high level of consumer satisfaction (94 per cent), despite continued water rationing by the utility.
- **Empowerment of the end user:** The Pre-paid meters system was successful in empowering the end user to access water at their own discretion and convenience, not being reliant on a third part such as landlords or vendors. This suggests that the low-income residents enjoyed an aspect of independence in water access which higher-income consumers experience on a daily basis, possibly also contributing to the high levels of consumer satisfaction.

- **Implementation team:** The technical innovation could possibly be attributed to the diverse implementation team comprising of a combination of institutional and civil society stakeholders, possibly providing a shared platform for knowledge exchange.

At the end of the pilot, the pre-paid intervention was considered *effective* in reaching the target beneficiaries estimated at ~20,000, although the *efficiency* was affected by the rationed water supply. Evidently the overall progress was largely influenced by the *equitable* tariff structure, however the researcher considers the sustainability of the technology outsourced from South Africa the biggest threat to the long-term *viability* and *replicability* of this model (as also evidenced by the Kampala experience referred to earlier), despite the initial positive service progress.

### 7.2.2 WaterChoices Kiosks

WaterChoices intervention, the second best performing with a 20 per cent increase on the Cardinal Index – Arithmetic mean scale, interestingly produced different outcomes in each of the locations where it was piloted demonstrating the ‘unique’ state of each settlement. Ideally this should have been a function of consumers exercising their own choice but in reality the outcomes more closely matched the interests of the implementing NGO. In highlighting the specific improvements:

- **Accessibility:** This was also the only intervention, civil society-led, that managed to provide door-step access for the ‘very poor’ located in a mixture of global slum typologies which proved inaccessible for the utility, using innovative distribution mechanisms. This shows that civil society or possible private partnerships inherently add the most value in developing solutions for the most marginalised where conventional methods simply cannot work.
- **Women's Empowerment:** The findings consistently revealed that regardless of the intervention and location, it is the women who shoulder the responsibility for collecting and carrying water daily. Through the provision of ‘door-step’ access, WaterChoices demonstrated an astounding 43 per cent reduction in the number of women carrying water. The women used the extra time and

convenience to engage in business, look after their children, complete household chores and rest. The results demonstrated that any improvement in access directly benefits women at the forefront, which then trickles down as the women have more time to look after their families and generate income.

The downside to this intervention is clearly the limited ability of civil society organisations to reach – and maintain that reach- to large numbers of beneficiaries. This is mirrored by the inability of the utility to influence any sustained price adjustments, local forces too easily taking advantage of price-increasing opportunities caused by seasonal variations or disruptions to supply. Additionally, as delivered, the intervention showed no improvement in quality via introducing the hosepipe delivery from point of source to point of use, suggesting that non-conventional distribution mechanisms are equally vulnerable to contamination unless well maintained by the user, similar to jerrycan collect and carry approaches. The performance was also hindered by inadequate water supply.

The WaterChoices intervention was considered *effective* in reaching the neglected very poor target beneficiaries, estimated at ~1,375 out of a potential unserved catchment of 5,000 people within the service radius, and in improving access to water for women in particular. Despite investments made, the researcher also noted that the intervention failed to take off in one settlement (Korogocho) over the monitoring period, having earlier failed (before this monitoring commenced, in the even more socially challenged ‘very poor’ ‘informal inner city’ area of Kibera). Therefore the *replicability* and *viability* of this intervention as an *equitable* solution largely hinges on a very proactive implementing organisation and a transparent management group that pays the utility bills for revenue collected and regulates the tariff with the interests of the poor first, which this study implies can be very difficult to find. Overall this suggests that proactive engagement and partnership is needed from the public utility with local civil society, to implement and enforce price adjustments in the LIS.

### 7.2.3 Social Connections

The Social Connections intervention demonstrates the public utility will to extend conventional piped networks to the LIS residents (though heavily influenced by external donors), and willingness for LIS residents to be connected to the public utility. Although technically access has improved (distance to water point), the full impacts of this intervention remain to be seen. Despite the investment in the piped network infrastructure by the project stakeholders the pipes in Kayole-Soweto are frequently dry and residents were still walking long distances in search of alternative, unsafe sources. Therefore investments are equally needed in the bulk supply, then to be equitably distributed for the intervention to be *replicable* and *viable* in Nairobi, for ultimate benefits for the LIS residents.

Although at the end of the monitoring period there was a mean statistical difference of -1.03 in the average water price, the findings suggested that any savings for the end user could be short-lived and at the discretion of the landlords. No meter readings and late billing by the utility at the time of writing had left landlords apprehensive about the actual water bills for their plot and with no incentive to pass any savings onto the end user. As a result, in addition to paying for water inclusive of rent payments (even though some landlords hinted they might be forced to increase the rent to cover the water bills), residents were also spending their income to supplement their daily water supply to meet the demand from boreholes, ultimately paying twice for the same rare commodity. Indirect financial impacts were also evidenced by a statistical increase ( $p < 0.00$ ) in the household storage capacity of residents, clearly illustrating that the poor continue, directly or indirectly, to pay more, for a worse level of service.

Interestingly, following interviews with the water service providers from Nairobi and Nakuru, the Social Connections intervention seems to replicate the baseline situation in Nakuru before the introduction of the Pre-paid meters. This provides an insight to the nature of the problems that could be experienced over time with landlords manipulating and restricting access to the communal taps in an effort to limit the water utility bills and failing to make payments resulting in recurring disconnection and

reconnection costs. Lessons could have been learned and shared between the utilities in Nairobi and Nakuru in implementation of pro-poor initiatives to ensure improved and sustained service progress targeting the most vulnerable consumers to minimise the risk of LIS residents losing faith in the project and the ability of the utility to serve them.

Therefore although the Social Connections intervention was considered *effective* in reaching the target beneficiaries estimated at ~58,000, the *effectiveness* was hindered by inadequate water supply, forcing residents to resort to expensive *non-equitable* alternative sources. Additionally, as the billing process was not *transparent* to landlords, the researcher considered this an added threat to the long-term *viability*, as the landlords may increase the cost of rent and/or water beyond the reach of the poor, or simply disconnect the supply.

#### **7.2.4 Self-supplied Boreholes**

All groundwater sources were generally contaminated, even though regarded as improved sources. In distribution, the results showed residents walked the longest distances to access groundwater supply that was always readily available, when the utility pipes were dry. Therefore although consumer satisfaction was lowest and despite other on-going municipal interventions in the same LIS, the dependence on boreholes remained steady over the monitoring period – mainly out of necessity.

The mean statistical difference of USD\$ -1.53 in the average price over the monitoring period could be attributed to ‘competition’ from the extended utility piped network in the same area.

#### **7.2.5 The Underlying Social Factors**

The performance of all the interventions was directly or indirectly affected by external factors that were difficult to quantify and beyond the scope of this study. However it is important to reflect on some of them, which strengthens the case with regard to the unique and complex settings of LISs and recognises the particular challenges faced in developing viable solutions.

The performance of all the interventions was susceptible to influence by the number of other sources of water or vendors in the area, dictating the competitive landscape and essentially what an SSP can get away with in charging for water. This could have been a contributing factor to the unpredictable and fluctuating prices over the monitoring period.

The requirement for LIS residents to be in possession of a National Identity Card (ID) hindered the uptake of the pre-paid meters utility-led intervention in Nakuru, with anecdotal evidence suggesting many LIS residents did not have an ID or did not understand what the information would be used for. Similarly in Nairobi, the utility required landlords to provide some form of identification and claim legal land tenure to connect to the Social Connections project, which dissuaded some landlords. The transient nature of LIS residents essentially means that some residents are completely 'off the grid' so to speak and intending to remain that way, making them even more difficult to access.

The ripple effect of previous political campaigns which provided LIS residents with free water also created challenges for the utility to provide an equitable service in Kayole-Soweto, Nairobi. Since residents had been enjoying free water for an unknown period of time some believed that they were entitled to 'free' services on the basis that they are poor and should not have to pay for any amenities. Consequently the introduction of the intervention that required them to pay for water was met with resistance.

The WaterChoices intervention in Nairobi and Kisumu brought to light the gender issues in management and implementation on interventions. The up-take was influenced by gender negatively with some female customers fearful of male delivery men. The positive gender aspect being the household delivery, removing the need for female carrying and concern over child care during collection. However, some of the residents who did not take up the hosepipe delivery service, particularly the women, highlighted the social enjoyment aspect of walking to collect water daily. Some women used this time as a way to catch up with their friends and share stories at the water point, which provided an informal social meeting place. Therefore it should not be

assumed that an improvement in access necessarily results in a positive impact for women, as this fluctuated on a site-specific basis driven by the choice of the customer at that particular time. This aspect had been recognised in the original design of WaterChoices, to give the choice that consumers wanted and could exercise even on a daily basis if they so desired, but was found to be less straightforward to deliver during implementation.

This suggests that for larger strides in service progress higher inputs, in the ‘software’ as well as the ‘hardware’ aspects, are required, probably beyond the capacity of the utility as presently constituted to address the social barriers, leading to ultimately to societal behaviour change and consumer benefits.

## **7.3 “Transitions” or Solutions to Universal Service?**

### **7.3.1 Performance of Interventions in Context of Universal Service**

Although the literature suggests that the long-term solution to provide universal service to the poor is undoubtedly the extension of the conventional piped water supply and distribution networks into the low-income settlements, the findings from this study suggest that conventional solutions are simply not the singular solution in environments that the research has demonstrated are, essentially, anything but conventional.

In reviewing the evidence collected on the performance of the four interventions, this section reverts to the research hypothesis to summarise the study findings in the context of universal service. When assessing the distribution aspects, the researcher considers that the earlier descriptions of “transition phase” interventions are more likely to become the most appropriate medium-term solutions when the public utility is actively engaged in the implementation of, for example pre-paid meters and social connections. However to deliver such a service the utility needs cohesive partnerships not only in financing but in implementation as well, as evidently the two interventions did not deliver the same performance. It is also important to consider that when promoting innovation over conventional methods to expand coverage, the risks



associated with the long-term viability of imported technological innovation remains a major threat for the utility. NGO led interventions such as WaterChoices are best described as 'viable transitional stop-gaps,' specifically for the 'very poor' who are most difficult for the utility to access. However in the same breadth, the 'viability' heavily relies on the individual dynamics of the implementing organisation and management group which is hard to predict, and lack of utility engagement in the implementation means that the intervention is unable to show progress in certain criteria limiting the overall performance threshold.

What remained consistent across the performance of the three distribution interventions, as discussed in the service level analysis results, was that they were all reliant on the public utility water supply and consequently were all penalised in the scoring process for displaying no positive progress in the reliability criterion, regardless of the location. This one criterion in a non-discriminatory manner held back the overall performance score of both the public utility and NGO led interventions, which corresponds to the literature on the study locations highlighting that the surface water bulk supply does not meet the demand and is especially unreliable during periods of drought.

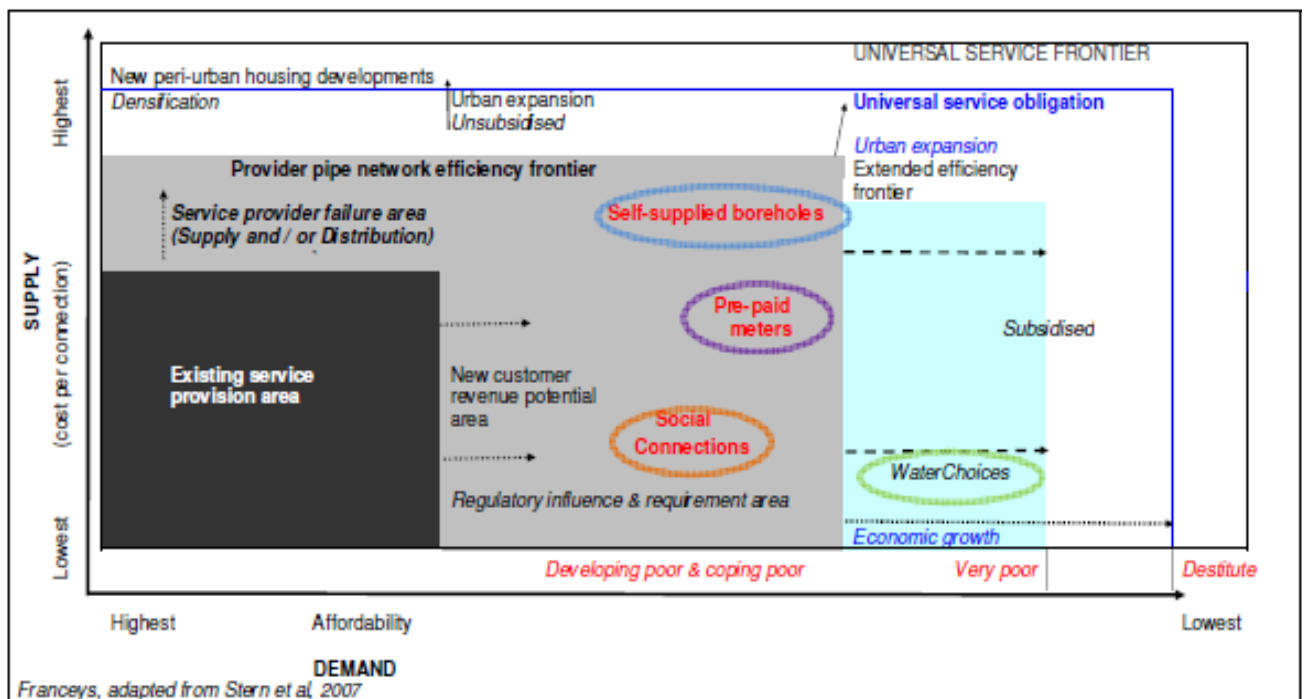
This confirms, although it may seem somewhat obvious, that regardless of the nature of the distribution interventions, despite how innovative and cost-effective they may be, to achieve the desired performance – at first there must be water! Therefore, rather than groundwater playing a key role on the periphery of urban expansion as the literature earlier suggests, findings from this study demonstrate the prominence of groundwater supply for the urban poor within the central public utility service provider area.

Based on the above, the researcher considers privately owned Self-supplied boreholes are best described as an 'expensive diversion.' As the private boreholes studied were located in LISs accessible by the public utility bulk supply, rather than adding much needed equitable value to the supply deficit boreholes are often exploited for private

gain, representing an expensive, unsafe and disorganised solution, which poor customers and the environment continue to pay for out of necessity.

In bringing these discussions and findings together in the context of the universal service dynamic discussed in Section 2.4.1, the researcher has adapted the concept to reflect the affordability of LIS customers as categorised in this research (very poor, coping poor and developing poor) in relation to the typology of the settlement where the intervention was applied. This was then plotted against the estimated investment cost per head, with the WaterChoices kiosks costing the least and the Self-supplied boreholes costing the most.

The performance of the interventions in relation to the universal service context is illustrated in Figure 7-2.



**Figure 7-2 Performance of interventions in the context of universal service (Source: Adapted from Franceys, 2010b).**

Figure 7-2 clearly demonstrates that clearly the 'very poor' remain the most disadvantaged, in terms of the service received in relation to affordability and most difficult for the utility to access via conventional methods.

Ultimately, what cannot be ignored is that the performance of all the distribution case studies was underpinned by the lack of bulk surface water supply to meet the growing population demand, particularly affecting the very poor and resulting in a heavy dependence on groundwater resources which were all generally contaminated, even when classified as protected. Based on the above findings highlighting the importance of groundwater, the next section explores the supply and demand gap to stimulate further discussions on the more prominent role of groundwater resources in meeting the growing urban poor demand.

### **7.3.2 The Future of Nairobi's Water Supply**

Self-supplied boreholes, although generally performing poorly across the service criteria, the intervention showed unrivalled consistency in supplying water 7 days per week and 24 hours a day hence directly or indirectly serving 81 per cent of surveyed residents, an apparent aspirational status for the public utility.

Essentially this means that as the preferred water supply solution or not, the role of groundwater in serving the urban poor needs to be integrated in the discussions. In coming to terms with the findings it is important to reflect on the combined effect of rapid urbanisation, climate change resulting in prolonged droughts and slow institutional investments in public water supply, as documented in the literature. More recent studies are also increasingly highlighting that there are rarely sufficient groundwater resources within an urban area to satisfy the full water demand in large cities threatening the resource sustainability, and calling for effective use of groundwater that optimises the utilisation particularly in developing countries (Foster & Vairavamoorthy, 2013).

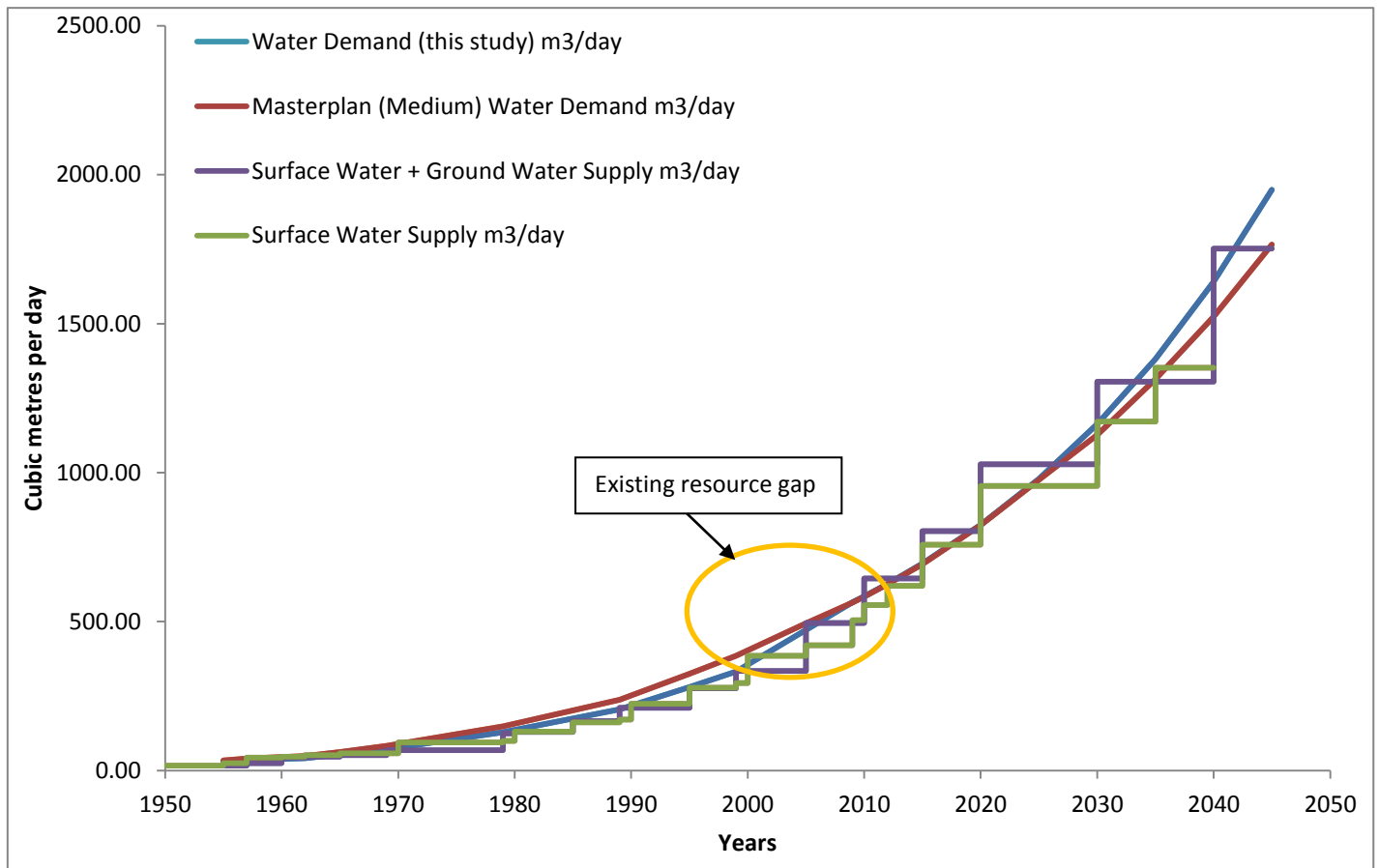
With results of this study indicating that boreholes are playing a significant role in providing a reliable water supply for the urban poor, a detailed analysis of the supply and demand gap in Nairobi has been undertaken to encourage a lively debate and develop a broader understanding on the role of private boreholes over time. The researcher focused on the capital city for this analysis and discussion as detailed information was available regarding the city's water resources and future growth

projections. However it is envisaged this exercise can be repeated in Kisumu and Nakuru with the relevant data.

To replicate the water Master Plan projection for Nairobi (see section 3.4.2) and develop projections based on the data collected as part of this study, existing water supply data was obtained from NCWSC and World Bank published records, with the future projections based on the proposed surface water and groundwater sources as per the Nairobi Water Master Plan (Egis Bceom International, 2011). The researcher's estimated demand for the years 2010 – 2040 was developed from various sources (Egis Bceom International, 2011; Jacobsen et al., 2012; Oparanya, 2010; UNEP & UN-HABITAT, 2012), to derive incremental population projection rates ranging from 6-3 per cent in accordance with the city's current growth rate and increasing consumption reaching 180 l/c/d by the year 2035 (this figure including for the rather significant, but presumed to be declining, non-revenue water/leakage). The results illustrating the researcher's supply and demand analysis in relation to the Master Plan are shown in Figure 7-3.

The graph shows a very delicate balance between supply and demand from the years 1950 – 2005, with the water demand for this study hovering slightly below the Master Plan. From the year 2005 a clear resource gap with the municipal surface water supply begins to take shape, however when taking the groundwater supply into account the graph shows that currently the city's surface water deficit is largely being met by groundwater resources (which are likely to be more in number than reference studies have estimated), bringing into question the equitable distribution and management of the resource. Assuming the Master Plan investments proceed on schedule (though with little sign of contracts being let to date), from about the year 2016 projections indicate that the supply would be adequate to meet the growing demand, however any utility reserves will be heavily reliant on groundwater supply. Beyond this period up to the year 2035, the Master Plan (medium) demand represents the projection rounded off to 1,300,000 cubic meters per day (Njoroge, 2011). In comparison, the simple demand projected as part of this study up to the year 2045 produced an

estimated demand of approximately 2,000,000 cubic meters per day, illustrating that benefits from the Master Plan investments may very well be short-lived.



**Figure 7-3 Comparative analysis of Nairobi supply and demand gap**

In summary, Figure 7-3 highlights what can be described as ‘optimistic’ assumptions from the Master Plan relating to the anticipated reduced demand from leakage reduction, resulting in lower water demand growth rates, lower per person demand and lower per capita usage, to replicate the projections shown in section 3.4.2. Although the more recent publications (Jacobsen et al., 2012) reflect the water resources gap illustrated in this study, this analysis indicates that if the Master Plan delays or fails to achieve the anticipated targets on schedule, this gap could potentially be wider and last for an alarmingly longer period, beyond the assumed 20 years. This also suggests that the utility will be overly reliant on groundwater resources to provide ‘headroom’ to cope with emergencies and recurring droughts. Additionally, in the

parody of the timing, as the GoK is implementing the pro-poor implementation plan (PPIP) to finally extend water supply network connections into the low-income settlements, despite planned measures such as water rationing (Water Services Regulatory Board, 2011; Jacobsen et al., 2012), information suggests that there will not be sufficient bulk water to supply the extended network. Similarly the graph indicates that the groundwater resources are essential to meet the growing demand but without equitable control of this scarce resource the poor may well continue to suffer the most, the rich always having the resources to deepen their boreholes.

A study has indicated the need for Nairobi to implement additional adaptive systems that can cope with uncertainty as suggested by the principles of water resource management such as water demand management, storm water harvesting, and greywater recycling (Jacobsen et al., 2012). However such measures are typically beyond the means on the poor. Based on this initial analysis, the results indicate that point source groundwater supply, be it an expensive diversion with adverse environmental impacts, could be the most viable and resilient solution in the foreseeable future to serve the urban poor. The implication of this finding therefore is that in the LIS, this resource needs to be 'protected' for the residents and not put at risk of being diverted to the suburbs of the city to supplement the limited bulk water resources by tankering from 'common pool' groundwater sources located too close to the ill-protected settlements - otherwise leading to yet another service failure by default, if not by design.

### **7.3.3 Groundwater as an Equitable and Safe Solution**

The results of this study draw attention to the unpredictable price (not necessarily the cost) of borehole water, escalating during the drought seasons and the poor quality of groundwater from microbiological and fluoride contamination.

In further investigating the concept of 'protecting' groundwater for low-income residents as a transitional arrangement whilst ensuring the price is equitable, calculations were undertaken to determine the indicative cost reflective tariff of private borehole water for the three scenarios: 1) Price per jerrycan with no water

treatment, 2) Price per jerrycan with microbiological water treatment and 3) Price per jerrycan with microbiological and fluoride treatment (highest level of treatment to mimic the public utility supply). The costs used to inform this investigation were based on the data collected from key informants, borehole field records in relation to consumption and market rates of equipment at the time of writing. The results are shown in Table 7-2.

**Table 7-2 Cost reflective tariff per jerrycan of borehole water**

Item	Untreated		Microbiological treatment		Microbiological and fluoride treatment	
	KES	USD\$	KES	USD\$	KES	USD\$
Average annual revenue from water sales	640,000	8,000	640,000	8,000	640,000	8,000
Capital expenditure	1,770,410	22,130	1,930,410	24,130	2,520,410	31,505
Recurrent expenditure (operation + depreciation)	403,721	5,047	430,721	5,384	583,721	7,297
PBIT (profit before Interest and Tax)	236,280	2,953	209,280	2,616	56,280	703
Return on capital employed (PBIT)	265,562	3,320	289,562	3,620	378,062	4,726
<b>Cost reflective tariff per jerrycan</b>	<b>1.67</b>	<b>0.021</b>	<b>1.80</b>	<b>0.023</b>	<b>2.40</b>	<b>0.030</b>

As shown in Table 7-2 the calculated cost reflective tariff of untreated borehole water in relation to consumption was KES 1.67/jc, whereas the results of this research showed the price of untreated borehole water per jerrycan being sold by vendors averaged at KES 4/jc - over two times the cost-reflective tariff. In developing the argument of groundwater as a viable transitional solution, the water quality issues become more prominent as the results of this study showed all groundwater sources studied were contaminated. To provide the same level of water quality as the

municipal supply, the highest calculated cost reflective tariff of borehole water was KES 2.40/jc, still well below the average selling price of KES 4/jc.

Although the calculations do not take into account external factors such as competition from other water sources that may impact the consumption, this results of this exercise demonstrate that vendors are largely 'profiteering' from the sale of borehole water at the expense of the urban poor. The calculated cost reflective tariff for the three scenarios strengthens the case for protecting groundwater to guarantee a reliable supply of good water quality where it is most needed for public health benefits – at a reduced price than poor customers are currently paying. This may be the least desirable option when environmental impacts of groundwater abstraction are taken into consideration, however, the Gok having failed in the equitable distribution of public utility supply, may be left with few other options than to consider the role of groundwater more prominently in the transition.

In comparison, higher-income consumers benefit from conventional piped household water connections with a lower lifeline block tariff that is below the cost reflective tariff (KES 18.71 per cubic meter), based on government policy. Therefore one is entitled to question why the government should allow the poor to pay the full cost reflective tariff for private boreholes, suggesting that the pro-poor tariff should be even lower than the calculations suggest. Policy should be reflecting a bias towards to poor in groundwater abstraction and tariff setting and explore avenues to offset this cost by potentially 'taxing' the higher-income consumers who do have alternative sources and choose to exploit groundwater as a coping strategy (which appears to be the status quo) as water scarcity prevails for all during the transition.



## 8 RESEARCH LIMITATIONS

The study findings do not represent the entire population living in the settlements studied, but rather the purposive sampling targeted residents located within the target radius of the intervention and were most likely to benefit. In some cases the researcher had no influence over the sample size or locations selected for household surveys, therefore conclusions have been drawn based on the available data.

The four interventions have been compared over varying monitoring periods. For the purposes of this study, interventions were largely considered 'settled' after three months, although the researcher noted that some interventions were still 'fresh' (i.e. operating for less than three months) when monitoring was undertaken, while others had an opportunity to settle longer which could have impacted the results presented.

The researcher was not able to verify independently all the household survey data provided by third parties and received in various formats. Therefore this study assumes that the data provided by third parties is an accurate representation of the target beneficiaries.

The research made several attempts to find an appropriate control or comparator groups through surveying middle and higher-income consumers in Nairobi. Although the results illustrated the inequitable distribution of water supply services between higher-income and low-income consumers, the research findings consistently showed the dynamics driving the performance of each intervention were very site-specific and unique to each settlement. Therefore unless a separate study was undertaken to establish more suitable control groups at each site-specific location where an intervention was piloted regardless of whether it was the same intervention or not, surveying middle and higher-income consumers as a control group in one location, added limited value to the overall research.

The service level framework has been adapted based on the range of data collected. The service level descriptors are developed from the researchers judgement, influenced by the literature review and the 'Post 2015 Monitoring' debate, and should

not be considered a rigid assessment of the actual experience of consumers on the ground. As such, a positive service progression should not be misinterpreted as a direct result of consumers increased enjoyment within that level of the descriptor, which in reality could fluctuate based on external factors beyond the scope of this study.

The various social external factors have not been investigated as part of this study and were extremely complex to correlate to the performance of the interventions. Therefore, the service level analysis results presented should not be misinterpreted to include the social aspects stated in relation to the actual service received by the consumer.

The service level analysis should be considered a flexible and dynamic representation of the performance of the interventions over the monitoring period, and not a fixed 'snapshot' of the performance at one moment in time. Therefore the results are subject to change with further monitoring.

No water quality tests were undertaken for the utility-led interventions. As the objective of this study was not to rate the water quality of existing conventional public utility networks that serve the cities/ towns, the water quality samples were only undertaken on interventions that involved alternate sources of water supply or distribution mechanisms that may impact the quality of water in distribution and storage at household level. Consequently, as not all the interventions were directly comparable with regards to water quality in the service level analysis, therefore this criteria was excluded from the final results presented and could negatively impact the overall performance.

The parametric statistical tests selected were based on the assumption that the target population followed a normal distribution, even if data sets were non-normal. Although this approach was considered appropriate in relation to the data, the researcher recognises that deviations from normality may render the parametric tests slightly inaccurate leading to bias conclusions.

## 9 CONCLUSIONS AND RECOMMENDATIONS

### 9.1 Achieving the Research Objective

**Table 9-1 Summary of interventions performance**

LIS	LIS Category	Intervention	Implementation Partner/s	100 scale	Service Level Descriptor
Manyani	Coping poor	Pre-paid Meters	NAWASSCO, WSTF & SUWASA	75	Acceptable
Mukuru Bandani Obunga	Very poor	WaterChoices Kiosks	Umande Trust NGO & Cranfield University	64	Basic
Kayole-Soweto	Peri-urban	Social Connections	NCWSC	53	Basic
Kayole-Soweto, Kawangware, Mukuru	Peri-urban / Developing poor	Self-supply boreholes	NGO's / Entrepreneurs (various)	44	Problematic

As shown in Table 9-1, from the four interventions evaluated in Kenya, the Pre-paid meters implemented in Nakuru town showed the highest improvement in service over the monitoring period. The 75 per cent price reduction introduced by the intervention was the single most important criteria that positively influenced the performance of the quantity consumed, leading to a statistically significant increase in the consumption of water per household by 20 litres. The positive service progress was also reflected by 94 per cent of the satisfied customers surveyed, despite continued water rationing by the utility supplying water on average 3-4 days per week. Notwithstanding this, anecdotal evidence suggests that the use of imported technology presents the biggest threat to the long-term viability of this intervention.

In second place, WaterChoices showed the highest service progress using innovative distribution mechanisms to provide door-step access for the 'very poor.' Making water more readily accessible within the household impacted the women the most, reducing the burden on women carrying water by 43 per cent. Consequently any improvements

in distribution and provision of water at household level had a direct impact on women in terms of time savings and reduced effort of energy spent carrying water. Although no definitive inferences can be made relating the hosepipe access improvement to an increase in household consumption when there are no piped networks, the water quality results emphasized the vulnerability of bacteriological contamination occurring between the water point and the place of use, which has been known to occur elsewhere from the literature. The overall performance of the intervention was hindered by unregulated water prices coupled with rationed and unpredictable water supply in some settlements; this being reflected in the marginal increase of satisfied customers, reaching 58 per cent at the end of the monitoring period.

The Social Connections intervention in third place, by this scoring, demonstrated the public utility will to extend services to the LIS residents and willingness for LIS residents to be connected to the public utility. However, the overall service progress of the intervention was hindered by inadequate water supply (1-2 days per week) which negatively influenced the criteria of affordability and quality; most residents continued to walk long distances in search of expensive and unsafe water when the pipes were dry, ultimately paying twice for the same commodity. Taking into consideration the indirect investments residents were forced to make in household water storage as coping strategies, clearly the poor were still directly or indirectly continuing to pay more, despite an overall progression in service.

Self-supplied boreholes, the worst performing according to global indicators, showed negligible service progress over the monitoring period besides the ability to maintain a reliable daily supply of water. The intervention demonstrated no service progress in accessibility, consumption and quality, reflected in the lowest proportion of satisfied customers at a mere 18 per cent. Notwithstanding this, in settlements with sporadic municipal supply, rather than using groundwater as a coping strategy, boreholes proved a necessity for LIS consumers to access an adequate quantity of water daily.

