Independent and small scale urban water providers in Kenya and Ethiopia

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Abstract

In many urban centres of developing countries a large population is without access to water or are poorly served by the official water utilities. These rely on independent and small scale water providers (I&SSWPs). Such providers largely operate unofficially. Their role is often ignored or misunderstood and described negatively. This research aimed at examining water provision by I&SSWPs and the need to integrate their services into the formal water supply as a possible means of improving water provision.

The research was done through household water usage study and analysis of I&SSWPs. Key water stakeholders were also involved. Questionnaires, interviews, focus group discussions and workshops were used. In addition, water quality monitoring involving supply chain analysis combined with sanitary inspections was carried out.

I&SSWPs operating under various business models bring basic water services to households in areas served. Water provision by I&SSWPs is complex resulting in interactions and overlaps between the formal and informal water provision. Some provide a 'virtual piped network' while where households have their own connections to official piped network discontinuity makes I&SSWPs the main sources. Through I&SSWPs with their own sources, households per capita water use improved remarkably. I&SSWPs generally operate competitively. Cost of water from I&SSWPs without their own sources is high for poor households, but would be pro-poor strategies are ineffective. I&SSWPs’ income and profits vary, but water selling remains an important means of sustaining livelihoods. Although household decision makers understand the importance of choosing safe drinking water, access factors can supersede resulting in the use of poor quality sources provided by some I&SSWPs.

This research demonstrates the need to reconcile the vital services I&SSWPs provide with the need to improve practice to protect users and make services affordable. Consumers will benefit if the role I&SSWPs play can be recognized and enhanced to improve water provision.
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**Acronyms**

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<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AAWSA</td>
<td>Addis Ababa Water and Sewerage Authority</td>
</tr>
<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of variance</td>
</tr>
<tr>
<td>BOT</td>
<td>Build operate transfer</td>
</tr>
<tr>
<td>CBOs</td>
<td>Community Based organisation</td>
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<tr>
<td>CBS</td>
<td>Central Bureau of Statistics</td>
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<tr>
<td>CFUs</td>
<td>Colony forming units</td>
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<td>Cl</td>
<td>Confidence Interval</td>
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<td>CRC</td>
<td>Convention on the Rights of the Child</td>
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<td>CSO</td>
<td>Civil Society Organisations</td>
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<td>DALYs</td>
<td>Disability-Adjusted Life Years</td>
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<td>DMM</td>
<td>Delegated Management Model</td>
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<td>DWO</td>
<td>Drawers of Water</td>
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<td>FDRE</td>
<td>Federal Democratic Republic of Ethiopia</td>
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<td>Focus Group Discussions</td>
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<td>GOK</td>
<td>Government of Kenya</td>
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<td>IBT</td>
<td>Increasing block tariff</td>
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<tr>
<td>ICESCR</td>
<td>International Covenant on Economic, Social and Cultural Rights</td>
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<td>IDDWS</td>
<td>International Decade for Drinking Water Supply and Sanitation</td>
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<td>I&amp;SSWPs</td>
<td>Independent and Small- Scale Water Providers</td>
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<td>ISO</td>
<td>International Standardization Organization</td>
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<td>JICA</td>
<td>Japan international Development Cooperation</td>
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<td>JMP</td>
<td>Joint Monitoring Programme</td>
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<td>KShs.</td>
<td>Kenya shillings</td>
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<td>KIWASCO</td>
<td>Kisumu Water and Sewerage Company</td>
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<td>Millennium Development Goals</td>
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<td>Median</td>
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<td>Membrane filtration</td>
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<td>Minimum</td>
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<td>MLSB</td>
<td>Membrane lauryl sulphate broth</td>
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<tr>
<td>MO</td>
<td>Master Operator</td>
</tr>
<tr>
<td>MoFED</td>
<td>Ministry of Finance and Economic Development</td>
</tr>
<tr>
<td>MPN</td>
<td>Most Probable Number</td>
</tr>
<tr>
<td>MSMEs</td>
<td>Micros, Small and Medium-Sized Entities</td>
</tr>
<tr>
<td>NGOs</td>
<td>Non Governmental Organizations</td>
</tr>
<tr>
<td>NSPs</td>
<td>Non-State water Providers</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>NWCPC</td>
<td>National Water Conservation and Pipeline Corporation</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
</tr>
<tr>
<td>PSP</td>
<td>Private Sector Participation</td>
</tr>
<tr>
<td>PW Ts</td>
<td>Public water taps</td>
</tr>
<tr>
<td>RCPEH</td>
<td>Robens Centre for Public and Environmental Health</td>
</tr>
<tr>
<td>SANA</td>
<td>Sanitation Aid in Africa</td>
</tr>
<tr>
<td>SDE</td>
<td>Senegaise des eaux</td>
</tr>
<tr>
<td>SIWI</td>
<td>Stockholm International Water Institute</td>
</tr>
<tr>
<td>SMEs</td>
<td>Small and micro-enterprise</td>
</tr>
<tr>
<td>SODECI</td>
<td>Societe de distribution d'eau de la Cote d'Ivore</td>
</tr>
<tr>
<td>TTC</td>
<td>Thermotolerant coliforms</td>
</tr>
<tr>
<td>TU</td>
<td>Turbidity unit</td>
</tr>
<tr>
<td>UfW</td>
<td>Unaccounted-for-Water</td>
</tr>
<tr>
<td>UShs</td>
<td>Ugandan Shillings</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNESC</td>
<td>United Nations Committee on Social and Cultural Rights</td>
</tr>
<tr>
<td>UNCHS</td>
<td>United Nations Centre for Human Settlement (UN-Habitat)</td>
</tr>
<tr>
<td>UNCSID</td>
<td>United Nations Commission for Sustainable Development</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>UNFPA</td>
<td>United Nations Population Division</td>
</tr>
<tr>
<td>UNICEF</td>
<td>United Nations Children's Fund</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>USV</td>
<td>Union of Vacuum-truckers</td>
</tr>
<tr>
<td>US$</td>
<td>United States Dollar</td>
</tr>
<tr>
<td>VIRED-Int.</td>
<td>Victoria Institute for Research on Environment and Development</td>
</tr>
<tr>
<td>WSREB</td>
<td>Water Services Regulatory Board</td>
</tr>
<tr>
<td>WEDC</td>
<td>Water and Environment Development Centre</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
<tr>
<td>WSBs</td>
<td>Water Services Boards</td>
</tr>
<tr>
<td>WSREB</td>
<td>Water Services Regulatory Board</td>
</tr>
<tr>
<td>WSSA</td>
<td>Water Supply and Sanitation Authority</td>
</tr>
<tr>
<td>WSP</td>
<td>Water and Sanitation Programme of the World Bank East Asia Office</td>
</tr>
<tr>
<td>WSPs</td>
<td>Water Services Providers</td>
</tr>
<tr>
<td>WTP</td>
<td>Willingness to pay</td>
</tr>
<tr>
<td>WUP</td>
<td>Water Utility Partnership for Capacity building (Africa office)</td>
</tr>
</tbody>
</table>
Chapter 1 Introduction

1.1 Problem Statement and Aims
Water is essential for sustenance of life. Everyone needs water and has to obtain water for survival. Access to water for drinking and other domestic uses is important for improving health (UNICEF & WHO, 2005). There is also a strong link between socio-economic growth, general human development and improved access to adequate and safe water supplies (Stockholm International Water Institute [SIWI], 2005; UNDP, 2006). Several efforts have therefore been directed at making access to safe water one of the top priorities in the international development agenda, for both developing countries and international development institutions. Evidence for international commitment to improving access to water supply spans from the International Decade for Drinking Water Supply and Sanitation (IDDWS) -the 1980s- to the United Nations Millennium Summit in 2000 and the resultant Millennium Development Goals (MDGs), by which a commitment was made to halve by 2015 the number of people without sustainable access to safe drinking water. This was followed by the Johannesburg Earth Summit in 2002 (United Nations Commission for Sustainable Development, 2002). However, the challenge of achieving this target is enormous and requires innovative approaches and concerted efforts from all involved in the water supply sector.

Notwithstanding the importance of water and the efforts so far made a review of the literature shows that a large number, over 1.1 billion people living in developing countries still lack access to safe drinking water (UNDP, 2006). The majority of these people are found in rural areas (UNICEF & WHO, 2005; 2006), but urban populations are also expanding rapidly (UNFPA, 2007), and already many urban households have little or no access to water supplies that are reliable and of good quality. The lowest drinking-water coverage levels are in sub-Saharan Africa and Oceania. But this is more pronounced in sub-Saharan Africa where 431 million of those with no access to improved water live, and the populations are growing faster than improvements to water availability (UNICEF & WHO, 2005; UNDP, 2006).

Many developing countries choose to provide services such as water supply through government departments or public enterprises (Solo, 1999). However, for various reasons
these public water supply utilities have been slow in extending water supply services (WHO & UNICEF, 2000; World Bank, 2004b), as is evidenced by the large number of people in developing countries, still lacking access to safe drinking water. From the 1990s, the international community and donor agencies (multilateral financial institutions and bilateral development agencies), in an attempt to solve the failure of official public water utilities, have facilitated the commercialization of public water utilities; this is often known as privatization or private sector participation (Budds & McGranahan, 2003). However, several studies conducted to assess performance of some of these large scale private companies report that for a range of reasons, there is little or inadequate evidence of improvement in water supply under private sector participation (Gutierrez et al., 2003; Budds & McGranahan, 2003; Davis, 2005; Anand, 2006; Bakker, 2007). Thus a large number of people remain without access to sufficient safe water despite presence of the large scale official public and private water utilities. Poor water supply has profound and inter-linked health and socio-economic effects (Howard, 2001; Anand, 2006; UN-Habitat, 2008). There is therefore an increasing acknowledgement that the current “official” methods have not worked for all, and that more flexible approaches may be necessary for water provision (Bakker, 2007). Some attention is being directed at investigating how populations un-served or inadequately served by official water utilities are meeting their water needs and what opportunities may exist for further improvement (Solo, 1999; Collignon & Vezina, 2000). This research seeks to contribute to this emerging investigation.

The inability of official large-scale public and private water utilities to meet the water needs of millions of people in urban areas of developing countries has resulted in the emergence of other suppliers. Such suppliers exist in many countries and are known by various names. Referred to here as Independent and Small-Scale Water Providers (I&SSWPs), they are also known as informal water providers; water vendors; small-scale independent providers; small-scale water enterprises/providers; mini-utilities; non-state water providers; or “the other private sector”. They provide water services supplementary or alternative to those provided by the official large scale water utilities whether public and/or private.

Studies suggest that half or more of the population in urban centres of some developing countries depend on I&SSWPs rather than the official water utilities, and further that I&SSWPs may also be growing faster (Solo, 1998; Davis, 2005). According to several studies, they may hold 50 to 80 percent of the domestic water supply market in many urban
areas of developing countries (Solo, 1999; Whittington et al., 1999; Collignon & Vezina, 2000). It is suggested that I&SSWPs play an important role in meeting water needs, making up for the deficiencies of the large concessionaires and thus providing a useful service for millions of people. I&SSWPs may sometimes supplement the unreliable water provided by the official utilities to those connected, but in some areas they may be the sole water providers for millions of urban people not served by the official network or who live within the official network area but remain unconnected. For a variety of reasons, some urban populations in developing countries are unable to connect and access water provided by large-scale official utilities even when piped water network is available within their reach (Lawrence et al., 2002; Barbara, 2007). Samson et al. (2003) suggests that water provision by I&SSWPs is also important because it creates employment and generates income for those involved; hence, it is a means of livelihood and important in poverty alleviation.