The combined service level analysis results demonstrated that making water more affordable for LIS residents was the single most important criteria able to influence

positive progress in two other criteria: quantity consumed per household and overall consumer satisfaction. The irony is that the 'very poor', who are often the target of NGO-led interventions, experience difficulties in influencing a sustained price reduction for more equitable services – essentially what is needed most by the poorest. The reliability criteria was also considered significant, as the availability of the supply negatively influenced the affordability criteria, represented by an increase in the mean price per jerrycan, and indirect costs associated with increased investments in household storage capacity.

Based on the findings of the future supply and demand gap for Nairobi city, the results suggest that even if institutional reforms are successful in extending piped networks to low-income settlements this is of no consequence unless there is adequate water supply.

## **9.2 Recommendations**

- A review of the tariff structure for the urban poor vs. higher income consumers is desperately needed, for equitable distribution of this precious resource and to curb exploitation of surface and groundwater resources by higher-income consumers.
- All the major or growing urban centres need to focus on investments in their water supply, as equitable distribution of water is needed for any interventions to be replicable and viable to benefit the LIS residents.
- Groundwater resources need to be 'protected' for the urban poor and not put at risk of being diverted to the wealthier suburbs of the city to supplement the limited bulk water resources, again threatening the poor by default, if not by design.
- In an effort to balance the revenue streams for the utility from groundwater resources, investments models should consider subsidising boreholes serving low-income areas so as to reduce the price in relation to higher-income consumers by 'taxing' the higher-income consumers who do have alternative sources and choose to exploit groundwater as a coping strategy.

- More opportunities need to be exploited for leveraging lessons learned and investments in new technologies amongst the pro-poor departments of utilities, to adopt national best practice guidelines.
- A combination of utility and civil society, suggesting a cohesive approach with strategic partners, could be the best method for overall service progress.

As proven by the research findings, a ‘one size solution does not fit all.’ The appropriate transition to the ultimate solution needs to be designed on a site specific basis, taking into consideration the three cross-cutting factors that influenced the overall performance of each intervention:

- Reliability of the bulk water supply in the LIS: shortages in supply should inform the nature of the investment.
- ‘Slum typology’ in relation to ‘very poor’, ‘coping poor’ and ‘developing poor’ as a gauge of affordability for different services and accessibility; or barriers that may influence accessibility, depending on the target beneficiaries.
- Selection of the implementing team in relation to the desired impacts and ability to enforce service progress under the different criteria.

### **9.3 Research Value**

Very little comprehensive information is available in the urban poor setting in Kenya evaluating the multitude of ongoing discrete interventions in the water sector to this degree, or comparing their performance against national and global benchmarks. This research fully achieved the overall objectives outlined in Section 1.6 to develop a combined portfolio evaluating the performance of four “transition phase” interventions in the urban context based on:

- 1) Capital investment, revenue generated and operation and maintenance records collected.
- 2) User needs, function, utilisation and consumer satisfaction household surveys.
- 3) An appraisal of the advantages and disadvantages of each intervention.
- 4) Comparative service level analysis of the factors that drive demand.

- 5) An overview of the performance of the four interventions in the context of achieving universal service.

The evaluation results of the research presented in a service level framework provides a useful and dynamic tool for organisations (both institutional and civil society) to interrogate and quantify the improvement in service as a result of different interventions implemented in different typologies of urban LISs over a period of time. This information also provides a helpful benchmark for the implementing partners and interested parties to easily gauge the particular criterion where the intervention has had little or no effect in service improvement, holding back the overall progress in comparison to other interventions. As the tool is dynamic, these results provide the organisations with a clearer picture on where efforts should be targeted, in aiming to improve the service received and provide a wider insight to the constraints faced hindering positive progress.

### **9.3.1 Contribution to Knowledge**

The findings of this research disproved the overall hypothesis that “transition phase” interventions are viable and cost-effective pro-poor solutions, which deliver appropriate (desired and valued) levels of service improvement in low-income urban areas in advance of the roll-out of conventional household water connections. The results showed that an appropriate improvement in service over the monitoring period was primarily hindered by inadequate bulk surface water supply, which in turn impacted the price and quality of water consumed by low-income urban consumers. The results have demonstrated that in developing pro-poor solutions in improving access to water, the role of groundwater simply cannot be ignored by policy makers. With effective policy regulation, point source groundwater supply, albeit an expensive diversion with adverse environmental impacts, could still be the most viable, affordable and resilient solution in the foreseeable future to supply adequate quantities of water to the urban poor. As long as conventional household water connections with adequate water supply remains and elusive pipe-dream for the urban poor, the viability of this solution should be explored further in research studies.

Research integrating both high-income and low-income groupings relying on this resource would aid regulation and policy making in curbing over-exploitation of groundwater, before it is no longer a viable option for the poor who need it most.

#### **9.4 Closing Statement**

There are no easy solutions to improving water supply and distribution for the urban poor in such difficult settings. This study demonstrates that transitional methods or solutions must be identified on a site-by-site basis, as each settlement and the constraints facing it are essentially unique. Regardless of whether the interventions are utility or civil society led, the best of both worlds is needed for innovative solutions catering to the target beneficiaries that can be properly implemented, managed and regulated, for lasting benefits.



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## **APPENDICES**

### **Appendix A Literature Review Critical Analysis Record**



Theme	Document Type	Title	Author / Date	YC Critical Analysis		
				Quality of methodology	Key points researcher agreed with	Researcher comments
MDG's and Water Supply	Paper	The Millennium Development Goals and urban poverty reduction: great expectations and nonsense statistics	David Satterthwaite, 2003	Review of previous WHO/ UNICEF publications. Reference to papers? Evidence seems a little too anecdotal. Analysis could be more statistical.	MDGs too narrow, concerned with measurable outcomes and neglect of developments that are not easily measured. Can also depict false positive representation of outcomes that are short-lived/ don't last. 2) Most 'expert' led solutions are led by people who lack engagement with the local population - cannot speak language. Lack of understanding in how cultural disparities can impact management and use of facilities. Make assumptions with regards to the community priorities.	Although the point is valid on the credibility of published statistics, the argument is based on anecdotal evidence and statistics that can not be proven to be more reliable. Question is it how the MDG targets are set or how they are applied at national and local level to blame?
	Paper	How the Millennium Development Goals are Unfair to Africa	William Easterly, 2007	Good statistical analysis. Research could reflect feedback from WHO in an attempt to understand some of the inconsistencies highlighted, before concluding pattern is inconsistent and random.	MDG campaign has emphasized the failure of Sub-Saharan Africa compared to other regions. 2) Valid question should progress be measured as the increase in a +ve indicator or the reduction in a negative indicator? Interesting to note the former gives advantages to other regions, the latter to Africa.	Does it make Africa look worse than it really is, or neglect to emphasize on the progress?; or does the presentation simply reflect the evident lack of progress for Africa's neglected populations? E.g. the urban poor?
	Journal	Accounting for water quality in monitoring the Millennium Development Goal on access to safe drinking-water: lessons from five countries	Rob ES Bain, Steve Pedley, 2012 Stephen W Gundry, & Jamie K Bartram Jim A Wright, Hong Yang,	Results presented for rural and urban populations combined - not reflecting true picture expect urban areas are worse in relation to factors considered.	Taking water quality is likely to lead to underestimation of number of sources considered 'improved.'	1) Paper reports progress on a +ve indicator - MDG's on -ve indicator. Confusing in light of Easterly (2007) revelations. Why not reported consistently as an increase in people WITHOUT rather than less people WITH? 2) How reliable is the data from Rapid Assessment of Drinking-Water Quality project?
	Journal	Global Access to Safe Water: Accounting for Water Quality and the Resulting Impact on MDG Progress	Kyle Onda, Joe LoBuglio and Jamie Bartram, 2012	More specific statistics on scale of over / under estimations. Methodology discussed in greater detail.	An association exists between water contamination and the presence of sanitary risk factors.	Grouping rural and urban populations in presentation. Exercise also assumed that no contamination occurs between the source and the point at time of use which is known to occur.
	Journal	Household Water Treatment and the Millennium Development Goals: Keeping the Focus on Health	THOMAS F. CLASEN, 2010	Generally good and easy to follow, although it is noted many of the references are grey literature.	HWTS is a water quality intervention only - does not address sustainable access. Not clear whether HWTS is sustainable. Potential of the intervention to make substantial contributions to health, particularly for vulnerable populations.	Health or Water? Aren't all water interventions targeted to achieve health improvements?
	Journal	How safe are the global water coverage figures? Case study from Madhya Pradesh, India	Sam Godfrey, Pawan Labhasetwar, Satish Wate, Sarika Pimpalkar, 2011	Comprehensive - RADWQ methodology was adapted for a sample size of more than 60,000 water supplies in the Zone. Noted TTC and FC were chosen to indicate fecal and animal origins which are the major causes of microbiological contamination.	The results indicate that microbial contamination is higher than chemical contamination in the majority of cases.	Check test for E.Coli? Not sure if the application of the RADWQ methodology demonstrates the need to consider water quality as fundamental to the definition of access to safe water.
	Journal	Household drinking water in developing countries: a systematic review of microbiological contamination between source and point-of-use	Jim Wright, Stephen Gundry and Ronan Conroy, 2004	Comprehensive review of field based studies limited to coliform bacteria (total coliforms, faecal coliforms and Escherichia coli).	Bacteriological contamination was higher than chemical contamination in the majority of cases.	Review only concerned with field-based studies and no laboratory based findings.
	Journal	Taking a service delivery approach to monitoring water supply in low income areas and implications for the Joint Monitoring Programme	Ton Schouten, Catarina Fonseca, Harold Lockwood, Patrick Moriarty, 2011			
	Journal	Estimating the Scope of Household Water Treatment in Low- and Medium-Income Countries	Ghislaine Rosa and Thomas Clasen, 2010	Comprehensive. Household surveys from samples ranging from 5,000 to 30,000 from 70 countries.	Boiling is the predominant method of HWT.	Definition of 'adequate' HWTS. Was it considered people may not use boiling because of no electricity/ source of power? Results largely referenced to rural environment. The use of adequate HWT methods was observed to be particularly low among the poorest households, which are also likely to suffer from higher levels of risk associated with waterborne disease.
	Journal	Basic Water Requirements for Human Activities: Meeting Basic Needs	Gleick, 1996	Generally good. Breaks down each water requirement in some detail - easy to follow.	Basic water requirement for drinking, basic sanitation services, human hygiene and food preparation. 50 litres per person per day should be considered a fundamental human right.	Too focused on rural areas? Implications? Not sure all case studies are relevant enough to set basic universal standards.
Journal	PUMPS, GERMS AND STORAGE: THE IMPACT OF IMPROVED WATER CONTAINERS ON WATER QUALITY AND HEALTH	ISABEL GÜNTHERa,* and YOUDI SCHIPPER	Randomized control trial - clear explanation.	A growing concern has therefore emerged that recontamination of water from safe sources has diminished or completely negated the expected positive health effects of providing access to improved water sources. In the short-term and medium term, improved water transport and storage containers can lead to a reduction of E. coli contamination of 70% and to a reduction of diarrhea incidence of 25% among household members aged 5 years and older.		
Journal Article	Tapped out: how can cities secure their water future?		Focus is on water utilised for agriculture - not relevant for the context of this study.			
Journal Article	Discourses of illegality and exclusion: When water access matters	Netsayi Noris Mudege* and Eliya M. Zulu, 2010	Paper is based on an analysis of 36 focus group discussions (FGDs) conducted between October 2004 and November 2004 in Korogochi and Viwandani. No quantitative data. Data is quite old almost 10 years out of date even though paper published in 2011.			
Journal	Public-private community partnerships in infrastructure for the poor	RICHARD FRANCEYS and ALMUD WEITZ, 2003	Very useful information on case studies, the objectives applied to PPP's. Assess relevance of PPP's as part of research.	Good description of the different management structures and roles i.e. PPP's and civil society. Notes none of these 'partners' appears capable of meeting the needs of the poorest in the rapidly growing urban areas on their own.	Most of the small-scale NGO approaches can be described as public-civil society partnerships as very often the public sector in some form or other is involved? Does everyone really 'aspire to have their own HH connection'?	
Journal	Pro-poor strategies for urban water supply and sanitation services delivery in Africa	P. Cross and A. Morel, 2005	Not clear, very limited - no references	Reaching the poor requires targeted interventions and broader actions at the municipal level, including: offering households a menu of service options, with differentiated costs that reflect their willingness to pay; establishing appropriate tariffs and subsidies (essentially WaterChoices); expanding the choice of service providers; and increasing hygiene awareness through social marketing (have not attempted this yet).	A little theoretical and vague in terms of references and basis of recommendations made. Specific case studies and examples would be more helpful.	
Journal	Deficiencies in drinking water distribution systems in developing countries	Ellen J. Lee and Kellogg J. Schwab, 2005	Good evidence based examples to support research from multiple countries in both developed and developing regions.	Links poor distribution networks with water quality and disease outbreaks in developing countries.	References probably too outdated for use in this study - good for general background though.	

Journal	Charging to enter the water shop? The costs of urban water connections for the poor	Richard Franceys, 2005	Clear explanation - not sure if countries where data was collected have a similar poverty threshold level.	The poorest have to rely upon vendors who are unable to access lifeline block subsidies. Various possible differentiations from a conventional piped supply enabling the poor access to household connections can realise significant economic and health benefits (WaterChoices?). The longer-term challenge for the water utility is to ensure that the overall costs are still recovered through equitable re-balancing to ensure financial sustainability.	Not sure if main benefits of having a HH connections relates to income generation? If the tariff was reduced would it be necessary to recover costs to pay the bill? Do the rich with HH connections sell water?
Journal	Cost recovery of community-managed piped water systems in Ashanti region, Ghana	K. B. Nyarko, S. Oduro-Kwarteng & I. Adama, 2006	Five out of 30 community-managed piped systems in the Ashanti region were selected for the study. Household surveys - 141 houses.	Cost recovery is affected by the ability and willingness of users to pay for the water services and sound financial management. All the small towns' water systems are not recovering the full supply cost of the water service which is the capital and operational cost.	The ability of the households to pay for the full cost of the water service was then estimated based on the 5% income rule, which states that household expenditure on water and sanitation not exceeding 5% of the household income is justified for cost recovery of the project loan. This is generally accepted as the norm by international development banks and financial institutions (ADB 1999, p. 188). - ON WHAT BASIS? Not clear if this study applies to urban poor or rural communities.
Journal	Profitability and the poor: Corporate strategies, innovation and sustainability	David Hall, Emanuele Lobina, 2006	Seems like a comprehensive study, but methodology not easy to follow.	The central theme of this argument was that private companies are more innovative and results-oriented, and so could deliver wider coverage more rapidly. Emphasised the inequity of the urban poor having to pay high prices and spend a high proportion of their income in buying water from private street vendors. The results show that efficiency is not significantly different in private companies than in public ones. The private sector is not a major innovator of these techniques.	The claims that private concessions have performed well can be criticised partly for over-optimistic interpretation of the evidence, but also for a failure to make comparisons with public sector achievements.
Journal	Costs of urban utility water connections: Excessive burden to the poor	Sam Kayaga, Richard Franceys, 2007	Used a case-study approach research method to evaluate utility performance. Approach involved review of customer database in the service areas, semi-structured interviews and focus group discussions. Therefore mixture of quantitative but mostly qualitative.	The results of the Uganda research demonstrate the substantial and unpredictable nature of the costs involved in obtaining a new water connection, costs which are often too risky as well as unaffordable. The poor, almost by definition, are unable to build up such capital sums.	Water utilities need to learn from the cable television and mobile phone operators who seem to have perfected the art of segmenting their customer base and differentiating their services to cater for all types of customers across the spectrum of the customer base - interesting point but not convinced transferable in the same manner.
Journal	Trickle Down? Private sector participation and the pro-poor water supply debate in Jakarta, Indonesia	Karen Bakker, 2007	Data collected through a household survey of poor households in six Jakarta neighbourhoods in 2005; data provided by the two private concessionaires and the Jakarta municipal government; and interviews with water supply managers, government officials, and NGO representatives in 2001 and 2005.	There is evidence that new connections have targeted middle-class customers, and that tariff increases have been higher for poorer customers, without concurrent attempts to address issues of ability to pay, income thresholds, and cross-subsidy mechanisms. Tariff pricing (with lower tariff bands below marginal costs), decided by the municipal government in negotiation with concessionaires, is implicitly 'anti-poor', providing a disincentive to both the municipality and the private concessionaires to connect the poor. The raises questions about the long term ability of PPP contracts to supply water to the urban poor.	
Journal	Better practice in supplying water to the poor in global PPPs	J. Jacobs and R. Franceys, 2008	Content analysis approach predominately used. Interviews were carried out with professionals from a range of backgrounds. Discussions with slum dwellers in conversation and in formal focus groups.	Evidence of PPP improvements. Nairobi taken from this example to set-up an in-house pro-poor department. Is it effective?	Not so clear on what the conclusion is. Best practices highlighted - but what is the conclusion on actual PPP experience?
Journal	Water services with independent providers in peri-urban Maputo: Challenges and opportunities for long-term development	Nelson P Matsinhe, Dinis Juizo, LC Rietveld and Kenneth M Persson, 2008	BH Pumping tests, Water quality measurements - 35 wells analysed for nitrates and bacteria (E. coli and faecal coliforms)	SSIPs have the dominant role in service provision and are reported to reach as many as 32% of unconnected households. This situation is not likely to change in the future, mainly because the physical expansion of the formal network is unlikely to ever match the speed at which new suburbs emerge in the city. In the long run SSIPs may face more serious water quality problems due either to over-exploitation of the aquifer system or increased hydraulic loads resulting from increased population density.	Suggesting SSP's should abstract more? Does this take into consideration population growth?
Journal	Regulation of formal and informal water service providers in peri-urban areas of Maputo, Mozambique	Nelson P. Matsinhe a,*, Dinis Juizo a, Berta Macheve b,1, Clara dos Santos b,1, 2008	Field undertaken in one of the five urban districts in Maputo. Methodology involved semi-structured interviews with consumers, owners and stand pipe attendants of small piped systems run by SSIPs, managers and stand pipe attendants. No quantitative data.	It is clear that the informal market plays the predominant role in the provision of water for the majority of residents of the surveyed neighbourhoods. Despite improvements being done to expand the formal network, in the near future, alternative service providers will continue to play an important role in service delivery in peri-urban Maputo either because the selling of water is an important source of income for households or because the expansion of the formal network is not likely to match the speed at which the suburbs of the city will grow.	
Journal	Governance Failure: Rethinking the Institutional Dimensions of Urban Water Supply to Poor Households	KAREN BAKKER, MICHELLE KODY, 2008	A reconstruction of the growth of the city's network, incorporating primary archival interview data using GIS-based mapping.	Primary factor identified by interviewees is the culture of governance within urban government in Indonesia, which does not prioritize the poor. Local governments have typically been unwilling or unable to make politically unpopular decisions or require water utilities to improve performance.	The lower income households spent, on average, a greater proportion of their household income on water supply, in part because of the choices of types of water supply varied with income. Only 10% of households in the lowest income bracket used networked water supply, whereas 30% of those in the higher-income groups did so.
Journal	The price-setting process and a potential role for economic regulation in a water scarce developing country	Anna Matros-Goreses and Richard Franceys, 2008	Overall Very clear and easy to comprehend.	The tariff-setting process is highly political and sensitive. Transparency is the most obvious way of making price-setting processes more understandable (people need to know what their money is used for), but politics mostly comes first.	
Book	Public-Private Partnerships for Urban Water Utilities: A Review of Experiences in Developing Countries	Phillippe Marin, 2009	Focuses on projects where private sector is introduced to run the utility. Analysed data from 65 water PPP projects in place for at least five years. Looked at access, quality of service, operational efficiency & tariff levels.	Does not really address the issue of lack of comparative evidence on PPP vs. public performance.	
Journal	Improved access to urban water services in Uganda	S. Kayaga MSc, PhD, CEng, MCIWEM, J. Fisher MA, PhD and R. Franceys PhD, MBA, Eur Ing, MICE, 2009	Compiling data from different sources.	Access to safe water services does not only enhance environmental sustainability. It also has a direct and highly significant influence on the achievement of other MDGs. Statistics on the most recent household size and access is computed based on the assumption that a household connection serves six people, yard taps supply 24 people (four households) and a public stand pipe, deep borehole or protected spring serves 150 people (25 households).	



Institutional Failure

Journal	Regulating water services for the poor: The case of Amman	Esther Gerlach *, Richard Franceys, 2009	Detailed methodology and fieldwork outlined	The overwhelming majority of households interviewed for this research (93%) try to conserve their water, mostly through carrying out water-intensive activities (cleaning, laundry, etc.) on the rationing day and generally limiting water use. Only few households report being seriously affected by rationing to the extent that personal water use is restricted.	
Journal	Typical urban water supply provision in developing countries: a case study of Semarang City, Indonesia	W. Hadipuro* and N.Y. Indriyanti, 2009	In-depth interviews with the chiefs.	Water peddlers are only needed by people in the case when the public water supply cannot deliver sufficient and good quality water. There is also a tendency that, for drinking, people tend to choose more reliable source in terms of quality, in this case from water kiosks.	Very simplistic outlook on the constraints of serving the urban poor.
Journal	Regulating Water Services for All in Developing Economies	ESTHER GERLACH and RICHARD FRANCEYS, 2010	11 case studies examined the variety of challenges and constraints related to urban water supply from the perspective of regulators, providers and low-income households. Initial fieldwork, comprised of semi-structured interviews with representatives of regulatory agencies, national and local government, water service providers, civil society groups and development partners, substantiated by quantitative document reviews.	Many indicators that become targets, coverage figures can be manipulated to give the appearance of pro-poor service without achieving the reality (very true!). It requires the flexibility of a regulator to look beyond the actual targets to the underlying meaning and enable service providers to trial different approaches which deliver sufficient quantities of water through an appropriate delivery mechanism, even if these do not easily translate to conventional coverage figures.	
Journal	'STANDPIPES AND BEYOND'—A UNIVERSAL WATER SERVICE DYNAMIC	ESTHER GERLACH* and RICHARD FRANCEYS, 2010		Explains universal service dynamic concept - very relevant to bringing results together.	
Working Paper	Provision of Water to the Poor in Africa: Experience with Water Standposts and the Informal Water Sector	Sarah Keener, 2010 Manuel Luengo Sudeshna Banerjee			
Journal	An econometric analysis of private sector participation in China's urban water supply	Hongwei Wang a, *, Wenqing Wub, Shilin Zhenga, 2011	Comprised of a panel dataset of the water supply sector in thirty-five major cities, although the quality of the data used is not clear.		
Journal Article	Consumer involvement in water services regulation	Richard W.A. Franceys*, Esther Gerlach, 2011	Based on case study evidence from multiple developing countries (Africa and Asia) paper discusses the risks and constraints of consumer involvement and offers interesting recommendations for appropriate involvement mechanisms that recognise the specific circumstances of low-income consumers.	Emphasizes on giving customers, present and potential, a process through which they can be involved in decision-making is an important aspect of extending water services regulation, not only to enable positive service development, but also as a means to support the legitimacy of young or fragile regulatory agencies.	Conclusions a bit weak - recommendations not so strong.
Journal	Pipe Dreams? The Governance of Urban Water Supply in Informal Settlements, New Delhi	Suneetha Dasappa Kacker and Anuradha Joshi*, 2012	Methodology followed was one of structured interviews, with both residents of Sangam Vihar and private providers.	Citizens, on their part, are trapped into unsatisfactory relationships with providers due to the lack of alternatives and, more importantly, the problems of collective action. The profile of residents subscribing to piped water services is also a factor: most of these households are not at the bottom of the ladder, but very much in the process of consolidating their status and habitat in the city.	
Journal	When urban taps run dry: Sachet water consumption and health effects in low income neighbourhoods of Accra, Ghana	Justin Stoler a,n ,G* unther Fink b, John R. Weeksa, Richard Appiah Otoo c, Joseph A. Ampofod, Allan G. Hill b, 2012	Three hypotheses tested are (1) urban slum residents enduring lower socioeconomic living standards are more likely to consume sachets, (2) slum residents experiencing greater water rationing in their neighbourhood are more likely to choose sachets, and (3) children under five in sachet-using households are less likely to experience diarrhea.	Willingness-to- pay and billability of customers is strongly influenced by the level of service and customer expectations. Despite these obstacles, the current rationing procedure remains the best known way to manage Accra's limited water resources - also done in all the case study locations. Because sachet water is typically treated during the filling process, it is plausible that residents are in fact drinking higher quality water in sachets than they would otherwise be drawing from atap, even with proper storage.	
Journal	Urban water sector performance in Africa: A step-wise bias-corrected efficiency and effectiveness analysis	Dorcas Mbuviya*, Kristof De Witte b,c, Sergio Perelman, 2012	The model specification relies on two output measures: water supply service coverage (measured in terms of the population served with piped water) and the volumetric water sold. The data correspond to 21 African countries.	In Africa, independent regulatory structures are commonly established solely for the water sector (e.g., in Kenya, Mozambique and Zambia). Utilities across the East, West and Southern African regions seemed less ineffective than technically inefficient. South African utilities are the most well performing (both effectively and efficiently) followed by (i.e., when both service connectivity and continuity variables are considered) the East African and the West African utilities. Water utilities can improve their effectiveness by increasing their efficiency. To do so, they should learn from best practices. Second, utility regulators, managers and policy makers should carefully take into account both efficiency and effectiveness performance indicators.	
Journal	A global survey of urban water tariffs: are they sustainable, efficient and fair?	David Zetlanda* and Christopher Gassonb, 2012	Primary data come from Global Water Intelligence's 2011 survey of water and wastewater tariffs for 308 cities in 102 countries. The presence of fixed charges means that the cost per cubic metre at a consumption rate of 40 litres per day may overstate the average cost per cubic metre for a household that consumes 200 litres per day - or it may not: increasing block rates may make the average cost per cubic metre at higher consumption volumes significantly higher.	Good example of how people concerned about water affordability make two assumptions that weaken their arguments. The first is that higher prices will harm the poor. That idea - simple in theory - does not hold when higher prices are used to extend service to people relying previously on the informal water market. (Zetland & Gasson, 2012). This analysis of water tariff data from around the world reveals that water prices are relatively low and that low prices are correlated with higher water consumption and greater risk of shortages. Higher prices would not only reduce water consumption and the risk of shortage, they would also provide funds to operate, repair and expand water services to people now forced to drink dirtier, more expensive and less convenient water.	Interesting findings - support previous literature. Many caveats to assess robustness of study in a particular location.
Journal	Field survey on water supply, sanitation and associated health impacts in urban poor communities - a case from Mumbai City, India	S. Kumar Karn and H. Harada, 2002	Four settlements of urban poor representing slums, squatters and pavement dwellers of Mumbai City were chosen under this study. The questionnaire was organized so as to get information on four broad perspectives; socio-economic, infrastructure, environmental health, and behaviour and environmental awareness.		

	Journal	Investigations into slum tourism in Mumbai: poverty tourism and the tensions between different constructions of reality	Julia Meschkank, 2010	An observation-theoretical approach was chosen as the theoretical framework to structure the present study. This approach recognizes all knowledge as contingent and conceptualizes reality as a construction dependent upon observation.		Content on slum tourism not relevant to this study
	Journal	Informal Urbanism and the Taste for Slums	KIM DOVEY & ROSS KING, 2012	General descriptions	Interesting insight into different slums / settlements in Asia. Good differentiation.	
	Journal	Introduction: African Development in an Urban World: Beyond the Tipping Point	Jo Reall & Basudeb Guha-Khasnobis & Ravi Kanbur, 2010			
	Journal	Discourses of illegality and exclusion: When water access matters	Netsayi Noris Mudgege* and Eliya M. Zulu, 2011			
	Journal	Privatization of Water and Sanitation Services in Kenya: Challenges and Prospects	Kenneth O. Nyangena, 2011	Methodology could be more robust to support the conclusions made. Too much grey literature in references - paper needed more research on the actual successes or failures of PPP's in Africa.		Privatization of water and sanitation services is likely to produce important benefits beyond cost savings and improved performance if the water policy is well designed and managed by all stakeholders - can this statement be made so strongly??
	Report	A CASE STUDY of PUBLIC-PRIVATE AND PUBLIC-PUBLIC PARTNERSHIPS IN WATER SUPPLY AND SEWERAGE SERVICES IN DAR ES SALAAM	Researched and written by Thelma Triche Managed and supervised by Mukami Kariuki and Midori Makino, 2012			
	Journal	Assessing the financial viability of investing in water connections for low-income households, Maputo, Mozambique				
Report	The billion dollar master plan to address Nairobi's water woes	MBUGUA NJOROGE, 2011	Many references at the end for the length of article, although not very clear were data has been sourced from. Quite a lot appears to be direct quotes from the masterplan launch event?	The water supply problems in Nairobi not only impact the health and welfare of the city's many millions of residents – rich and poor alike – but also relate to a huge cost for the nation's economic base, including its industrial and service sectors.	Current water supply, that stands at about 410,000m3 a day m- this figure is higher according to MW&I website	
Groundwater	Journal	A Framework for planning of sustainable water and sanitation systems in peri-urban areas	R. To' nqvist, A. Norstro' m, E. Ka' rrrman and P.-A. Malmqvist, 2008	Five sustainability criteria (health, environment, economy, technical function and socio-cultural aspects). Framework developed that takes account the chosen sustainability criteria and indicators. Examples of tools are checklists, participatory methods, methods for evaluating environmental and health impact, and software tools to enable decision-making.	Urban infrastructure systems are constantly changing with time and there are many uncertainties to consider when choosing a technology and/or a system, which implies that one best solution is hard to find in urban or rural settings. Socio-cultural aspects include gender structures and cultural acceptance of different types of technologies, environmental situation including ground- water levels and available freshwater sources, health situation, future urbanisation, affordability for water and sanitation, level of infrastructure, legal acceptance to onsite sanitation, and many more - to consider in research framework.	Indicators seem too broad? Overall very broad study. Not quite sure how to link to Dissertation. Maybe refer to sustainability indicators later.
	Journal	Climate change, population trends and groundwater in Africa	RICHARD C. CARTER* & ALISON PARKER, 2009	Use is made of the Africa Rainfall and Temperature Evaluation System (ARTES)	Outlines the impact of global climate change in Africa - is this well understood by policy makers in pro-poor sector?	Not certain what the key point from the paper is in conclusion. Climate change does not matter because of increased population demand...or matters anyway but not as much?
	Journal	Partnerships between utilities and small-scale providers: Delegated management in Kisumu, Kenya	Klaas Schwartz a,*, Anthony Sanga, 2010			
	Journal	An assessment of microbiological water quality of six water source categories in north-east Uganda	A. H. Parker, R. Youlten, M. Dillon, T. Nussbaumer, R. C. Carter, S. F. Tyrrel and J. Webster, 2010			
	Working Paper	Human Settlements Working Paper Series Groundwater, self-supply and poor urban dwellers A review with case studies of Bangalore and Lusaka	Grönwall, Jenny T, 2010		Many more urban dwellers in the surveyed countries can, however, be presumed to depend both directly, and even more indirectly, on groundwater distributed via taps (defined as 'piped water'). This is a lesson learned in Lusaka, where a large number of residents in the low-income areas have dug their own wells and thereby benefit from improved access to water within a short distance. Rather than the existence of shallow wells, environmental conditions such as the lack of sanitation, drainage, and solid waste disposal infrastructure, along with poor hygiene awareness, are to blame for ill-health. Diarrhoeal disease is endemic, and cholera outbreaks are regular, yet the use of chlorine or other water treatment methods is irregular.	Considering that many people who live in slums and low-income areas would benefit from access to more water than is currently available to them, it is important not to discourage people from using water from 'unimproved' wells. For all purposes? Self-supply offers the choice of technology, progressive upgrading, and replicability with little, if any, dependence on outside funds, enabling it to bring rapid and significant improvements to the lives of millions of people.
		An assessment of microbiological water quality of six water source categories in north-east Uganda.	Parker, a H; Youlten, R; Dillon, M; Nussbaumer, T; Carter, R C; Tyrrel, S F; Webster, J, 2010	Data collection was undertaken between May and July 2008, visiting as many villages as possible in the time available (346 in total). The chosen method for measuring TTC in the field laboratory was to use the Oxfam DeAgua kit.		Relates to rural areas.
		GROUNDWATER MANAGEMENT & PROTECTION progress through World Bank operations and beyond during 2000-10	Foster, Stephen Tovey, Catherine Tyson, Gill, 2011		Climate-change issues looming larger each year of the past decade. Making progress with groundwater management and protection is, of essence, a long-term activity – has been that it has allowed long-term continuity of support to World Bank clients well beyond the 'normal project cycle' of 3-5 years.	
Report	KENYA GROUNDWATER GOVERNANCE CASE STUDY	Mumma, Albert Lane, Michael Kairu, Edward Tuinhof, Albert Hirji, Rafik, 2011	Strong critical arguments that highlight strengths and weaknesses of Nairobi's governance system.	Highlights Kenya does not have policies, laws, and institutions dedicated specifically to the management of its groundwater. Overlaps in perceived responsibilities between the Ministry and the implementing agencies (WRMA, water boards and water service providers), particularly with respect to data handling and sharing. There is a poor level of understanding amongst both water sector staff and the public about the specific characteristics of groundwater that affect its management and the connectivity between surface water and groundwater.		

		Global Urban Growth and the Geography of Water Availability, Quality, and Delivery	Douglas, Ian Revena, Carmen Hale, Rebecca Grimm, Nancy Grönwall, Jenny Fekete, Balazs, 2011	A global, quantitative analysis of proxy variables used to estimate water availability, delivery, and quantity (for		Study is covering too many points. Difficult to pin down the findings and conclusions.	
	Paper	Urban wells: a vital but ignored resource	Mulenga, Martin McGranahan, Gordon, 2011	Not very clear.	There is a striking lack of information about urban self-supply of groundwater, especially given the amount of attention to water quality and availability for piped water systems. Climate change makes this gap even more worrying.	"Decision makers have assumed that urban wells are undesirable and unimportant."	
	Journal	Global Urban Growth and the Geography of Water Availability, Quality, and Delivery	Robert I. McDonald, Ian Douglas, Carmen Revena, Rebecca Hale, Nancy Grimm, Jenny Grönwall, Balazs Fekete, 2011	Quantitative analysis of proxy variables used to estimate water availability, delivery, and quantity.	Outlines two broad sets of strategies to cope with insufficient water: strategies that involve building infrastructure to obtain more water than is currently available, and strategies that involve making wiser use of existing supplies, either by improving water-use efficiency or water quality. For more than a billion people in cities, particularly in sub-Saharan Africa, facing water delivery challenges, both are in short supply	Water quality is more likely to be an issue where there are more people upstream. Chemical pollution? For example fluoride in Nairobi? It appears likely that other major water quality problems, whether microbial or chemical in nature (WHO 2008), will be greater in areas with higher upstream population density.?	
	Journal	Quantitative maps of groundwater resources in Africa	AM MacDonald, H C Bonsor, B O Dochartaigh and R G Taylor, 2012	Mainly quantitative study and methods used. Included collation and review of existing national hydrogeological maps as well as both published and grey literature for Africa. Appears to have good quality data.	Groundwater provides a natural buffer against climate variability, including drought	Groundwater generally does not require treatment since it is naturally protected from pathogenic contamination, although in some environments elevated iron, fluoride or arsenic concentrations can be a problem. Estimates of groundwater storage do not consider water quality as there is currently insufficient data to make meaningful regional assessments for Africa- how can we be certain then in relying on groundwater resource.	
Boreholes	Journal	Maintenance of rural water supply boreholes in Africa an overlooked issue	Riekel, TH, 2002	Reasonable. Mostly quantitative. Few references.	Borehole maintenance at the local level virtually impossible, without outside assistance in terms of information, funding and expertise. Donot organisations to conceptualize the importance of maintenance costs for a sustainable supply. Study in Botswana showed if boreholes would be properly maintained, this would sharply reduce annual operational costs for all borehole installations by at least 40%. Also when boreholes are not working people return to other unsafe sources.	Most local authorities neither have the funds for detailed investigation or regular maintenance, nor the skills required. Need comprehensive O&M procedures...but does one size fit all?	
	Journal	Borehole Sustainability in Rural Africa: An analysis of routine field data	Peter Harvey, 2004	Approach does not consider the hydrogeological conditions in which different boreholes are drilled	Pumps failed due to operation and maintenance and poor workmanship.	Most research based in West Africa - Ghana.	
	Journal	APPRAISAL OF WATER SUPPLY FACILITIES IN RURAL RIVERINE COASTAL AREAS OF LAGOS STATE	E.O. Longe, O.B. Omotoso and G.A. Sodamide, 2009	Formal and informal interviews, questionnaires, physical assessment, and secondary data. Very few references.			
	Working Paper	Where every drop counts: tackling rural Africa's water crisis	Jamie Skinner, 2009				
	Journal	Cost-Effective Boreholes in sub-Saharan Africa					
		Journal	The Case Study Method in Social Inquiry	Stake, Robert E., 1978	Good narrative, examples and case studies	The appropriateness of the case study methodology with social research	Not sure the points are relevant for multiple case study research?
	Journal	Successfully completing case study research: combining rigour, relevance and pragmatism	Darke, Peta Shanks, Graeme Broadbent, Marianne, 1998	Good introduction and explanation of case study research and how this can be applied	The difficulties cited, tips on how to develop an analysis strategy.	Helpful tips in overcoming difficulties which such a flexible and diverse strategy. A good read!	
	Journal	Five Misunderstandings About Case-Study Research	Flyvbjerg, B.	Good case studies and references	The appropriateness of the case study methodology with social research	Not sure the arguments surrounding the five misunderstandings are relevant for multiple case study research? Seems to dwell on single case studies.	
Case Study	Journal	Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers	Baxter, Pamela Jack, Susan, 2008	Step-by-step layout is easy to follow. Good narrative.	Guidance for novice researcher - one danger associated with the analysis phase is that each data source would be treated independently and the findings reported separately which is not the purpose of a case study. Rather, the researcher must ensure that the data are converged in an attempt to understand the overall case, not the various parts of the case, or the contributing factors that influence the case.	Very good tips and references on analysis and reporting using the case study method.	
	Journal	Effective case research in operations management: a process perspective	I. Stuart*, D. McCutcheon, R. Handfield, R. McLachlin, D. Samson, 2002	Step-by-step layout is easy to follow. Good narrative.	As reviewers for a variety of journals, the authors have noted three specific weaknesses in the data analysis section of case research paper submissions: the inability to extract significant patterns, the inability to simplify from descriptive information and the inability to think laterally.		
	Report	CASE STUDY METHODS	Robert K. Yin COSMOS Corporation, 2004	Good guide to the case study methodology and when to use the approach, limitations and tips for data collection and analysis.	Case study analysis can rely on several techniques whose use might even be anticipated during the initial design of the case study; the analysis can be presented throughout a case study, as you gradually build an argument that addresses your research questions.		
	Journal	The Use of Qualitative Content Analysis in Case Study Research	Kohlbacher, Florian, 2006		Case studies do not imply the use of a particular type of evidence and they can be done using either qualitative or quantitative evidence (or both). data collection and analysis are "developed together in an iterative process. the ultimate goal of the case study is to uncover patterns, determine meanings, construct conclusions and build theory.		

## **Appendix B Data Collection Tools and Conceptual Framework**

### **B.1 Data Collection Tools**

### **B.2 Conceptual Framework Master Spreadsheet**



NAME OF KEY INFORMANT: .....

JOB TITLE/COMPANY: .....

LOCATION: .....

Date..... Time.....

**KEY INFORMANT TEMPLATE**

1. What are the general water-related problems in this community/area? Explain:  
.....
2. What is the main water source?.....
3. How many customers do you serve per day?.....and per week? .....
4. Is the water supply reliable? (YES/NO).....
5. How many days per week is water received in this area?.....
6. Does the number of customers change during periods of drought and/ or heavy rains? (YES/NO) Explain:  
*(probe separately for both increase and decrease in number of customers)*  
.....
7. What time of day is the highest demand for the service? .....
8. Do you serve customers who buy water in bulk/ large quantities? (YES/NO) Explain:  
.....
9. How much is the average income from selling water in this area (monthly)? .....
10. How much is the average utility water bill received by vendors in this area (monthly)? .....
11. Have you experienced challenges providing the water supply service? (YES/NO) Explain: *(prompt when necessary)*  
.....
12. Why do you think some residents have never taken up the water supply service? Explain *(probe for reasons):*  
.....
13. Do you have any suggestions for improving the water supply service in your area? Explain *(probe for reasons):*  
.....

*Facilitator to collect vendor records where available*

**FOCUS GROUP DISCUSSIONS (FGD) TEMPLATE**

Hello, My /Our name is .....,.....

You have been identified to take part in the survey on a random basis. Any information you give will be treated with the strictest confidentiality and your name will not be indicated on the questionnaire or disclosed to any third parties. The main objective of this visit is to enable the researcher get the customers' reaction to and satisfaction from this project to enable improvements in other areas of the country underserved with water. I therefore request that you give your very honest responses pertaining to this project. This session will last for at least one hour but not more than two hours.

Thank you for your co-operation.

Language used:..... Date:..... Time:.....

1. Group composition: Male..... Female.....
2. What are the general water-related problems in this community/area? Explain:  
.....
3. What is your main source of water in the household? .....
4. What are other alternatively available water sources for local residents living in this area? *(Probe for at least three sources)*  
.....
5. How many days per week is the water supply available from your main source? .....
6. How long have you been using your current water supply service? Why do you use this service? Explain:  
.....
7. How many jerrycans were you using before the service/ and now? *(explain reasons for increase or decrease and what any extra water is used for)*  
.....
8. How much time does fetching water via the service take (mins)? Is this more or less time than before? (YES/NO) Explain:  
.....
9. What are some of the advantages and disadvantages this project has over the other water sources you mentioned above? *(Please probe for at least three advantages and disadvantages)*  
.....
10. Has the service helped your household? (YES/NO) Explain:  
.....
11. Have you experienced any challenges using the service? (YES/NO) Explain:  
.....

12. What would you advise needs improvement or change altogether with the service? Explain:

.....

13. Do you intend to continue using this service? (YES/NO) Explain:

.....

14. Why do you think some residents in this area have never used this service? Explain:

.....

15. Do you think this service should expand this service to other settlements? (YES/NO) Explain:

.....



**BASELINE HOUSEHOLD SURVEY TEMPLATE**

Hello, My /Our name is .....,.....

We would like you to assist us by taking time to answer the following questions and telling us about your access to and consumption of water in this area. If you do not wish to answer any particular questions, please inform us. You have been identified to take part in the survey on a random basis. Any information you give will be treated with the strictest confidentiality and your name will not be indicated on the questionnaire or disclosed to any third parties.

Thank you for your co-operation.

Language used..... Date..... Time.....

Respondent:  Male  Female

1. Are you the respondent the head of the household? (YES/NO).....
2. How many people live in the household, including children?.....
3. What business/job does head of household do? .....
4. How much is monthly rent?(Kes).....or are you the owner?.....
5. What is the daily water usage of the household: cost (Kes) .....no of jerricans:.....
6. Where do you normally purchase water?.....Why do you use this water point (kiosk/ tapstand/etc).....
7. What times of the day do you normally fetch water?  Morning  Afternoon  Evening Anytime
8. Is this water source reliable? (YES/NO) (i.e. can you access when you want)? Explain (*Probe for explanations*):.....
9. How many days is water available per week from your main source? .....
10. Do you collect and carry your water household or have it delivered?.....Who in the household carries water?.....
11. How much total time do you estimate you spend accessing your households' daily water requirements every day?(mins).....How many times do you go to the kiosk/water point per day?.....
12. How much do you pay per jerrycan (or alternative) during
  - a. Normal Service? (Kes).....
  - b. Water shortages? (Kes).....

13. Do you think you pay too much for water? (YES/NO).....If yes, what do you think is a fair price? (Kes).....
14. Do you currently pay extra to have water delivered to your house? (YES/NO)If yes, how much per jerrycan? (Kes).....
15. How do you rate the water quality from this source? Good (clear, good taste) or bad (cloudy, bad taste)?.....
16. Do you treat the water in your home?.....If yes, how do you treat it?  Boiling  Waterguard  
 Water filters  Other (Explain) ..... Why do you treat your water? (Explain).....
17. Do you have a drinking water storage tank in your house? (YES/NO).....If yes, state size in litres?.....  
 How do you use this tank? Do you fill and use the water in the tank daily?.....or do you just use it for shortages?.....
18. What most concerns you when you purchase water?  Cost  Time involved  Quality  Other  
 Explain:.....
19. What other factors must you take in to account when accessing water? i.e. do you have children to look after? Must you lock your house? Is it more difficult during bad weather? What other difficulties do you face when buying water? *(Please probe for at least three factors)*  
 .....  
 .....

**FOLLOW-UP HOUSEHOLD SURVEY TEMPLATE**

Hello, My /Our name is .....

We would like you to assist us by taking time to answer the following questions and telling us about your access to and consumption of water in this area. If you do not wish to answer any particular questions, please inform us. You have been identified to take part in the survey on a random basis. Any information you give will be treated with the strictest confidentiality and your name will not be indicated on the questionnaire or disclosed to any third parties.

Thank you for your co-operation.

Language used..... Date..... Time.....

Respondent:  Male  Female

1. How many people live in the household, including children?.....
2. Do you rent or own your house?  Rent  Own. If tenant, how much is monthly rent? .....
3. Where do you purchase water?.....Why do you use this water point?.....
4. What is the daily water usage of the household: cost (Kes) .....no of jerricans:.....
5. Do you collect and carry your water household or have it delivered?..... Who in the household carries water?  Women  Children  Men  Other.....
6. How much total time do you estimate you spend accessing your households' daily water requirements every day?(mins).....
7. Do you treat the water in your home?.....If yes, how do you treat it?  Boiling  Waterguard  
 Waterfilters  Other (Explain) .....
8. Do you have a drinking water storage tank in your house? (YES/NO)..... If yes, state size in litres?.....
9. Do you fill and use the water in the tank daily or during shortages only?.....
10. Has the project in this area helped your household?  Yes  No.

If yes, please state how the service has most helped your household:

- Saves time  Reduced effort  Saves money  More convenient  Other Explain (*Please probe for explanations*):.....  
.....

11. Any other comments: i.e. effect on children, what do people spend the spare time doing, any extra stories

Explain (*Please probe for stories*):.....

.....  
.....

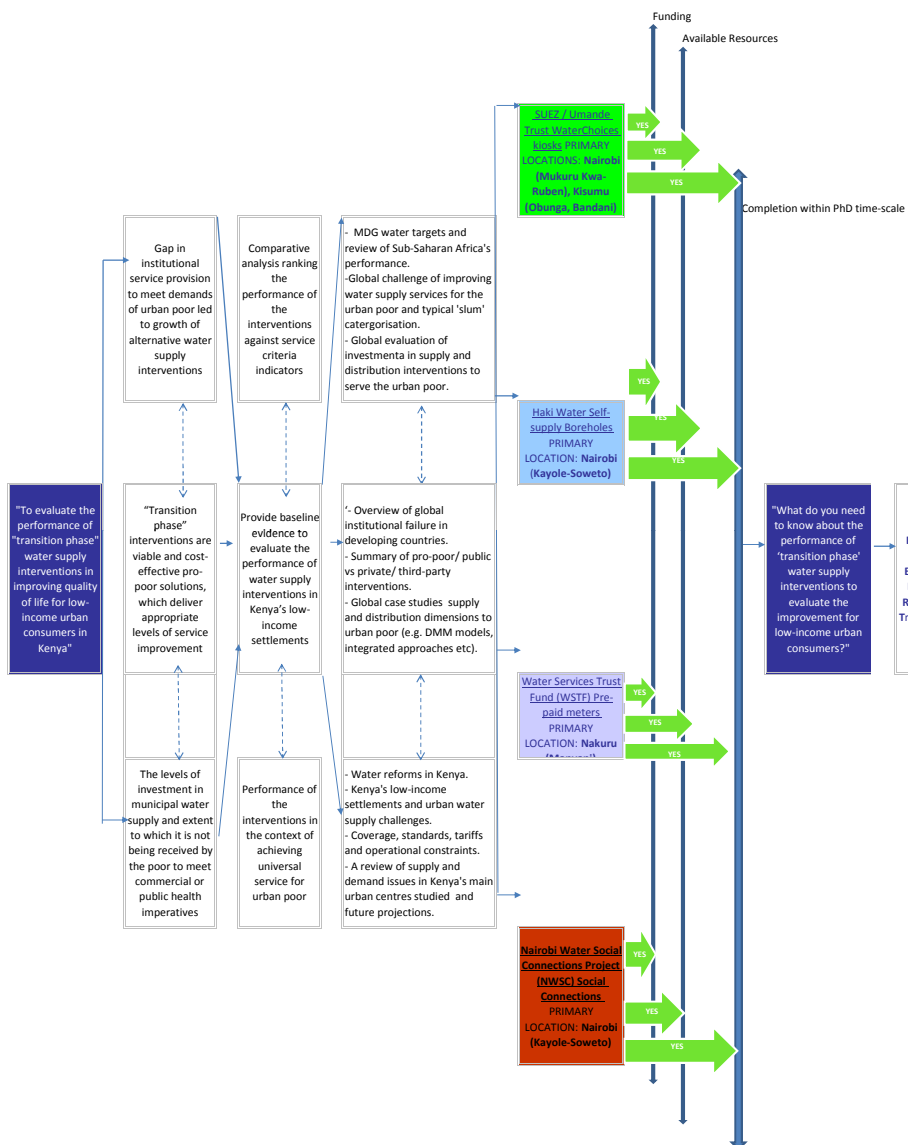
12. How satisfied are you with the service provided by the project?

- Very satisfied       Service is fair       Not satisfied       Never used the service

Explain (*Please probe for explanations*):.....

.....  
.....

Purpose	Hypothesis	Main Objectives	Literature Review	Project Interventions for Evaluation	Criteria for Selection	Research Question	Goal	Sub-Questions 1	Sub-Questions 2	Sub-Questions 3	Data Required	Data Collection Methods	Analysis	Conclusions in relation to Goal
To evaluate the performance of "transition phase" water supply interventions in improving quality of life for low-income urban consumers in Kenya	Transition phase interventions are viable and cost-effective pro-poor solutions, which deliver appropriate levels of service improvement	Provide baseline evidence to evaluate the performance of water supply interventions in Kenya's low-income settlements	<ul style="list-style-type: none"> <li>MDG water targets and review of Sub-Saharan Africa's performance.</li> <li>Global challenge of improving water supply services for the urban poor and typical 'slum' categorisation.</li> <li>Global evaluation of investment in supply and distribution interventions to serve the urban poor.</li> </ul>	Haki Water Self-supply Booths (Muhuru Kazi, Muhuru Kazi, Muhuru Kazi)	YES	Is the quantity of water adequate to meet the demand?	<ul style="list-style-type: none"> <li>Design criteria.</li> <li>Actual production.</li> <li>Capacity.</li> </ul>	<ul style="list-style-type: none"> <li>Desk study of design and operational data.</li> <li>Direct observation.</li> <li>Key informant interviews.</li> </ul>	<ul style="list-style-type: none"> <li>Per person production &amp; consumption of water.</li> <li>Available capacity (including seasonal variations).</li> </ul>	Function of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> </ul>				
				Did the project get non-functioning facilities into operation?	Is the water supply reliable?	<ul style="list-style-type: none"> <li>Revenue collection records.</li> <li>Maintenance programmes and budgets.</li> <li>Resources dedicated to maintenance.</li> <li>Annual breakdowns.</li> <li>Recorded stoppages and / or disruptions to service.</li> </ul>	<ul style="list-style-type: none"> <li>Desk study of institutional and financial data.</li> <li>Direct observation.</li> <li>Semi-structured and unstructured interviews.</li> <li>Key informant interviews.</li> </ul>	<ul style="list-style-type: none"> <li>Actual operation and maintenance costs vs. budget and resources.</li> <li>Revenue collection vs. operation and maintenance budget and actual costs.</li> <li>Annual breakdown and stoppage costs recorded per month/year.</li> <li>Hours supply per day / extent of interruptions of service pressure.</li> </ul>	Function of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> <li>Efficient</li> </ul>					
				Did the project improve the function of existing facilities?	Is access to the water supply point convenient and reasonable?	<ul style="list-style-type: none"> <li>Distance from water source.</li> <li>Distribution between households and water points and cost per jerrycan / litres per person per day.</li> <li>Consumer feedback.</li> </ul>	<ul style="list-style-type: none"> <li>Direct observation.</li> <li>Semi-structured and unstructured interviews.</li> <li>Focus Group Discussions.</li> <li>Household surveys.</li> </ul>	<ul style="list-style-type: none"> <li>Distance of water source from households in relation to sector benchmarks (during wet and dry season).</li> <li>Affordability of tariffs (Annual cost of 20/50? litres per person per day). Affordability of new connections (Average connection costs/GDP per person) Cross-subsidy to poorest within 'tariff basket'?</li> </ul>	Function of the facilities is / is not: <ul style="list-style-type: none"> <li>Equitable</li> <li>Viable</li> </ul>					
				Is the water quality within regulatory requirements?	Is the water quality within regulatory requirements?	<ul style="list-style-type: none"> <li>Physical and bacteriological samples.</li> <li>Methods and frequency water treatment.</li> </ul>	<ul style="list-style-type: none"> <li>Water quality testing.</li> <li>Semi-structured and unstructured interviews.</li> <li>Key informant</li> </ul>	<ul style="list-style-type: none"> <li>Water quality results vs. frequency and methods of treatment applied.</li> <li>Comparative water quality analysis between interventions in relation to industry standards.</li> </ul>	Function of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> </ul>					



Sub-Questions 1	Sub-Questions 2	Sub-Questions 3	Data Required	Data Collection Methods	Analysis	Conclusions in relation to Goal
1) Are the facilities functioning as intended?	Is the quantity of water adequate to meet the demand?	Is the water supply reliable?	<ul style="list-style-type: none"> <li>Design criteria.</li> <li>Actual production.</li> <li>Capacity.</li> </ul>	<ul style="list-style-type: none"> <li>Desk study of design and operational data.</li> <li>Direct observation.</li> <li>Key informant interviews.</li> </ul>	<ul style="list-style-type: none"> <li>Per person production &amp; consumption of water.</li> <li>Available capacity (including seasonal variations).</li> </ul>	Function of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> </ul>
	Did the project get non-functioning facilities into operation?	Is the water supply reliable?	<ul style="list-style-type: none"> <li>Revenue collection records.</li> <li>Maintenance programmes and budgets.</li> <li>Resources dedicated to maintenance.</li> <li>Annual breakdowns.</li> <li>Recorded stoppages and / or disruptions to service.</li> </ul>	<ul style="list-style-type: none"> <li>Desk study of institutional and financial data.</li> <li>Direct observation.</li> <li>Semi-structured and unstructured interviews.</li> <li>Key informant interviews.</li> </ul>	<ul style="list-style-type: none"> <li>Actual operation and maintenance costs vs. budget and resources.</li> <li>Revenue collection vs. operation and maintenance budget and actual costs.</li> <li>Annual breakdown and stoppage costs recorded per month/year.</li> <li>Hours supply per day / extent of interruptions of service pressure.</li> </ul>	Function of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> <li>Efficient</li> </ul>
	Did the project improve the function of existing facilities?	Is access to the water supply point convenient and reasonable?	<ul style="list-style-type: none"> <li>Distance from water source.</li> <li>Distribution between households and water points and cost per jerrycan / litres per person per day.</li> <li>Consumer feedback.</li> </ul>	<ul style="list-style-type: none"> <li>Direct observation.</li> <li>Semi-structured and unstructured interviews.</li> <li>Focus Group Discussions.</li> <li>Household surveys.</li> </ul>	<ul style="list-style-type: none"> <li>Distance of water source from households in relation to sector benchmarks (during wet and dry season).</li> <li>Affordability of tariffs (Annual cost of 20/50? litres per person per day). Affordability of new connections (Average connection costs/GDP per person) Cross-subsidy to poorest within 'tariff basket'?</li> </ul>	Function of the facilities is / is not: <ul style="list-style-type: none"> <li>Equitable</li> <li>Viable</li> </ul>
	Is the water quality within regulatory requirements?	Is the water quality within regulatory requirements?	<ul style="list-style-type: none"> <li>Physical and bacteriological samples.</li> <li>Methods and frequency water treatment.</li> </ul>	<ul style="list-style-type: none"> <li>Water quality testing.</li> <li>Semi-structured and unstructured interviews.</li> <li>Key informant</li> </ul>	<ul style="list-style-type: none"> <li>Water quality results vs. frequency and methods of treatment applied.</li> <li>Comparative water quality analysis between interventions in relation to industry standards.</li> </ul>	Function of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> </ul>
	What is the proportion of households using the facilities?	What is the proportion of households using the facilities?	<ul style="list-style-type: none"> <li>Details regarding who uses the facilities and why.</li> <li>Distance travelled and why.</li> </ul>	<ul style="list-style-type: none"> <li>Desk study and mapping.</li> <li>Direct observation.</li> </ul>	<ul style="list-style-type: none"> <li>Daily water availability.</li> <li>Per capita water consumption based on operational water facilities (including seasonal variations).</li> </ul>	Utilisation of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> <li>Efficient</li> </ul>
	Is the infrastructure provided being utilised as intended?	What volume of water is used and for what purpose?	<ul style="list-style-type: none"> <li>Daily water use.</li> <li>Consumption.</li> </ul>	<ul style="list-style-type: none"> <li>Direct observation.</li> <li>Key informant interviews.</li> <li>Focus Group Discussions.</li> </ul>	<ul style="list-style-type: none"> <li>Factors constraining demand e.g. queuing times.</li> <li>Expected future changes that may increase demand.</li> </ul>	Utilisation of the facilities is / is not: <ul style="list-style-type: none"> <li>Viable</li> <li>Effective</li> <li>Equitable</li> </ul>
	Are the educational services provided being utilised as intended?	What are the water storage habits?	<ul style="list-style-type: none"> <li>Details of water storage containers used.</li> </ul>	<ul style="list-style-type: none"> <li>Direct observation.</li> <li>Key informant interviews.</li> <li>Focus Group Discussions.</li> </ul>	<ul style="list-style-type: none"> <li>Comparison in data / observations between target groups.</li> </ul>	Utilisation of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> <li>Viable</li> <li>Equitable</li> </ul>
3) Are notable socio-economic impacts being achieved?	Have there been relative improvements in water quality from alternative levels of service?	What is the proportion of households using treated water as main source?	<ul style="list-style-type: none"> <li>Baseline data on household / institutional water treatment habits.</li> <li>Ongoing data on households water treatment habits and why (if changed).</li> <li>School attendance records (where applicable).</li> </ul>	<ul style="list-style-type: none"> <li>Desk study of financial data.</li> <li>Water quality testing.</li> <li>Household surveys.</li> </ul>	<ul style="list-style-type: none"> <li>Relationship between water treatment vs. school attendance, expenditure on medical bills.</li> <li>Relationship between water treatment vs. consumer satisfaction.</li> <li>Relationship between water treatment vs. willingness to pay.</li> </ul>	Impact of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> <li>Viable</li> <li>Equitable</li> </ul>
	Have there been relative improvements in convenience from alternative levels of service?	What is the time taken daily, to collect what quantity of water, from what source?	<ul style="list-style-type: none"> <li>Baseline data on time taken to collect water daily.</li> <li>Baseline data on quantity of water collected daily.</li> <li>Baseline data on preferred source of water.</li> </ul>	<ul style="list-style-type: none"> <li>Direct observation.</li> <li>Semi-structured and unstructured interviews.</li> <li>Key informant interviews.</li> <li>Focus Group</li> </ul>	<ul style="list-style-type: none"> <li>Relative time-savings from alternative levels of service.</li> <li>Factors influencing preferred sources of water.</li> <li>Relationship between consumption per household in relation to level of service.</li> </ul>	Impact of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> <li>Efficient</li> <li>Equitable</li> </ul>
	Have there been relative economic improvements from alternative levels of service?	What is the return on investment relative to the service received?	<ul style="list-style-type: none"> <li>Baseline data on household incomes.</li> <li>Water tariffs for different levels of service.</li> <li>Relative bill / revenue collection efficiency from alternative levels of service.</li> <li>Capital investment costs</li> <li>Operation and maintenance costs.</li> </ul>	<ul style="list-style-type: none"> <li>Direct observation.</li> <li>Semi-structured and unstructured interviews.</li> <li>Key informant interviews.</li> <li>Focus Group Discussions.</li> <li>Household surveys.</li> </ul>	<ul style="list-style-type: none"> <li>Revenue generated vs. operation and maintenance costs.</li> <li>Factors influencing better or worse returns on investment.</li> <li>Willingness to pay vs. level of service received.</li> <li>Average tariff per m3.</li> <li>Average replacement life of fixed assets.</li> <li>Electric energy uses per customer.</li> </ul>	Impact of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> <li>Viable</li> <li>Efficient</li> <li>Replicable</li> <li>Transparent</li> </ul>
	Have there been relative improvements in consumer satisfaction from alternative levels of service?	What proportion of households served by the facilities are satisfied with the level of service received?	<ul style="list-style-type: none"> <li>Consumer feedback</li> </ul>	<ul style="list-style-type: none"> <li>Key informant interviews.</li> <li>Focus Group Discussions.</li> <li>Household surveys.</li> </ul>	<ul style="list-style-type: none"> <li>Consumer rating system of alternative interventions in relation to the service criteria and why.</li> <li>Comparison in data / observations between target groups across interventions.</li> </ul>	Impact of the facilities is / is not: <ul style="list-style-type: none"> <li>Effective</li> <li>Efficient</li> <li>Viable</li> <li>Replicable</li> <li>Transparent</li> </ul>