Nevertheless, for a long time the role played by I&SSWPs has often either been ignored or is misunderstood and described negatively (Whittington et al. 1991; Laurie & Marvin, 1999; Nickson, 2001; The World Bank, 2002; WHO, 2004; UNDP, 2006). I&SSWPs are generally described as offering services of variable quality. Firstly, I&SSWPs are described as providing water of questionable quality (Marvin & Laurie, 1999; Nickson, 2001). According to World Health Organization, I&SSWPs may provide water that may be inadequately treated or transport the water in inappropriate containers which has the potential of contamination. Households dependent on some of the independent water providers for their water supply are therefore categorised as not having reasonable access to safe drinking water (WHO, 2004). Solo, (1999) reports that some I&SSWPs may provide water at higher prices and therefore those who rely on I&SSWPs tend to pay more. However, because majority of those who rely on I&SSWPs are poor, hence it is the poor households who pay high prices, not only per unit cost but higher in terms of affordability (Whittington et al. 1991; Laurie & Marvin, 1999; The World Bank, 2002; UNDP, 2006). Marvin and Laurie (1999) further suggests that people without access to a formal water supply network usually buy water from private vendors and are also faced with more interruptions implying that those who rely on water supply from I&SSWPs suffer from unreliability or irregularity in supply and its associated problems. They further observe that those using water from the informal sector (I&SSWPs) therefore generally suffer substantial economic, health, social and environmental costs of low quality, expensive and uncertain water supply.
Innovative approaches are needed that will promote and maximise the contribution of all players including, where appropriate, I&SSWPs, which in the literature are suggested as reaching the population un-served or inadequately served by official water utilities. Hence there is a significant gap between water sector policy and actual practices on the ground. However, when the role played by I&SSWPs is better understood, problematic aspects of their service provision can be identified and minimised, and any benefits provided maximised to the advantage of the consumers.

This research was conducted in Kisumu Kenya and Addis Ababa in Ethiopia as part of a larger project (F/00 242/F), funded by the Levehulme Trust, with the overall objective of establishment of legal frameworks for independent water providers. The two study sites were chosen based on their different legal systems. However, as further shown below under background to the case study areas, there are water supply gaps not met by the official water utilities in both case studies that are expected to be met by I&SSWPs thus making them suitable area for the study to examine water supply by I&SSWPs and the need to integrate them into the formal water supply as a means of improving water provision. While this research focuses on two contrasting case studies, Kisumu in Kenya and Addis Ababa in Ethiopia, the findings, should be broadly applicable to other countries in which I&SSWPs play a significant role in the water sector. Furthermore ongoing debates and research on water provision have mainly concentrated on the role of public utilities and large-scale privatisation to the exclusion of I&SSWPs. This research, by explicitly focusing on the role of I&SSWPs will contribute to balancing and expanding this debate.

1.2 Background on the case study areas

As already mentioned in section 1.1, two case study areas were used as the focus for this research, Kisumu in Kenya and Addis Ababa in Ethiopia.

1.2.1 Kisumu - Kenya

The city of Kisumu is located on the eastern shores of Lake Victoria at the tip of Winam Gulf in the western part of Kenya (Fig.1.1) at an altitude of about 1300 meters above sea level. It covers an area of about 40,000 hectares and is the third largest city in Kenya. The climate shows comparatively small seasonal temperature variations, and is generally hot and humid. Average rainfall is between 1200 and 1400 mm per year, received in two rainy
seasons, with the major rains occurring between March and May and a shorter rainy season around November.

Figure 1.1 Map showing the locations of Kisumu and Addis Ababa
Source: Base map- Modified from Asanya (2007)
The population of Kisumu like those of other cities in developing countries, has grown tremendously from only 400 inhabitants in 1910 (Anyumba 1995) to 50,000 in 1969 and 349,000 in 1999 with a growth rate of 2.6% as per the 1999 national census (CBS, 1999). The 2006 population is estimated at between 500,000 and 650,000 (UN-Habitat 2004). This rapid population increase is attributed to migration, natural increase and the expansion of the municipal boundaries to include peri-urban areas, expanding the municipal area from 19 km$^2$ in 1969 to 297 km$^2$ at present. The town has a mixed economy with only a few industries; agriculture and fishing are the major economic activities. The informal service sector is growing rapidly, but without a proper industrial base, employment opportunities are scarce and unemployment levels high.

1.2.1.1 Water provision in Kisumu: the water supply context
Water provision in Kisumu, as in other urban centres in Kenya, was for along time under the control of the Department of Water and Sewerage within the Kisumu City Council. Under the old arrangement, the domestic water supply was undertaken by the public and local authorities, as well as persons or bodies appointed as water providers by the then Minister for Water Development after consultation with the Water Resources Authority. Until the beginning of the ongoing reforms, the largest water providers were the Ministry of Water Development and the National Water Conservation and Pipeline Corporation (NWCPC). In addition, some municipalities also undertook water provision. By the year 2000, there were ten municipalities licensed to provide water services, among them Kisumu Municipality, through its Water and Sewerage Department. Together the municipal water suppliers in Kenya served about 3.9 million urban dwellers (Ngingi & Macharia, 2006).

For municipalities that were not directly providing water, the NWCPC was responsible for the provision of water services. But the NWCPC also provided bulk water to some municipalities undertaking provision, who in turn supplied their customers. Recently, however, following ongoing major countrywide water sector reforms ushered by Sessional Paper No. 1 of 1999 and the subsequent Water Act of 2002, (GOK, 1999; 2002), the Kisumu Water and Sewerage Company (KIWASCO) was established in 2001 by Kisumu City Council from the previous Water and Sewerage Department and became operational in 2003. KIWASCO is licensed by the Lake Victoria South Water Service Board (LVSWSB) to
provide water. Under the new national arrangement Kenya is divided into seven Water Services Boards (WSBs) as shown in Table 1.1 and Figure 1.2.

Table 1.1 The seven Waters Service Boards in Kenya, number of districts each covers, and area and population each serves

<table>
<thead>
<tr>
<th>Name of WSB</th>
<th>No. of Districts</th>
<th>Area Km²</th>
<th>1999 Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coast</td>
<td>7</td>
<td>82,816</td>
<td>2,487,000</td>
</tr>
<tr>
<td>Nairobi</td>
<td>6</td>
<td>40,130</td>
<td>5,617,000</td>
</tr>
<tr>
<td>Central</td>
<td>13</td>
<td>52,777</td>
<td>5,032,000</td>
</tr>
<tr>
<td>Rift Valley</td>
<td>8</td>
<td>113,771</td>
<td>2,999,000</td>
</tr>
<tr>
<td>Northern</td>
<td>9</td>
<td>244,864</td>
<td>1,703,000</td>
</tr>
<tr>
<td>Lake Victoria North</td>
<td>11</td>
<td>16,977</td>
<td>5,135,000</td>
</tr>
<tr>
<td>Lake Victoria South</td>
<td>16</td>
<td>20,340</td>
<td>5,730,000</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>571,675</td>
<td>28,703,000</td>
</tr>
</tbody>
</table>

Source: WSREB (2008)

Each WSB owns the corresponding water supply system and is also a licensee with respect to the supply of water services within its area of jurisdiction. Kisumu City falls within the area of jurisdiction of LVSWSB. WSB are the legal owners of water and sewerage supply assets within their areas of jurisdiction and therefore has the mandate to plan, develop and expand water and sewerage services. However, the Water Act 2002 prohibits these bodies from being directly involved in the operation of the system, and allows a WSB board to take the responsibility for the provision of services through signing of Service Provision Agreements with Water Service Providers (WSPs). Hence WSPs supply water on behalf of a WSB, enabling the WSB to fulfil its mandate. The Water Act of 2002 thus allows delegation of water provision but it is the WSB that decides whether to provide water services directly or indirectly through an agent. Consequently, KIWASCO is a water service provider licensed by LVSWSB to provide water to Kisumu residents on its behalf. The company (KIWASCO) is almost wholly (99%) owned by Kisumu City Council within whose local boundary it operates. The Act, however, does not state whether a WSB can licence more than one water service provider to serve the same area.

### 1.2.2.2 Availability of piped water supply in Kisumu as a whole

The official water water supply system within Kisumu consists of the official supply system (i.e. tap water) and independent sources. The official water supply has two sources supplying a total of 16,900m³/day: firstly the Kibos River through the Kajulu Waterworks with a

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1 Indicates the water service board within whose jurisdiction Kisumu is found
capacity of 1,800m³/day and secondly the Lake Victoria system with a capacity of 15,100m³/day by 1998.

Figure 1.2 The seven water services boards in Kenya
Source: WASREB (2008)
The overall actual daily water production as at 2007/2008 was estimated to have improved under KIWASCO management to 18,700 m³ with an absolute potential of 21,000 m³ and meets only a third of the current daily water demand estimated at 63,000 m³. Estimated total unaccounted for water (UfW), including leakage was high and currently stands at between 60-67 percent. This suggests that of the current 18,700 m³/day produced only 40% bring revenue to KIWASCO. The distribution network, comprises about 112 km of pipes, but is old, with 81 percent having been laid before 1970 to serve a population of less than 50,000 (Anyumba, 1995). Water leakage was estimated by 1989 to be at 40 percent (JICA, 1998).

By 1998 it was estimated that 60 percent of the city was served with piped water by the then Water and Sewerage Department of Kisumu Municipality. However, only 8 percent of this population had a regular supply, while 34 percent had limited supply and 58 percent were supplied from kiosks (JICA, 1998). Since then, the percentage served has probably declined given that no expansions or improvements have been made despite a continuous increase in population. The average demand has been projected to increase from 29,000 m³ per day in 1998 to 42,000 m³ per day in 2005 (JICA, 1998). The present capacity thus probably meets less than half of the demand. LVWSWB, the asset owner of water infrastructure is currently involved in rehabilitation of the existing water provision system through a Kshs. 430 million loan from the French government which may reduce the high UfW partly caused by the old infrastructure. It is anticipated that the rehabilitation will enable the system produce to its current treatment potential of 21,000 m³/day and also help in reducing UfW lost through leakage in the current old pipes in the system. But even after rehabilitation of the present system, the water production capacity will still be approximately only a third of the demand of 63,000 m³/day and therefore there are plans to move beyond the current rehabilitation and expand the system to enable it meet the current demand. Data on connection from the official utility are shown in Table 1.2.

Currently it is estimated that these connections serve 159,000 (31.8%) of a population projected to reach 500,000 by the 1999 census (CBS, 1999). This may suggest that several areas including those selected for this study are un-served or inadequately served and hence residents have no option but to use other available providers and sources. McGranahan et al. (2006) notes that in most urban centres in Kenya about 60 percent of the urban population, mainly the poor, are supplied by either water kiosks and water vendors or they get water from other polluted sources like streams rather than directly from the pipeline network. This
observation for Kenyan urban centres is confirmed by other studies (Katui-Katua, 2004; Gulyani et al., 2005). The gaps not met by the official water utility in Kisumu are expected to be met by I&SSWPs. Moreover, with poor coverage and a total absence of official supplies in some parts of the city, together with unreliability and irregularity in the areas supplied, a significant proportion of the population of Kisumu is undoubtedly relying on I&SSWPs, making Kisumu a suitable case study area.

<table>
<thead>
<tr>
<th>Type of connection</th>
<th>No. of connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic/individual household connections</td>
<td>6,800</td>
</tr>
<tr>
<td>Business premises</td>
<td>1,500</td>
</tr>
<tr>
<td>Public taps</td>
<td>5</td>
</tr>
<tr>
<td>Individual private kiosks/standpipes</td>
<td>230</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,535</strong></td>
</tr>
</tbody>
</table>

1.2.2 Addis Ababa – Ethiopia

Addis Ababa, the capital city of Ethiopia is located in the central highlands of Ethiopia (Fig. 1.1), covering an area of 530 km² at 2000-2800 m above sea level. It has a hilly topography dissected by valleys, rivers and streams. It experiences a warm but fairly constant air temperature throughout the year, with small variations: 20 to 25 °C during the day and 7 to 11 °C at night. Rainfall averages 1200 mm per year, with the major rains occurring between July and September.