## **Appendix C Data Collected**

### **C.1 Social Connections**

#### **C.1.1 Social Connections Conceptual Framework**

#### **C.1.2 Social Connections Site Record Notes**

### **C.2 Pre-paid meters**

#### **C.2.1 Pre-paid meters Conceptual Framework**

#### **C.2.2 Pre-paid meters Site Record Notes**

### **C.3 WaterChoices Kiosks**

#### **C.3.1 Mukuru-Ruben Conceptual Framework**

#### **C.3.2 Mukuru-Ruben Site Record Notes & Water Quality Test Results**

#### **C.3.3 Obunga & Bandani Conceptual Framework**

#### **C.3.4 Obunga & Bandani Site Record Notes & Water Quality Test Results**

### **C.4 Self-supply Boreholes**

#### **C.4.1 Self-supply Boreholes Conceptual Framework**

#### **C.4.2 Boreholes Inventory and Mapping**

#### **C.4.3 Boreholes Water Quality Test Results**

Research Question	Project Intervention for Evaluation	Goal	Sub-Questions 1	Sub-Questions 2	Sub-Questions 3	Data Required	Data Collection Methods	PRIMARY LOCATION: Bahariya - Kayole (Sewer) (NCWSC)	Site NCWSC Kayole-Sewer: BASELINE DATA COLLECTED MAY 2012	Site NCWSC Kayole-Sewer: FOLLOW UP SURVEY COLLECTED JUNE 2013	Site NCWSC Kayole-Sewer: FOLLOW UP SURVEY COLLECTED AUGUST 2013	Analysis (EVERT)
<p>1) Are the facilities functioning as intended?</p> <p>What do you need to know about the performance of transition from water supply interventions to increase the effectiveness for low income settlement residents?</p> <p><b>Baseline Water Supply Interventions: Project (NCWSC) Social Connections: PRIMARY (NCWSC) Kayole-Sewer</b></p> <p><b>DESIRE: Effective, Usable, Equitable, Efficient, Reliable, Transparent</b></p>	<p>2) Are the facilities being utilized as intended?</p> <p>3) Are notable social and economic impacts being achieved?</p>	<p>Is the quantity of water adequate to meet the demand?</p>	<p>Design criteria: Actual production, Capacity.</p>	<p>Desk study of design and operational data. Direct observation. Key informant interviews.</p>	<p>Key informant interviews with AWWA (various), NCWSC (various), and landfills (June 2013). Baseline HH surveys dated May 2012 and follow up surveys dated June 2013 (41 sites). Researcher observations (various).</p>	<p>Site 1 (Kayole-Sewer) Total 30m. HH surveys - 36% Males and 64% Females. The majority (45%) aged 13-29yrs. Average no. of people in HH = 4. Average no. of jerrycans filled daily = 6. Therefore average HH consumption per person per day is 48 litres for domestic purposes (drinking, cooking, bathing, washing clothes, general cleaning etc). 7% of respondents rely on BH as a main source of water. 12% who rely on public Standpipe Booth. 4% had piped water to plot (NCWSC), a low 2% piped water to HH (NCWSC) and 1% tankers. Seasonal variations in water supply noted due to post variations charged per jerrycan. Source: HW Baseline community HH surveys dated May 2012.</p>	<p>Site 1 (Kayole-Sewer, Bahariya) Total 33 no. HH surveys from Bahariya where the first phase of social connection meters have been installed for at least 1 month. Respondents comprised of 19% male and 81% female. Average no. of people in HH = 4. The landfills responsible for supplying the connection directly to NCWSC. 100% of respondents confirmed using NCWSC meter within their plot as their main source of water. However, all respondents confirmed relying on BH water as an alternative source of water, particularly for washing and general cleaning etc. indicating the NCWSC supply is inadequate to meet the demand. Therefore in addition to paying for water included in rent, 100% of respondents confirmed paying less 3¢ per jerrycan to meet their daily demand of 5 jerrycans per day. Source: HW community follow up HH surveys dated May 2013.</p>	<p>Site 1 (Kayole-Sewer, Mubajala) Total 30m. HH surveys from Mubajala, an area which has the highest number of applicants to the NCWSC project. Respondents comprised of 10% male and 90% female. 87% of those interviewed were landfills and 13% were tenants. Average no. of people in HH = 4. 57% were connected to the NCWSC SC, 43% were not connected. Those connected confirmed using NCWSC meter within their plot as their main source of water. From those not connected, 23% relied on NCWSC SC from the neighbour, and 10% reported using an 'old connection', despite the utility stating all old networks had been disconnected. 93% of the total respondents (connected and non-connected) confirmed relying on BH water as an alternative source of water indicating the NCWSC supply is inadequate to meet the demand. The remaining 7% used another connection from their neighbour. Therefore in addition to paying for water included in rent, respondents confirmed paying on average less 4¢ per jerrycan from alternative sources to meet their daily demand of 7 jerrycans per day. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Per person production &amp; consumption of water. Available capacity (including seasonal variations).</p>			
		<p>Did the project get non-functioning facilities into operation?</p>	<p>Revenue collection records, Maintenance programmes and budgets. Resources dedicated to maintenance. Annual breakdowns. Reported stoppages and/or disruptions to service.</p>	<p>Desk study of institutional and financial data. Direct observation. Semi structured and unstructured interviews. Key informant interviews.</p>	<p>Key informant interviews with NCWSC and landfills (June 2013). Stoppages and/or disruptions to service community records 3 months. Researcher observations (various).</p>	<p>81% of respondents, mostly those who rely on BH water as main supply confirmed water is available daily. A utility reduced 75% stated a reliable water supply is available throughout the plot. 5% of respondents confirmed the main reason for using BH water is because it is Public Utility Banked. BH supply was considered most adequate. Source: HW Baseline community HH surveys dated May 2012.</p>	<p>Post implementation, respondents stated water was available from the NCWSC meters on average 3 days per week. 38% of respondents complained of pipe leakage and long water shuttles with the service, indicating the supply was not reliable. When questioned why residents relied on BH as an alternative source, 81% confirmed BH water was the only available source in the area. Source: HW community follow up HH surveys dated May 2013.</p>	<p>Post implementation, those connected to the NCWSC project stated that water was available from the NCWSC meters on average 1 day per week. 10% of respondents complained of long water shuttles with the service, indicating the supply was not reliable. When questioned why residents relied on BH as an alternative source, 90% confirmed BH water was the only reliable water source in the area. Respondents confirmed paying on average less 4¢ per jerrycan from alternative sources to meet their daily demand of 7 jerrycans per day. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Actual operation and maintenance costs vs. budget and resources. Revenue collection vs. operation and maintenance budget and actual costs. Annual breakdowns and stoppage costs recorded per month/year. Hours supply per day/ extent of interruptions of service pressure.</p>			
		<p>Did the project improve the function of existing facilities?</p>	<p>Distance from water source. Distribution between households and water points and cost per jerrycan/litre per person per day. Consumer feedback.</p>	<p>Direct observation. Semi structured and unstructured interviews. Key informant interviews. Focus Group Discussions. Household surveys.</p>	<p>Baseline HH surveys dated May 2012 and follow up surveys dated June 2013 (41 sites). Researcher observations (various).</p>	<p>7. Only 33% confirmed using the current source because of distance to HH - the main driver was availability of supply from available sources. Generally the highest number of respondents (84%) confirmed waiting times of less than 15mins, followed by 23% waiting 15-30mins. Only 7% reported waiting times of 60mins+. Average cost per 200l jerrycan is less 3¢. Source: HW Baseline community HH surveys dated May 2012.</p>	<p>Meters located within plot - by observation all within 10m walking distance. From observation, some water points were located in close proximity to the toilets or entrance to plots, making it difficult to fill jerrycans and visible leakage/ponds of standing water around the taps. Access to the NCWSC supply is solely through landfills - the respondents must register and pay for the connection to water. The project involved new pipe networks and meter boxes - access to old (illegal) lines was to be disconnected prior to implementation of this project. 93% of respondents confirmed one of the major benefits of the project is reducing the distance walked to fetch water. Source: HW community follow up HH surveys dated May 2013.</p>	<p>30% of respondents confirmed one of the major benefits of the project is reducing the distance walked, so women do not have to carry water for long distances. When questioned why more residents were not connected to the project, 60% stated this was because access to the project depended on the landfills, and the landfills do not want to pay. To connect to the project landfills pay a subsidised fee of Kes 1.48. Despite the reports from tenants, only 1 in four landfills confirmed this connection fee too high - majority stated it was affordable. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Distance of water source from households in relation to sector boundaries (during wet and dry seasons). Reliability of tariffs (annual cost of 2610¢/litre per person per day). Affordability of new connections (average connection cost/200l per person). Cross-subsidy to poorest within tariff basket?</p>			
		<p>Is the water quality within regulatory requirements?</p>	<p>Physical and bacteriological samples. Methods and frequency water treatment.</p>	<p>Water quality testing. Semi structured and unstructured interviews. Key informant interviews. Household surveys.</p>	<p>No data (No water quality tests). Baseline HH surveys dated May 2012 and follow up surveys dated June 2013 (41 sites). Source: HW Baseline community HH surveys dated May 2012.</p>	<p>No water quality tests conducted at baseline. When questioned about what is most important with their current water source, 39% complained of pipe leakage and long water shuttles. Public utility was regarded as providing the safest water. Source: HW Baseline community HH surveys dated May 2012.</p>	<p>No water quality tests conducted. 29% of respondents confirmed one of the major benefits of the project is the good water quality compared to other water sources. 13% complained of pipe leakage resulting in contaminated water at times. Source: HW community follow up HH surveys dated May 2013.</p>	<p>No water quality tests conducted. 13% of respondents confirmed one of the major benefits of the project is the good water quality, although some residents complained that when there were long periods of no water, when the water came at times the water was contaminated. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Water quality results vs. frequency and methods of treatment applied. Comparative water quality analysis between interventions in relation to industry standards.</p>			
		<p>What is the proportion of households using the facilities?</p>	<p>Details regarding who uses the facilities and why. Distance travelled and why.</p>	<p>Desk study and mapping. Direct observation.</p>	<p>Site location maps. Baseline HH surveys dated May 2012 and follow up surveys dated June 2013 (41 sites). Researcher observations (various).</p>	<p>From the 110th survey, 53% stated the women are responsible for carrying water from their main common water source, which is the BH water used by 43% and the remaining 9% from tankers and piped NCWSC water. 27% confirmed the men (HH) collect water from the two main sources: BH (21%) and piped water (6%). Children also formed a small 6% carrying water from BH, while the remaining population shared the responsibility with everyone on the BH or had water delivered via water tankers. The longest waiting time for water 30mins was reported by 44% of consumers of BH water only. Source: HW Baseline community HH surveys dated May 2012.</p>	<p>At the time of survey, applicants to date + 2,440; paid to date + 1,804, although it was not clear the actual number of plots installed was not clear. Respondents confirmed filling their jerrycans to gain access to water. When questioned if the residents knew a reason why people were not connected, the majority, 85% believed this was due to financial constraints experienced by the landfills. Source: HW community follow up HH surveys dated May 2013 and VC notes dated 17th April 2013.</p>	<p>The majority, 30% stated that the main reason for using the water sources is the proximity to BH. From the 27% who rely on the neighbour, this was also the nearest source if their connections had no water. Borehole water was considered most reliable. When questioned, some residents stated that there were other old connections of water that people were using. NCWSC was considered better water quality for drinking and BH water for HH chores. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Daily water availability. Per capita water consumption based on operational water facilities (including seasonal variations).</p>			
		<p>Is the infrastructure provided being utilized as intended?</p>	<p>Daily water use. Consumption.</p>	<p>Direct observation. Key informant interviews. Focus Group Discussions. Household surveys.</p>	<p>Baseline HH surveys dated May 2012 and follow up surveys dated June 2013 (41 sites). Researcher observations (various).</p>	<p>From the 110th survey, 62% majority of respondents confirmed BH was most reliable and available as the main source of water, however not preferred for drinking due to the 'salty taste'. Some respondents stated using BH water mainly for washing and other chores which use large quantities, and when the piped public utility was available that would be used for drinking. However public utility paid supply was regarded as very unreliable, therefore most respondents rely on other options for drinking water. Consumption as per above. Source: HW Baseline community HH surveys dated May 2012.</p>	<p>Based on filling an average of 5no. 200l jerrycans per day for an average family size of 4. Therefore consumption per person is estimated at a basic minimum of 250litres per person per day for all purposes (drinking, cooking, washing clothes, bathing, general cleaning etc). The surveys were not conclusive on whether the project had resulted in higher consumption per day, as due to the irregular supply respondents confirmed filling all their jerrycans/storage containers with water for fear of missing water the next day, regardless of whether they needed water at that time. Source: HW community follow up HH surveys dated May 2013.</p>	<p>Based on filling an average of 7no. 200l jerrycans per day for an average family size of 4. Therefore consumption per person is estimated at a basic minimum of 350litres per person per day for all purposes (drinking, cooking, washing clothes, bathing, general cleaning etc). The surveys were not conclusive on whether the project had resulted in higher consumption per day, as due to the irregular supply respondents confirmed filling all their jerrycans/storage containers with water for fear of missing water the next day, regardless of whether they needed water at that time. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Factors constraining demand e.g. timing limits. Expected future changes that may increase demand.</p>			
		<p>What are the water storage habits?</p>	<p>Details of water storage containers used.</p>	<p>Direct observation. Semi structured and unstructured interviews. Key informant interviews. Focus Group Discussions. Household surveys.</p>	<p>Baseline HH surveys dated May 2012 and follow up surveys dated June 2013 (41 sites). Researcher observations (various).</p>	<p>When questioned, 60% of respondents confirmed having a water storage tank at home, while 40% stated they did not. From those with storage, the most common size 100litres. Source: HW Baseline community HH surveys dated May 2012.</p>	<p>When questioned, 55% of respondents confirmed having a water storage tank at home, while 45% stated they did not. Respondents confirmed filling their storage tanks with water for fear of missing water the next day, regardless of whether they needed water at that time. Source: HW community follow up HH surveys dated May 2013.</p>	<p>The majority, 93% (significantly more than baseline and Bahariya) surveys had a water storage tank at home, with the most common size 100 litres. Respondents confirmed filling their storage tanks whenever water was available from NCWSC. Those with storage containers used 70 litres or more. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Comparison in target groups. Households in relation to level of service.</p>			
		<p>Have there been relative improvements in water quality from alternative levels of service?</p>	<p>Baseline data on household / institutional water treatment habits. Ongoing data on household water treatment habits and why (if changed). School attendance records (where applicable). Expenditure on medical bills (where available).</p>	<p>Desk study of financial data. Water quality testing. Household surveys.</p>	<p>Baseline HH surveys dated May 2012 and follow up surveys dated June 2013 (41 sites).</p>	<p>56% of respondents confirmed treating water prior to consumption - the majority being women at 88% and men at 17%. The most common water treatment was Chlorine (waterguard) used by 48% of the total population. The remaining 8% stated they boil their water. Source: HW Baseline community HH surveys dated May 2012.</p>	<p>52% confirmed treating water prior to consumption, 42% do nothing. Most common water treatment was Chlorine (waterguard) by 38%, followed by boiling at 18% - marginally different from previous data. 23% stated treating water to kill germs, 19% stated the water is contaminated and 10% state they treat as a routine action. 23% of respondents confirmed one of the major benefits of the project is improved water quality from previously relying on 'salty' BH water for drinking. Source: HW community follow up HH surveys dated May 2013.</p>	<p>53% confirmed treating water prior to consumption, 47% do nothing. Most common water treatment was Chlorine (waterguard) by 37%, followed by boiling at 17%, marginally different from previous data. 23% stated treating water to kill germs, 19% stated the water is contaminated and 10% state they treat as a routine action. 13% of respondents who are connected to the project confirmed one of the major benefits of the project is improved water quality. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Relationship between water treatment vs. school attendance, expenditure on medical bills. Relationship between water treatment vs. consumer satisfaction. Relationship between water treatment vs. willingness to pay.</p>			
		<p>Have there been relative improvements in convenience from alternative levels of service?</p>	<p>Baseline data on time taken to collect water daily. Baseline data on quantity of water collected daily. Baseline data on preferred source of water daily. Ongoing data on all the above and why (if changed).</p>	<p>Direct observation. Semi structured and unstructured interviews. Key informant interviews. Focus Group Discussions. Household surveys.</p>	<p>Baseline HH surveys dated May 2012 and follow up surveys dated June 2013 (41 sites). Source: HW Baseline community HH surveys dated May 2012.</p>	<p>From the 110th survey, over 50% confirmed taking 30mins or less to collect water from their main and alternative water sources (when supply was available) but difficult to quantify as residents were still paying for alternative water sources due to the unreliable NCWSC water supply. Source: HW community follow up HH surveys dated May 2013.</p>	<p>Respondents confirmed taking 30mins or less to collect water from their main and alternative water sources (when supply was available) but difficult to quantify as residents were still paying for alternative water sources due to the unreliable NCWSC water supply. Source: HW community follow up HH surveys dated May 2013.</p>	<p>Respondents confirmed taking 30mins on average to collect water from their main and alternative water sources (when supply from their main (NCWSC) was not available). The majority 93% (initially the women) collect water in the morning only, followed by 10% who collect in the evening only. The remaining respondents collected water less a day, at anytime. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Relative time savings from alternative levels of service. Factors influencing preferred sources of water. Relationship between consumption per household in relation to level of service.</p>			
		<p>Have there been relative economic improvements in consumer satisfaction from alternative levels of service?</p>	<p>Baseline data on household incomes. Relative tariffs / revenue collection efficiency from alternative levels of service. Capital investment costs. Operation and maintenance costs. Consumer willingness to pay for alternative levels of service.</p>	<p>Direct observation. Semi structured and unstructured interviews. Key informant interviews. Focus Group Discussions. Household surveys.</p>	<p>Baseline HH surveys dated May 2012 and follow up surveys dated June 2013 (41 sites). Source: HW Baseline community HH surveys dated May 2012.</p>	<p>From 110th survey, 81% of respondents stated monthly income of Kes 10,000 -15,000. The average rent for the area was calculated at Kes 1,700 -1,900. The average daily cost per jerrycan during normal service was less 1¢, for an average of 5no. jerrycans per day. During shortages, the average cost per jerrycan is less 3¢. Therefore in any given 20 month (including weekends), the average net cost of water ranges between Kes 360 - Kes 600 (Kes 3 - 6). Therefore in a 20 day month (including weekends), the cost of water can account for up to 1% of HH income. Water plus rent over 20% of monthly HH income. Source: HW Baseline community HH surveys dated May 2012.</p>	<p>From 110th survey, the average HH rent was calculated at Kes 1,800 (increase from baseline to Kes 1,900). At the time of survey, majority of tenants (77%) confirmed that the cost of water was included in the rent and were not aware of the amount of that monthly water bill for the plot. However as all respondents confirmed relying on alternative water during the week for a regular supply of water, residents were actually paying twice to access and adequate quantity of water per week. At the time of survey some landfills had just received their first water bill in 3 months. Landfills complained NCWSC do not reach the meters, bills are late and were considered too high. Although residents were currently enjoying cost savings, reports from landfills indicated the next night might increase due to the increased water bills. Output Based Aid (OBA). Source: HW community follow up HH surveys dated May 2013.</p>	<p>From the respondents connected to the project, 17% stated the water bill was included in the rent and 20% had not received a bill. At the time of the survey none of the landfills had received the bill. The landfills complained that meters are not being read, and were apprehensive about receiving the bill as they would be no idea how high the bills would be. However as all respondents confirmed relying on alternative BH during the week for a regular supply of water for an average of Kes 4¢ per 20 litre jerrycan, residents could end up paying twice to access and adequate quantity of water per week. Although 10% of residents were currently enjoying cost savings, reports from landfills indicated the next night might increase due to the increased water bills. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Revenue generated vs. operation and maintenance costs. Factors influencing better or worse returns on investment. Willingness to pay vs. level of service received. Average tariff per lit. Average replacement life of fixed assets. Electric energy use per customer.</p>			
		<p>Have there been relative improvements in consumer satisfaction from alternative levels of service?</p>	<p>Consumer feedback.</p>	<p>Focus Group Discussions. Household surveys.</p>	<p>Baseline HH surveys dated March 2012 + 2 sites. Follow up HH surveys Aug 2012, Nov 2012 + 2 sites. Key informant interviews with landfills (June 2013). Source: HW Baseline community HH surveys dated May 2012.</p>	<p>Advantages of the Service: Saves time while doing domestic chores as water is more easily accessible. Residents do not have to walk far to collect and carry water. Good water quality. Residents reported savings in money, as monthly water costs are included in rent. Disadvantages/Challenges: Landfills complained NCWSC do not read the meters, bills are late and were considered too high. Landfills can potentially pay water costs to the tenants, yet tenants are also paying extra to access water from BH's per person in the unreliable municipal supply. Respondents indicated some residents in the area were still illegally accessing their 'bore' water. Hidden cost of project. Respondents complained of pipe leakage, some of which were visible during the survey resulting in contaminated water. Source: HW community follow up HH surveys dated May 2013.</p>	<p>Advantages of the Service: 30% of residents most valued that they do not have to walk far to collect and carry water. 11% most valued good water quality. 11% reported savings in money, as monthly water costs are included in rent. Disadvantages/Challenges: 62% complained landfills are preventing them from accessing the service. There is no mechanism of protection to the poor if their costs are linked by a result of water bills. Respondents and landfills also stated they did not understand the billing process or the last financial scheme, this was not transparent to the end user and it too complicated. As they did not understand the billing, meters were not being read and water in the area was scarce, this made customers unhappy with the service. Customers had not received a bill - no mobile money payment systems were in operation at the time of survey. Source: HW community follow up HH surveys dated August 2013.</p>	<p>Consumer rating system of alternative interventions in relation to the service criteria and why. Comparison in I/O / observations between target groups across interventions. Level of consumer participation in intervention/ decision making.</p>				

# RESEARCH – NCWSC MEETING MINUTES

**Date: 21<sup>st</sup> June 2012 – NCWSC Office**

Attendees: Yolanda Chakava (YC) – Cranfield University  
Engineer Lucy Njambi (ELN) – HEAD OF INFORMAL SETTLEMENT DEPT.  
ENGINEER Patrick

## **1 NWSC/ WB Project:**

ELN summarised the NWSC/WB project in Kayole-Soweto involved the construction of water pipes and installation of individual metered household (HH) connections. To date the water piping works had been completed, installation of the individual HH connections is still ongoing. Each plot will be served with a HH connection – 100 connections have been made so far for the people who have paid. NWSC has subsidised the initial connection charge of kes 5,000 for residents, to be re-paid through a loan over 3 years. ELN estimated the repayment would add approximately kes 150 to the HH bill. YC confirmed the residents had not relayed the connection charge was subsidised.

ELN stated the project would be online in about one week. The people who cannot afford to have a HH connection will buy the water from people who do. YC questioned what would happen to the existing kiosks. Eng. Patrick confirmed NWSC supply to Kayole-Soweto had been disconnected. YC mentioned at the time of survey, kiosks were still selling NWSC water. ELN requested Eng. Patrick to confirm, as during a recent meeting with community members, resident were still receiving NWSC supply.

YC relayed feedback from the HH surveys indicated water supply in Kayole-Soweto was rationed to 2-3 days a week. ELN confirmed water supply is currently being rationed, and this will continue post-project completion. The water rationing will continue for at least 5 -8 years, until the Nairobi Water Masterplan project is complete.

ELN discussed the key indicators of the NWSC/WB project will be the number of the accounts opened – project target is 2,200 accounts. To date, 900 applications had been received. ELN acknowledged this does not reflect the actual no. of people per account. NWSC are hoping to collect this data.

YC also highlighted the community elders had requested a BH despite being aware of the imminent connection to the NWSC/WB project, and if this was a lack of trust issue between the community and NWSC. ELN stated the issue was a 'willingness' to pay issue rather than 'ability' or 'trust.' NWSC had taken all measures to make it as easy as possible for the residents to connect. BH's are attractive as people do not want to pay for water.



YC commented Eng. Miguna had previously highlighted NWSC resources for customer service / feedback had been an issue. ELN confirmed this is still an ongoing challenge.

Regarding detailed project data (maps, documented tariffs etc), ELN requested YC to write a formal letter to MD of NWSC requesting for the data before information that can be used for publication is released. YC agreed.

## RESEARCH – NCWSC MEETING MINUTES

**Date:** 31<sup>st</sup> January 2012 – NCWSC Station (Kayole)

**Attendees:** Yolanda Chakava (YC) – Cranfield University  
Vicky Maiyo (VM) - NCWSC  
Jackline Otieno (JO) - NCWSC  
Rachel Wako (RW) - NCWSC

The meeting was chaired by VM, the NWSC Sociologist .She started off the meeting by welcoming everyone to the meeting.

VM said that the social connection project is going on well and so far 1,450 out of the expected 2,200 plots have paid commitment fee. She added that connection of water to the plots is ongoing and the project which is funded by the World Bank will come to an end in February 2013. She said that consumers who would wish to get connected after March 2013 will have to go through the normal application process that requires one to make an application with the Nairobi Water office and pay the full amount before they are connected.

**Sanitation-**VM said plans are underway to connect the Kayole, Soweto to the Nairobi sewerage system. She added that currently most plots use septic tanks and pit latrines which normally exhausted in a non-conventional method when full and the process is unhygienic manner .The sludge is poured on the drainage system which poses a health risk to the public as it can lead to water contamination, it encourages flies breeding and there is odour. She said it has not been confirmed when the project will commence.

**Community meeting-** VM said they will hold a meeting with the community which is scheduled for February 2nd, 2013. The agenda of the meeting is application, billing, vandalism and use of water pump. YC asked who will attend the meeting and VM said all community members and local leaders have been invited.

**Monitoring of the pro-poor project -** YC asked how NWSC will monitor success of the project. VM said they are using several indicators to monitor success such as number of plots who have paid bills and loan, number of plots connected etc.

**Field visit -**The team later conducted a visit to some of the plots to see how the connection has been done.

Project Intervention for Evaluation	Research Question	Goal	Sub-Questions 1	Sub-Questions 2	Sub-Questions 3	Data Required	Data Collection Methods	PHASE 1: LOCATION: Nakuru, Meru, Mt Kenya (NEMK)	Site WST1: Meru, Mt Kenya: BASELINE DATA COLLECTED JULY 2012	Site WST1: Meru, Mt Kenya: FOLLOW-UP SURVEY COLLECTED NOVEMBER 2012 - Intervention in operation for 3 months	Site WST1/WASASA 6 Locations: FOLLOW-UP SURVEY COLLECTED FEBRUARY 2013 - Intervention in operation for 6 months	Site WST1: Meru, Mt Kenya: KEY INFORMANT INTERVIEW APRIL 2013 - Intervention in operation for 6 months	Analysis
Water Supply, Toilet, Drainage, WST1 (in and outside PRIMARY LOCATION: Nakuru (Meru))	What do you need to know about the performance of 'transient' water supply interventions to reduce the responsibility for low income settlement residents?	EFFECT: Effective, Visible, Equitable, Resilient, Transparent	1) Are the facilities functioning as intended?	Is the quantity of water adequate to meet demand?	Design criteria: Actual production: Capacity	Desk study of design and operational data. Direct observation. Key informant interviews.	Key informant interviews with WST1 baseline, NAWASSCO baseline and WST1 baseline HH surveys dated July 2012 (41 sites). Researcher observations 2 sites (Nov 2012).	Site 1 (Nakuru, Meru): Total of 41 no. HH surveys, 19% are located within plots, with the average number of HH per plot = 12. Average no. of people in HH = 4. Average no. of persons filled daily = 4. Therefore average HH consumption per person per day = 20 litres for domestic purposes (drinking, cooking, bathing, washing clothes, general cleaning etc). All respondents confirmed that plot is connected to the municipal supply and metered. Main source of water during the dry and rainy season stated by 82% was from private well or within the plot, while 18% reported using water from borehole or other source. Of respondents who rely on the supply within the plot, 51% indicated that the water supply was inadequate to meet the demand. Source: WST1 Baseline HH surveys dated July 2012.	Site 1 (Nakuru, Meru): Total of 41 no. HH surveys from within the 15 plots when the first phase pilot project meters were installed. At least 1 respondent per plot interviewed. Average number of HH per plot = 24. Average no. of people in HH = 4. 84% confirmed using 5 jerrycans or less, 25% stated consumption varies daily and 32% use 20 jerrycans or less. Based on an average of 5 jerrycans filled daily, the average HH consumption per person per day is 25 litres for domestic purposes (drinking, cooking, bathing, washing clothes, general cleaning etc). 12% of respondents confirmed using the pre-paid system within their plot as their main source of water. The meter is designed to deduct Kes 1,200 per 20 litres jerrycans and was functioning well at the time of the first visit in November. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	Site 1 (Nakuru, Meru, Masai, Mau, Mt Kenya): Total of 15 no. HH surveys from the six locations where pre-paid meters were installed. Average no. of people in HH = 4. 82% of respondents confirmed using 4 or more jerrycans per day (consumption per person per day) for domestic purposes (drinking, cooking, bathing, washing clothes, general cleaning etc). 10% of respondents confirmed using the pre-paid system within their plot as their main source of water. The meter is designed to deduct Kes 1,200 per 20 litres jerrycans and was functioning well at the time of the first visit in November. Source: WASASA Follow-up surveys dated February 2013.	Site 1 (Meru, Mt Kenya): To date, 34 pre-paid meters have been installed in plots - this figure is set to increase to 91 by the end of April 2013. Approximately 1,700 litres per household have been distributed during an average of 8 people per household. One plot contains an increased average of 42 households, 2 ARE OPERATIONAL as at August 2014, WITH OVER 4,000 LITRES IN STORAGE. Source: 1C / NAWASSCO meeting minutes dated 10.04.13.	Per person production & consumption of water. Available capacity (including seasonal variations).	
				Did the project get the facilities functioning?	Is the water supply reliable?	Revenue collection records. Maintenance programmes and budgets. Revenue dedicated to maintenance. Annual breakdowns. Recurrent stoppages and/or disruptions to service.	Desk study of institutional and financial data. Direct observation. Semi-structured and unstructured interviews. Key informant interviews. Household surveys.	Key informant interviews with WST1 baseline, NAWASSCO baseline and WST1 baseline HH surveys dated July 2012 (41 sites). Researcher observations 2 sites (Nov 2012).	The majority, 47% of respondents stated water is available within the plot for 1 year per week. 42% stated availability 4 days per week and 11% stated availability 2 days per week. The majority of respondents stated that the water supply is reliable. When questioned what the main disadvantage with the main water source the majority, 42% stated often there was not enough water to meet the demand, 7% complained of pressure and 4% complained of poor maintenance. Source: WST1 Baseline HH surveys dated July 2012.	Post implementation, 90% of respondents positively responded that water was always available from the pre-paid system. However, approx. half of the complainants were residents from Nakuru, indicating the problem is not uniform across the settlement. When questioned if the surroundings of the pre-paid meter system are clean and maintained well by the residents in the 40% of respondents surveyed, 18% said 'no'. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	31% complained of water rationing and low water pressure. However approx. half of the complainants were residents from Nakuru, indicating the problem is not uniform across the settlement. 81% of respondents confirmed the water supply is reliable, water available 2 days per week. Source: WASASA Follow-up surveys dated February 2013.	The pre-paid system needs a regular supply of water. Areas with water shortages have problems, if supply is not constant, NAWASSCO maintain water rationing. This has been observed in some areas and people are comfortable with this system, as long as they know when water is available. Source: 1C / NAWASSCO meeting minutes dated 10.04.13.	Actual operation and maintenance costs vs. budget and revenue. Revenue collection vs. operational and maintenance budget and actual costs. Annual breakdowns and stoppages records recorded per household. Hours supply per day versus interruptions of service.
				Did the project improve the function of existing facilities?	Access to the water supply point convenient and reasonable?	Distance from water source. Distribution between households and water points and cost per person/litre per person per day. Consumer feedback.	Direct observation. Semi-structured and unstructured interviews. Focus Group Discussions. Household surveys.	Baseline HH surveys dated July 2012 and follow-up surveys dated Nov 2012 (41 sites). Researcher observations 2 sites (Nov 2012).	Although the majority access water from within their plot, a significant 31% complained of long waiting times. From the 40% of respondents who access water from within their plot, 42% stated that the water supply was adequate to meet the demand, 7% complained of pressure and 4% complained of poor maintenance. Source: WST1 Baseline HH surveys dated July 2012.	No complaints of long waiting times were recorded in the surveys. 13% of respondents listed reduced waiting for water as a major advantage the pre-paid meter. Registration for meters was deemed easy by 90% of the respondents during registration process. This was to ensure the token assigned to every tenant can be traced and is safe. 17% formed the process of registering for meters is hard because the procedure takes long and NAWASSCO officers are far. From the estimated 400 tokens in circulation (WST1 & WASASA combined) at the time of the field visit, only 100 had been reported lost. Each token has a security number same system with a serial number to identify the individual the token has been allocated to within the system. Over the duration of our visit approximately 15 minutes, it was observed 5 people visited the office to top up and 1 person visited to apply for the token. Topping up was very fast, approximately 2 per customer. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	Before the pre-paid system, majority of respondents (42%) stated fetching water took 2 hrs daily, 20% stated more than 1 hr, 23% stated less than 15 minutes while the remaining only 24% stated less than 15 mins. Now an average 18% stated 6 litres less than 15 minutes to fetch water daily, 7% stated 15-30mins and now only 1% reported more than 30 minutes. Massive improvement from baseline. Most complainants due to walking shorter distances, was reported by 28%. Most people (44%) reported topping up once a month, followed by 30% who reported topping up once every two weeks. A reduced 14% stated topping up weekly, 2-3 days per week - significant behaviour change from having water daily. The mean top-up amount is Kes 1400. Minimum top-up is Kes 500 and maximum top-up is Kes 2,000. 83% reported no faulty meters, 17% stated the meters were sometimes faulty. Source: WASASA Follow-up surveys dated February 2013.	Distance of water source from households in relation to factor benchmarks (during wet and dry seasons). Availability of staff (annual cost of 207000 litres per person per day). Affordability of new connections (average connection cost/SDP per person). Cross-utility for improved water 'top off' benefit?	
Is the water quality within regulatory requirements?	Physical and bacteriological quality. Methods and frequency water treatment.	Water quality testing. Semi-structured and unstructured interviews. Key informant interviews. Household surveys.	No data (No water quality tests). Baseline HH surveys dated July 2012 and follow-up surveys dated Nov 2012 (41 sites).	No water quality tests conducted at baseline. The majority, 64% of respondents stated that water quality is good, with a clear taste, 2% reported it as bad and 2% reported it as poor. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	No water quality tests conducted. There were no complaints regarding water quality. 13% stated one of the improvements of the pre-paid system as better water quality. Source: WASASA Follow-up surveys dated February 2013.	No water quality tests conducted. There were no complaints regarding water quality. 13% stated one of the improvements of the pre-paid system as better water quality. Source: WASASA Follow-up surveys dated February 2013.	Water quality results vs. frequency and methods of treatment applied. Comparative water quality analysis between interventions in relation to industry.						
Water Supply, Toilet, Drainage, WST1 (in and outside PRIMARY LOCATION: Nakuru (Meru))	What do you need to know about the performance of 'transient' water supply interventions to reduce the responsibility for low income settlement residents?	EFFECT: Effective, Visible, Equitable, Resilient, Transparent	2) Are the facilities being utilised as intended?	What is the proportion of households using the facilities?	Details regarding who use the facilities and why.	Desk study and mapping. Direct observation.	Key informant interviews with WST1 baseline, NAWASSCO baseline and WST1 baseline HH surveys dated July 2012 (41 sites). Researcher observations 2 sites (Nov 2012).	From the 40% of surveyed, 49% confirmed the mother was responsible for carrying the water daily, 18% stated all members of the household, 9% stated the father and the remaining 4% stated children alone. 71% of respondents stated they do not enter their plot to access water, 27% of respondents did enter their plot to access water, 2% of respondents did not enter their plot to access water. Source: WST1 Baseline HH surveys dated July 2012.	Approximately 80% of respondents confirmed carrying the water daily, 16% stated all members of the household, 1% stated the mother, 1% stated the father and the remaining 4% stated children alone. 71% of respondents stated they do not enter their plot to access water, 27% of respondents did enter their plot to access water, 2% of respondents did not enter their plot to access water. Source: WST1 Baseline HH surveys dated July 2012.	A continuing trend from the 155HH's surveyed, 80% confirmed the mother was responsible for carrying the water daily, 18% stated all members of the household, 1% stated the father and the remaining 4% stated children alone. 71% of respondents stated they do not enter their plot to access water, 27% of respondents did enter their plot to access water, 2% of respondents did not enter their plot to access water. Source: WASASA Follow-up surveys dated February 2013.	Water quality availability.		
				Is the infrastructure provided being utilised as intended?	What volume of water is used and for what purpose?	Daily water use.	Direct observation. Key informant interviews. Focus Group Discussions. Household surveys.	Baseline HH surveys dated July 2012 and follow-up surveys dated Nov 2012 (41 sites). Researcher observations 2 sites (Nov 2012).	From the 40% of surveyed, respondents confirmed utilising water from their main source mainly for drinking, bathing, washing clothes, general cleaning etc, 13% confirmed improved personal and household hygiene and 13% confirmed improved personal and household hygiene. The majority of respondents confirmed using water for drinking, bathing, washing clothes, general cleaning etc, 13% confirmed improved personal and household hygiene and 13% confirmed improved personal and household hygiene. The majority of respondents confirmed using water for drinking, bathing, washing clothes, general cleaning etc, 13% confirmed improved personal and household hygiene and 13% confirmed improved personal and household hygiene. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	As per above, average consumption per person at basic minimum of 20 litres per person per day for all purposes (drinking, cooking, washing clothes, general cleaning etc). 14% confirmed improved personal and household hygiene and 13% confirmed improved personal and household hygiene. The majority of respondents confirmed using water for drinking, bathing, washing clothes, general cleaning etc, 13% confirmed improved personal and household hygiene and 13% confirmed improved personal and household hygiene. Source: WASASA Follow-up surveys dated February 2013.	Factors constraining demand e.g. bearing times. Expected maintenance that may increase demand.		
				Are the educational services provided being utilised as intended?	What are the water storage containers used?	Details of water storage containers used.	Direct observation. Key informant interviews. Focus Group Discussions. Household surveys.	Baseline HH surveys dated July 2012 and follow-up surveys dated Nov 2012 (41 sites). Researcher observations 2 sites (Nov 2012).	Respondents were asked how drinking water is stored within the HH, 44% stated in all drums, 27% stated in buckets, 20% in metal or plastic containers, 4% stated in the bathtub and the remaining 4% stated in jerrycans. To prevent drinking water from getting dirty during storage, 71% confirmed using a lid or tray, 24% used a cloth container and the remaining 2% do nothing. 44% of respondents confirmed storing water for between 1 - 3 days. Source: Baseline HH surveys dated 27.03.2012.	As water was available daily, residents reported they could now collect five jerrycans per day not as before when they had to fill and store water in their containers for fear of missing water for the next day. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	No questions on HH storage. Source: WASASA Follow-up surveys dated February 2013.	Comparison in between target groups.	
Water Supply, Toilet, Drainage, WST1 (in and outside PRIMARY LOCATION: Nakuru (Meru))	What do you need to know about the performance of 'transient' water supply interventions to reduce the responsibility for low income settlement residents?	EFFECT: Effective, Visible, Equitable, Resilient, Transparent	3) Are suitable social and economic impacts being achieved?	Have there been relative improvements in water quality from alternative levels of service?	Baseline data on household / institutional water treatment habits. Ongoing data on household water treatment habits and school attendance records (where applicable). Expenditure on medical bills (where available).	Desk study of financial data. Water quality testing. Household surveys.	Baseline HH surveys dated July 2012 and follow-up surveys dated Nov 2012 (41 sites).	76% of respondents confirmed treating water prior to consumption, 24% do nothing. Most common water treatment was Chlorine (watering) by 41%, followed by boiling at 42%, FCB by 20% and filtration by 1%. The survey revealed 88% of respondents were connected to the municipal electricity supply, metered and paid for. Respondents were questioned how they determine if water is safe for drinking, 50% stated if it has no taste, 22% stated if it had been treated, 18% relied on smell and colour while 2% stated if they get sick after consumption. 44% of respondents confirmed storing water for between 1 - 3 days. Source: WST1 Baseline HH surveys dated July 2012.	When questioned about water treatment, although majority generally rated the quality as good. Respondents noted that previously a considerable part of the household budget was allocated to water being treated. 62% of the survey respondents sampled and interviewed agreed that residents do clean and maintain pre-paid meter facility banks, but they do the same time complained that this should be the work of the landlord and that all tenants should be involved in the cleaning and maintaining the facility by as to avoid the hygiene issue. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	No follow-up questions on water treatment. Source: WASASA Follow-up surveys dated February 2013.	Relationship between water treatment vs. school attendance, expenditure on medical bills, relationship between water treatment vs. consumer satisfaction.		
				Have there been relative improvements in water quality from alternative levels of service?	What is the time taken daily to collect water?	Baseline data on time taken to collect water daily. Baseline data on quantity of water collected daily. Baseline data on preferred source of water daily. Ongoing data on all the above and any of changed).	Direct observation. Semi-structured and unstructured interviews. Key informant interviews. Focus Group Discussions. Household surveys.	Baseline HH surveys dated July 2012 and follow-up surveys dated Nov 2012 (41 sites).	No data collected on time taken to fetch water daily. However for the majority of respondents their main source of water was located within the plot, distance did not appear to be a significant constraint, although results indicate long waiting times in the past. Source: Baseline HH surveys dated 27.03.2012.	When questioned what the main advantages of the project were and impact to HH, 13% stated reduced waiting for water and 13% stated improved personal and household hygiene. 13% stated reduced waiting time (longer waiting times was no longer highlighted as a constraint) and 7% stated psychological/mental relief. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	When questioned what the main advantages of the project were and impact to HH, 28% stated more convenience (drinking), 27% stated reduced waiting for water, 18% stated higher availability of water, 14% reported higher and 13% stated better water quality. Source: WASASA Follow-up surveys dated February 2013.	Relative time savings from alternative levels of service. Factors influencing preferred source of water. Relationship between consumption per household in relation to level of service.	
				Have there been relative economic improvements from alternative levels of service?	What is the return on investment relative to the service received?	Baseline data on household income. Relative bill / revenue for different levels of service. Capital investment costs. Operation and maintenance costs. Consumer willingness to pay for alternative levels of service.	Direct observation. Semi-structured and unstructured interviews. Key informant interviews. Focus Group Discussions. Household surveys.	Baseline HH surveys dated July 2012 and follow-up surveys dated Nov 2012 (41 sites).	From 70HH's surveyed, the average HH rent was calculated at Kes 1,780 (less than baseline by Kes 1207). 84% confirmed the pre-paid meter deducted the correct amount of Kes 1,200 per 20 litres jerrycans. The respondents however complained that the figure should be rounded to the nearest whole number to make it easier to calculate and pay. 8% of tenants were not bothered to monitor how much the system deducts. Although there was a minor deduction in average rent from the baseline, according to 84% of respondents' comments, the rent which is inclusive of the water bill has remained the same, despite them having to pay for water using the new pre-paid system. 13% reported paying more, with only 30% paying after the pre-paid system was installed. More than half (51%) of the respondents confirmed that the project had greatly impacted on reduced spending on water and a charge only Kes 1,200 per 20 litres jerrycans as reported to the KWS, 5,200 - charged by other water vendors from the neighborhood. Using the pre-paid system, in an average 10 day month based on using 15 jerrycans daily, the maximum cost of water was calculated at KES 180. The survey revealed that 49% of the respondents are willing to pay Kes 100 per month for water, 13% can afford to pay Kes 200 while 10% prefer to pay Kes 500. The remaining 1% were willing to pay Kes 1000 per month as they have many uses of water and that they feel they get the value for their money as do not need paying for it. These 21% who said they are willing to pay Kes 2000 - argued that they are used to the flat rate of the same amount included in the rent and would not mind paying the same as long as water was available for the low income earners. 22% of respondents requested for a new method of payment such as through mobile (i.e. M-PESA, Airtel money) to be introduced since the token collection system when they come to pay to NAWASSCO offices to recharge, especially over the weekends. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	From 155HH's surveyed, consumers said before the pre-paid system, the average cost of water was Kes 1,100 per 20 litres jerrycans. Now residents pay Kes 1,200 per 20 litres jerrycans. Therefore customers are saving Kes 1900 per cubic meter. 14% confirmed the meter was faulty, most due to not changing water although money had been deducted. Source: WASASA Follow-up surveys dated February 2013.	The average transaction value per day was Kes 2,000. Minimum top-up is Kes 500 per token. Highest top-up to date above Kes 1,800. Most people top-up between Kes 600. Source: 1C / NAWASSCO meeting minutes dated 10.04.13.	Revenue generated vs. operation and maintenance costs. Factors influencing better or worse returns on investment. Willingness to pay vs. level of service received. Average top up per month. Average requirement days of need status. Domestic energy user per customer.	
Have there been relative improvements in water quality from alternative levels of service?	What proportion of households served by the facilities are satisfied with the level of service received?	Consumer feedback.	Key informant interviews. Focus Group Discussions. Household surveys.	Baseline HH surveys dated July 2012 and follow-up surveys dated Nov 2012 (41 sites).	Male and female respondents were asked to describe the main problems with water supply. Male: 43% stated the time they have to wait, 25% stated the quantity of water available and 13% complained of long waiting times. Female: Same priorities faced with 49% stating long waiting times and 32% highlighting inadequate quantity available. Respondents also stated price and service improvements were not as indicated by 5% respectively, with 4% expressing no problems. All respondents reported positively and welcomed the pre-paid meter pilot project. Source: Baseline HH surveys dated 27.03.2012.	Advantages of the Service: Reduced cost of water to more affordable for community members, who do not have to undergo the anxiety of allocation, which previously was a source of conflict. Less water wastage at the standposts. People are more careful paying for the amount they use. Reduced conflict between tenants at the standposts. Water is available at anytime. Community ownership - landlord at site 1 had incorporated her own security measures at her cost. Landlords not passing on cost savings to poorer consumers. Source: WST1 Follow-up surveys dated November 2012 and 1C notes dated November 2012.	Advantages of the Service as per above. All complainants were generally satisfied with 41% using the performance of NAWASSCO as excellent, 57% as good, 1% as fair, 1% as poor, 1% as very poor, 1% as not applicable. Source: WASASA Follow-up surveys dated February 2013.	Consumer rating system of alternative interventions in relation to service criteria and why. Comparison in between target groups across interventions. Participation in interventions/ decision making.					

## **RESEARCH – NAKURU SITE VISIT NOTES**

**Dates: 26<sup>th</sup> November 2012**

**Locations visited: Nakuru (Manyani & Lakeview)**

Attendees: Han Seur (HN) – Water Services Trust Fund (WSTF)  
Lawrence Ojwang (LO) – WSTF Field Monitor  
Yolanda Chakava (YC) – Cranfield University  
Rachel Wako (RO) – Haki Water

Key Informant interviews – James Nganga (JN), Technical Manager Nakuru Water and Sanitation Services Company (NAWASSCO).

*HS provided transportation to and from Nakuru.*

### **1 WSTF/ NAWASSCO Project Overview**

The pre-paid meter system is aimed at improving access to urban poor customers who often have difficulty meeting monthly bills and battle with disconnections and reconnection costs; and/ or are forced to rely on alternative poor quality sources, often at high unregulated prices.

The pilot project in Nakuru has been funded by the WSTF and implemented by NAWASSCO. As part of this pilot, 15 prepaid meters at public water points have been successfully constructed in Manyani, serving 15 -20 households (HH) per plot (average HH has 4 people). JM confirmed the pilots have now been in operation for 3 months.

The second phase of the project is underway in partnership with SUWASA, to implement 80 additional prepaid meters in Nakuru's low-income settlements. At the time of our visit, JN confirmed 28 SUWASA meters had been installed.

#### **1.1 Project Description (Key Informant Interview)**

*Discussions at NAWASSCO Head Office in town.*

Under the pilot initiative, urban poor communities have been provided with prepaid meters at public standposts where they can purchase water at a regulated cost of kes 1.2 per 20 litre jerry can (previously kes 2 from kiosks), using personal tokens which are allocated per HH.

The complete Elser Kent technology to operate the system has been imported from South Africa. Nairobi Ironmongers has been trained as the local Contractor and is responsible for supply of materials, installation, training for staff operatives and trouble-shooting. JN estimated the construction costs of the prepaid meter at kes 70,000 (kes 60,000 for the

standpost and kes 10,000 for the base). Noted this was significantly cheaper than NAWASSCO kiosk construction, estimated at kes 500,000 per kiosk.

To connect to this system, customers complete a registration form obtained from the nearest regional office and pay NAWASSCO a refundable deposit of kes 300 for the token (market price is kes 1,100). Forms are usually processed and tokens ready for collection within one working day. To load the tokens, customers must visit the regional office - most people top-up in multiples of Kes 50. JN confirmed efforts made to conduct HH visits to top-up were not successful, as most people were not home during the day.

Usage of the token is not restricted per plot, currently the system allows tokens to be used in any prepaid meter. JN and LO confirmed as part of the second phase to upscale the project, the prepaid meters will serve a wider catchment of up to 40 people. Lessons learned from the first 15 pilots indicated the standposts were underutilised when restricted to plots of 15-20 HH's.

- **Summary of NAWASSCO Advantages:** recovering revenue from 'new customers' that were previously underserved or not able to pay; less staff resources required; the stress of dealing with customers disconnections and reconnections has been minimised.
- **Summary of NAWASSCO Disadvantages:** landlords refusing to reduce the rent of tenants previously paying water bills inclusive of rent, therefore tenants are not experiencing the full savings from adopting the prepaid system; slow uptake of tokens; shortages in overall water supply.

JN confirmed water is currently rationed in Nakuru low-income areas. In some parts water is available for 8 hours per day (Rhonda/ Kamtemba) and in other parts water is available for 3 days per week. The overall current demand is 70,000 cubic meters per day and supply is 40,000 cubic meters a day, leaving a shortfall of 30,000 cubic meters daily, with the low-income areas suffering the most.

Although future plans for a dam are underway, NAWASSCO is considering options to minimise the impacts of the shortages, particularly in considering plans to upscale the prepaid system. Options include establishing dedicated lines to low-income areas? Increasing the storage capacity?

JN also proposed the low-income council housing would be an ideal area for prepaid technology, as they currently do not pay for water (i.e. revenue of kes 50 for water bill paid directly to the council is not recovered by NAWASSCO).

In Nakuru suburbs, the regulated tariff structure is as follows:

- 0 – 6 m<sup>3</sup> = kes 200
- 7 – 20 m<sup>3</sup> = an additional kes 50 per m<sup>3</sup>

A refundable deposit of kes 2,500 is paid for connection, along with a kes 200 non-refundable application fee.

## 2 Field Visit Interviews & Observations

### 2.1 NAWASSCO Regional Office – Manyani

- Site operatives confirmed the system is working well so far. Approximately 15 – 20 customers top-up per day.
- Most customers load credit in denominations of kes 50.
- The busiest day for transactions is Friday, as the office is closed over the weekend.
- From the estimated 400 tokens in circulation (WSTF & SUWASA combined), only two have been reported lost. Each token has a security mainframe system with a serial number to identify the individual the token has been allocated to within the system.
- Over the duration of our visit (approximately 15 minutes), it was observed 5 people visited the office to top-up and 1 person visited to apply for the token. Topping-up was very fast, approximately 2 mins per customer.



Figure 1 Customer topping up

### 2.2 Site Visits (2 sites) & SUWASA (1 site)

#### 2.2.1 Advantages:

- The landladies at Site 1 and Site 3 were present at the time of our visit. Explained prior to the prepaid system, tenants were not paying their water bills. The bills were read from one single meter covering the whole plot, making it very difficult to confirm who pays for what. The landlady would be disconnected and left to pay bills ranging from kes 15,000 to as high as kes 26,000 per month. Now she is only responsible for paying for what she uses and her bills average at kes 900 per month. There is now less conflict between tenants and landlords.
- Reduced cost of water is more affordable for community members, who do not have to undergo the anxiety of disconnection and burden of reconnection costs.
- Less water wastage at the standposts. People are more careful paying for the amount they use. At Site 1, HS confirmed less standing water was visible at the base of the standpost from his last visit to the plot (pre-construction).
- No queuing for water and long waiting times anymore. Water is accessible at anytime.
- Reduced conflict between tenants at the standposts.
- Very convenient as water can be obtained any time.
- Community ownership – landlady at Site 1 had incorporated her own security measures at her cost.



### 2.2.2 Disadvantages:

- HS noted that since the prepaid system had been introduced, the storage tank and showers were no longer in use – drop in service.
- Long walking distances observed to the nearest NAWASSCO regional office to top-up.

## 3 Opportunities & Threats

Figure 2 Site 1 Standpost

### 3.1 Researcher Observations

- Nakuru low-income settlements vary greatly in character. Site 1 & 2 comprised of well built-up demarcated structures. The plot areas were generally very clean and tidy.
- Site 3 was surrounded by more informal structures, sparsely populated, feeling more ‘rural’ in nature, yet located in close proximity to the town centre.



### 3.2 Opportunities

- Access to an affordable water supply at any time.
- Tariff is regulated – cannot increase during droughts or at vendors/ landlords discretion.
- Plots consist of significant numbers of children – possible to integrate hygiene messages with prepaid system.
- Water Choices kiosks present strong potential to combine main impacts from prepaid system (cost) with reduced effort/ burden from carrying water.
- HS to advise on materials to reduce to construction cost of the water choices kiosk to within the range 1,000 – 2,000 Euros.

### 3.3 Threats

- Lack of cooperation from landlords and cartels, due to decreased cost of water.
- Vandalism for community members.
- Technology is still relatively new – maintenance issues may arise as project develops e.g. rigid hose pipe causing leakages. Flexible, but strong hose-pies needed.

# WATER SERVICES TRUST FUND MEETING MINUTES

## PRE-PAID METERS

Date: 19<sup>th</sup> April 2013

Attendees: Han Seur (HS)–Water Services Trust Fund (WSTF)  
Edward Kungu (EK) – WSTF  
Lawrence Ojwang (LO) – WSTF  
Zaituni Kanneje (ZK) – Nakuru Water and Sanitation Services Company NAWASSCO  
Timothy Wanjohi (TW)- NAWASSCO  
Yolanda Chakava (YC) - Haki Water  
Jack O'Regan (JoR) - Consultant

### *Introductions*

HS kicked-off the meeting with introductions. He then continued to summarise WSTF interests and priorities with regards to the WaterChoices kiosk concept as:

- Exploring methods to upscale the pre-paid meters based on the initial successes of the pilot in Nakuru.
- Interested in pro-poor innovation and piloting concepts with potential to upscale.
- To reach 1.6 million people by the end of 2013.

### *Pre-paid Meters*

ZK summarised the experiences, advantages and disadvantages of using the pre-paid meters in Nakuru. To date, 84 pre-paid meters have been installed in plots – this figure is set to increase to 95 by the end of this month. Approximately 1,700 tokens per household have been distributed serving an average of 6 people per household. One plot contains an average of 40 households.

Plots with pre-paid meters are about 50mx100m in size; therefore people walk less than 15 meters to access water (distance reduction of over 50%). The water pressure to fill one jerry is considered always above minimum.

TW confirmed the average transaction value per day is kes 3,000/-. Minimum top-up is kes 50/- per token. Highest top-up to date is kes 800/-. Most people top-up between 8am-3pm.

### **Advantages:**

- Elevated the tenant from being dependent on the landlord for accessing water. Now the customer has rights.



- TW stated NAWASSCO revenue collection is 100%.
- TW confirmed cases of water theft (illegal connections) and stolen meters have significantly reduced.
- Customers recognise the benefits - demand for pre-paid system is very high. Customers with yard tap now also want pre-paid.
- Minimises water wastage.
- Has been a relief to landlords who no longer have to manage and monitor water supply within their compounds, which previously was a source of conflict.

**Disadvantages:**

- The main problem is associated with operation and maintenance and relates to inefficiencies with the supplier – Nairobi Ironmongers considered extremely disappointing and did not provide the full services they were paid for. Other options considered include Grundfos lifelink, although this system is very expensive and relies on Mpesa. HS confirmed the WSTF cannot use a system that makes people dependent on one mobile service phone provider in the market. Additionally as a payment option mpesa transaction fees are too high.
  - No spare parts for the meters. By the end of February 12 meters had broken down. When the pre-paid system is down, customers have an option of buying water from another meter within the same village or reverting to water vendors.
  - NAWASSCO technical team did not receive adequate training on the system.
- Pre-paid system needs a regular supply of water. Areas with water shortages have problems. If supply is not constant, NAWASSCO maintain water rationing. This has been enforced in some areas and people are comfortable with this system, as long as they know when water is available.
- In isolated cases where rent was inclusive of water, some landlords have refused to reduce the rent. NAWASSCO work to resolve this through clear communication with the landlords.



# RESEARCH – MUKURU-RUBEN SITE VISIT NOTES

**Dates:** 06<sup>th</sup> September 2012

**Locations visited:** Mukuru-Ruben

**Attendees:** Yolanda Chakava (YC) – Cranfield  
Rachel Wako (RW) – Haki Water  
Leon – Umande Trust



## ***Project Overview***

First visit by YC to see the completed WaterChoices projects in Mukuru-Ruben and to meet the management group. Leon explained that WaterChoices had been implemented at two locations in Mukuru-Ruben: Heshima and Top 1. Both locations are within walking distance of each other. The findings are summarised below:

### **Heshima**

The vendor, Abigail explained the WaterChoices concept. The kiosk had been constructed by Jack O'Regan and the meter bank has three hose connections. She explained she has developed a list of customers and during the day, she takes one hose reel herself to deliver water to HH's around the kiosk. The other two hose reels are released to her customers to fill water for themselves, then she collects the money after. When questioned about the risk of theft, she stated this was not possible as she knew all her customers. Any unauthorised person given the reel by the customer on the list will be charged. This has been agreed by all parties. Average daily income received is about kes 350. Sales could be improved with better water pressure – due to low pressure at the moment she was unable to deliver to more customers. Stated the group would need a pump to improve the pressure and increase service coverage.


**Table 1 Heshima WaterChoices kiosk – Source: YC Site visit 06/09/12**

Heshima WaterChoices - meter bank	Heshima WaterChoices - delivery
 <p>- View of new meters</p>	 <p>- View of delivery service in operation</p>

**Top 1**

The vendor, Isaac explained the WaterChoices concept clearly and comprehensively – showed good understanding of the project. The meter banks had been fitted and hoses stored behind the kiosk in the corner. The service was not in operation at the time of the visit, as he confirmed needed to find another Caretaker to operate the kiosk. He did not have capacity to operate the bio-centre and WaterChoices. One attempt had been made to steal the meters. Stated the initial findings had shown people around Top 1 were greatly benefitting as there were limited water resources in the area, and the delivery service will be reinstated soon.

**Table 2 Top 1 WaterChoices kiosk – Source: YC Site visit 06/09/12**

Top 1 WaterChoices - meter bank	Top 1 Kiosk
 <p>- View of new meters installed at Top 1.</p>	 <p>- View of Top 1 collection point at kiosk</p>

# RESEARCH – MUKURU-RUBEN SITE VISIT NOTES

Dates: 21<sup>st</sup> February 2013

Locations visited: Mukuru-Ruben

Attendees: Yolanda Chakava (YC) – Cranfield  
Jack O'Regan  
Leon – Umande Trust

## ***Project Overview***

Visit by YC to collect vendor records and monitor progress of the project.



### **Heshima**

A new vendor had been appointed – Elizabeth Mwangi. Suggestions there were problems with the revenue collection and Abigail. Elizabeth provided comprehensive book keeping records – vendor records collected for the months November 2012, December 2012, January 2013 and February 2013.

The kiosk has since been fitted with a pump. At the time of the visit, it was observed that Elizabeth had combined the delivery pipes to make one long pipe (over 100m). The pipe was serving extended HH's and women conducting businesses such as making chips.

Elizabeth did not express any challenges and stated the project was going well. Vendor records noted some days of no sales, which she confirmed were days when there was no water at the kiosk.

**Table 1 Heshima WaterChoices kiosk – Source: YC Site visit 21/02/13**

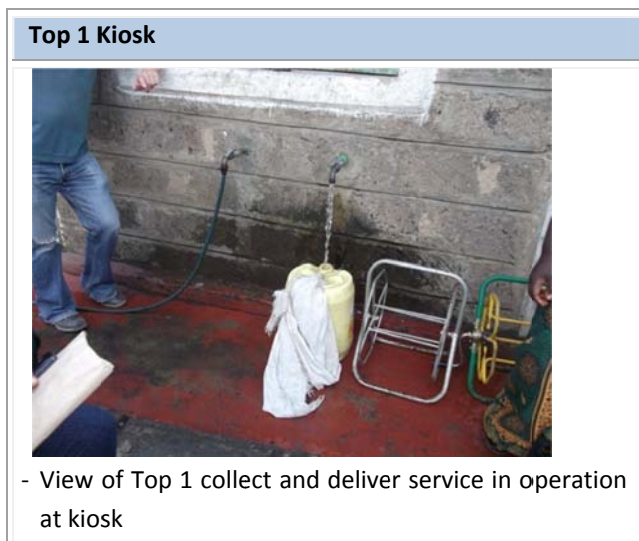
Heshima WaterChoices – delivery at HH's	Heshima WaterChoices - delivery
 <p>- View of delivery at HH's and womens business.</p>	 <p>- View of pipe extending over 100m</p>

## **Top 1**

Two pipes were in operation at the time of the visit. Daniel provided comprehensive book keeping records – vendor records collected for the months November 2012, December 2012, January 2013 and February 2013.

In addition to the surrounding residents, the Top 1 delivery was also serving the brewery located nearby – service was noted to be benefitting heavy commercial water users. Technically this does not present a problem, provided the residents are also receiving adequate water.

**Table 2 Top 1 WaterChoices kiosk – Source: YC Site visit 06/09/12**



# RESEARCH – MUKURU-RUBEN FOCUS GROUP DISCUSSIONS

**Dates:** 10<sup>th</sup> April 2013

**Locations visited:** Mukuru-Ruben

**Attendees:** Yolanda Chakava (YC) – Cranfield  
Faith Nyakundi – Haki Water  
Faith – Area Manager, Umande Trust

## ***Project Overview***

Visit by YC to conduct Focus Group Discussions with residents from Heshima and Top1.

### **Heshima**

FDG Attended by 5 Females and 2 Males.

Conducted in: Heshima WaterChoices Kiosk

1. All respondents confirmed accessing Heshima WaterChoices kiosk as their main source of water for the household.
2. 3 out of 7 respondents had a storage tank at home with capacities of 50lit, 100lit and 200lit. The remaining group members used multiple 20lit jerrycans for storage – up to 12 jerrycans reported by one.
3. All confirmed using the hosepipe delivery service at least twice a week to fill their jerrycans or water storage tanks at home, alleviating the need to collect water daily. Although some members stated there was not always a reliable water supply at the kiosk, this was no longer an issue as they were able to collect and store water at home as a direct result of the service.
4. Group members confirmed via the delivery option, they are able to purchase more water for daily use (as indicated in household surveys). The women stated they use the extra water for washing clothes – particularly bedding which takes up a lot of water, household cleaning and for their businesses to clean vegetables for sale.
5. Group members confirmed using the delivery option takes less time than fetching water from the kiosk, although it was difficult to ascertain how much time is actually saved. The delivery service takes 5-10mins to fill jerrycans, although some members complained waiting long durations for the hose pipe to reach them.

### **Advantages of the Service**

- More water available for personal hygiene. They can now clean their clothes and particularly bedding more frequently (items that require large quantities of water).
- Has helped to support women in their businesses – selling vegetables and food. It takes a lot of water to clean the vegetables, now they can operate their businesses from home.

## Disadvantages/ Challenges

- Not enough pipes. Sometime people are waiting for the delivery service and the pipes cannot meet the demand.
- Concerns have been raised regarding the cleanliness of the pipes – some residents do not like to see the pipes passing though the dirty ditches etc.

## Summary

- All emphasised the benefits of the service and desire to continue using it.
- When questioned, group members stated one possible reason people do not use the service is dependent on how many jerrycans they wish to fill. If less than four, some people may prefer to walk to the kiosk rather than waiting for hose pipe delivery.

Table 1 Heshima FDG – *Source: YC Site visit 10/04/13*



## ***Key Informant Interview with Vendor***

- Elizabeth Mwanyi stated in one week, he serves about 14 customers via delivery. This number increases during the rainy season. The collect option serves about 10-15 people daily – significantly more people preferring to use this option despite their being no difference in cost for delivery.
- Confirmed some residents have not used the service as they do not like to see the pipes passing though the dirty ditches etc., although this was not highlighted in the FDG.
- At the time of visit, none of the hosepipes were in operation. .
- Elizabeth Mwanyi and YC mapped the houses receiving service.



## **Top1**

FDG Attended by 5 Females

Conducted in: Outside Top1 Bio-centre

1. All respondents confirmed accessing Top1 WaterChoices kiosk as their main source of water for the household.
2. 3 out of 5 respondents had a storage tank at home with capacities of 50lit and 100lit. The remaining group members used multiple 20lit jerrycans for storage – up to 6 jerrycans reported by two.
3. All confirmed using the hosepipe delivery service at least twice a week to fill their jerrycans or water storage tanks at home, alleviating the need to collect water daily. Water supply was considered reliable.
4. Group members confirmed via the delivery option, they are able to purchase more water for daily use (as indicated in household surveys). The women stated they use the extra water for personal hygiene and washing clothes –bedding was mentioned again as taking up a lot of water. None of the women stated using the water for business.
5. Group members confirmed using the delivery option takes less time than fetching water from the kiosk. The women estimated with delivery at home takes 5-10mins maximum depending on the storage they have, while collecting water from the kiosk was reported to take approximately 30mins or longer, especially on Sundays when there are long queues.

### **Advantages of the Service**

- Water is always available in the house even if you come home late from work.
- Do not have to leave the children to go and fetch water daily.
- More water available for washing clothes and bedding (items that require large quantities of water).

### **Disadvantages/ Challenges**

- Not enough pipes, especially on Saturdays and Sundays when there are long queues at the kiosk. Wider pipes were suggested to serve more people at once.

### **Summary**

- All emphasised the benefits of the service and desire to continue using it.
- When questioned, group members stated one possible reason people do not use the service is dependent on how close they live to the kiosk – if nearby some people prefer to carry.

### ***Key Informant Interview with Vendor***

- Daniel Orenge stated in one week, he serves about 20 customers via delivery. This number increases during the rainy season. The collect option serves about 20 people daily – significantly more people preferring to use this option despite their being no difference in cost for delivery.
- Confirmed some residents have not used the service as they do not like to see the pipes passing through the dirty ditches etc., although this was not highlighted in the FDG.

- At the time of visit only one hosepipe was in operation. The other pipe given to them had broken down, and the group had not made any further investments. He stated the current pipe was too short – 60m. He needs a pipe about 200m to expand coverage.
- Stated the water was more expensive at 5/-, as there is no other vendor in the vicinity.
- Daniel Orege and YC mapped the houses receiving service.

**Table 1 Top1 FDG – Source: YC Site visit 10/04/13**



# AQUATECH INDUSTRIES LTD.

JUNE 3<sup>RD</sup>, 2013

## BACTERIOLOGICAL ANALYSIS

Sample N<sup>o</sup> : 1306/07  
Date Sampled : 31/05/2013  
Date Received : 01/06/2013  
Sample Source : HESHIMA, FROM 20 LITERS JERRY CAN  
Sample Submitted by : HAKI WATER

## EXAMINATION RESULTS

TEST	KS 459 – 1: 2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	ND
MPN of Feacal Coliform Organisms in a 100 ml sample	Shall be absent	ND

**MPN: Most Probable Number**

**ND: Not Detected**

**<: Less Than**

**KS: Kenya Standard (KEBS 2007)**

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENT

The water sample complies with the set bacteriological guideline values for potable water.



**AARON MUTHOKA**  
**WATER QUALITY LAB**

# AQUATECH INDUSTRIES LTD.

JUNE 3<sup>RD</sup>, 2013

## **BACTERIOLOGICAL ANALYSIS**

Sample N<sup>o</sup> : 1306/08  
Date Sampled : 31/05/2013  
Date Received : 01/06/2013  
Sample Source : HESHIMA, FROM HOSEPIPE  
Sample Submitted by : HAKI WATER

## **EXAMINATION RESULTS**

<b>TEST</b>	<b>KS 459 – 1: 2007 THIRD EDITION 2007</b>	<b>RESULTS TREATED</b>
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	2.2
MPN of Feacal Coliform Organisms in a 100 ml sample	Shall be absent	2.2

**MPN: Most Probable Number**

**ND: Not Detected**

**<: Less Than**

**KS: Kenya Standard (KEBS 2007)**

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## **COMMENT**

The water sample does not comply with the set bacteriological guideline values for potable water.

  
**AARON MUTHOKA**  
**WATER QUALITY LAB**

# AQUATECH INDUSTRIES LTD.

JUNE 3<sup>RD</sup>, 2013

## BACTERIOLOGICAL ANALYSIS

Sample N<sup>o</sup> : 1306/09  
Date Sampled : 31/05/2013  
Date Received : 01/06/2013  
Sample Source : HESHIMA, FROM HH STORAGE 100 LITERS  
Sample Submitted by : HAKI WATER

## EXAMINATION RESULTS

TEST	KS 459 – 1: 2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	ND
MPN of Faecal Coliform Organisms in a 100 ml sample	Shall be absent	ND

**MPN: Most Probable Number**

**ND: Not Detected**

**<: Less Than**

**KS: Kenya Standard (KEBS 2007)**

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENT

The water sample complies with the set bacteriological guideline values for potable water.



**AARON MUTHOKA**  
**WATER QUALITY LAB**

# AQUATECH INDUSTRIES LTD.

JUNE 3<sup>RD</sup>, 2013

## BACTERIOLOGICAL ANALYSIS

Sample N<sup>o</sup> : 1306/10  
Date Sampled : 31/05/2013  
Date Received : 01/05/2013  
Sample Source : TOP 1, FROM 20 LITERS JERRY CAN  
Sample Submitted by : HAKI WATER

## EXAMINATION RESULTS

TEST	KS 459 – 1: 2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	ND
MPN of Faecal Coliform Organisms in a 100 ml sample	Shall be absent	ND

**MPN: Most Probable Number**

**ND: Not Detected**

**<: Less Than**

**KS: Kenya Standard (KEBS 2007)**

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENT

The water sample complies with the set bacteriological guideline values for potable water.



 **AARON MUTHOKA**  
WATER QUALITY LAB

5

AQUATECH INDUSTRIES LTD WATER QUALITY LAB

**HAKI WATER, WATER SAMPLES – JUNE 3<sup>RD</sup>, 2013**

# AQUATECH INDUSTRIES LTD.

JUNE 3<sup>RD</sup>, 2013

## BACTERIOLOGICAL ANALYSIS

Sample N<sup>o</sup> : 1306/11  
Date Sampled : 31/05/2013  
Date Received : 01/05/2013  
Sample Source : TOP 1, FROM HOSE PIPE  
Sample Submitted by : HAKI WATER

## EXAMINATION RESULTS

TEST	KS 459 – 1: 2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	ND
MPN of Faecal Coliform Organisms in a 100 ml sample	Shall be absent	ND

**MPN: Most Probable Number**

**ND: Not Detected**

**<: Less Than**

**KS: Kenya Standard (KEBS 2007)**

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENT

The water sample complies with the set bacteriological guideline values for potable water.