In terms of economy, even though the city has 67% of Ethiopia's industry, this sector accounts for only 13% of the city's economically active population. The biggest employer is the public service sector, which employs 42%, while the informal sector employs 26%. According to UNDP, 60% of households have incomes below the poverty line, with one-fifth of the total income shared by 63% of the city's population. Informal economic activities by women and children (the population considered to be "economically active" starts from 10 years) form the main source of income for 41% of households belonging to the poorest segment (WSP, 2002).
The population census of 1984 reported a population of 1.4 million, an increase of 60% over a decade and an annual growth rate of 3.8%. Most of this growth is due to in-migration. With an estimated population of 2.7 million inhabitants by 2002, Addis Ababa accounted for about 30% of the total urban population of Ethiopia. By 2020, this population is expected to increase to nearly 6.5 million. The increase will place enormous pressure on public services delivery as the city continues to grow in terms of both number of residents and land area. Already, several sections of the city suffer from poor sanitation and water supply (WSP, 2002).

1.2.2.1 Water provision in Addis Ababa: the water supply context

According to the Ethiopian Constitution and the 1960 Civil Code all natural resources, water included, are publicly owned and provides the formal basis for the role of government in regulating the allocation and utilization of water resources. Before Ethiopia was restructured from a unitary to federal government, a central government authority - the Water Supply and Sanitation Authority (WSSA) - was responsible for water and sanitation. The WSSA was established in 1981, as a division within the Water Resources Commission, the predecessor to the Ministry of Water Resources. With the restructuring of the state, the functions of the WSSA were transferred to the constituent units of the federation (Dessalegn, 1999). Currently, therefore, water supply in Ethiopia is the responsibility of the regional and local governments. The level of government responsible for the supply of water (and sanitation) depends on the constitutions and laws of the regional states but these must be in accordance with the federal laws.

Addis Ababa Water and Sewerage Authority (AAWSA), an autonomous department of the Addis Ababa city government, is in charge of providing water and sewerage services and indeed has a monopoly of official water services. AAWSA is charged with and has an exclusive right of providing water to the whole city with a population given as 2.7 million in 2002 and currently estimated at 3.5 million. The main water resource is surface water. The city has two conventional treatment plants located by the two dams of Gefersa and Legadadi, built in 1960 and 1970 respectively, and together supplying drinking water through the piped network. These two reservoirs were projected to be adequate to serve the needs of Addis Ababa up to 1992; however, they produce less than their design capacity and water leakage is high, estimated at 36% (Shewaye & Adam, 1999). The total production is estimated at a total of about 173,000m³/day. The city is also increasingly relying on ground water sources.
in a bid to close the supply-demand gap and meet future demand with the Akaki well fields producing about 30,000m³/day and springs and boreholes 10,000m³/day. It is estimated that an additional 200,000m³/day is required to meet current demand. Some 97.5% of the city’s residents are believed to have some form of access to piped water. But only 26.8% have private water connections (with 4.4% having tap water inside the house). The rest rely on shared taps or obtain their drinking water from outside their compounds. Still other residents of Addis Ababa are thought to rely on unprotected wells or springs, rivers, lakes or ponds (Shewaye & Adam, 1999). It is believed that over 45% of residents depend on taps outside their immediate compounds. Therefore informal water provision/vending may be a required source of water for those without own connections (UNCHS-Habitat, 2000). Thus alternative providers play a critical role in water supply in Addis Ababa. Table 1.3 provides summary of some operational aspects of AAWSA.

Table 1.3 A summary of AAWSA’s operation (2008)

<table>
<thead>
<tr>
<th>Date established</th>
<th>Department under municipality 1942 Established as autonomous public utility 1971 Established as supply and provision of waste water and sludge disposal 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services provided</td>
<td>Responsible for water and sewerage</td>
</tr>
<tr>
<td>Type of utility</td>
<td>Autonomous Public Authority –water 1995</td>
</tr>
<tr>
<td>Coverage level</td>
<td>63 percent</td>
</tr>
<tr>
<td>Population living below poverty line</td>
<td>60</td>
</tr>
<tr>
<td>No. of water connections</td>
<td>200,000</td>
</tr>
<tr>
<td>Non revenue water</td>
<td>37 percent</td>
</tr>
</tbody>
</table>

1.3 Overall aim
The main focus of this PhD is to examine water supply provision by I&SSWPs and assess the need for incorporating their services into the formal water supply as a means of improving water provision for the benefit of both consumers and I&SSWPs. The hypothesis to be tested is that:

*Independent and small scale water providers need to be integrated into the formal water supply system as a means of moving towards improved water provision.*
1.3.1 Research objectives and research questions

In the context of the two case study areas, Kisumu in Kenya and Addis Ababa in Ethiopia, this research has the following objectives and questions aimed at testing the stated hypothesis:

O1. to determine current water supply sources and quantify the proportions of water supply provision from different sources, including, the formal water supply system, independent providers, private sources, and any other sources;

O2. examine water usage, costs and rank water use in household budgets: namely,
- for what purposes is the water from the various sources used?;
- what factors influence households’ choice of water sources and/or suppliers and usage of water from different sources;
- what are the water costs and how can the costs be reduced?;

O3. Analyse business models used by independent water providers to deliver water to consumers and undertake an economic assessment of their businesses and customers: namely,
- what business models are used by I&SSWPs to supply water?, and
- What is the socio-economic status of customers of I&SSWPs?

O4. to measure the quality of water and water quality variation (both chemical and microbial) from the main sources, including water supplied by I&SSWPs throughout the supply chain to point-of-use: that is
- what is the water quality of the various sources including I&SSWPS sources?
- what is the perception of water quality from the various sources, and how does such perception affect water usage? and
- how can the quality of water provided by I&SSWPs be improved?

O5. to investigate how I&SSWPs and the services they provide are perceived with regard to their role as suppliers of potable water by users and other key stakeholders.
1.3.2 The structure of the thesis

In order to examine water supply provision by I&SSWPs as a possible means of improving general water service provision in urban centres of developing countries, this thesis will examine water supply in urban centres of developing countries, using two cases studies from a number of perspectives. Chapter 2 provides an overview of water supply provision in urban centres of developing countries, providing a framework for understanding the emergence of I&SSWPs as well as the role they play in domestic water supply. It covers the importance of water supply and approaches hitherto used in supplying water. It highlights the challenges of each approach and the gaps that still exist. Chapter 3 explores the literature on existing practices around the world, including perceptions of I&SSWPs and their ability to meet water supply needs, thus providing insights into the nature of I&SSWPs, the various categories that exist, how they are perceived, and their importance in the provision of water supply in developing countries in general. Chapter 4 looks at indicators of water supply in relation to water supply provision by I&SSWPs. It highlights on the indicators that need to be considered in examining water provision by I&SSWPs. Chapter 5 outlines the methodology of the present study encompassing household water usage survey, interviews, focus group discussions, observations workshops and water quality monitoring. Methods used in data analysis are presented.

Chapter 6 presents data on sources of water and various water supply indicators gathered from the household water usage study in the case studies, and determines the extent to which households rely on I&SSWPs. Water quality monitoring results from the various sources used by households including those of I&SSWPs are also presented.

Chapter 7 presents results on detailed analysis of I&SSWPs from the case study area and ascertains the extent to which I&SSWPs are involved in domestic water supply provision in the case study areas. Chapter 8 draws upon the information in the preceding chapters and discusses water supply situation in the context of various indicators of water supply in the case study areas and the role played by I&SSWPs in the overall supply of water. Chapter 9 presents conclusion and recommendations.
Chapter 2 Water supply provision in developing countries

2.1 Introduction
An understanding of water supply provision in urban centres of developing countries is necessary as a basis for understanding the role of I&SSWPs. This chapter examines the current domestic water supply situation in urban centres of developing countries. Section 2.2 discusses current approaches to domestic water supply provision including public water utilities, private sector participation and community management, highlighting the problems and challenges of each approach. Section 2.3 discusses the water provision gap that still exists today, the disadvantaged position of the poor with regard to water supply, the impacts of poor water supply and the link between water supply and health. Conclusion is presented in section 2.4.

2.2 Approaches used and the challenges faced in meeting water supply needs in urban areas of developing countries
At independence, many developing countries chose to provide services such as water supply through government offices or public enterprises. However, from the 1990s, the international community and donor agencies have promoted other approaches. This section highlights the approaches used, together with the challenges and problems encountered.

2.2.1 Public water utilities
In many developing countries, water supply has for a long time been monopolized by central government through official public water supply utilities (Collignon & Vezina, 2000). In most cases, the model followed is that of a single operator charged with water supply and wastewater removal for all settlements, even for the characteristically very heterogeneous urban centres (Troyano, 1999; Solo, 1998). Historically, therefore, the delivery of water services in developing countries was largely seen as a public service. The official public water utilities have, however, been slow in extending services, as is evidenced by the large number of people that still lack access to safe drinking water.

Various reasons have been put forward to explain this slow expansion and the apparent failure of public water utilities. A shortage of capital springing from inadequate resources to
cover operational and maintenance costs and leading to a tendency towards underinvestment in expansion has often been blamed (Howard, 2001; Estache & Kouasi, 2002; The World Bank, 2004). Another commonly cited reason is the rapidly expanding urban population (mainly due to migration, though natural increase may also be important). Rapid growth in population leads to an increased demand for services and pressure on public utilities to provide adequate infrastructure, including urban water and sanitation infrastructure. However, Collignon and Vezina (2000) have also observed that rapid population growth is often accompanied by an absence of clear public policies to deal with urban growth together with a lack of any clear strategy for extending infrastructure and developing new land. When population growth is not accompanied by expansion in service provision, deterioration of access is often the result (Drangert et al., 2002).

Some studies suggest that inefficiency and technical failure leading for example to high unaccounted-for-water (UfW) and unpaid bills have also contributed to the poor performance of public utilities (Estache & Kousai, 2002; Harris, 2003). Technical problems encompassing both design and operational weaknesses, among them reliance on conventional treatment, have brought sustainability problems, since the cost of imported chemical coagulants such as aluminium sulphate often tends to be high. Thus the widely used coagulation-flocculation settling process may be bypassed constantly or on a regular basis, (as for example in Uganda, Ghana and Zimbabwe; Howard, 2001), while dosing of coagulant in smaller facilities is rarely done efficiently, leading to substandard treated water (WHO & UNICEF, 2000). Howard (2001) further observes that in other cases due attention is not given to changes in influent turbidity or flow rate while drip feeding coagulant into settler tanks, again leading to poor quality water. In cases where rapid sand filtration and chlorination are the main methods relied on for producing water of adequate quality, failures are frequent due to the high cost of chlorine (The World Bank, 1993; 2004).

Some problems leading to poor water supply by official public utilities are related to the infrastructure age and lack of maintenance. Poor operation and maintenance, often manifested in leakages, is a common problem usually resulting in high UfW and is compounded for example by absence or lack of frequent routine cleaning of service reservoirs. Reported cases of discontinuity are frequent, resulting in unreliable supply forcing people to store water or use other sources, often of poor quality. In addition, lack of
metering leads to inaccurate measurements of leakage rates, which makes it difficult to obtain correct billings and to ensure that water is produced efficiently (Howard, 2001).