**AARON MUTHOKA**  
WATER QUALITY LAB

# AQUATECH INDUSTRIES LTD.

JUNE 3<sup>RD</sup>, 2013

## BACTERIOLOGICAL ANALYSIS

Sample N<sup>o</sup>. : 1305/12  
Date Sampled : 31/05/2013  
Date Received : 01/05/2013  
Sample Source : TOP 1, HH STORAGE 75 LITERS  
Sample Submitted by : HAKI WATER

## EXAMINATION RESULTS

TEST	KS 459 – 1: 2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	>16
MPN of Faecal Coliform Organisms in a 100 ml sample	Shall be absent	>16

**MPN: Most Probable Number**

**ND: Not Detected**


**<: Less Than**

**KS: Kenya Standard (KEBS 2007)**

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENT

The water sample does not comply with the set bacteriological guideline values for potable water.

  
*for* **AARON MUTHOKA**  
WATER QUALITY LAB





# RESEARCH – KISUMU SITE VISIT NOTES

Dates: 26<sup>th</sup> – 27<sup>th</sup> April 2012

Locations visited: Nyalenda, Obunga, Bandani

## 1 PROJECT OVERVIEW

Kisumu Water and Sewerage Company Limited (KIWASCO) is the Water Service Provider (WSP) appointed by Lake Victoria South Water and Sewerage Board (LVSWSB), to supply water within the jurisdiction of Kisumu Municipality. KIWASCO is officially mandated to “effectively and efficiently provide adequate water to customers and to collect, treat and dispose sewerage in a safe and environmentally friendly manner.” The Company draws its mandate from Water Act 2002 which replaced Water Act Cap 372. In an effort to improve on revenue collection and access to water for informal settlements, KIWASCO piloted the use of a pre-paid water metering system led by a Namibian based company TagMeter Namibia, operated under a Delegated Management Model (DMM). The pre-paid software supports both KIWASCO and DMM services. Ref: <http://www.kiwasco.co.ke/mission.html> extracted 15th May 2012.

## 2 KEY INFORMANT INTERVIEWS

### 2.1.1 KIWASCO

Attendees: Joshua Ondolo – Area Manager for Nyalenda (KIWASCO)  
Alex Atwetu – Technical Manager (KIWASCO)  
William Sunday (Umande Trust)  
Jack O’Regan (JO - Cranfield)  
Yolanda Chakava (YC - Cranfield)

KIWASCO Reasons stated for Introducing the DMM:

- Excessive leakages / vandalism along KIWASCO lines resulting in high Unaccounted For Water (UFW).
- Lack of community ownership.
- To create employment.

**Table 1** KIWASCO vs DMM – Source: KIWASCO Area Manager for Nyalenda (interview 26/04/12)

KIWASCO	DMM
<p><b><u>Customer base:</u></b></p> <ul style="list-style-type: none"><li>- KIWASCO still directly serve majority of Nyalenda, with approximately 800 customers.</li><li>- By July 2012, KIWASCO intends to have</li></ul>	<p><b><u>Customer base:</u></b></p> <ul style="list-style-type: none"><li>- DMM’s operate 8 lines serving a total of 685 customers in Nyalenda only.</li></ul>

transferred 500 more customers to the DMM lines.	
<p><b><u>KIWASCO Tariff Structure:</u></b></p> <ul style="list-style-type: none"> <li>- Meter deposit = kes 1,800</li> <li>- Connection charge for ½ inch pipe = kes 4,000</li> <li>- 0 – 6m<sup>3</sup> = kes 200 per litre</li> </ul>	<p><b><u>DMM Tariff Structure:</u></b></p> <ul style="list-style-type: none"> <li>- Meter deposit = kes 1,000</li> <li>- Connection charge for ½ inch pipe = kes 1,500</li> <li>- 0 – 6m<sup>3</sup> = kes 180 per litre</li> <li>- Bulk supply is purchased from KIWASCO at kes 25 per litre and can be sold at a maximum rate of ksh 35 per litre, allowing a 40% profit margin.</li> <li>- Consumers who continue to purchase from water points pay kes 2 per 20 litre jerry can.</li> </ul>
<b>Advantages</b>	<b>Disadvantages</b>
<ul style="list-style-type: none"> <li>- Reduced leakages / UFO. Believe this is from increased sense of community ownership – leakages and vandalism are now reported promptly.</li> <li>- Employment has been created locally. DMM staff are trained by KIWASCO – 5 day course where a certificate is provided upon successful completion.</li> <li>- People don't like receiving bills. This model encourages people to be more careful with money – paid in advance.</li> </ul>	<ul style="list-style-type: none"> <li>- Customer management – limited resources on the ground.</li> <li>- Competition between community members.</li> <li>- Vandalism still ongoing (DMM has no power of prosecutions therefore illegal connections must be reported to KIWASCO for action).</li> <li>- Illegal connections.</li> </ul>

#### Kiwasco on Pre-paid Software

- Online software - DMM staff can only see database with customers on their line only. KIWASCO can see all customers on all DMM lines and KIWASCO lines.
- Pre-paid system manufacturer from Namibia (company based in Germany and Namibia). Need online system to top-up. The system needs to interface with the server in Namibia to operate the database cheaply. The only cost incurred is an internet connection which is included in the ISP charges the company pays anyway, estimated at kes 18,000 monthly. To operate the system remotely from Kenya would cost in the range of kes 300 million annually.
- One the last visit JO made to Kisumu in March pre-paid metres in Nyalenda were being removed. KIWASCO confirmed the metres were only being removed due to no internet connection. Undersea cables disconnected internet to Kenya in early March 2012. As a result, KIWASCO and the DMM were unable to top up customers and the metres had to be removed.
- Overall KIWASCO relate this pilot project as a success. Has been in operation for 2 years with no problems until now. There are many fake products in the market, however the software from Namibia has proved reliable.



- The pilot project involved the use of 20 pre-paid metres. Due to the initial success, the DMM is now being rolled out on a much larger scale – KIWASCO is ordering over 3,000 metres for the next phase.
- KIWASCO’s strategy is to target the water kiosks first, as the owners/ operators of the kiosks cannot be there all the time.
- KIWASCO control the tariff charges up to the water kiosk. If the vendor decides to charge a tariff higher than approved, the consumer can complain to KIWASCO. The vendor will be closed down.
- KIWASCO aware of pre-paid kiosks used in Namibia – system operates using credit card, pre-paid standpost. No immediate plans to mimic this.
- Overall KIWASCO maintain that the ultimate solution is to provide household connections for all informal settlement residents.

### 2.1.2 Key Informant Interview –DMM Group Pamoja Uzalendo self help group

- They consist of 11 members in total. Running the line takes 4 – 5 people. The remaining members have other jobs and engage in adhoc responsibilities as and when needed.
- The group operates one line in Nyalenda, with a total of 67 customers (24 commercial clients, 43 domestic)
- The DMM’s role also involves sanitising the customers. KIWASCO set targets for the groups to make 10 new connections per month.
- Conditions of being awarded a DMM contract include: the management group must have been in existence for at least 6 months. Annual contracts are given – only renewed if the group meets the set targets.
- The Group confirmed currently no pre-paid meters are in operation. All removed when internet was disconnected. They are hoping this will be resolved soon to resume.
- The group members confirmed that the ultimate goal of the DMM, is for every household to have a connection. The group considers water points a ‘transition phase.’
- The main Group recommendation was to increase the network system. It was anticipated this would result in a 60% increase in revenue. The daily running of the line constitutes about 25% of the revenue.

**DMM – Source: DMM (PamojaUzalendo) in Nyalenda (interview 26/04/12)**

<b>DMM Tariff Structure</b>	
<p><b><u>Domestic:</u></b></p> <p>- 0 – 6m<sup>3</sup> = kes150. Flat rate. After this the rate increases from kes 35 – 50 per m<sup>3</sup>. Model based on the less you use, the less you pay.</p>	<p><b><u>Commercial:</u></b></p> <p>- 0 – 10m<sup>3</sup> = kes400. Flat rate. After this the rate reduces to kes 35 per m<sup>3</sup>. Model based on the more you use, the less you pay.</p>
<p>The DMM pay KIWASCO a fixed rate of kes25 per m<sup>3</sup>. The highest allowable rate is 35 per m<sup>3</sup>. DMM members confirmed it is not viable to sell for less than 35 per m<sup>3</sup>.</p>	
<b>Advantages</b>	<b>Disadvantages</b>
<p>- Pre-paid metres ensure you use what you pay for. Preferred by customers.</p>	<p>- Loading of credit is extremely slow. This causes friction between KIWASCO and the</p>

<ul style="list-style-type: none"> <li>- The customers are involved in the project and feel a sense of ownership. Now leakages etc are reported immediately.</li> </ul>	<ul style="list-style-type: none"> <li>customers.</li> <li>- Network and hardware limitations. At the time of the visit, the Group had close to 40 potential clients waiting that could not be connected due to these limitations. The DMM have laid down the chambers, however no piping has been done yet.</li> <li>- Problems of vandalism and meter theft. To combat this, the DMM now position the water points / kiosks next to the chambers.</li> <li>- In the informal settlement, people are too poor and cannot afford to pay the connection fees and deposit.</li> <li>- The DMM areas are roughly demarcated by lines. Boundary issues have been raised with KIWASCO by Group members. Zoning to be introduced by KIWASCO.</li> </ul>
 <ul style="list-style-type: none"> <li>- The DMM chambers with pre-paid meters removed.</li> </ul>	 <ul style="list-style-type: none"> <li>- Main KIWASCO / DMM meter reading chamber for their line in Nyalenda.</li> </ul>

### 2.1.3 Researcher Observations - Nyalenda

- Nyalenda as an informal settlement, quite spacious, organised, clearly demarcated plots with a mixture of temporary, semi-permanent and permanent structures.
- The DMM model has enabled KIWASCO to expand the water supply network to benefit the previously underserved urban poor.
- Although not initially identified by KIWASCO as an immediate disadvantage or 'challenge,' internet connection is a major constraint in getting the pre-paid system to operate efficiently. This does not seem to have been addressed, yet KIWASCO are significantly upgrading from the results of the pilot scheme.
- Software problems were highlighted as a major constraint by the DMM group, however this did not appear to be an equivalent constraint to KIWASCO. Question communication between DMM and KIWASCO? Potential friction between KIWASCO and the DMM over software limitations?
- KIWASCO have no means to enforce/ check the tariffs consumers are actually charged on the ground by the DMM's.

- Not much emphasis on 'customer benefits.' Emphasis more on how KIWASCO have benefitted from the DMM through reducing leakages, increasing customer base and recovering previously lost revenue.
- Although KIWASCO maintain a household connection for all informal settlement residents is the goal, it is difficult to see how they intend to achieve this through the DMM model. The model empowers community members and creates jobs that will become redundant with household connections. Question whether KIWASCO will be able to get power back from the DMM's for household connections, or if DMM's could eventually evolve into 'cartels' seen in Nairobi?
- Not clear why KIWASCO needed DMM's to increase efficiency – can the organisation not build the capacity to do so internally? What would be the cost of this?
- Income from the DMM profit is not sufficient to sustain the Groups livelihood. Some members are forced to work and on the side.
- Although the group members acknowledge the ultimate goal of the DMM is for every household to have a connection, members did not address the fact that this means they would be out of employment.

### 2.1.4 Key Informant Interview –William Otieno(Obunga)

- His hose pipe serves an estimated 100 m radius from the chambers. He has 3 chambers in his zone.
- Charges kes 4 per 20 litre jerry can for household delivery services.....some areas he charges kes 3.
- At the time of the visit, William reported his sales had gone down due to heavy rainfall – people harvesting rainwater for washing clothes etc.
- Obunga WATSAN is the only DMM group in the area. Unlike the DMM group in Nyalenda, there was no vetting or interviewing for the DMM group. Responsibility was handed to the existing tax body for the area.
- The DMM group has made 180 connections to date.
- Population in Obunga is about 15,000 people – ObungaWatsan DMM has a monopoly in the area.

**DMM – Source: William, Obunga (interview 26/04/12)**



- William at work!



- Aerial view of Obunga.

### 2.1.5 Researcher Observations - Obunga

- Obunga as an informal settlement is larger than it appears and quite mixed. Informal housing with a haphazard layouts, yet quite a few green spaces, reasonably clean with some organised plots, developments in-between.
- William very busy – business model has worked well for him. Requested for a more robust hose pipe – he has been using one JO gave him last June, mixed with other of poorer quality. Visible leakages. JO to provide him with better hose pipe.
- Inconsistency in how DMM's are procured and managed – very different from feedback received in Nyalenda.
- JO has paid for water connection to the kiosk. There used to be a connection that was cut off due to damage and unpaid bills, but this was a direct KIWASCO connection. The new connection is via Obunga WATSAN and also connects the bio-centre. YC to plan re-visit when water choices kiosk is in operation.

### 2.1.6 Key Informant Interview – Helen (Bandani)

- JO has paid for the water connection and the tank – Mary requested JO to pay for painting the base slab for the tank as well. JO declined.
- Questioned Mary on why the biocentre was closed mid-morning. She said it was due to the heavy rains in the morning.
- Confirmed the current main source of revenue and use for the biocentre is renting out the rooms upstairs. Although she indicated that with a source of electricity / power, the group could rent out the rooms at a higher cost.
- Mary requested JO to pay for electricity for the bio-centre as well. JO declined.
- She confirmed they are not charging for using the toilets. Free to attract more people as the need the bio-gas. With free use, they currently have 25 – 30 customers per day.
- She is hoping water supply will generate more activity at the bio-centre.

**Bandani– Source: Helen (interview 27/04/12)**



- Bandani bio-centre



- Bandani view of surrounding houses.

### **2.1.7 Researcher Observations - Bandani**

- Bandani definitely more of an absorbed village. Has a very 'rural' feel, yet on city fringes and subject to urban centre constraints and tariff structures.
- Due to poor heavy rains, baseline surveys could not be carried out on 27.04.12. YC and JO visited Bandani anyway to see the location of planned water kiosk.
- JO notified community contact we would be visiting the site. We arrived at 10.30 – biocentre closed. Waited till 11am for Helen to arrive and open the biocentre.
- Although the rain had subsided and Mary first said she would be opening the bio-centre, she did not appear to have any intention of doing this as she seemed to leave at the same time as we left.
- Group management very poor or business model not viable? Or both? Bio-centre very deserted. Even as a free service utilisation is very low. Why? If bio-centre toilets not in-use, what is the surrounding community doing for sanitation? Maintained status quo? Do people actually know what it is?
- JO to talk to Umande. Might be a difficult site for water choices due to poor management signs already evident, with closure of the bio-centre during working hours.



**Dates: February 2013**

**Locations visited: Obunga & Bandani (Kisumu)**

Attendees: Jack O'Regan – Cranfield

## **Kisumu**

There is a new bypass being constructed in Kisumu which passes both Bandani and Obunga and has had a detrimental effect on water supply in the area, particularly on water pressure but also on quality, i.e occasionally dirty water. Unfortunately your fish sellers have been moved on.

## **Obunga**

William is still chugging around with reel and barrow and recently passed the 1,000,000l mark on the meter I gave him. I've worked out that is about 80jc's a day but given how he complained how demand drops during the rainy season it's likely to be far higher on a 'normal' dry day (western Kenya has also had unseasonably high rainfall over the xmas period).

On the morning I visited pressure was too low to use a pipe, so jerrycans are just filled beside the ground level chambers. William says its generally like this these days but pressure improves throughout the day.



At the bio-centre, I hadn't expected to see the delivery service still operating but happily it is. A young guy has been hired who is given a minimum of 2,000 a month which increases based on overall volume, though I struggled to discover how much he had to sell to increase his wage. It was pleasing to see 3 ladies come to him to order their delivery, though the inevitable low pressure means the filling can be a slow process. Daily records are kept of sales using a secured meter. You may remember the chamber to the lid had been stolen. Dan of Umande has had the lid replaced twice with a concrete lid so it wouldn't be stolen, and its been whipped twice.



### **Bandani**

There was very little water in Bandani on the morning I was there so Moses wasn't running the delivery service. However delivery occurs when there is water and enough pressure. Records indicated similar average levels to what we surveyed back in August/September. Moses dispensed with the reel, its sitting in a room in the bio-centre. We also tried meters positioned in plots to give residents the choice of volumetric purchase, however this offer didn't take.

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**Dates: 15<sup>th</sup> – 17<sup>th</sup> May 2013**

**Locations visited: Nyalenda, Obunga and Bandani (Kisumu)**

**Attendees:** Lawrence Ojwang (LO) – WSTF  
Zaituni Kannenje (ZK) – Nakuru Water and Sanitation Services Company NAWASSCO  
Timothy Wanjohi (TW) - NAWASSCO  
Joe Wachira (JW) - NAWASSCO  
Yolanda Chakava (YC) – Cranfield University  
Isaac Okoyo (IO) – Pro-poor Unit, Kisumu Water and Sewerage Company (KIWASCO)

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## **1 OVERVIEW OF THE DMM**

The Delegated Management Model (DMM) concept is a partnership between Kisumu Water and Sewerage Company (KIWASCO) and the community in water service delivery. Small-scale operators known as Master Operators (MO's) are contracted directly by the municipal water utility (KIWASCO), to manage the supply lines that take water directly from the bulk supply into the informal settlements. The MO's are then responsible for managing the network distribution within the settlements via metered chambers and take control of billing, revenue collections and minor maintenance works.

KIWASCO sells bulk water supply to the MO at the standard 'commercial tariff' of Kes 25 per cubic meter, and the MO resells water to the customer at a tariff of kes 35 per cubic meter. All kiosks are to retail water at kes 2/- per 20 litre jerrycan. The initial construction involved 5no. 50mm MO pipes running 600 meters into the settlements, with 12 DMM



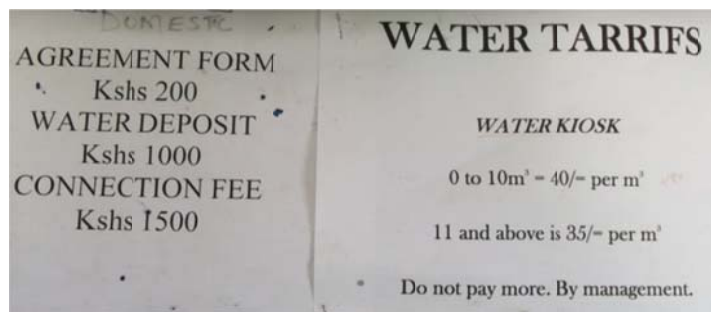
chambers holding capacity for 15 meters. Both KIWASCO and the MO'S have access to their meter chambers. All meters are labelled 'KIWASCO' including the specific meter number. Meter servicing is under KIWASCO's responsibility, charged at kes 100/-.

### **1.1 INTERVIEW WITH KATUORO**

*Member/s interviewed: John Owuor-Chariman, Secretary, Margaret Omondi-Treasurer, Technician*

#### **1.1.2 Summary of Group Composition & Operations**

Katuoro MO is a registered Community Based Organisation (CBO) operating in Nyalenda informal settlement, which has an approximate population of 100,000 residents (served by 8 MO's in total). The CBO entered into the contract of partnership with KIWASCO in the year 2005. Members described their mandate as to provide clean, affordable water to communities and stop leakages.



The CBO comprises of 15 members (10 males and 5 females) and three staff members (Office Manager/Receptionist, Technical Coordinator and Project Coordinator). Members are involved in a number of income generating projects, with the sale of water forming one component and the most profitable. All staff members are paid from the water sales. The MO has a customer base of 353 connections out of which 333 are active, served via 24 water meter chambers. The average population reached by the MO is 4,000.

The customer pays a deposit of Kes 1,500/- for connection. The commercial tariff for customers is kes 0.7/- cents and for domestic customers kes 1/- per 20 litre jerry can. Customers are attracted to their line, as the DMM tariff is less than that tariff for the community still served directly by KIWASCO.

KIWASCO read the meters twice a week (Monday and Friday) with the MO, to minimise risks of manipulation of readings and complaints with regards to billing.

*Financial Records*

The table below summarises Katuoro financial records for 2012.

**Table 1-1 Obunga Watsan Financial Records for 2012:**

Month	Amount collected by KIWASCO (KES)
December 2012	156,824
November 2012	158,455
October 2012	157,800
September 2012	149,140
August 2012	147,260
July 2012	141,345
June 2012	143,745
May 2012	135,770
April 2012	139,395
March 2012	145,434
February 2012	138,200
January 2012	146,470
<b>Total revenue collected by KIWASCO in 2012</b>	<b>1,759,838</b>

The MO produces water bills for customers. Any customer complaints are first directed to the staff members. If unresolved they are escalated to the executive. If there are still pending issues, the group requests for a meeting with the KIWASCO Managing Director to resolve them. This has proven to be an effective procedure. Technical complaints are initially addressed by testing the supply using a 20 litre jerrycan for efficiency, then checking leakages on the line.

### 1.1.3 Group Strengths

- Well defined operational, management and leadership structure governed by a constitution to resolve any internal issues.
- Manageable number of members with gender representation.
- Engages in multiple projects other than the water sales to generate income.
- Established internal motivational strategies for members e.g. share capital with dividends or bonuses annually, SACCO, welfare schemes, loans for members at reduced interest rates etc.
- Good teamwork and co-operation amongst members.
- Water tariffs are lower than KIWASCO's tariff.
- Active in reporting cases of vandalism. Suspects have been arrested which has reduced the number of cases reported.
- Created ownership within the community - everyone is responsible for their line and the community supports them to report vandalism and leakages.
- Greatly exceeded KIWASCO minimum target of 120 connections (the group are currently at 333 connections).
- Increased KIWASCO revenue in Naylenda by over 3 times.
- Proceeds from water sales are able to cover their operational overheads and generate profit.
- Established an effective complaints and feedback system.
- Functional office with good book-keeping records.

### 1.1.4 Group Challenges

- Vandalism of meter chambers. Last year 24 meters were lost/ stolen and the group had to pay for their replacements at a cost of kes 3,000/- per meter (this cost is not passed to the customer). This was described as an oversight in the contract as the DMM is charged monthly meter rent. The lifespan of a good meter is five years.
- The cost of leakages or any NRW has to be absorbed by the group. KIWASCO collect 100% revenue from water billed. For example the group had to pay for water lost from damage to the water pipes from the road upgrading construction.
- Long distances from master meter chambers and their customers premises.
- Lack of funds for pipeline extension.
- Groups' investments on chamber constructions, pipeline extensions and maintenance not being recognised/appreciated by KIWASSCO as per the contract. This has resulted in lack of motivation to continue extending the provision of water supply services.

- Service area of coverage being served by both KIWASCO and the MO creating competition. KIWASCO meters used by those not on the DMM described as ‘stagnant’ and people are used to obtaining water at a flat rate regardless of how much they consume.
- Poor communication and lack of trust between the MO and KIWASCO.
- Community sensitization of services - if the concept is not explained well people do not believe they are acting on behalf of the utility.
- The group was not involved in the DMM contract development and there are no opportunities for contract review as the concept expands; some contents of the contract are not favourable to the MO and were not foreseen at the time of signing e.g KIWASCO has the power to re-call meters and any pipeline extensions at any time regardless of the investment made by the MO. KIWASCO is considered to manipulate some clauses agreed upon hence the group only sees the contract as a paper and not as a binding agreement.
- Lower sales during the rainy season as most residents tend to harvest rainwater.
- KIWASCO does not calibrate the meters often, which can produce inaccurate readings.
- Has no alternative source of water in case of any serious pump breakdown or disruption to supply from KIWASCO.
- Hostility from some community members who feel its KIWASCO’S responsibility to supply water.

## 1.2 INTERVIEW WITH OBUNGA WATSAN

### 1.2.1 Summary of Group Composition & Operations

The group comprises of 10 members (6 males and 4 females). The group has a customer base of 127 connections, served using 8 water meter chambers. The estimated population reached is 30,000 in four zones: Kasarani, Segasega, Obunga A, Obunga B and Kamakoa.

The members are actively involved in running the water operations. The group does not employ any permanent staff, but contracts one meter reader and one bill supplier as and when needed. One jerrycan is sold at kes 4/- per 20 litres (set price in the area). This group also has a slightly different costing system than Katuoro, allowing for ‘meter separation’ for those who wish to move the meters into their compound. This service is provided at an additional cost of kes 5,000/-.

There is no other MO operating in the area, therefore the group has no competition and demand for water supply services is high. Despite this, records indicate uptake of new customers is low, in some cases only 2 new customers were connected per month. Members stated this was due to the low-level of income in the area. The group priority is to extend the water supply network in Obunga, due to the high demand.

WATER RESALE PRICES		
Application fee (Non refundable)	200/-	
Master Operator Domestic Tariff	Water/m <sup>3</sup>	Tariff (Ksh)
	0-6m <sup>3</sup> x	30/- = 180/-
	7-20m <sup>3</sup> x	35/-
	21m <sup>3</sup> & above x	50/-
Master Operator Kiosk Tariff	0-10m <sup>3</sup> x	40/- = 400/-
	11m <sup>3</sup> & above x	35/-
Other costs		
Connection fee	1500/-	(Non-refundable)
Deposit for Domestic	1000/-	(refundable)
Deposit for Kiosk	5000/-	(refundable)
Deposit for Construction	10000/-	(refundable)
Meter Rent	70/-	per Month
Service charge	100/-	per month

## Financial Records

The table below summarises Obunga Watsan financial records for 2012.

**Table 1-2 Obunga Watsan Financial Records for 2012:**

Month	Amount collected by KIWASCO (KES)
December 2012	60,000
November 2012	78,000
October 2012	73,000
September 2012	72,000
August 2012	77,000
July 2012	96,000
June 2012	73,000
May 2012	75,000
April 2012	77,000
March 2012	81,000
February 2012	82,200
January 2012	82,100
<b>Total revenue collected by KIWASCO in 2012</b>	<b>926,300</b>

Community mobilisation is undertaken by the group twice a month. Complaints are answered within 48 hours and most complaints are regarding pipe leakages.

### 1.2.2 Group Strengths

- Customer monopoly as they are the only MO supplying water in the area.
- High demand for water supply services.
- Sense of ownership from the community.
- Water supply in the area is generally reliable therefore the group is able to collect steady revenue.
- The group has developed a well designed and shared revenue collection schedule known to customers to avoid disconnections.
- The group has developed their own systems to extend water meters to households for those able to pay for additional services.
- The group is able to pay its members and contract staff from the proceeds of the water sales.
- Functional office with good book-keeping records.

### 1.2.3 Group Challenges

- High customer tariff of kes 4/- per 20 litre jerry can unaffordable for poor consumers resulting in low up-take, and double the DMM tariff.
- Vandalism and meter theft are rampant in the area hence unaccounted for water is high. At the time of our visit, some chambers were still without meters.
- Lack of funds for pipeline extension and maintenance.
- Turbid and low water pressure.

- Over billing by KIWASSCO when there's no supply.
- Competition from other water vendors affecting the group's revenue collection.
- Slow response by KIWASCO in responding complaints.

## 2 OVERVIEW OF WATERCHOICES

### 2.1 INTERVIEW WITH WILLIAM (WATERCHOICES VENDOR IN OBUNGA)

#### 2.1.1 Summary of Services Provided

William supplies water to an average of 150 customers per day via a hose reel pipe. One jerrycan is sold at kes 4/- per 20 litres and does not vary for collection or delivery. His average income per day from the delivery service ranges from kes 500/- – kes 600/-.

His main source of water is Obunga Watsan DMM (confirmed no other safe potable water source is available in the area). William explained prior to *WaterChoices*, his ¾ inch pipe was too heavy and he was getting tired. Jack O'Regan introduced him to the smaller more robust ½ inch pipe, hose reel and metering system, for accurate billing of customers. This enabled him to expand his customer base and increase his monthly income. The maximum radius of his pipe from the chamber source is 100m (range of customers). His service operates from early morning, and can continue late into the night up to 11pm if there is demand. At the time of our visit, the service seemed very popular and he was evidently busy with water delivery. William confirmed business is less during the rainy season, as residents harvest rainwater for activities that use large quantities like washing clothes.

His average monthly utility water bill ranges from kes 5,000/- – kes 6,000/- per month. His last bill received in April 2013 was kes 4,000/-. His highest monthly bill received to date amounts to kes 7,000/-.

The project team noted that William did not have a tap fixed at the end of the hose pipe, and had to return to the meter chamber to turn off the water. When questioned, he stated with experience he is able to estimate how long it takes to fill one 20 litre jerry can, so water wastage is minimal.

William informed the team the water delivery service is his livelihood and he is able to educate his children with the income he receives per month.

#### 2.1.2 Key Strengths

- Demand for his delivery service in the area is high, with between 150 – 200 residents benefitting from improved access to water.
- The area of service is densely populated.
- Despite the stiff competition, he has developed his own sales strategy to attract and maintain his customer base.
- His price is constant regardless of fluctuations in water availability within the area.
- Water supply in the area is generally reliable, therefore William is able to collect steady revenue.
- The income he receives from the delivery service is able to sustain his livelihood.



### 2.1.3 Key Challenges

- Insufficient water supply and low water pressure, resulting in customers losing trust with the delivery service.
- Turbid water supply at times resulting in water losses, yet William still has to pay the utility. The utility does not write off debt or account for leakages in billing.
- Competition from other water vendors.
- Sole proprietor business thus continuity challenges.
- Some customers default in payment while others fail to pay within the agreed time.
- Due to the high demand he works late into the night, presenting potential personal safety and health risks.

## 2.2 FOCUS GROUP DISCUSSION - OBUNGA

### 2.2.1 Summary of Group Composition and Water Challenges

The focus group comprised of 5 people (1 male and 4 females).

The group confirmed that Obunga Watsan is their main source of water in the area and the supply is generally available daily. If there is no water or residents cannot afford to connect to the DMM, then they fetch water from a nearby river. However, this water was described as very dirty and unsafe, resulting in stomach problems. If the river has dried up, then residents are forced to walk long distances in search of water. Previously, scarcity of water in the area brought about cases of cholera and typhoid.

All respondents confirmed they have been using WaterChoices delivery for one year and depend on the service. Previously the respondents used to walk to collect water, but none of them do this anymore since they started relying on William to deliver. Respondents confirmed the price does not vary and is a fixed flat rate at kes 4/- per 20 litre jerry can for delivery, or to collect from the bio-centre. This price was considered fair.

### 2.2.2 Advantages of WaterChoices

- Residents can choose to access water according to their desired level of convenience - water is now available at the doorstep of Obunga residents.
- Improved accessibility and flexibility - residents no longer have to carry heavy jerrycans over long distances in search of water.
- As water is more accessible, residents are able to use larger quantities. The respondents estimated using at least 2-3 extra 20 litre jerry cans per day.
- Residents have more time during the day which was generally used for hygiene (cleaning), household chores and business.



### 2.2.3 Disadvantages of WaterChoices

- Low water pressure causing delays with the delivery service.
- Demand in the area is high and only one pipe cannot serve everyone, so customers end up anxiously waiting for William to reach them.
- Water cost of kes 4/- per 20 litre jerry can over double the nationally approved tariff – exploitation of customers due to lack of competition in the area and high demand.
- Complaints of turbid water supply.
- In case of serious water shortage, pump breakdown and or leakages, residents resort back to the dirty source of water.
- The water pipe used is shorter compared to the needs and distribution of the houses within the area.

## 2.3 FOCUS GROUP DISCUSSION - BANDANI

*Member/s interviewed: Chair, Secretary and Members*

### 2.3.1 Summary of Group Composition and Water Challenges

The group comprises of 300 members (20 males and 280 females). Group members are actively involved in a number of community projects, with *WaterChoices* forming one component of their activities. *WaterChoices* was introduced to the group in July 2012 through an initiative by Umande Trust NGO.

There are no other water sources in the area apart from KIWASCO, and water shortages are frequent. At the time of our visit the group reported having no water since March 2013.

The *WaterChoices* kiosk is located within the Bandani bio-centre, and has a 5,000 litre storage tank which was considered insufficient. The 'Choices' offered include paying kes 2/- to collect water from the kiosk, or paying kes 3/- for delivery to your household. The vendor, (Moses Oguche) reported supplying water to an average of 150 customers per day over a radius of 100m, depending on the preferred customer choice. More customers tend use the delivery service during the dry season, as residents harvest rainwater.

The average monthly utility water bill ranges from kes 2,500/- – kes 3,000/- per month. The last bill received in April 2013 was kes 2,985/-, despite there being no water in the area. The highest water bill the group has received to date amounts to kes 5,000/-. The group believe their water line has been diverted to serve the new airport.



### 2.3.2 Advantages of WaterChoices

- The kiosk has improved access to water for approximately 150 residents in the area.
- Competition advantage i.e. customers have a number of choices to access water depending on their affordability and desired level of convenience. Trends indicate the delivery service appeals

to people who live far and prefer to pay slightly more rather than carry water over long distances.

- The delivery service at kes 3/- is cheaper than the competition (in the surrounding people pay to collect water for kes 3/-).
- Residents can leave their orders with the vendor and go about their daily routine for the day, with the security that water will be available in their household when they return.
- Robust pipe material used for the delivery service – still in good condition after 10 months.
- Quality of water is ensured by the water service provider.

### 2.3.3 Disadvantages of WaterChoices

- Insufficient water supply and low water pressure, resulting in customers losing trust with the delivery service.
- Vandalism – their water meter was stolen about 2 months ago.
- Group need to maintain sales to be able to pay the vendor, which is difficult during water shortages.
- Cost to end customer is higher than the nationally approved pro-poor tariff.
- Complaints of high and abnormal water bills to be paid by the group, presenting a potential revenue collection problem for the utility.
- Mode of household delivery (hosepipe on wheel barrow) can be improved so not tiresome for the vendor.