Poor financial and commercial management also contribute to poor water supply (Estache & Kouasi, 2002; Harris, 2003). Nixon (1997) observed that for most public water utilities both revenue collection and services are very poor. This makes it difficult to prioritize improvement since an improvement in revenue collection that would lead to consolidation of resources for further investment is constrained by a perceived poor service. Any attempt at increasing tariffs or improving collection may lead to consumers withdrawing from the service. Drangert et al. (2002) point out that poor management and collection of revenue result in a poorly functioning infrastructure and no investments in expansion.

Mismanagement manifested in areas such as diversion of revenues [including foreign aid] to other activities, corruption by employees and overstaffing have also been blamed for poor performance of public utilities (The World Bank, 1993; 2004; Cotton & Taylor, 1994; Laurie & Marvin 1999; Estache & Kouasi, 2002; Harris, 2003). While in some countries the perception of inadequate and corrupt public services may be accurate, some studies show that alternative efforts have not resulted in any noticeable improvements (Budds & McGranahan, 2003; Gulyani et al., 2005).

2.2.2 Private sector participation

As part of an attempt to deal with the failure of the official public water utilities, multilateral financial institutions and bilateral development agencies have facilitated the commercialization of public water utilities, often known as privatization or private sector participation (PSP). This is typically thought of as a more efficient approach to water service provision with better ability to recover costs from consumers. Pitman (2002) reports that privatisation has also aimed to leverage the much-needed funds for investment in the water sector. Proponents of PSP in water supply have argued that with over one billion people lacking access to safe and sufficient water supplies (WHO, 2000), PSP is a vital means of improving water delivery to the poor (Nickson & Franceys, 2003; Cross & Morel, 2005). Specifically, through efficiency gains, improved management, and better access to finance than public utilities, it was envisaged that PSP would improve performance (including cost-recovery rates) and increase access by extending networks and providing new connections to
previously un-served customers. This, it was thought, would particularly benefit the poor in urban areas, who are often un-served, poorly served or served by a variety of informal arrangements and thus typically pay much higher prices per unit volume for poorer quality water than wealthier consumers (Johnstone & Wood, 2001; Shirley, 2002; World Bank, 1994, 1997, 2004; Bakker, 2007).

Some reviews of PSP performance have suggested that newly privatized water firms are more efficient, invest in more infrastructure and provide better quality services, resulting for example in reductions in child mortality of about 5-7 percent (Hazzin, 2001; Giliani et al., 2002; Giliani et al., 2005). The largest gains are reported to be among the poorest populations; for example in Argentina (Giliani et al., 2005). Assessing the World Bank water resources strategy, Pitman (2002) also reports that privatization of municipal water supplies in Africa and in Latin America and the Caribbean has achieved greater coverage at no public cost, and that in the few cases where failure occurred; poor governance could have been the main cause. But the report by Pitman (2002) also acknowledges that the poor and peri-urban areas which posed a challenge before privatisation remain the biggest service challenge to both public and private sector utilities implying that poverty in low income areas may have been one of the causes of unsatisfactory performance of privatization programmes. Other studies, for example Briscoe (1996) and Sharma et al. (1996), have indicated that private sector delivery of water supply services is more effective, although we should note that both studies are from the World Bank who actively promoted PSP. Some studies, however, suggest that there is inadequate evidence of improvement in water supply under PSP (Gutierrez et al., 2003; Hukka & Katko 2003; Budds & McGranahan (2003 p. 89) categorically assert that: “despite being vigorously promoted […], privatization has achieved neither the scale nor benefits anticipated”. Other more recent comprehensive reviews of privatisation report that only five percent of the world’s population are served by the large private water utilities (Davis, 2005; Anand, 2006; Bakker, 2007).

The move to PSP - peaking in 1997 and declining since – may perhaps have been too rapid (Harris, 2003). Several arguments have been proposed for the little -if any- improvement in water supply through PSP. Political conflict and resistance from civil society (which views water as a public good that should not be privatised), seem to have undermined private sector involvement. The civil society opposition calls for the management of water as a common resource, arguing that private sector control is not ethically appropriate. This has
resulted, for example, in cancellation of contracts by governments (e.g. La Paz and Cochabamba), or decisions leading to private sector withdrawal (e.g. Manila) (Nickson & Vargas, 2002; Bond, 2005).

Macro-economic crises (financial and resource constraints) and difficulty in sustaining cost-covering user fees may also have contributed to unsatisfactory performance by the large private companies. In addition, lack of efficient and well run urban government may have played a part in the slow progress of private sector involvement in urban water service provision and thus resulted in poor performance (Cotton & Taylor, 1994). Solo (1998) further suggests that in some cases when public authorities decide to privatize a public utility derailed by diverse problems, the tendency has been to pass the utility undivided to single operator; thus the problems of the public utility are perpetuated despite its transformation into a private company. As a result, the study notes that such private companies tend to be as bureaucratic and as inefficient as their predecessors.

Other reasons put forward for poor performance by PSPs relate to the motives behind private sector promotion. Budds and McGranahan (2003) argues that the promotion of privatisation has been based not on experiences in the water and sanitation sector but rather on international political trends and policy shifts in the international development arena, especially those of international financial institutions. Since the 1970s these institutions have promoted the international free market economy. It is therefore suggested that the underlying interests of some of the actors directly concerned, including market expansion for multinational water companies and the perceived need to cut back jobs in the public sector may have fuelled the trend towards privatisation of water provision (Laurie & Marvin, 1999; Hardoy & Schuterman, 2000; Harris, 2003; Budds & McGranahan, 2003).

Some studies suggest that the lack of success in improvement in water supply through the involvement of large-scale private sector companies may also be explained by the nature of the private sector itself, i.e. that private companies do business for profit (Budds & McGranahan, 2003). Studies challenging privatisation as a means of improving access to water supply argue that it is not a reliable mechanism for supplying water services to the poor because private companies are unable to supply the poor on profitable terms (Bakker, 2007). PSP, therefore, tends to select attractive locations, whether on a regional, country or neighbourhood level, while poorer regions, countries and neighbourhoods are avoided. The
profit motive of the private sector is seen as compromising access to water as a basic human right, and harms the welfare of the poor (critics point to the withdrawal of the private sector from certain contracts and certain regions of the world, in light of unacceptably high risk-return ratios) (Smith, 2002; Hukka & Katko, 2003), in part because of the low ability to pay of poor consumers. These claims have been confirmed by some water supply service firms and multilateral financial institutions. For example, in a study of provision of urban services to the poor by the private sector, the Asian Development Bank states that "the private sector is not willing or able to solve the problems of un-served areas on its own" (ADB, 2003, p 56). Furthermore, according to a World Bank data base on infrastructure, 75 percent of contracts for water privatisation in Latin America and the Caribbean had either been renegotiated or cancelled by 2002 (Gómez-Ibáñez et al., 2004). Bakker (2007) reports that discourse analysis of public statements of senior executives of water supply service firms reveals they are backing away from earlier commitments to pursuing PSP globally, with senior figures publicly acknowledging high risks and low profitability in supplying the poor. Britain's influential economic weekly The Economist reported to have warned of a 'retreat of the private sector' from water supply in developing countries (The Economist, 2004).

In a review of PSP performance, Davis (2005) reports that where privatization has occurred, challenges still persist regarding ensuring access to and affordability of services for low-income households. The study concludes that PSP will probably not benefit the majority of the over one billion people who lack access to improved water supply and live in the poorest countries. In another review of the performance of privatization in Jakarta over the period 1989-2005, Bakker (2007) concludes that new connections were preferentially targeted at middle-and upper-income households as opposed to the poor, showing that the Jakarta private sector involvement, like others, has not been pro-poor. Therefore, it is likely that the belief behind privatisation - that international profit-seeking companies would invest their capital in heavy infrastructure and maintain it to provide water for poor households who cannot afford to pay either capital or running costs - could have been misconceived (Budds & McGranahan, 2003). The low income levels in many cities in developing countries, which makes them unable to afford tariffs high enough to generate adequate returns for private sector operation, together with the very poor present state of water utilities has made the
large multinational companies\(^2\) that dominate the private water sector reluctant to invest in these markets (Carter & Danert, 2003; Budds & McGranahan, 2003; Anand, 2006). Moreover, many who have tried are withdrawing after years of arguably contributing to, rather than alleviating, the water crisis (Gueri, 2007; Bakker, 2007).

Even though large-scale private utilities can still provide water, including in disputed informal and low income settlements, they do so at a price and under conditions that justify such risks. Often, the cost of water increases and becomes unaffordable to the poor (Budds & McGranahan, 2003; Davis, 2005), favouring the public perception that privatization hurts the poor and thus creating an obstacle to privatization, despite evidence that privatization may be beneficial in reducing health inequality (Giliani et al., 2002). Where critics agree, in principle, to the management of water by the private sector, there are still arguments that political conflict over the socio-economic identity of water raises risks and reduces the likelihood of the private sector being able to supply the poor on a profitable basis.

Consequently, concerns have been raised that the contribution of large private-sector companies to improving access to water will be relatively limited (Davis 2005; Bakker, 2007). In response, a discussion has arisen among consumers, governments, donors, and private water companies about how best to implement a ‘pro-poor’ agenda. Several suggestions have been put forward not only on how the performance of official utilities (whether private or public) can be enhanced in general, but also on how their services can be made more sensitive to the needs of the poor (Hardoy & Schuterman, 1999; Budds & McGranahan, 2003; Franceys & Weitz, 2003; McGranahan et al., 2006; Bakker, 2007).

As the foregoing shows, the role and appropriateness of the involvement of the large-scale private companies in water provision in urban centres of developing countries has been the subject of a long debate and may continue to be so. However, for a long time this debate has obscured the role played by other providers whose contributions may be particularly relevant in the water and sanitation sector in those areas in which the majority of those un-served or poorly served by the official utilities live. Cairncross (1990) and Nixon (1997) suggest that provided good management practices are followed, water suppliers, whether public or

\(^2\) The international private water sector is dominated by five large multinational corporations. Three are from France (Suez, Veolia and Saur), one from Germany (Thames water) and one from Spain (Aquas de Barcelona). See e.g. Budds & McGranahan (2003:103) and Bayliss (2003)
private sector, can be effective. However, if the focus remains only on conventional large-scale water and sewerage networks operated by official public utilities or private water companies, only a few of those without access to safe drinking water will be reached, especially in sub-Saharan Africa (Estache, 2005). This is partly because some of the barriers to water service provision, especially among the poor, persist regardless of whether the large scale water and sanitation providers are public or private (Budds & McGranahan, 2003). According to (Budds & McGranahan, 2003: 106), “sub-Saharan African countries have in general been unable to attract companies that are willing to invest in the region, as it is regarded as too risky”.

2.2.2.1 The nature and forms of private sector participation in water supply

Private sector participation in water supply has taken many forms, as briefly discussed below and summarised in Table 2.1. The categories differ primarily in the extent to which responsibility for capital investment and the burden of commercial risk are shifted from the public to the private sector.

The first categories involve “light” forms of privatisation or public private partnerships (PPP) and are usually pursued as cost-cutting measures by local or state governments. These include outsourcing of individual tasks (e.g. billing and collection, water quality testing) through a service contract on a fee-for-service basis. A more comprehensive form of contracting out is a management contract. This may involve most or all of an agency’s operations and shifts operational decision-making to the private sector. As an encouragement for the private firm to improve efficiencies, payment in some cases may be coupled to performance. In service and management contracts, responsibility for capital investment and commercial risk as well as ownership of assets remains with the public sector and not the private firm (Owen, 2003; Davis, 2003; 2005).

Another form of PSP involvement is through lease agreements, where the firm assumes full responsibility for the operation and maintenance of a given set of water and sanitation infrastructures (e.g. distribution network) for a specific period of time typically 10 to 15 years. Government retains responsibility for major capital investments such as system
rehabilitation and extension, but the firm agrees to bear at least part of the risk associated with day-to-day operation of the system (Davis, 2005).

Table 2.1 Forms of private-sector participation

<table>
<thead>
<tr>
<th>Type of PSP arrangement</th>
<th>Asset ownership</th>
<th>Responsibility for capital investment</th>
<th>Commercial risk</th>
<th>Illustrative case examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service or management contract</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Chennai, India (sewage pumping stations), Santiago, Chile (computer and engineering services), Trinidad and Tobago (operations and maintenance)</td>
</tr>
<tr>
<td>Lease</td>
<td>Public</td>
<td>Public</td>
<td>Public and private</td>
<td>Lyon and Paris, France Conakry, Guinea Prague, Czech Republic Hawthorne, California</td>
</tr>
<tr>
<td>Concession</td>
<td>Public</td>
<td>Private</td>
<td>Private</td>
<td>Buenos Aires, Argentina Manila, Philippines Abidjan, Cote d’Ivoire La Paz, Bolivia Gabon (national) Sofia, Bulgaria Tangiers, Morocco</td>
</tr>
<tr>
<td>Build-operate-transfer (BOT) and variations</td>
<td>Public and private</td>
<td>Private</td>
<td>Private</td>
<td>Israel (desalination) Australia (water treatment) Malaysia (water treatment) Turkey (wastewater treatment) Seattle, Washington (waste treatment) England Wales Chile (partial)</td>
</tr>
<tr>
<td>Divestiture</td>
<td>Private</td>
<td>Private</td>
<td>Private</td>
<td>England Wales Chile (partial)</td>
</tr>
<tr>
<td>Independent service providers</td>
<td>Public and private</td>
<td>Private</td>
<td>Private</td>
<td>Aguaterros in Latin America Tanker trunk operators in South Asia Bicycle and cart vendors in sub-Saharan Africa Septic tank emptier(s) in United States and Europe</td>
</tr>
</tbody>
</table>

Source: After Davis (2005)

In a concession the private operator assumes both the responsibility for commercial risk as well as most or all capital investments over a period of time (usually much longer than a lease, typically 20 to 30 years). This longer period allows the private firm the opportunity to

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3 Independent service providers are the subject of this research and are discussed in Chapter 3
recover its investments. But as with leases, asset ownership remains in public hands and the government must therefore establish contractual standards to ensure that the private firm transfers the infrastructure back to the public sector in good condition at the end of the concession period (Owen, 2005; Davis, 2003; 2005).

In build operate transfer (BOT) agreements and their variations (e.g. design-build-operate, build-own-operate, rehabilitate-operate-transfer), the burden of infrastructure investment for rehabilitation or construction of an asset shifts to the private sector. Typically BOT-type contracts are restricted to a single facility e.g. a reservoir or a waste water treatment plant and to sector management. Divestiture refers to the sale or transfer of assets, along with responsibility for their operation, to a private firm with the state retaining only regulatory functions. This is uncommon except in the UK. Some authors suggest that full privatisation as a way to reform water sector is undesirable and unnecessary (Bayliss, 2003). However, there is also partial divestiture, for example in Chile, where a controlling stake in an agency is sold to private interests, while the remaining shares are divided between company employees and the government, (Owen, 2005; Davis, 2005).

2.2.3 Other approaches to water supply: community management

In view of the challenges and problems faced by public and private water utilities, there is increasing acknowledgement that more flexible approaches may be vital for provision of water supply for urban populations in developing countries (World Bank, 1993; Samson et al., 2000). Community management of infrastructure or beneficiary participation based on decentralised participatory approaches is another method that has been proposed and tried with a number of successes in some areas. These approaches have their roots in diverse self-help initiatives that have arisen more or less spontaneously in marginal settlements with little or no infrastructure. In these areas communities have organised, through self-help and local governance by neighbourhood associations, to fill the gaps in infrastructure services left by the centralised institutions. Such community groups mobilise and organise fund-raising, mutual self help and external technical assistance to provide water supply and other services (Cotton & Taylor, 1994; Kyessi, 2005). Mitlin & Thompson (1995) observed that community participation works particularly well in developing countries, since a tradition of community-based approaches to development already exists not only in rural communities but even in urban centres.
Several studies document how poor urban communities have participated in water supply and management leading to improvement in water supply services (Singha, 1996; Subramanian et al., 1997; McCommon et al., 1998; Gomez & Nakat, 2002; Kyessi, 2005; Akbar et al., 2007). Khurana (2001) reports that community-based water management has played a role in reducing water shortage and proposes that this alternative water management should be taken forward into mainstream water management. Other studies suggest that involving users in water supply results in sustainability of services, as the services are likely to reflect user demands (World Bank, 1993; Cotton & Taylor, 1994; Franceys & Weitz, 2003). Cotton & Taylor (1994) reported community participation in contract management and procurement of services from the private sector that successfully met the water supply needs of the poor and resulted in sustainability in the provision of water services.

Shingha (1996) and Subramanian et al. (1997) observed that some poor urban communities have participated in the introduction of water points (like public taps) that are community owned and managed, that cater for community needs, and for which residents pay the development, operation and maintenance costs. In addition, residents have participated in the establishment of alternative administrative structures in the form of water users associations for delivery of water services. Informal communities have also been reported to have the capacity to operate and maintain small-scale water supply systems, cooperate with official water utilities and Non Governmental Organisations (NGOs) for the development of water points, and to help system providers with system development. Further examples of community involvement are found in participation in bulk purchase and distribution of water from the official utility (McCommon et al., 1998), as well as improvement of point sources as a temporary solution to water supply problems (Howard et al., 2001a).

The reviews above provide some evidence of the various potential ways in which communities in poorly serviced areas have been involved in planning, development and operation of water points and thereby ensuring accessibility to water as well as sustainability of the water supply system. Some studies have therefore proposed the need to develop a legal and institutional framework to empower communities (Khurana, 2001). However, the feasibility of community management of water supplies as a long-term solution to water service provision in urban areas has raised concerns (Feachem, 1980; White, 1981). Bond (2005) points out that where there are no effective neighbourhood governing structures - as common in many urban neighbourhoods in developing countries - community ownership is
not sufficient to ensure community maintenance. In agreement with this observation, Akbar et al., (2007) observed that community-maintained water supply infrastructure and services often deteriorate very fast as a result of failure to operate the water points properly. Deficiency in maintaining discipline with respect to water distribution is also common, resulting, for example, in people having to wait for a long time to collect water at certain times of the day. In other cases the water price is too high, such that some of the poorest of the poor cannot afford water provided under this approach. Hence other studies have suggested that community management should only be a temporary solution (Carter et al., 1993) or a transitory step to improving water supply (WHO, 2006).

As shown in this section, different approaches are therefore available and have been adopted or can be used in different set-ups with the aim of improving access to water supply. However, even though the different approaches as discussed above have been promoted and used to different extents in different areas to improve access to safe water supply, it is clear that a large number of people living in developing countries (including those in urban areas) are not reached through these approaches, and either still lack access to water supply or get water from other sources. Furthermore, though there are indications that poor management practices and policies could be the cause, there is significant disagreement over the most appropriate approaches to be taken to address these problems.

2.3 The water provision gap in urban centres in developing countries

Official water utilities - whether public or private - operating in many urban centres in developing countries often have exclusive rights, and are under contract to provide water to all the population. While in theory the basis for awarding this monopoly - that of preventing other operators from taking advantage of the utilities best customers because of their universal service obligation - may appear acceptable (Valfrey-Visser et al., 2006), the literature shows that the utilities often serve only a fraction of the urban population (Solo, 1998; Collignon & Vezina, 2000). Consequently many urban residents are not served and have no access to piped water supply and get water from other sources and providers.

Studies suggest that even where water supply by an official utility exists, the provision is often seriously deficient. Among those reached, the service in general tends to be poor and is
marked by major problems of availability, inadequacy, irregularity/unreliability and poor quality (Howard, 2001; WHO & UNICEF, 2005). Gulyani et al. (2005), using three of what they considered the most basic and important water service variables (quantity, time spent in collection and price) found that even those connected to official water utilities were served poorly, using little water and paying highly for it. Tremolet (2002), in a review of SODECI (a private operator in Senegal), reported that a third of production centres it owned no longer met water quality guidelines set by the WHO, but that the government had not applied any sanction to SODECI for failing to meet its contractual obligations.

According to some studies official utilities often tend to focus on the most profitable wealthy areas, and ignore low-income areas (Budds & McGranahan, 2003; Davis 2005; Bakker, 2007). A piped water connection to households is often available only to a minority of the population, mostly those with high income. Ironically, this privileged minority also benefits from lower water costs arising from economies of scale, or in some countries cross-subsidies (McIntosh, 2003; Kyessi, 2005).

Other studies further report evidence that the majority of those not served by official water utilities tend to be poor. UN-Habitat (2003; 2007) reported that over half of the people living in large cities of developing countries are not only poor but also lack potable water supply. Studies in Port-au-Prince in Haiti and Jakarta in Indonesia (Fass, 1988), and in Onitsha, Nigeria (Whittington et al., 1999), likewise indicated that the majority of those not served are poor. Collignon & Vezina (2000) further observed that 75 percent of poor urban households in the ten African cities they studied get their water from providers other than the official utilities. Howard (2001, p. 483) notes that “it is overwhelmingly the poor who most lack access to water supplies that are of good quality and close to their homes and who suffer most from outbreaks of infectious diseases related to a lack of access to water supplies” Gulyani et al. (2005 p.1248) further reports that even where both non-poor and poor are all inadequately served, the poor are still much more disproportionately underserved; the poor are “rarely connected directly to the public utility; rely on vending system [...]; buy water by the bucket [...]; pay vendors several times the unit price paid by connected non-poor households [...] and use only a fraction of the amount of water used by those connected to the official network”. The poorest individuals typically live in multi-occupancy tenements or compounds, in informal non-linear settlements posing diverse problems for infrastructure provision (e.g. slums, shanties, unplanned/informal and illegal settlements, flood prone
areas, peri-urban areas) and these types of settlements are typically poorly served (Habitat, 2003; Barbara, 2007).

### 2.3.1 The urban poor and access to water supply

A review of the literature suggests that various factors put the urban poor at a disadvantage as regards accessing potable water from official piped water supply networks so that the poor are the most likely to rely on other water suppliers or sources. The Human Development Report 2006 argues that the crisis in water (and sanitation) is above all a crisis for the poor (UNDP, 2006). It is suggested that because of low income levels, the poor have depressed ability to pay (Habitat, 2003; UNDP, 2006; Barbara, 2007). Anand (2006b) found a positive association between income and water endowment, and reports that most people in the lowest-income group did not have any source of water in their homes.

However, others have suggested that it is the challenge of obtaining an initial network connection, rather than the ability to pay monthly service fees, that prevents many poor households in developing countries from accessing piped water (Whittington, 1998; Whittington et al., 1999). Studies indicate that often the amount of money required for connection, or the aggregated unit costs (which include both the connection charge and the service fee) may be high, sometimes amounting to as much as two months income for a poor household (Fass, 1988; Howard et al., 2002; Kayaga & Franceys, 2007) so that the poor are often unable to pay for connection. In studies conducted in Uganda, it was estimated that in addition to a ‘joining fee’ of USH 125,000 (about US$ 85) for meter installation, further payments are required both for materials to connect to the supply main and to pay for labour to ensure that the connection is done properly and does not leak giving a total cost of USH 6,000,000/00 (US$ 400) (Howard et al., 2002; Kayaga & Franceys, 2007). This is way above the ability-to-pay of poor households, which are often living on less than a dollar a day. In Buenos Aires, payment of an amortized connection fee alone claimed an average of 18% of household income (Davis, 2005).