## 2.4 PERFORMANCE OF WATERCHOICES

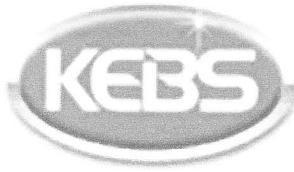
### 2.4.1 Overall Advantages

- An ideal model that can improve access to water in terms of delivery and cost in a densely populated community.
- Offers residents' an alternative to pay for water delivered at their door steps or collect from the water kiosk depending on their affordability and desired level of convenience. High demand for the delivery service was observed in Obunga.
- Water costs can be regulated by the utility.
- Provides a source of livelihood for the vendors.
- Manned by dedicated staff with a vested financial interest, reducing chances of vandalism.
- Accessible to any customer with cash.
- Alleviates the need for walking long distances and reduces queues/ waiting times at water points.
- Saves time for poor consumers who can engage in other activities for work or leisure.

### 2.4.2 Overall Disadvantages

- Low water pressure and leakages result in customers losing faith in the project.
- *WaterChoices* needs a reliable water supply network to make it effective.
- Cash only payments (can be a disadvantage to poor consumers).

- Risk of fraud and mechanism for theft in customers households (using delivery service).
- Theft and vandalism of meters.
- Lengthy municipal licensing, permit process for kiosk vendor.
- Management groups do not understand the utility bills, which may make revenue collection difficult.
- Poor residents in the area may resort to other cheaper means of accessing water such as illegal connections.
- The Bandani *WaterChoices* was poorly placed since there are many water selling points around and the population in the area is low (site of the facility business wise it's not viable).
- Large management groups may not feel benefit of the facility i.e cash from water sold.
- Poor relations between the utility and management group can reduce performance and supply for the poor.
- *WaterChoices* should be developed to the benefit of the community and not individuals (persons or groups).



# Kenya Bureau of Standards

Standards for Quality life

August 8<sup>th</sup> 2013

## BACTERIOLOGICAL ANALYSIS

Sample No. : 3020/9  
Date Sampled : 20/08/2013  
Date Received : 21/08/2013  
Sample source : OBUNGA, FROM 100lts Storage tank  
Sample Submitted by : Daniel Opiyo

### **EXAMINATION RESULTS**

TEST	KS 456-1:2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E-Coil Organism in 100 ml Sample	Shall be absent	>18
MPN of Faecal Coliform Organisms in 100 ml sample	Shall be absent	>18

**MPN: Most Probable Number**

**ND: Not Detected**

**< : Less Than**

**KS: Kenya Standard (KEBS2007)**

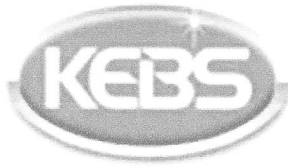
### COMMENT

The results relate to the samples submitted. The laboratory will not be held responsible for any sampling errors.

MARTIN NYAKIAMO

**KEBS WESTERN REGIONAL MANAGER**

The Kenya Bureau of Standards (KEBS) is a member of the International Organization for Standardization (ISO), Codex Alimentarius Commission (CAC), The African Regional Organization for Standardization (ARSO), Associate Member of the International Electrotechnical Commission (IEC), Associate Member of Bureau International des Poids et Mesures (BIPM) and International Organization of Legal Metrology



# Kenya Bureau of Standards

Standards for Quality life

August 8<sup>th</sup> 2013

## BACTERIOLOGICAL ANALYSIS

Sample No. : 3020/9  
Date Sampled : 20/08/2013  
Date Received : 21/08/2013  
Sample source : BANDANI, FROM TAP WATER  
Sample Submitted by : Daniel Opiyo

## EXAMINATION RESULTS

TEST	KS 456-1:2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E-Coil Organism in 100 ml Sample	Shall be absent	ND
MPN of Faecal Coliform Organisms in 100 ml sample	Shall be absent	ND

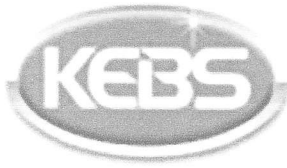
**MPN: Most Probable Number**  
**ND: Not Detected**  
**< : Less Than**  
**KS: Kenya Standard (KEBS 2007)**

## COMMENT

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for **MARTIN NYAKIAMO**  
**KEBS WESTERN REGIONAL MANAGER**

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# Kenya Bureau of Standards

Standards for Quality life

August 8<sup>th</sup> 2013

## BACTERIOLOGICAL ANALYSIS

Sample No. : 3020/9  
Date Sampled : 20/08/2013  
Date Received : 21/08/2013  
Sample source : BANDANI, FROM HOSEPIPE  
Sample Submitted by: Daniel Opiyo

## EXAMINATION RESULTS

TEST	KS 456-1:2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E-Coil Organism in 100 ml Sample	Shall be absent	2.4
MPN of Faecal Coliform Organisms in 100 ml sample	Shall be absent	2.4

MPN: Most Probable Number

ND: Not Detected

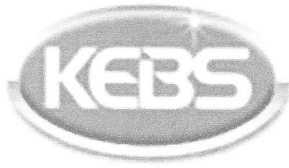
< : Less Than

KS: Kenya Standard (KEBS 2007)

## COMMENT

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August 8<sup>th</sup> 2013

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Date Received : 21/08/2013  
Sample source : BANDANI, FROM 100lts Storage tank  
Sample Submitted by : Daniel Opiyo

## EXAMINATION RESULTS

TEST	KS 456-1:2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E-Coil Organism in 100 ml Sample	Shall be absent	ND
MPN of Faecal Coliform Organisms in 100 ml sample	Shall be absent	ND

**MPN: Most Probable Number**  
**ND: Not Detected**  
**< : Less Than**  
**KS: Kenya Standard (KEBS 2007)**

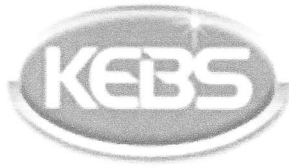
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August 8<sup>th</sup> 2013

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Date Sampled : 20/08/2013  
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Sample source : OBUNGA, FROM TAP WATER  
Sample Submitted by: Daniel Opiyo

### **EXAMINATION RESULTS**

TEST	KS 456-1:2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E-Coil Organism in 100 ml Sample	Shall be absent	ND
MPN of Faecal Coliform Organisms in 100 ml sample	Shall be absent	ND

**MPN: Most Probable Number**

**ND: Not Detected**

**< : Less Than**

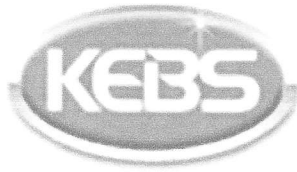
**KS: Kenya Standard (KEBS 2007)**

### COMMENT

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for **MARTIN NYAKIAMO**  
**KEBS WESTERN REGIONAL MANAGER**

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# Kenya Bureau of Standards

Standards for Quality life

August 8<sup>th</sup> 2013

## BACTERIOLOGICAL ANALYSIS

Sample No. : 3020/9  
Date Sampled : 20/08/2013  
Date Received : 21/08/2013  
Sample source : OBUNGA, FROM HOSEPIPE  
Sample Submitted by : Daniel Opiyo

### **EXAMINATION RESULTS**

TEST	KS 456-1:2007 THIRD EDITION 2007	RESULTS TREATED
MPN of E-Coil Organism in 100 ml Sample	Shall be absent	2.4
MPN of Faecal Coliform Organisms in 100 ml sample	Shall be absent	2.4

**MPN: Most Probable Number**

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**< : Less Than**

**KS: Kenya Standard (KEBS 2007)**

### COMMENT

The results relate to the samples submitted. The laboratory will not be held responsible for any sampling errors.

MARTIN NYAKIAMO

**KEBS WESTERN REGIONAL MANAGER**

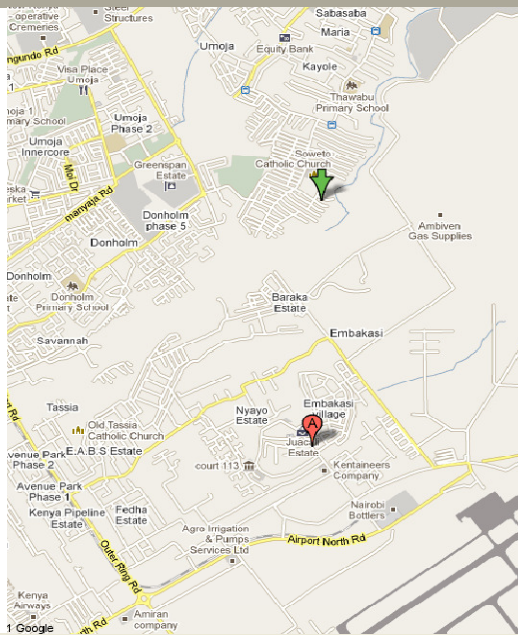
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Project Intervention for Evaluation	Research Question	Goal	Sub-Questions 1	Sub-Questions 2	Sub-Questions 3	Data Required	Data Collection Methods	Site HW1: Kayole-Soweto: PRIMARY LOCATION: Kayole-Soweto	Site HW1: Kayole-Soweto: DATA COLLECTED FEBRUARY 2011	Site HW1: Kayole-Soweto: DATA COLLECTED MAY 2012	Site HW1: Kayole-Soweto: DATA COLLECTED MAY 2013	Analysis
<p>1) Are the facilities functioning as intended?</p> <p>2) Are the facilities being utilized as intended?</p> <p>3) Are the facilities functioning as intended?</p> <p>4) Are the facilities being utilized as intended?</p> <p>5) Are the facilities functioning as intended?</p> <p>6) Are the facilities being utilized as intended?</p> <p>7) Are the facilities functioning as intended?</p> <p>8) Are the facilities being utilized as intended?</p> <p>9) Are the facilities functioning as intended?</p> <p>10) Are the facilities being utilized as intended?</p> <p>11) Are the facilities functioning as intended?</p> <p>12) Are the facilities being utilized as intended?</p>	<p>What do you need to know about the performance of transition from borehole water supply interventions to evaluate the improvement for low-income settlement residents?</p> <p>DESIGN, Effective, Viable, Efficient, Reliable, Transparent</p>	<p>Are the facilities functioning as intended?</p>	<p>Is the quantity of water adequate to meet the demand?</p>	<p>Design criteria: Actual production, Capacity.</p>	<p>Desk study of design and operational data. Direct observation. Key informant interviews.</p>	<p>Key informant interviews with borehole operators, community institutional stakeholders, NCWSC and Haki Water Services. 300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites). Researcher observations (various).</p>	<p>Site 1 (Kayole-Soweto): Total 240 no. HH surveys - 100 Males and 140 Females. Average no. of people in HH = 5. Surveys undertaken suggest that the average quantity consumed per low-income resident per day is 23 litres in the average household with a family size of 5. 87% of respondents confirmed they rely on BH as their source of water, and an adequate amount of water is available daily to meet the demand. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>Site 1 (Kayole-Soweto): Total 120 no. HH surveys - 50 Males and 70 Females. Average no. of people in HH = 4. Average no. of jerrycans filled daily = 6. Therefore average HH consumption per person per day is 30 litres for domestic purposes (drinking, cooking, bathing, washing clothes, general cleaning etc.) followed by 12% who rely on public standpipes (kiosk, 6% had piped water to plot (NCWSC), a low 2% piped water to plot (NCWSC) while the remaining 68% used both piped water to plot (NCWSC) and borehole. Seasonal variations in water supply noted due to cost variations charged per jerrycan. Source: HW community HH surveys dated May 2012.</p>	<p>Site 1 (Kayole-Soweto): Total 150 no. HH surveys - 70 Males and 80 Females. Average no. of people in HH = 4. Average no. of jerrycans filled daily = 4. Therefore average HH consumption per person per day is 20 litres for domestic purposes (drinking, cooking, bathing, washing clothes, general cleaning etc.) followed by 10% who had received piped water to plot (NCWSC) and borehole. Source: HW Baseline community HH surveys dated May 2013.</p>	<p>Per person production &amp; consumption of water. Available capacity (including seasonal variations).</p>		
			<p>Did the project get non-functioning facilities into operation?</p>	<p>Revenue collection records, Maintenance programmes and budgets, Resources dedicated to maintenance, Annual breakdowns, Reported stoppages and / or disruptions to service.</p>	<p>Desk study of institutional and financial data. Direct observation. Semi-structured and unstructured interviews. Key informant interviews.</p>	<p>Key informant interviews with borehole operators, community institutional stakeholders, NCWSC and Haki Water Services. 300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites). Stoppages and / or disruptions to service. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>87% regarded borehole water as a reliable supply, available daily all year round and providing an adequate quantity of water to meet the community's needs, usually during times of drought when water is needed the most. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>84% of respondents, mostly those who rely on BH water as their main source of water, confirmed that the main reason for using BH water is because it is the only reliable source in the area. Public utility water supply was considered most unreliable. Source: HW community HH surveys dated May 2012.</p>	<p>22% of consumers of BH water stated the supply is reliable and available 7 days per week. Of the 60% who now rely on piped water to their plots as their main source, available 3 days per week. The 60% that confirmed using both sources as the municipal supply was inconsistent BH water was used to supplement their daily needs. BH water consumers confirmed using this source as it was the most reliable source available daily - no change. Source: HW community HH surveys dated May 2013.</p>	<p>Actual operation and maintenance costs vs. budget and resources. Revenue collection vs. operation and maintenance budget and actual costs. Annual breakdown and stoppage costs recorded per month/year. Hours supply per day (extent of interruptions of service pressure).</p>		
			<p>Did the project improve the function of existing facilities?</p>	<p>Distance from water source, Distribution between households and water points and cost per jerrycan/litre per person per day, Consumer feedback.</p>	<p>Direct observation. Semi-structured and unstructured interviews. Focus Group Discussions, Household surveys.</p>	<p>300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites). Researcher observations (various).</p>	<p>99% confirmed boreholes provide an accessible source of drinking water to within 300m (or less) of households, as verified by observations. Average cost per 20L jerrycan is less than 4¢. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>Only 13% confirmed using the current source because of distance to BH - the main driver was reliability of supply from available source. Average cost per 20L jerrycan is less than 3¢. Source: HW community HH surveys dated May 2012.</p>	<p>The majority, 55% of respondents with the current source because of distance to BH. Average cost per 20L jerrycan is less than 3¢ - no change. Source: HW community HH surveys dated May 2013.</p>	<p>Distance of water source from households in relation to vector benchmarks (drinking water and dry seasons). Affordability of tariffs (Annual cost of 20L/20L litre per person per day). Affordability of new connections (Average connection cost/20L per person). Only subsidy to poorest within 'tariff based'?</p>		
			<p>Is the water quality within regulatory requirements?</p>	<p>Physical and bacteriological samples, Methods and frequency water treatment.</p>	<p>Water quality testing. Semi-structured and unstructured interviews. Key informant interviews, Household surveys.</p>	<p>Water quality tests results from 9 BH's. 300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites). Researcher observations (various).</p>	<p>300 complete water quality tests conducted. None of the water samples met the WHO guidelines on safe drinking water. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>300 water quality tests conducted for bacteria and coliforms. None of the water samples met the WHO guidelines on safe drinking water. Source: HW community HH surveys dated May 2012.</p>	<p>300 water quality tests conducted for bacteria and coliforms. None of the water samples met the WHO guidelines on safe drinking water. Source: HW community HH surveys dated May 2013.</p>	<p>Water quality results vs. frequency and methods of treatment applied. Comparative water quality analysis between interventions in relation to industry standards.</p>		
			<p>What is the proportion of households using the facilities?</p>	<p>Details regarding who uses the facilities and why, Distance travelled and why.</p>	<p>Desk study and mapping. Direct observation.</p>	<p>Site location maps. 300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites). Researcher observations (various).</p>	<p>The field study targeted low income consumers of borehole water, adults and children, in a range of settings including churches, communities groups and schools. 21% confirmed relying on BH water at home and their main source of water. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>From the 110HH's surveyed, 53% stated the women are responsible for carrying water from their most common water source, which in this case is BH water used by 43% and the remaining 5% from tankers and piped NCWSC water. The longest waiting times for water &gt;30mins was reported by 48% of consumers of the water only. Municipal supply located within plots - walking distance 1-15m from BH doorsteps. When accessing BH water, 32% stated living within 300m, 14% reported walking distance of 300-500m, 15% reported distances of 500-2000m from the nearest BH, verified by observations. Source: HW community HH surveys dated May 2012.</p>	<p>The results showed a reduced 20% of respondents rely on BH as their main source of water, followed by 16% who had received piped water to plot (NCWSC) while the remaining 65% used both piped water to plot (NCWSC) and borehole. When questioned the majority stated that the municipal supply was inadequate to meet their daily needs, therefore they supplemented with BH water. Municipal water was preferred for drinking and BH water for washing and for chores due to the 'lumpy' taste. Municipal supply located within plots - walking distance 1-15m from BH doorsteps. When accessing BH water, 59% stated living within 300m, the remaining 41% reported walking distances of 300-500m, verified by observations. Reduction in longest distances walked, possibly due to more accessible municipal supply. Source: HW community HH surveys dated May 2013.</p>	<p>Daily water availability. The capita water consumption based on operational water facilities (including seasonal variations).</p>		
			<p>Is the infrastructure provided being utilized as intended?</p>	<p>Daily water use, Consumption.</p>	<p>Direct observation. Key informant interviews, Focus Group Discussions, Household surveys.</p>	<p>Key informant interviews with borehole operators, community institutional stakeholders, NCWSC and Haki Water Services. 300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites). Researcher observations (various).</p>	<p>From the key informant interviews, stakeholders reported that the water was highest during drought conditions. Other than that BH water was preferred for washing clothes, household cleaning etc but not for drinking due to a 'lumpy' taste. Municipal supply was preferred for drinking, although the source was not reliable in the area. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>From the 110HH's surveyed, 62% majority of respondents confirmed BH was most reliable and accessible as the main source of water, however not preferred for drinking due to the 'lumpy' taste. Some respondents stated using BH water mainly for washing and for chores which use large quantities, and when the piped public utility was available that would be used for drinking only. However public utility piped supply was regarded as very unreliable, therefore most times there is no other option for drinking water. Consumption as per above. Source: HW community HH surveys dated May 2012.</p>	<p>As per 2012 results BH water is mainly used for washing and for chores which use large quantities, and when the municipal supply was available that would be used for drinking only. However municipal supply was regarded as very unreliable, therefore most times there is no other option for drinking water other than BH's. Consumption as per above - less than 2012 which indicates no positive changes. Source: HW community HH surveys dated May 2013.</p>	<p>Factors constraining demand e.g. waiting times. Expected future changes that may increase demand.</p>		
			<p>Are the educational services provided being utilized as intended?</p>	<p>Details of water storage containers used.</p>	<p>Direct observation. Key informant interviews, Focus Group Discussions, Household surveys.</p>	<p>300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites). Researcher observations (various).</p>	<p>No information collected on water storage habits. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>When questioned, 60% of respondents confirmed having a water storage tank at home, while 40% stated they did not. From those with storage, the most common size was 100 litres. Source: HW community HH surveys dated May 2012.</p>	<p>When questioned, 51% of respondents confirmed having a water storage tank at home, while 49% stated they did not. From those with storage, the most common size was 100 litres which was considered adequate - no change. Source: HW community HH surveys dated May 2013.</p>	<p>Comparison in data / observations between target groups.</p>		
			<p>Have there been relative improvements in water quality from alternative levels of service?</p>	<p>Baseline data on household / institutional water treatment habits, Changing data on households water treatment habits and why (if changed), School attendance records, Handwashing on medical lists (where available).</p>	<p>Desk study of financial data, Water quality testing, Household surveys.</p>	<p>Water quality tests results from 9 BH's. 300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites). Researcher observations (various).</p>	<p>49% of respondents confirmed treating BH water prior to consumption - the remaining 51% said no. The most common water treatment was chlorine / waterguard used by 32% of the total population. The remaining 17% stated they boil their water. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>54% of respondents confirmed treating BH water prior to consumption - the majority being women at 58% and men at 17%. The most common water treatment was chlorine / waterguard used by 48% of the total population. The remaining 8% stated they boil their water. Source: HW community HH surveys dated May 2012.</p>	<p>41% of respondents confirmed treating BH water prior to consumption - the remaining 59% do nothing. The most common water treatment was chlorine (waterguard) used by 31% of the total population. The remaining 14% stated they boil their water - slight increase in boiling but generally no significant change. Source: HW community HH surveys dated May 2013.</p>	<p>Relationship between water treatment vs. school attendance, expenditure on medical bills, Relationship between water treatment vs. consumer satisfaction, Relationship between water treatment vs. willingness to pay.</p>		
			<p>Have there been relative improvements in consumer satisfaction from alternative levels of service?</p>	<p>Baseline data on time taken to collect water daily, Baseline data on quantity of water collected daily, Baseline data on preferred source of water daily, Changing data on all the above and why (if changed).</p>	<p>Direct observation, Semi-structured and unstructured interviews, Key informant interviews, Focus Group Discussions, Household surveys.</p>	<p>300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites). Researcher observations (various).</p>	<p>No data collected on time taken at this stage. 43% stated on time taken to collect water, 24% within 100-300m and 17% within 300-500m. Consumption and main sources as per above. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>From the 110HH's surveyed, over 50% confirmed taking 30mins or more to collect water, for an average of 3 trips per day to the main water source. Consumption and main sources as per above. Source: HW community HH surveys dated May 2012.</p>	<p>From the 110HH's surveyed, 85% of respondents who rely on BH water as an alternative source reported taking 30mins or less to collect water, also when their main NCWSC was not available, for an average of 2 trips per day. Source: HW community follow-up HH surveys dated May 2013.</p>	<p>Relative time savings from alternative levels of service. Factors influencing preferred sources of water. Relationship between consumption per household in relation to level of service.</p>		
			<p>Have there been relative economic improvements from alternative levels of service?</p>	<p>Baseline data on household incomes, Water tariffs for different levels of service, Relative bill / revenue collection efficiency from alternative levels of service, Capital investment costs, Operation and maintenance costs, Consumer willingness to pay for alternative levels of service.</p>	<p>Direct observation, Semi-structured and unstructured interviews, Key informant interviews, Focus Group Discussions, Household surveys.</p>	<p>Monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites).</p>	<p>From 240HH's surveyed, 40% of respondents stated earning monthly incomes of between Kes 5,000-10,000. 80% of respondents who earn Kes 10,000 (US\$ 125) or less, in a typical 30-day month, the average cost of buying water can range anywhere between Kes 180 (US\$ 21) to Kes 300 (US\$ 36). This equates to 10% - 30% of their monthly income. Average electricity costs equating to 19 3/4¢ per person. Water also cost over 20% of monthly HH income. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>From 110HH's surveyed, 81% of respondents stated earning monthly incomes of Kes 10,000 (US\$ 125) or less. The average cost for the area was calculated at Kes 1,700 (US\$ 21). The average daily cost per jerrycan during normal service was Kes 1, for an average of 600 jerrycans per HH per day. During droughts, the average cost per jerrycan is a Kes 5. Therefore in any given 30-day month (excluding weekends), the average HH cost of water ranges between Kes 300 - Kes 1,500 (US\$ 36 - 180). Therefore in a 30-day month (excluding weekends), the cost of water can account for up to 8% of HH income. Water also cost over 20% of monthly HH income. Detailed monthly records of electricity bills obtained - MOA calculations for Galilee BH. Source: HW community HH surveys dated May 2012.</p>	<p>From 110HH's surveyed, the majority 67% of respondents stated earning monthly incomes of Kes 10,000 (US\$ 125) or less. The average cost for the area was calculated at Kes 1,700 (US\$ 21). The average daily cost per jerrycan during normal service was Kes 1, for an average of 600 jerrycans per HH per day. Therefore in any given 30-day month (excluding weekends), the average HH cost of water is approximately Kes 300 (US\$ 36). Detailed monthly records of electricity bills obtained - MOA calculations for Galilee BH and Two-Whoto BH's. Source: HW community HH surveys dated May 2013.</p>	<p>Revenue generated vs. operation and maintenance costs. Factors influencing better or worse returns on investment. Willingness to pay vs. level of service received. Average tariff per m<sup>3</sup>. Average replacement life of these assets. Electric energy uses per customer.</p>		
			<p>Have there been relative improvements in consumer satisfaction from alternative levels of service?</p>	<p>Consumer feedback.</p>	<p>Key informant interviews, Household surveys.</p>	<p>300 monitoring surveys dated February 2011, May 2012 and May 2013 (x4 sites).</p>	<p>Male and female respondents were asked to describe the main problems with the water supply. Interviews indicated BH water quality was of most concern. The majority 53% stated they had no problems. 18% of the adult respondents followed by 19% of the children. The highest self-reported cases of diarrhea and typhoid fever were recorded from the 49% of adult respondents who 'do nothing' to treat their water. Source: HW Baseline community HH surveys dated February 2011.</p>	<p>Male and female respondents were asked to describe the main problems with the water supply. 21% stated the quality of the water, 5% cost and 4% taste. The majority 53% stated they had no problems. 18% of the adult respondents followed by 19% of the children. The highest self-reported cases of diarrhea and typhoid fever were recorded from the 49% of adult respondents who 'do nothing' to treat their water. Source: HW community HH surveys dated May 2012.</p>	<p>When questioned if they were satisfied with their current level of service, a responding 90% said no. Male and female respondents were asked to describe the main problems with the water supply. The majority, 40% complained about the poor water quality, particularly from BH water. Followed by 20% who complained of the quantity available in relation to the municipal supply, cost was the most contentious item identified by 20% and the remaining 18% were most concerned with the time involved. Source: HW community HH surveys dated May 2013.</p>	<p>Consumer rating system of alternative interventions in relation to the service criteria and why. Comparison in data / observations between target groups across interventions. Level of consumer participation in intervention/ decision making.</p>		

## KAYOLE BOREHOLE NO. 1



**Borehole name:** - Galilee School  
**Construction date:** - 2006  
**Drilling cost:** - KES 1.65 million(USD\$ 20,630)  
**Depth:** - 200metres  
**No of tanks:** - 7  
**Consumption per day:** 30,000 litres  
**Price per 20 litre jerrycan:**KES 3

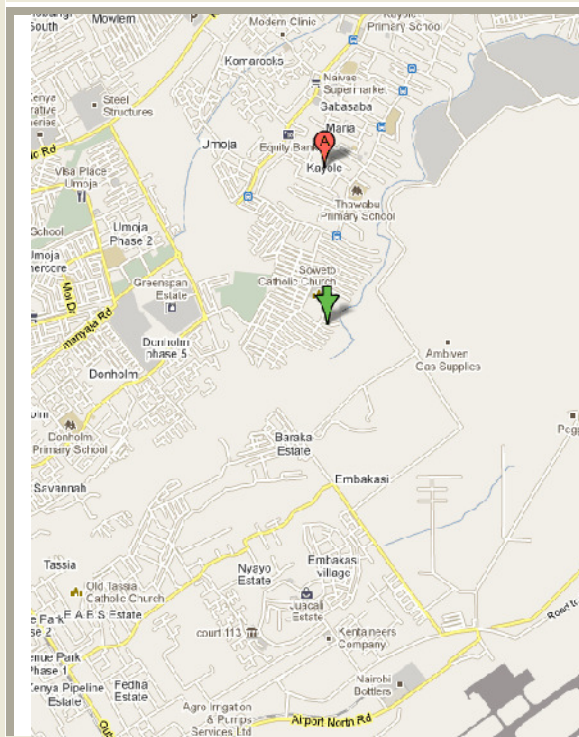


**Location:** S1.288271 E36.914016  
Kayole-Soweto

## KAYOLE BOREHOLE NO. 2



**Borehole name:** - KwaWatoto School  
**Construction date:** - 2007  
**Drilling cost:** - KES 1.8 million(USD\$ 22,500)  
**Depth:** - 200metres  
**No of tanks:** - 2  
**Consumption per day:** 30,000 litres  
**Price per 20 litre jerrycan:**KES 3



**Location:** S1.288271 E36.914016  
Kayole-Soweto

### KAYOLE BOREHOLE NO. 3



**Borehole name:** - Flomina Children's Home  
**Construction date:** - 2007  
**Drilling cost:** - KES 1.5 million(USD\$ 18,750)  
**Depth:** - 200 metres  
**No of tanks:** - 1  
**Consumption per day:** 10,000 litres  
**Price per 20 litre jerrycan:**KES 3

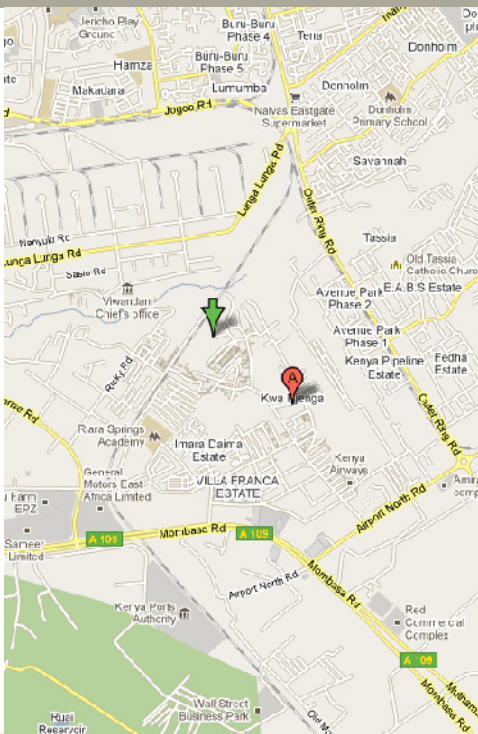


**Location:** S1.281308 E36.911513  
Kayole-Soweto

## MUKURU-KWA-NJENGA BOREHOLE NO. 1



**Borehole name:** - St. Mary's Church  
**Construction date:** - 2004  
**Drilling cost:** - KES 2 million (USD\$ 25,000)  
**Depth:** - 200metres  
**No of tanks:** - 7  
**Consumption per day:** 10,000litres  
**Price per 20 litre jerrycan:**KES 3

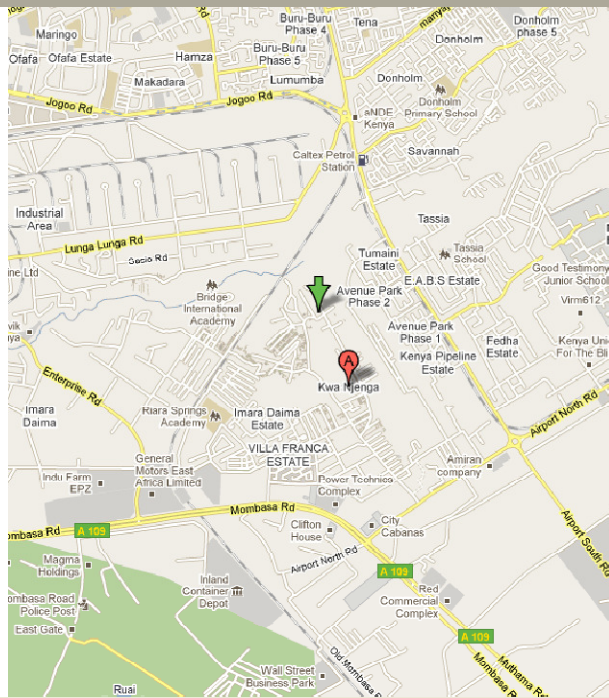


**Location:** S1.314152 E36.880975  
Mukuru-Kwa-Njenga

## MUKURU-KWA-NJENGA BOREHOLE NO. 2



**Borehole name:** - Kwa Patel  
**Construction date:** - 1979  
**Drilling cost:** - Not available  
**Depth:** - 120metres  
**No of tanks:** - None  
**Consumption per day:** Not available  
**Price per 20 litre jerrycan:** free



**Location:** S1.313566 E36.884651  
**Mukuru-Kwa-Njenga**




### MUKURU-KWA-NJENGA BOREHOLE NO.3

**Borehole name:** - Chief's Office  
**Construction date:** - 2007  
**Drilling cost:** - KES 1.8 million(USD\$ 22,500)  
**Depth:** - 240m  
**No of tanks:** - 9  
**Consumption per day:** - Not available  
**Price per 20 litre jerrycan:**-KES 3


### MUKURU-KWA-NJENGA BOREHOLE NO.4

**Borehole name:** - Komedo School  
**Construction date:** - 2010  
**Drilling cost:** - KES 2 million (USD\$ 25,000)  
**Depth:** - 240metres  
**No of tanks:** - 1  
**Consumption per day:** - Not available (not commissioned yet)  
**Price per 20 litre jerrycan:**-N/A

## KAWANGWARE BOREHOLE NO. 1



**Borehole name:** - Sweetwater  
**Construction date:** - 2007  
**Drilling cost:** - KES 2 million(USD\$ 25,000)  
**Depth:** - 310metres  
**No of tanks:** - 13  
**Consumption per day:** 60,000 litres  
**Price per 20 litre jerrycan:**KES 5



**Location:** S01°16'43.9" E036°44'57.6"  
Kawangware

## KAWANGWARE BOREHOLE NO. 2



**Borehole name:** - KwaRaila  
**Construction date:** - 2007  
**Drilling cost:** - KES 2 million(USD\$ 25,000)  
**Depth:** - 300metres  
**No of tanks:** - 3  
**Consumption per day:** 15,000 litres  
**Price per 20 litre jerrycan:**KES 3