In addition to high aggregated connection costs, the ways in which charges and payments are made also limits accessibility to water supply by the poor. The poor, it is suggested, have low ability to pay volumetric water rates, and are also often unable to pay bills if this aims at cost recovery (Budds & McGranahan, 2003; Carter & Danert, 2003; Kayaga & Franceys,
2007). But even where water is subsidised, the way in which payment is made puts the system out of reach of poor people, who may want to use little water and pay for it in smaller quantities as it is used (Collignon & Vezina, 2001; Howard et al., 2002). The predominant method of payment is usually monthly billing which requires lump sum payments and hence does not take into account the income patterns of the poor, which tend to be secure only for short periods of time (Howard et al., 2002; Kayaga & Franceys, 2007). Systems of lump sum payments through monthly (or similar) billings, and non-flexibility of monthly payments, often result in non-payment leading to disconnections.

The perception of high connection fees and bills barring poor people from getting connected to water from the official utility may be true in some countries; however, in a comprehensive review of water service provision in ten African cities, Collignon & Vezina (2000) assert that, contrary to popular belief, the poor are actually ‘able’ to pay for piped water supply. However, they prefer to pay lower amount for a lower-quality and a more flexible service. Many poor households may therefore prefer to get water from a neighbour with an individual connection or from other vendors since such a supply may be stopped with immediate notice without negatively jeopardising future access (Howard, 2001). However, it is possible that poor households’ preference for vended water may also reflect ignorance of the very high unit costs of this type of water. Dungumaro (2007) further observes that although most informal dwellers cannot pay the capital or establishment cost of a connection fee by a one-off payment, they have the ability to pay for it through instalments as a service charge alongside the user charge, in addition to being always ready to pay some upfront development fees for the construction of water points.

Other studies (Whittington et al., 2002; Raje et al., 2002; Casey et al., 2006) report that consumers, including the poor, are ‘willing to pay’ (WTP) more for better services. Akbar (2005) and Akbar et al., (2007) further argue that it may be wrong to assume that the urban poor are not ‘able’ or ‘willing to pay’ for water. This is not only because research findings show that poor people are already paying higher rates, but also because even though the poor are not able to pay the large amount of money needed for connection, they generally have ability to pay the user charge. These authors further point out that in many cases it is the existing legislation that does not allow the poor to be directly connected to the formal water supply system, for example because of the insecure tenure in informal settlements. Critics, however, argue that studies which assert that the ability-to-pay and willingness-to-pay of
poor customers are higher than previously thought frequently cite as evidence the higher rates per unit volume paid by poor customers relying on other providers (e.g. Winpenny, 1994; Soto Montes de Oca et al., 2003). Thus, the view that the poor are 'able and willing to pay' may be faulty and the fact that the poor pay high water costs to alternative providers should not be misconstrued as indicating that the poor are necessarily able and willing to pay high prices for water (Merret, 2003; Oxfam International, 2006; Bakker, 2007).

Other reasons put forward by official water utilities for failing to serve the urban poor include the often illegal status of low-income settlements and the transient nature of their residents (Akbar, 2005; Akbar et al, 2007; Kayaga & Franceys, 2007). UN-Habitat, (2003; 2007) confirms that the highest concentration of the urban poor in developing countries tend to be in informal settlements. Many of the poor lack tenure security which makes the official water utilities unwilling or constrained by law to invest in such areas, because doing so may be tantamount to legalizing the settlements. At the same time, because of insecure tenure, the informal dwellers themselves may also be fearful of eviction, and therefore unwilling to spend some of their meagre income on development and improvement of water supply.

Moreover, some of the urban poor often live on difficult terrain, and/or in cramped and unplanned plot lay-outs which make these locations difficult to reach. Costs involved in extending services to poorly planned low-income settlements and a settlement with difficult topography are often very high (Njiru, 2003) and this may discourage official water utilities from supplying water to such areas. Some settlements are located long distances from existing water mains, yet are too poor to create a demand that can sustain heavy infrastructural investments in such areas (Budds & McGranahan, 2003; Njiru, 2003; McGranahan et al., 2006).

Overall, as seen in the foregoing discussion in this section, low water availability may not be the principal reason why potable water is not available to the urban poor. Rather, the main reasons are economic, institutional and political, since there are many cities where there is little or no problem with water availability but where the poor still do not have access to potable water. Cairncross (1990a) and Howard (2001) have suggested that a key impediment to improving water supply service to the poor in developing countries is the notion currently held by service providers and planners that the urban poor are a homogenous group who require single or very restricted options for service improvement. Barbara (2007) argues that
the root cause of exclusion of millions of urban dwellers from formal water supply systems is the long-standing inability of utility and city managers and their advisers to plan and implement systems which respond to the reality of the lives of the urban poor. Barbra (2007) further suggests that current approaches in water provision are not flexible to allow for strategies like regulated vending, licensed on-selling, small-scale network operation and community-managed systems, strategies which could extend utilities’ reach into previously un-served urban spaces.

2.3.2 The impacts of poor water supply
Poor water supply has profound and linked health and socio-economic effects. The health impacts are further discussed in section 2.3.3. In terms of social and economic impacts, poor water supplies necessitates purchase of water from other sources which may be more expensive, thus reducing resources available for other basic needs. In addition, lack of or poor access to water results in time and energy wastage in looking for water, leading to a loss of income earning opportunity which significantly impacts on women by limiting opportunities available to them (Curtis, 1986; Anand, 2006; UN-Habitat, 2008). Time lost in water collection, transportation and storage also significantly impacts on girls who lose opportunities for education (UNDP, 2006; UN-Habitat 2007). Longer-term impacts of missed educational opportunities include exacerbation of inequalities, thus slowing progress towards gender equality which UNDP (2006) highlight as a key perpetuator of poverty and the growing gap between the rich and poor. High costs, poor accessibility and reliability may also result in insufficient quantities of water for household hygiene, or the use of sources of poorer quality which may also lead to spread of water-related diseases (as shown below) and increased burden of diseases. Other social and economic impacts include the costs associated with ill-health, like expenditure on drugs, treatment and care (Howard, 2001).

Other indirect impacts have also been noted. Anand (2006) observes that scarcity of water supply may restrict the functioning of households in several ways. Among others, it imposes restriction on occupational choice for certain members of the family. For instance, where water supply is rationed and there is no certainty as to the hours or times of water supply availability, a member of the household may be forced to stay at or close to home so that they do not miss out when water is delivered. A reliable supply of water is therefore an
indirect but crucial factor needed for individuals to engage in productive urban livelihood activities (Kyessi, 2005).

2.3.3 The interaction between water supply and health
Safe potable water is generally defined as water having acceptable quality in terms of its physical, chemical, and microbiological parameters so that it can be safely used for drinking and cooking (WHO, 2004). It is now broadly recognised that such safe drinking water should be free from pathogenic (disease-causing) micro-organisms; should meet standard guidelines for taste, odour, appearance and chemical concentrations; and should be available in adequate quantities for domestic purposes. Quality and quantity of drinking water is therefore of concern to consumers, water suppliers, regulators and public health authorities. Microbiological quality of drinking water is of particular concern because of the potential of drinking water to transport microbiological pathogens to great numbers of people resulting into various illnesses. But high levels of chemical contaminants like nitrate and fluoride among others may also be toxic and may lead to a cute and chronic illness (WHO, 1993).

Even though the impacts of drinking water on human health were not then fully understood, the tremendous improvements in water supplies currently enjoyed in the developed countries were to a great extent introduced in the 19th century mainly as a response to epidemics of cholera, typhoid and dysentery. Furthermore the development of a ‘sanitary concept’ acknowledged that water and access to water supplies are important for health (Howard, 2002). Recent research further suggests that improvements in water quality led to a rapid decline in child mortality in the US in the early twentieth century (Cutler & Miller, 2005). Presently, however, despite increased scientific understanding of the relationship between water and health, a similar ‘sanitary concept’ approach to improvement in water supply is not often seen in developing countries. Large-scale investments in piped water infrastructure as happened in the developed countries have been largely thought of as infeasible in poor countries, thus the need to search for complimentary and workable alternatives.

Notwithstanding these concerns as well as increased scientific understanding of the relationship between water and health, water supplies in developing countries are not only inadequate, but the source supplies used are often devoid of protection or treatment. Where the sources of water supply are unprotected, they become susceptible to external
contamination from surface runoff, windblown debris, human and animal faecal pollution and sometimes unsanitary collection methods (Chadevaenzi et al., 1998; WHO, 2000). A significant source of pollution for the main sources of drinking water in developing countries is domestic sewage (WHO, 2004). Even though proper management of excreta acts as a primary barrier to prevent the spread of pathogens in the environment, the problem of excreta disposal has persisted. It is estimated that nearly 2500 million people in developing countries lack an adequate system for disposing of their faeces, thereby threatening not only household hygiene, but also water sources such as wells, tanks and reservoirs (Ashbolt, 2004; Pandey, 2006). Faeces has been reported as the most common pollutant of potable water and studies indicate that in many water sources the levels of thermotolerant coliforms (the indicator organism for faecal contamination) consistently exceed internationally accepted standards, including WHO Guidelines for Drinking Water Quality (Pandey, 2006).

The use of such water is suggested to be the chief cause of some important human diseases. For decision making purposes, four broad categories of diseases related to water have been identified. Table 2.2 gives a summary of the main diseases and their transmission routes.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Transmission route</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Water-borne    | Pathogens are ingested in drinking water | • Diarrhoeal diseases  
|                 |                     | • Enteric fevers such as typhoid  
|                 |                     | • Hepatitis A |
| Water-washed   | Result from having insufficient water for bathing and hygiene purposes | • Diarrhoeal diseases  
|                 | Pathogens are incidentally ingested in the course of other activities | • Trachoma  
|                 |                     | • Scabies |
| Water-based    | Caused by repeated physical contact with contaminated water, transmission occurs via an aquatic invertebrate host | • Guinea worm  
|                 |                     | • Schistosomiasis |
| Water-related  | Transmission occurs via an insect vector which breeds in or near water | • Malaria (parasite)  
| Insect vector  |                     | and yellow fever (virus) |

Sources: White et al. (1972); Bradley (1977); Feachem et al. (1993); Howard (2002b); Caincross and Valdmanis (2006)
Drinking and bathing in polluted water supplies are amongst the most common routes for the spread of infectious disease, and nearly half of the world’s population suffers from water-related diseases. Use of contaminated drinking water can create serious problems in human health and the WHO (1993) notes that despite lack of data on the exact relationship between use of water from untreated sources and disease, there is evidence that water containing indices of faecal pollution remains the principal cause of disease in developing countries.

Apart from untreated water sources, studies also show that water that is not properly treated can lead to health problems. A study done in France by Collin et al. (1991) on gastrointestinal illnesses associated with consumption of tap water reported five epidemics associated with poorly treated water, though they did not address the endemic levels of gastrointestinal diseases. The same study reported a relationship between faecal streptococci and acute gastrointestinal disease in a study of 64 villages. Another study investigated the effect of chlorination on water that did not meet microbiological standards, and found that, even after chlorination, children from villages where there was evidence of faecal pollution in water supplies had 1.4 times more frequent occurrence of diarrhoea (Zmirou et al., 1995).

Other studies in developed countries have also suggested that even drinking water meeting current regulations could still be of health concern (Payment et al. 1991; 1997; Mackenzie et al., 1994; Morris et al., 1996).

Contaminated drinking water (and poor sanitation) account for a large part of the burden of diseases and mortality in developing countries, and is the second most important risk factor in terms of the global burden of disease after malnutrition (Gadgil, 1989; WHO, 1993; Pandey, 2006). Some 5-10 million deaths annually are attributed to diseases (Zeid, 1998) caused by ingestion of water contaminated with pathogens or toxic chemicals, or use of insufficient amounts of water for personal hygiene. DeZuane (1997) estimated that annually about 28 million disease episodes in developing countries are caused by 10 major waterborne diseases, while the WHO (2004b) estimates that diseases related to unsafe drinking water are responsible for 5 million deaths annually, with the worst impact falling on children. Diarrhoeal diseases including cholera cause the death of 1.8 million people annually, 90 percent under 5 years and mostly in developing countries. Indeed diarrhoea alone, a disease associated with dirty water, is the biggest killer of children under five in poor countries, resulting in many preventable deaths every year (World Bank, 1993; WHO, 2004). Children who drink contaminated water or live in unsanitary conditions are reported
to be sick more often and more seriously; many may die from water and sanitation-related diseases including cholera and malaria, which are amongst the largest killers, but even those who do survive lag behind others in growth and development. The disease burden is particularly high among infant and children in areas where a large part of the population does not have access to safe drinking water, and which also happen to be the areas where the population has inadequate medical care.

It is estimated that diarrhoeal diseases alone accounts for an estimated 4.3% (62.5 million) of the total disability-adjusted life years (DALYs) of the global burden of diseases, and 88% of this burden can be attributed to unsafe water supply, sanitation and hygiene (WHO, 2001; Fox-Rushby & Hanson, 2001). Furthermore, sickness of the adult breadwinner has severe impact on the income and nutritional status of children and other family members in poor households (UNDP, 2006). WHO & UNICEF (2000) estimates the economic costs stemming from waterborne diarrhoeal diseases to include billions of dollars of lost adult productivity. Furthermore, annual economic and health costs in terms of time and effort by women and girls carrying water from distant, often polluted, sources is estimated at about 10 million person-times.

The literature suggests that good drinking water quality is a necessary but by no means sufficient condition for elimination of diarrhoeal diseases. Apart from quality, the quantity of water available for consumption and basic hygiene also affects infectious disease transmission. Some studies suggests that the quantity of water used for personal and domestic hygiene is more important than the quality of drinking water in its impact on health outcomes, specifically reductions in diarrhoea, parasitic infections, morbidity and mortality, and increases in child growth (Esrey et al., 1991; Huttley et al., 1997). Esrey (1996) further suggests that better water quality only improves health when hygiene and sanitation is improved as well and when the quantity of water is sufficient. Two reviews (Esrey et al., 1985; 1991) of several studies (though many of the studies did not conduct water quality testing) mainly done in developing countries, and other later studies (Quick et al., 1991; Semenza et al., 1998), which carried out measurements of E.coli levels and chlorine residual respectively, suggest that improvements in water supply and sanitation in general, and in drinking water quality in particular, results in improved health and particularly in a median reduction in diarrhoeal disease incidence of 26-27%.
The public health importance of providing improved access to adequate and safe drinking water supplies, though now well known, is not a guarantee for improved or better usage. Usage patterns may change more or less slowly with improved access depending on the perceived need to use the water for improved sanitation and hygiene. In a study done in Bolivia only 30 percent of respondents associated dirty water with diarrhoea, showing a lack of knowledge about probable causation or simply a casual attitude to childhood diarrhoea, a common phenomenon in developing countries (Pandey, 2006).

2.4 Conclusion

This chapter has outlined several approaches that have been adopted in supplying water in urban centres of developing. The use of public utilities has largely been unsuccessful for a number of reasons as outlined and as evidenced by the large number of people that still remains un-served. To solve the problems of public utilities, participation of large scale private concessionaires has been promoted but with its own challenges and as a result a large number of urban residents are still not reached. The past and ongoing effectiveness of large-scale private companies in water provision in urban centres of developing countries remain a subject of debate. However, for a long time this has obscured the role played by other providers whose roles may be particularly relevant in areas where the majority of those without access live. Community participation in water supply has also been tried in different areas sometimes successfully: but again, this approach is not without difficulties. Thus diverse challenges still exist that require innovative approaches and concerted efforts: hence the present study’s interest in I&SSWPs.

The literature reviewed here further suggests that although both poor and non-poor households may be un-served or inadequately served, because of various reasons, the majority of those who have least access to water supplies from official utilities are poor households. Furthermore, poor water supply has significant negative and linked health and socio-economic impacts. Consequently it is suggested that it is the poor who are not served or inadequately served that may suffer related socio-economic, environmental and health impacts associated with lack of or inadequate access to water supply, as well as bearing the burden of water-related diseases when they are forced to use water from sources of poorer quality. This review has further suggested that poor water supply could be related to poor management policies and the inflexibility in water supply provision and to a long-standing
inability of utilities, water authorities, city managers and their advisers to plan and implement water supply approaches and systems which meet the real needs of the majority of those not served, the urban poor.

However, water being a basic need, those unserved and poorly served by the official utilities have not only devised ways to meet their own needs but other providers have emerged to supply the needs. The next chapter looks at these providers. It examines who they are and seeks to clarify their identity as well as to discuss their actual and perceived roles in domestic water supply.
Chapter 3  The independent and small scale water providers

3.1 Introduction
Analysis of water supply provision by I&SSWPs requires an understanding of existing practices around the world and perceptions of I&SSWPs and their ability to meet water supply needs. Chapter 2 showed that although several approaches have been used to provide water in urban centres of developing countries, because of various reasons, the methods so far used have not been able to cope with the water needs of certain areas or sections of the populations. A water supply gap was therefore shown to exist with some sections of the population inadequately served while others remain unserved by the official utilities.

The population unserved and those poorly served, however, have to find ways of meeting or supplementing their daily water requirements given that water is a basic need. Studies point out that this population depend on other providers. Referred to here as independent and small scale water providers (I&SSWP), such providers exist in many countries with large population unserved or poorly served. They may therefore be important in providing access to water and therefore the need to integrate their services into the formal water supply system. The purpose of this chapter is to examine literature on I&SSWPs, their practices, perceptions of their role and ability to meet water supply needs. It aims at providing an insight into the identity of I&SSWPs, how they are perceived and the role they play in the provision of water supply in developing countries in general. The chapter is structured as follows: section 3.2 presents definition and various categories of I&SSWPs thus seeks to clarify who they are. The perception of their place in water supply is discussed in 3.3, while their business practises are considered in 3.4. Their position in legal frameworks is discussed in 3.5, whilst section 3.6 examines institutional and policy frameworks. A summary of their key features is outlined in 3.7, and section 3.8 provides conclusions.

3.2 Definition and categories of I&SSWPs
Different terms are used to refer to I&SSWPs providers from one country to another and in the water supply literature. Referred to as informal water providers; water vendors; small scale independent providers; mini-utilities; non state water providers; the other private
sector; and small scale water enterprises/providers, they provide water services supplementary to, or alternative to, those provided by the official water utilities. The I&SSWPs may supply households lacking connections to the piped system, but households with inadequate or unreliable supply from official water utilities also find them important in augmenting their water needs thus their services are important to millions of people and without which, many of such households would be worse off (Solo, 1998; 1999; 2003; Collignon & Vezina, 2000; McIntosh, 2003; WSP, 2004).

I&SSWPs are diverse. Several attempts have been made to classify I&SSWPs (Snell, 1998; Solo, 1999; 2003; Collignon & Vezina, 2000; Water Utility Partnership for Capacity building [WUP] Africa, 2003; Moran & Batley, 2004; WSP, 2004; Kariuki & Schwartz, 2005). Summarising twenty profiles including six from Africa, eight from Asia and six from Latin America and The Caribbean, Snell (1998) suggests that I&SSWPs may be categorised as follows:

- providers in permanent partnership with water utilities whose water they distribute at kiosks or standpipes;
- pioneers who bring their piped water from their own sources to communities where water utilities have not yet expanded their network; and
- mobile water truckers, carters, and water carriers who provide water at times and places that water utilities are unable to serve.

In another attempt, Solo (1999) identified three groups. Firstly, individual families with their own water connections providing water to their neighbours. Secondly, bulk water supply systems including tanker trucks which distribute water to cisterns or to individual families. Lastly, privately owned and managed water networks which provide house hold connections to water, sometimes overlapping with competitors, for example the aguateros (local term used for small water providers) of Paraguay or service cooperatives of Argentina. Collignon and Vezina (2000), in a study of ten African cities, also found a variety of I&SSWPs ranging from standpipe operators, water carters and water truckers, to network providers.

WUP- Africa (2003) and Moran and Batley (2004) classify what they call informal water providers into two distinct types. First are the independent water service providers, which consist of those not connected to the official utility network and might even, compete with it. Such providers often get their water from alternative sources; for example, own boreholes.
and may then distribute through a pipe network, or through carriers or a single supply point. The second type which they call intermediate water service providers include those who obtain water from the utility piped network and either (i) install and manage network extensions or water points or (ii) buy, transport and deliver water direct to customers willing to pay for them. In this classification, intermediate water service providers include both individual providers and community based organisations and several of such have emerged to fill specific market niches in urban water supply.

Solo (2003) focusing on a classification that would be useful for policy decisions suggested two categories; mobile providers and those with fixed networks who undertake piped delivery. However, Kariuki and Schwartz (2005), suggests that I&SSWPs can be classified based on two criteria; their relationship to source of water and the technology in use (see summary in Table 3.1)

Table 3.1 Classification of I&SSWPs by source of water and technology in use

<table>
<thead>
<tr>
<th>Technology Employed</th>
<th>Relationship to source of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network</td>
<td></td>
</tr>
<tr>
<td>Network integrated production/distribution</td>
<td>Dependent (Source supplied by the larger utility)</td>
</tr>
<tr>
<td>Network point source</td>
<td>Own source, fixed location</td>
</tr>
<tr>
<td>Network mobile distributors</td>
<td>Own source, mobile vendor</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Purchasing water and selling through mini-network</td>
</tr>
<tr>
<td></td>
<td>Connected to utility fixed location vendor</td>
</tr>
<tr>
<td></td>
<td>Purchase from utility, mobile vendor</td>
</tr>
</tbody>
</table>

Adapted after Kariuki and Schwartz, 2005

Based on relationship to source, this classification differentiates ‘independent’ from ‘dependent’ small scale water providers. ‘Independent’ are those with their own source of water supply e.g. well, borehole etc., whereas ‘dependent’ are those whose water source/supply comes from the official utility network, which others (WUP-Africa, 2003; Moran & Batley, 2004) refer to as intermediate water providers. Kariuki and Schwartz (2005), base their classification on the idea that requirements for policy, legislative and regulatory frameworks may be different based on source. For example, they suggest that for those with their own sources whom they call independent, key issues may include ground water abstraction and distribution, water quality and public health standards, while for the group they call dependent, key issues may include contract terms with the supplying utility, including tariff and connection charges, fee structures and licensing procedures.
When the technology employed is used, the classification produces: networks, point sources and mobile distributors. Networks, as the name suggests, refer to laid down pipes through which water supply is delivered via a ‘fixed system’ up to a customer by the water provider. Point sources on the other hand refer to where customers travel to purchase water by the container at a ‘fixed end’ and include standpipes or kiosks. Lastly are mobile distributors, which, as the name suggests, are providers with mobility such as tankers and carters which deliver water up to the door of customers.

Although the classification by Kariuki and Schwartz (2005) is more comprehensive and provides a good summary as well as captures most of I&SSWPs, a wider review of literature, however, shows that it may not be realistic to classify mobile sellers into only two categories- own source mobile vendors and those relying on the official utility. Some mobile providers neither has own sources nor buy from the official utility but are dependent on third party producers (Solo, 1999; 2003; Collignon & Vezina, 2000). Since I&SSWPs are very varied, there may not be a uniform way to categorise I&SSWPs in clear cut distinctions and the attempted classifications have their own shortcomings and overlaps. For this study, a broad classification is adopted and described below. Briefly I&SSWPs may fall into one of two categories; water vendor without own source and small-scale water producer.