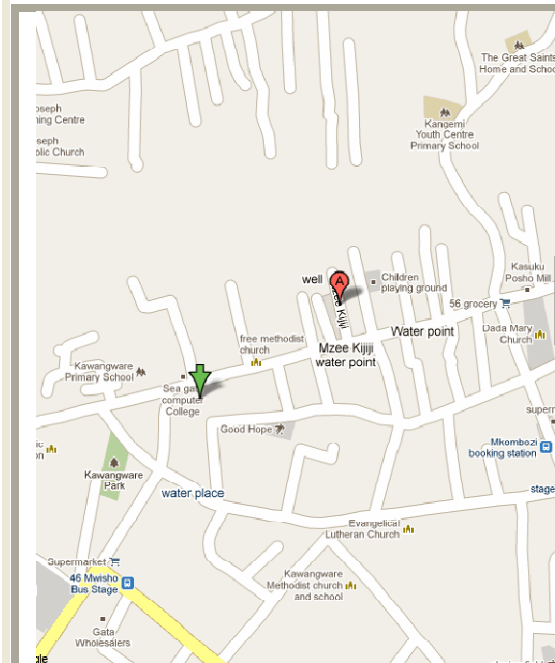


**Location:** S01°16'43.0" E036°44'42.0"  
Kawangware

### KAWANGWARE BOREHOLE NO. 3



**Borehole name:** - KABAZI (Kwa Margaret)  
**Construction date:** - February 2010  
**Drilling cost:** - KES 3 million(USD\$ 37,500)  
**Depth:** - 250metres  
**No of tanks:** - 2  
**Consumption per day:** 25,000 litres  
**Price per 20 litre jerrycan:** - free

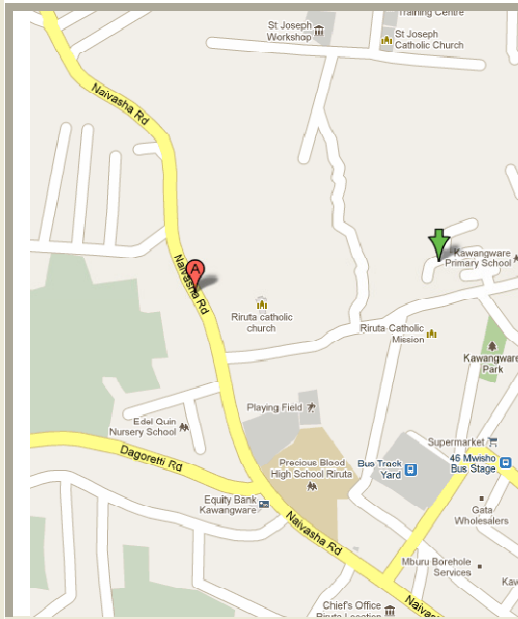


**Location:** S01°16'49.0" E036°44'40.6"  
Kawangware

## KAWANGWARE BOREHOLE NO. 4



**Borehole name:** - Mosque (Muslim)  
**Construction date:** - 2007  
**Drilling cost:** - KES 1.8 million(USD\$ 22,500)  
**Depth:** - 250metres  
**No of tanks:** - 1  
**Consumption per day:** 10,000 litres  
**Price per 20 litre jerrycan:** -KES 3

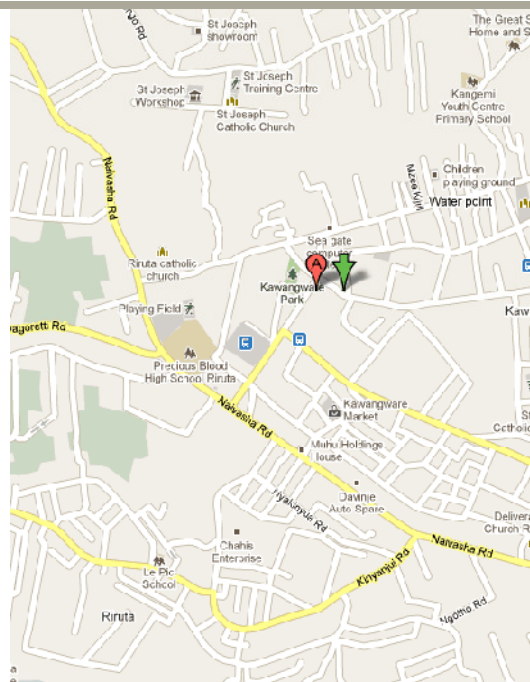


**Location:** S01°16'47.3" E036°44'30.0"  
Kawangware

## KAWANGWARE BOREHOLE NO. 5



**Borehole name:** - Kwa Njoroge  
**Construction date:** - November 2009  
**Drilling cost:** - KES 2 million (USD\$ 25,000)  
**Depth:** - 300metres  
**No of tanks:** - 6  
**Consumption per day:** 15,000 litres  
**Price per 20 litre jerrycan:** -KES 5



**Location:** S01°16'56.0" E036°44'41.3"  
Kawangware

## KAWANGWARE BOREHOLE NO. 6



**Borehole name:** - Nguma  
**Construction date:** - September 2009  
**Drilling cost:** - KES 1.6 million (USD\$ 20,000)  
**Depth:** - 180metres  
**No of tanks:** - 4  
**Consumption per day:** 40,000 litres



**Location:** S01°16'57.8"  
E036°44'36.2"

## KAWANGWARE BOREHOLE NO. 7



**Borehole name:** - Elizabeth Wacheke  
**Construction date:** - November 2009  
**Drilling cost:** - KES 1.6 million (USD\$ 20,000)  
**Depth:** - 180metres  
**No of tanks:** - 4  
**Consumption per day:** 80,000 litres  
**Price per 20 litre jerrycan:** -KES 5



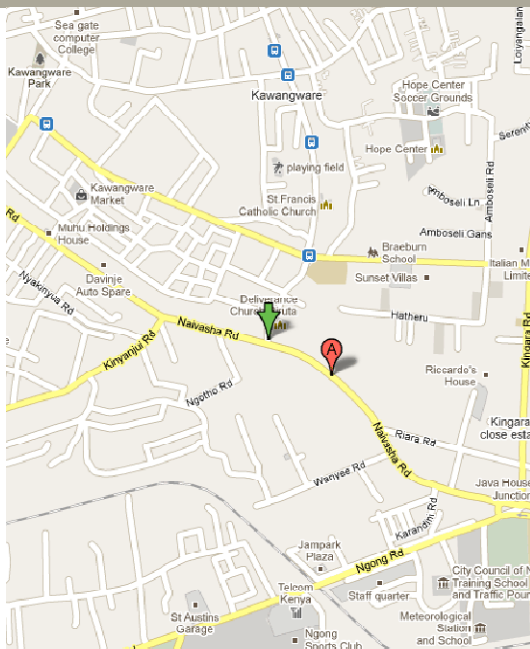
**Location:** S01°16'58.2" E036°44'38.1"  
Kawangware



## KAWANGWARE BOREHOLE NO. 8



**Borehole name:** - Deliverance  
**Construction date:** - 2000  
**Drilling cost:** - KES 1.6 million (USD\$ 20,000)  
**Depth:** - 250m  
**No of tanks:** - 2  
**Consumption per day:** - 40,000 litres  
**Price per 20 litre jerrycan:** -KES 7

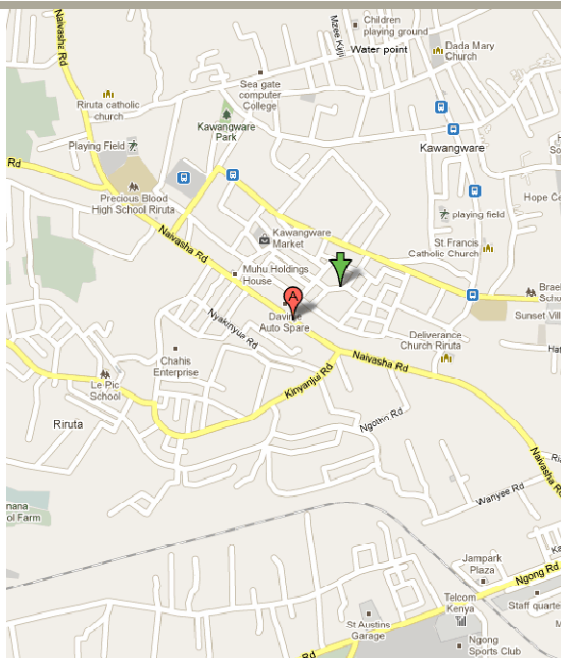


**Location:** S01°17'32.9" E036°45'05.9"  
Kawangware

## KAWANGWARE BOREHOLE NO. 9



**Borehole name:** - Emmanuel Church  
**Construction date:** - 2009  
**Drilling cost:** - KES 3 million (USD\$ 37,500)  
**Depth:** - 230metres  
**No of tanks:** - 1  
**Consumption per day:** - Not available  
**Price per 20 litre jerrycan:** -KES 5



**Location:** S01°17'19.9" E036°44'51.5"  
Kawangware

## KAWANGWARE BOREHOLE NO. 10

**Borehole name:** - International Management  
**Construction date:** - 2009  
**Drilling cost:** - KES 1.8 million (USD\$ 22,500)  
**Depth:** - 250metres  
**No of tanks:** - 9  
**Consumption per day:** - Not available  
**Price per 20 litre jerrycan:** -KES 5

## KAWANGWARE BOREHOLE NO. 11

**Borehole name:** - Homestead – WambuiGitau  
**Construction date:** - 2005  
**Drilling cost:** - KES 1.6 million (USD\$ 20,000)  
**Depth:** - 268metres  
**No of tanks:** - 1  
**Consumption per day:** - Not available  
**Price per 20 litre jerrycan:** -KES 3

## KAWANGWARE BOREHOLE NO. 12

**Borehole name:** - Girl Child School  
**Construction date:** - 2010  
**Drilling cost:** - KES 6 million (USD\$ 75,000)  
**Depth:** - 250metres  
**No of tanks:** - 2  
**Consumption per day:** - Not available (not commissioned yet)  
**Price per 20 litre jerrycan:** -free for school children



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### CERTIFICATE OF LABORATORY ANALYSIS

Sample No: 013/10  
Name: Flomina  
Source: B/H (Kayole Area)  
Purpose of sampling: Domestic

Date of Sampling: 04/10/2010  
Date Received: 04/10/2010  
Submitted by: IC

PARAMETERS	UNITS	RESULTS	WHO GUIDELINE	CURRENT	1st Test
<b>PHYSICAL TESTS</b>					
Color	CU	-	< 15	-	
Turbidity	NTU	-	< 5	-	
Odor		<b>NOB</b>	<b>Not Objectionable</b>	<b>NOB</b>	
Temperature	°C	<b>23.4</b>			
<b>CHEMICAL TESTS</b>					
pH	pH Scale	<b>6.90</b>	<b>6.5 – 8.5</b>		
Conductivity (25°C)	µS/cm	-	< 2500		
Iron	mg/l	<b>0.31</b>	<b>&lt; 0.30</b>		
Manganese	mg/l	0.08	< 0.40		
Cadmium	mg/l	-	< 0.01		
Copper	mg/l	-	< 0.05		
Chromium	mg/l	-	< 2		
Total Hardness	mgCaCO <sub>3</sub> /l	<b>19</b>	< 500		
Total Alkalinity	mgCaCO <sub>3</sub> /l	<b>0</b>	< 500		
Chloride	mg/l	-	< 250		
<b>Fluoride</b>	<b>mg/l</b>	<b>2.00</b>	<b>&lt; 1.50</b>		
Nitrate	mgN/l	5	< 10		
Nitrite	mgN/l	-	< 0.5		
Sulphate	mg/l	-	< 250		
TDS	mg/l	254	< 1500		
<b>BACTERIOLOGICAL TESTS</b>					
Total Coliform	No/100ml	<b>1</b>	< 10		
Feacal Coliform	No/100ml		<b>Nil</b>		
<b>OTHERS</b>					
UV Transmittance	%T		> 85		



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### CERTIFICATE OF LABORATORY ANALYSIS

Sample No: 014/10  
Name: Galilee  
Source: B/H (Kayole Area)  
Purpose of sampling: Domestic

Date of Sampling: 04/10/2010  
Date Received: 04/10/2010  
Submitted by: IC

PARAMETERS	UNITS	RESULTS	WHO GUIDELINE	CURRENT	1st Test
<b>PHYSICAL TESTS</b>					
Color	CU	-	< 15	-	
Turbidity	NTU	-	< 5	-	
Odor		<b>NOB</b>	<b>Not Objectionable</b>	<b>NOB</b>	
Temperature	°C	<b>23.1</b>			
<b>CHEMICAL TESTS</b>					
pH	pH Scale	<b>6.85</b>	<b>6.5 – 8.5</b>		
Conductivity (25°C)	µS/cm	-	< 2500		
Iron	mg/l	<b>0.80</b>	<b>&lt; 0.30</b>		
Manganese	mg/l	0	< 0.40		
Cadmium	mg/l	-	< 0.01		
Copper	mg/l	-	< 0.05		
Chromium	mg/l	-	< 2		
Total Hardness	mgCaCO <sub>3</sub> /l	<b>11</b>	< 500		
Total Alkalinity	mgCaCO <sub>3</sub> /l	<b>0</b>	< 500		
Chloride	mg/l	-	< 250		
Fluoride	mg/l	<b>2.05</b>	<b>&lt; 1.50</b>		
Nitrate	mgN/l	10	< 10		
Nitrite	mgN/l	-	< 0.5		
Sulphate	mg/l	-	< 250		
TDS	mg/l	298	< 1500		
<b>BACTERIOLOGICAL TESTS</b>					
Total Coliform	No/100ml	<b>210</b>	< 10		
Feacal Coliform	No/100ml	<b>Nil</b>	<b>Nil</b>		
<b>OTHERS</b>					
UV Transmittance	%T		> 85		



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## CERTIFICATE OF LABORATORY ANALYSIS

Sample No: 020/10  
 Name: Kawangware deliverence  
 Source: B/H  
 Purpose of sampling: Domestic

Date of Sampling: 26/10/2010  
 Date Received: 28/10/2010  
 Submitted by: IC

PARAMETERS	UNITS	RESULTS	WHO GUIDELINE
<b>PHYSICAL TESTS</b>			
Color	CU	-	< 15
Turbidity	NTU	-	< 5
Odor		<b>NOB</b>	<b>Not Objectionable</b>
Temperature	°C	<b>24</b>	
<b>CHEMICAL TESTS</b>			
pH	pH Scale	<b>6.90</b>	<b>6.5 – 8.5</b>
Conductivity (25°C)	µS/cm	-	< 2500
<b>Iron</b>	<b>mg/l</b>	<b>0.42</b>	<b>&lt; 0.30</b>
Manganese	mg/l	nil	< 0.40
Cadmium	mg/l	-	< 0.01
Copper	mg/l	-	< 0.05
Chromium	mg/l	-	< 2
Total Hardness	mgCaCO <sub>3</sub> /l	<b>19</b>	< 500
Total Alkalinity	mgCaCO <sub>3</sub> /l	<b>nil</b>	< 500
Chloride	mg/l	-	< 250
<b>Fluoride</b>	<b>mg/l</b>	<b>3.5</b>	<b>&lt; 1.50</b>
Nitrate	mgN/l	6	< 10
Nitrite	mgN/l	-	< 0.5
Sulphate	mg/l	-	< 250
TDS	mg/l	-	< 1500
<b>BACTERIOLOGICAL TESTS</b>			
<b>Total Coliform</b>	<b>No/100ml</b>	<b>2420</b>	<b>&lt; 10</b>
<b>E.Coli</b>	<b>No/100ml</b>	<b>214</b>	<b>Nil</b>
<b>OTHERS</b>			
UV Transmittance	%T		> 85



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### CERTIFICATE OF LABORATORY ANALYSIS

Sample No: 022/10  
Name: Kawangware Sweet water  
Source: B/H  
Purpose of sampling: Domestic

Date of Sampling: 26/10/2010  
Date Received: 28/10/2010  
Submitted by: IC

PARAMETERS	UNITS	RESULTS	WHO GUIDELINE
<b>PHYSICAL TESTS</b>			
Color	CU	-	< 15
Turbidity	NTU	-	< 5
Odor		<b>NOB</b>	<b>Not Objectionable</b>
Temperature	°C	<b>25</b>	
<b>CHEMICAL TESTS</b>			
pH	pH Scale	<b>6.58</b>	<b>6.5 – 8.5</b>
Conductivity (25°C)	µS/cm	-	< 2500
<b>Iron</b>	<b>mg/l</b>	<b>0.41</b>	<b>&lt; 0.30</b>
Manganese	mg/l	0.02	< 0.40
Cadmium	mg/l	-	< 0.01
Copper	mg/l	-	< 0.05
Chromium	mg/l	-	< 2
Total Hardness	mgCaCO <sub>3</sub> /l	<b>20</b>	< 500
Total Alkalinity	mgCaCO <sub>3</sub> /l	<b>nil</b>	< 500
Chloride	mg/l	-	< 250
<b>Fluoride</b>	<b>mg/l</b>	<b>2.3</b>	<b>&lt; 1.50</b>
Nitrate	mgN/l	7	< 10
Nitrite	mgN/l	-	< 0.5
Sulphate	mg/l	-	< 250
TDS	mg/l	-	< 1500
<b>BACTERIOLOGICAL TESTS</b>			
<b>Total Coliform</b>	<b>No/100ml</b>	<b>48</b>	<b>&lt; 10</b>
<b>E.Coli</b>	<b>No/100ml</b>	<b>36</b>	<b>Nil</b>
<b>OTHERS</b>			
<b>UV Transmittance</b>	<b>%T</b>		<b>&gt; 85</b>



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### CERTIFICATE OF LABORATORY ANALYSIS

Sample No: 021/10

Date of Sampling: 26/10/2010

Name: Kawangware Emmanuel

Date Received: 28/10/2010

Source: B/H

Submitted by: IC

Purpose of sampling: Domestic

PARAMETERS	UNITS	RESULTS	WHO GUIDELINE
<b>PHYSICAL TESTS</b>			
Color	CU	-	< 15
Turbidity	NTU	-	< 5
Odor		<b>NOB</b>	<b>Not Objectionable</b>
Temperature	°C	<b>23.2</b>	
<b>CHEMICAL TESTS</b>			
pH	pH Scale	<b>6.60</b>	<b>6.5 – 8.5</b>
Conductivity (25°C)	µS/cm	-	< 2500
Iron	mg/l	<b>0.75</b>	<b>&lt; 0.30</b>
Manganese	mg/l	0.13	< 0.40
Cadmium	mg/l	-	< 0.01
Copper	mg/l	-	< 0.05
Chromium	mg/l	-	< 2
Total Hardness	mgCaCO <sub>3</sub> /l	<b>14</b>	< 500
Total Alkalinity	mgCaCO <sub>3</sub> /l	<b>nil</b>	< 500
Chloride	mg/l	-	< 250
Fluoride	mg/l	<b>5.0</b>	<b>&lt; 1.50</b>
Nitrate	mgN/l	5	< 10
Nitrite	mgN/l	-	< 0.5
Sulphate	mg/l	-	< 250
TDS	mg/l	-	< 1500
<b>BACTERIOLOGICAL TESTS</b>			
Total Coliform	No/100ml	<b>Nil</b>	< 10
E. Coli	No/100ml	<b>Nil</b>	<b>Nil</b>
<b>OTHERS</b>			
UV Transmittance	%T		> 85





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### CERTIFICATE OF LABORATORY ANALYSIS

Sample No: 015/10  
Name: Kwa Watoto  
Source: B/H (Kayole Area)  
Purpose of sampling: Domestic

Date of Sampling: 04/10/2010  
Date Received: 04/10/2010  
Submitted by: IC

PARAMETERS	UNITS	RESULTS	WHO GUIDELINE
<b>PHYSICAL TESTS</b>			
Color	CU	-	< 15
Turbidity	NTU	-	< 5
Odor		<b>NOB</b>	<b>Not Objectionable</b>
Temperature	°C	<b>23.1</b>	
<b>CHEMICAL TESTS</b>			
pH	pH Scale	<b>6.90</b>	<b>6.5 – 8.5</b>
Conductivity (25°C)	µS/cm	-	< 2500
<b>Iron</b>	<b>mg/l</b>	<b>0.33</b>	<b>&lt; 0.30</b>
Manganese	mg/l	0	< 0.40
Cadmium	mg/l	-	< 0.01
Copper	mg/l	-	< 0.05
Chromium	mg/l	-	< 2
Total Hardness	mgCaCO <sub>3</sub> /l	<b>4</b>	< 500
Total Alkalinity	mgCaCO <sub>3</sub> /l	<b>0</b>	< 500
Chloride	mg/l	-	< 250
<b>Fluoride</b>	<b>mg/l</b>	<b>2.03</b>	<b>&lt; 1.50</b>
Nitrate	mgN/l	5	< 10
Nitrite	mgN/l	-	< 0.5
Sulphate	mg/l	-	< 250
TDS	mg/l	291	< 1500
<b>BACTERIOLOGICAL TESTS</b>			
Total Coliform	No/100ml	<b>Nil</b>	< 10
Faecal Coliform	No/100ml	<b>Nil</b>	<b>Nil</b>
<b>OTHERS</b>			
UV Transmittance	%T		> 85



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**CERTIFICATE OF LABORATORY ANALYSIS**

Sample No: 017/10  
Location: Direct from the mains  
Source: B/H  
Purpose of sampling: Domestic

Date of Sampling: 15/10/2010  
Date Received: 18/10/2010  
Submitted by: IC

PARAMETERS	UNITS	RESULTS	WHO GUIDELINE	CURRENT
<b>PHYSICAL TESTS</b>				
Color	CU	-	< 15	
Turbidity	NTU	-	< 5	-
Odor		<b>NOB</b>	<b>Not Objectionable</b>	<b>NOB</b>
Temperature	°C			
<b>CHEMICAL TESTS</b>				
pH	pH Scale	6.93	6.5 – 8.5	6.93
Conductivity (25°C)	µS/cm	-	< 2500	-
Iron	mg/l	0.25	< 0.30	0.25
Manganese	mg/l	NIL	< 0.40	NIL
Cadmium	mg/l	-	< 0.01	-
Copper	mg/l	-	< 0.05	-
Chromium	mg/l	-	< 2	-
Total Hardness	mgCaCO <sub>3</sub> /l	<b>13</b>	< 500	<b>13</b>
Total Alkalinity	mgCaCO <sub>3</sub> /l	<b>NIL</b>	< 500	<b>NIL</b>
Chloride	mg/l	-	< 250	-
<b>Fluoride</b>	<b>mg/l</b>	<b>9.4</b>	<b>&lt; 1.50</b>	<b>9.4</b>
Nitrate	mgN/l	8	< 10	8
Nitrite	mgN/l	-	< 0.5	-
Sulphate	mg/l	-	< 250	-
TDS	mg/l	434	< 1500	434
<b>BACTERIOLOGICAL TESTS</b>				
<b>Total Coliform</b>	<b>No/100ml</b>	<b>178</b>	<b>&lt; 10</b>	<b>178</b>
<b>E.Coli</b>	<b>No/100ml</b>	<b>137</b>	<b>Nil</b>	<b>137</b>
<b>OTHERS</b>				
UV Transmittance	%T	-	> 85	-



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### CERTIFICATE OF LABORATORY ANALYSIS

Sample No: 018/10 Date of Sampling: 15/10/2010  
Location: Direct from the mains Date Received: 18/10/2010  
Source: B/H mukuru next to St Mary's Submitted by: IC  
Purpose of sampling: Domestic

PARAMETERS	UNITS	RESULTS	WHO GUIDELINE	CURRENT
<b>PHYSICAL TESTS</b>				
Color	CU	-	< 15	
Turbidity	NTU	-	< 5	-
Odor		<b>NOB</b>	<b>Not Objectionable</b>	<b>NOB</b>
Temperature	°C			
<b>CHEMICAL TESTS</b>				
pH	pH Scale	6.87	6.5 – 8.5	6.87
Conductivity (25°C)	µS/cm	-	< 2500	-
Iron	mg/l	0.20	< 0.30	0.20
Manganese	mg/l	NIL	< 0.40	NIL
Cadmium	mg/l	-	< 0.01	-
Copper	mg/l	-	< 0.05	-
Chromium	mg/l	-	< 2	-
Total Hardness	mgCaCO <sub>3</sub> /l	<b>23</b>	< 500	<b>23</b>
Total Alkalinity	mgCaCO <sub>3</sub> /l	<b>NIL</b>	< 500	<b>NIL</b>
Chloride	mg/l	-	< 250	-
Fluoride	mg/l	0.42	< 1.50	0.42
Nitrate	mgN/l	4	< 10	4
Nitrite	mgN/l	-	< 0.5	-
Sulphate	mg/l	-	< 250	-
TDS	mg/l	65	< 1500	65
<b>BACTERIOLOGICAL TESTS</b>				
Total Coliform	No/100ml	<b>2420</b>	< 10	-
E.Coli	No/100ml	<b>Nil</b>	<b>Nil</b>	-
<b>OTHERS</b>				
UV Transmittance	%T	-	> 85	-

# AQUATECH INDUSTRIES LTD.

JUNE 18<sup>TH</sup>, 2012

## WATER QUALITY ANALYSIS: PHYSICAL & CHEMICAL TESTS

Sample No : 1206/38  
 Date Sampled : 13/06/2012  
 Date Received : 13/06/2012  
 Sample Source : BOREHOLE WATER – GALILEE SCHOOL  
 Sample Submitted by : KIMUNGA KARIUKI

PARAMETERS	UNITS	RESULTS	KS 459 – 1: 2007 THIRD EDITION 2007
<b>CHEMICAL TESTS</b>			
Chloride	Mg/l Cl <sup>-</sup>	12	250
Iron	Mg/l Fe	0.02	0.3
Fluoride	Mg/l F	12.00	1.5

NS: No Set Standard

ND: Not Detected

KS: Kenya Standard (KEBS 2007)

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

### COMMENTS

The sample performed as shown.



**MUGUN KIPCHUMBA**  
**WATER QUALITY LAB.**

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AQUATECH INDUSTRIES LTD WATER QUALITY LAB

NAKI WATER, BOREHOLE WATER SAMPLE (GALILEE SCHOOL) – JUNE 18<sup>TH</sup>, 2012

# AQUATECH INDUSTRIES LTD.

JUNE 18<sup>TH</sup>, 2012

## BACTERIOLOGICAL ANALYSIS

Sample N<sup>o</sup> : 1206/38  
 Date Sampled : 13/06/2012  
 Date Received : 13/06/2012  
 Sample Source : BOREHOLE WATER – GALILEE SCHOOL  
 Sample Submitted by : KIMUNGA KARIUKI

## EXAMINATION RESULTS

TEST	KS 459 – 1: 2007 THIRD EDITION 2007	RESULTS TREATED
Total Bacteria Count/ ml	100 Max	<1
MPN of Coliform Organisms in a 100 ml sample	Shall be absent	ND
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	ND
MPN of Faecal Coliform Organisms in a 100 ml sample	Shall be absent	ND

MPN: Most Probable Number

ND: Not Detected

<: Less Than

KS: Kenya Standard (KEBS 2007)

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENT

The water sample complies with the set bacteriological guideline values for potable water.



for

**MUGUN KIPCHUMBA**  
**WATER QUALITY LAB.**

5 | AQUATECH INDUSTRIES LTD WATER QUALITY LAB

**HAKI WATER, BOREHOLE WATER SAMPLE (GALILEE SCHOOL) – JUNE 18<sup>TH</sup>, 2012**

# AQUATECH INDUSTRIES LTD.

NOVEMBER 19<sup>TH</sup>, 2012

## WATER QUALITY ANALYSIS: PHYSICAL & CHEMICAL TESTS

Sample N<sup>o</sup> : 1211/34  
Date Sampled : -/11/2012  
Date Received : 16/11/2012  
Sample Source : FILOMINA CHILDREN'S HOME  
Sample Submitted by : HAKI WATER ORGANIZATION

PARAMETERS	UNITS	RESULTS	KS 459 – 1: 2007 THIRD EDITION 2007
<b>CHEMICAL TESTS</b>			
Fluoride	Mg/l F	<b>4.11</b>	<b>1.5</b>
Iron	Mg/l Fe	0.01	0.3

NS: No Set Standard

ND: Not Detected

KS: Kenya Standard (KEBS 2007)

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENTS

The sample performed as shown.



**MUGUN KIPCHUMBA**  
WATER QUALITY LAB.

# AQUATECH INDUSTRIES LTD.

NOVEMBER 19<sup>TH</sup>, 2012

## BACTERIOLOGICAL ANALYSIS

Sample N<sup>o</sup> : 1211/34  
Date Sampled : -/11/2012  
Date Received : 16/11/2012  
Sample Source : FILOMINA CHILDREN'S HOME  
Sample Submitted by : HAKI WATER ORGANIZATION

## EXAMINATION RESULTS

TEST	KS 459 – 1: 2007 THIRD EDITION 2007	RESULTS TREATED
Total Bacteria Count/ ml	100 Max	100- 1000
MPN of Coliform Organisms in a 100 ml sample	Shall be absent	16.0
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	ND
MPN of Feacal Coliform Organisms in a 100 ml sample	Shall be absent	ND

**MPN: Most Probable Number**

**ND: Not Detected**

**<: Less Than**

**KS: Kenya Standard (KEBS 2007)**

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENT

The water sample does not comply with the set bacteriological guideline values for potable water. The source of contamination should be established and corrective measures taken.

  
**MUGUN KIPCHUMBA**  
**WATER QUALITY LAB**

# AQUATECH INDUSTRIES LTD.

APRIL 12<sup>TH</sup>, 2013

## WATER QUALITY ANALYSIS: PHYSICAL & CHEMICAL TESTS

Sample N<sup>o</sup> : 1304/21  
Date Sampled : -/04/2013  
Date Received : 10/04/2013  
Sample Source : BOREHOLE WATER – FLOMINA  
Sample Submitted by : HAKI WATER ORGANIZATION

PARAMETERS	UNITS	RESULTS	KS 459 – 1: 2007 THIRD EDITION 2007
<b>CHEMICAL TESTS</b>			
Fluoride	Mg/l F	4.02	1.5
Free Chlorine	Mg/l Cl <sub>2</sub>	0.02	0.2

NS: No Set Standard

ND: Not Detected

KS: Kenya Standard (KEBS 2007)

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENTS

The sample performed as shown above.



**MUGUN KIPCHUMBA**  
WATER QUALITY LAB.



# AQUATECH INDUSTRIES LTD.

APRIL 12<sup>TH</sup>, 2013

## BACTERIOLOGICAL ANALYSIS

Sample N<sup>o</sup> : 1304/21  
Date Sampled : -/04/2013  
Date Received : 10/04/2013  
Sample Source : BOREHOLE WATER – FLOMINA  
Sample Submitted by : HAKI WATER ORGANIZATION

## EXAMINATION RESULTS

TEST	KS 459 – 1: 2007 THIRD EDITION 2007	RESULTS TREATED
Total Bacteria Count/ ml	100 Max	10 - 100
MPN of Coliform Organisms in a 100 ml sample	Shall be absent	ND
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	ND
MPN of Feacal Coliform Organisms in a 100 ml sample	Shall be absent	ND

**MPN: Most Probable Number**

**ND: Not Detected**

**<: Less Than**

**KS: Kenya Standard (KEBS 2007)**

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENT

The water sample complies with the set bacteriological guideline values for potable water.

  
**MUGUN KIPCHUMBA**  
**WATER QUALITY LAB**

# AQUATECH INDUSTRIES LTD.

APRIL 12<sup>TH</sup>, 2013

## WATER QUALITY ANALYSIS: PHYSICAL & CHEMICAL TESTS

Sample N<sup>o</sup> : 1304/22  
Date Sampled : -/04/2013  
Date Received : 10/04/2013  
Sample Source : BOREHOLE WATER – GALILEE  
Sample Submitted by : HAKI WATER ORGANIZATION

PARAMETERS	UNITS	RESULTS	KS 459 – 1: 2007 THIRD EDITION 2007
<b>CHEMICAL TESTS</b>			
Fluoride	Mg/l F	1.75	1.5
Free Chlorine	Mg/l Cl <sub>2</sub>	0.03	0.2

NS: No Set Standard


ND: Not Detected

KS: Kenya Standard (KEBS 2007)

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENTS

The sample performed as shown above.

  
**MUGUN KIPCHUMBA**  
WATER QUALITY LAB.

# AQUATECH INDUSTRIES LTD.

APRIL 12<sup>TH</sup>, 2013

## BACTERIOLOGICAL ANALYSIS

Sample N<sup>o</sup> : 1304/22  
Date Sampled : -/04/2013  
Date Received : 10/04/2013  
Sample Source : BOREHOLE WATER – GALILEE  
Sample Submitted by : HAKI WATER ORGANIZATION

## EXAMINATION RESULTS

TEST	KS 459 – 1: 2007 THIRD EDITION 2007	RESULTS TREATED
Total Bacteria Count/ ml	100 Max	<1
MPN of Coliform Organisms in a 100 ml sample	Shall be absent	ND
MPN of E- Coli Organisms in a 100 ml sample	Shall be absent	ND
MPN of Faecal Coliform Organisms in a 100 ml sample	Shall be absent	ND

**MPN: Most Probable Number**

**ND: Not Detected**

**<: Less Than**

**KS: Kenya Standard (KEBS 2007)**

The results relate to the sample(s) submitted. The laboratory will not be held responsible for any sampling errors.

## COMMENT

The water sample complies with the set bacteriological guideline values for potable water.



**MUGUN KIPCHUMBA**  
**WATER QUALITY LAB**