3.2.1 Water vendors
The term ‘water vendor’ has been used variedly in literature, often in contradictory ways. Firstly, the term is frequently used to describe those who deliver water to their customers at the door regardless of the source. For example, Howard (2001) refers to vendors as ‘anyone selling water whose source is not known to the consumer’. Secondly, the term is often used in a way that refers only to those who sell water purchased from the official utility network; those not having a source of their own. However, a review of literature shows that in addition to those not having their own source and therefore selling water obtained from the official utility network, there are some vendors who sell water purchased from third party producers.

The third Edition of the WHO Guidelines for Drinking Water Quality (GDWQ), describes vendors as someone selling water to households or at collection points where water scarcity
or faults in or lack of infrastructure limits access to suitable quantities of drinking-water (WHO, 2004). From this definition, the term ‘vendor’ is simply a reference to selling and implies that water vendors can broadly be said to refer to any person (besides the official utility itself), selling water to households without access to official piped water, whether having own source, getting from official utility or from a third party. However, in this study I&SSWPs selling water they produce (have own sources like wells, boreholes or dams) are considered as producers/suppliers. The water sellers/vendors (those without own source) generally vary and further distinction is made between fixed and the mobile sellers.

### 3.2.1.1 Fixed source water vendors (sellers)

Fixed water sellers have a stationary point for example standpipes/ taps/ kiosks from where they sell water. Also included in this category are individual households with connection to formal water supply who resell water from their private homes (home water) to neighbours either through flexible plastic tubing or informal standpipes, often also referred to as on-sellers or household resellers. Several studies suggest that fixed/point source sellers mostly rely on water from the official utility (Collignon & Vezina, 2000; WUP- Africa, 2003; Moran & Batley, 2004). Where they rely on official water network, they may have some contractual relationship with the official water utility, upon which three groups can be identified:

- **standpipe vendors** - are small entrepreneurs who operate a standpipe. The standpipe can be public, installed by official water utility, but others may with the licence from authority put up own (private) standpipe (Snell, 1998; Collignon & Vezina, 2000);
- **licensed household resellers** - are micro-entrepreneurs who have contracted to resell water piped to their homes and may at times invest in standpipe installation and network extension to achieve this (Collignon & Vezina, 2000; Davis, 2005);
- **unlicensed household water resellers** - are those who sell water piped to their homes though without permission from the official water utility (Howard et al., 2001); and
- **local sub-network providers** are those who construct small secondary water networks (WUP-Africa, 2003; Valfrey-Visser et al., 2006).

Some studies suggest that operators of standpipe or kiosks getting water from the official network can distribute as much as 35 per cent or more of a city’s water (Collignon & Vezina, 2000; McIntosh, 2003; WUP- Africa, 2003). Collignon and Vezina, (2000), found
standpipe or kiosks fixed on official water network to be the most popular resale outlet. However, Gulyani et al. (2005) found that although water provision through standpipes was common, they were not preferred by respondents.

In a study done on sources of water used by low income households in Uganda, Howard et al. (2002) reported that household resellers were the most common way through which households got piped water even though the price of water bought from such was found to be about three to four times that of a household with direct connection. For local sub-network providers, WUP-Africa (2003) report that they tend to operate mainly in informal settlements and are increasingly recognised as an important means of getting water to those of low income. The official water utility may provide water up to a water meter fixed on their pipeline, typically located at the edge of such settlements, while the I&SSWPs take responsibility for water distribution to one or more water points in the settlements, from where they sell to consumers. The public and private standpipes and local sub-network providers exist alongside those operated by community based organisations (CBOs) some supported by civil society organisations (SCOs) or NGOs.

3.2.1.2 Mobile water vendors (sellers)

Mobile water vendors/sellers on the other hand are also known as water carriers and involve those who buy water from various sources and then deliver it at the door of their customers (Collignon & Vezina, 2000; McIntosh, 2003; WUP- Africa, 2003). They include hand carters, water tanker trucks, delivery by donkeys, bicycle and back loaders, even though the last two categories are gradually disappearing. Collignon and Vezina (2000) found that although standpipes were the most popular resale outlet, water sold at standpipes actually reached households through hand carters who they found to be very important in door to door delivery, even if an individual handcart vendor may serve only a small number of customers. The tanker trucks or water tankers on the other hand may deliver to a community storage tank, a local fixed network serving a group of standpipes, and to households (Solo, 1999; WSP, 2004). Some studies suggest that water-tankers in Africa and Asia mainly provide water to un-served often poor and high volume water consumers such as municipal buildings in addition to private firms and hotels (Collignon & Vezina, 2000; McIntosh, 2003; WUP- Africa, 2003; WSP, 2004).
In terms of sources, the mobile provider may operate his own source, hence may also be a producer, may buy from a third party private source, or retail water purchased in bulk or sometimes stolen from the official utility mains (Collignon & Vezina, 2000; Solo, 2003). Mobile water sellers getting water from the official utility may thus be said to extend effective ‘coverage’ of the official water supply since carriers and carters are able to carry this water to areas at the urban fringe, difficult terrain and new areas being developed far from water network (Solo, 2003).

3.2.2 Water producers/suppliers
In contrast to mere vendors (those without own source), small scale water producer or suppliers usually also control the means of production of the water. They may dig wells or drill boreholes where there is abundant supply of ground water (Solo, 1999; 2003) but others have small water treatment plants or dams (Troyano, 1998; 1999). In a study conducted in Onitsha, Nigeria, several producers with private boreholes were found, with some selling water exclusively to secondary distributors like tankers, but others were also found to be selling to individual households who buy by the bucket (Whittington et al., 1999).

Some private producers may in addition to production also maintain private networks and therefore control the section of distribution into private households (Solo, 1999; 2003; Valfrey-Visser et al., 2006). Those with their own distribution system are also referred to as independent/piped network operators/providers (McGranahan et al., 2006; Valfrey-Visser et al., 2006) and may serve as many as 1000 connections each (Kariuki & Schwartz, 2005). In a preliminary survey of ten West African countries, followed by a comprehensive review of three of the countries (Ghana, Mali, Mauritania) and Mozambique in Central Africa where independent network operators were thought to be predominant, Valfrey-Visser et al., (2006) suggest that suppliers who operate networks are few in Africa, except in countries where they have been specifically encouraged like in Mauritania where they supply water in small towns. A similar observation was made by Collignon and Vezina (2000) in their study of ten African cities and Kariuki and Schwartz (2005). Available literature therefore suggest that even though producers with piped networks may exist in specific countries, they may not be prevalent in Africa, as those with wells, boreholes or small treatments may shy away from laying piped network.
Studies done in Latin America suggest that availability of abundant ground water has allowed independent suppliers/producers to access a good volume of water through wells and boreholes (Troyano, 1999; Solo, 2003), enabling even piped network operation. Some studies conducted in Africa, however, suggest that the volume provided by ground water is limited, hence private boreholes and wells were not found to be significant as points of sale except in Nairobi and Ouagadougou, (Collignon & Vezina, 2000), and also in Conakry and Nouakchott (Valfrey-Visser et al., 2006). Nevertheless, where conditions allow, boreholes and wells provide a large share of water to low income and peri-urban areas un-served or inadequately served by water from the official piped networks (Collignon & Vezina 2000; Valfrey-Visser et al., 2006). Some studies further suggest that water provided by I&SSWPs with own sources may be unsafe and therefore can present health risk to the consumers given that producers are often unauthorised and unregulated (WUP-Africa, 2003).

3.2.3 Interactions amongst I&SSWPs
I&SSWPs may or may not associate with fellow practitioners in the same area. The relationships may range from cooperation to indifference or outright hostility (Collignon & Vezina, 2000). The same report identified and classified relationships among I&SSWPs into five groups: friendly competition, business relationships, cooperative teamwork, professional and trade associations, and collusion.

Friendly competition occurs where I&SSWPs, faced by their common struggles against public authorities, develop solidarity and follow some self imposed guideline. This competition can sometimes deteriorate into a conflict. Business relationships on the other hand may develop, for example between a borehole manager who sells water to a trucker who then supplies a cistern manager and who in turn supplies a water carrier. Collignon and Vezina (2000) observe that over time such business relationships become permanent and more or less comparable to official contracts.

In cooperative teamwork, I&SSWPs may extend business relation beyond supplier-subcontractor to referring and recommending customers at a commission. In some areas, professional and trade associations have also emerged as a means of organizing collective action to advocate common interests for example tanker truck owners in Ghana (Valfrey-Visser et al., 2006) and Maji bora Kibera (better water for Kibera in Swahili) in Nairobi
(Mehrotra & Morel, 2003). Collignon and Vezina, (2000) and Valfrey-Visser et al. (2006) have observed that such associations may be important in improving professional practice, monitoring technical innovation and integrating private and public systems and hence they have suggested that such associations be recognized and negotiated where they exist but only for establishing fair conditions for doing business rather than to encourage cartel like business practices. In some areas, however, a form of collusion has emerged where I&SSWPs have moved from legitimate cooperative movements to economic conspiracy and where cartels seek total market controls, including control over barriers to entry; for example, in Port-au-Prince in Haiti (Snell, 1998) and in Jakarta (Susantono, 2001 quoted in Bakker, 2007). Although earlier studies in Africa report that such cartel like practices were not found in a study of ten African cities and further suggest that such cartels are unlikely to succeed unless they are given support by public authorities (Collignon & Vezina, 2000), other recent studies have observed such cartel like practices in urban neighbourhoods where lack of other sources of water make vendors the only source of water, for example, among tanker truck owners in Ghana (Valfrey-Visser et al., 2006).

### 3.3 General perception of the place of independent and small scale water providers in the water supply sector

The perception of I&SSWPs and their place in water supply sector vary. For some, I&SSWPs may be viewed as an outright nuisance and unwanted exploitative opportunists, charging the poor high prices sometimes for a litre of water of poor quality because they are not regulated by the government in their pricing or service quality (World Bank, 1994, 1997, 2002, 2004; Oxfam, 2006; Johnstone & Wood, 2001; Shirley, 2002). However, for others, water being such a basic human need and since millions of people not reached by the official water utilities also need water, those meeting this need are acknowledged as playing an important role (Solo, 1998; 2003); hence I&SSWPs are vital in supplying the water needs where official utilities have failed or are not able to cope with the demand in the water sector. Solo (2003) observes that I&SSWPs have mostly been considered a transitory and temporary phenomenon to be ignored rather than supported since they operate in ways inconsistent with service provision models considered ideal by many governments. According to Collignon and Vezina (2000), the I&SSWPs are part of the significant but less appreciated general informal sector economy that has taken over the economy alongside the private sector as a whole as governments relinquished control, and now employs half of all
labour force in these countries. Solo (1999), further suggests that I&SSWPs may as well be the small and micro-enterprise (SMEs) version of the water sector. Katua-Katua (2004) reinforces this view by observing that the emergence of I&SSWPs may well be the early face of water enterprises, while Kariuki and Schwartz (2005) further suggests that because I&SSWPs tend to serve fewer than 50,000 people each or 5,000 customers, they therefore fall under the Micros, Small and Medium-Sized Entities (MSMEs) and hence are the MSMEs of the water sector. Thus it is plausible to argue that though MSMEs are a common phenomenon of the development scenario in urban centres of developing countries, the water sector seem not to have recognised I&SSWPs as the water sector version of the same phenomenon. This may partly be due to the belief that this sector is naturally monopolistic. It may also be that I&SSWPs currently fall outside regulation. Without regulation they cannot be recognised. However, it has also been observed that even when the sector has been opening up to privatisation the general tendency has been to reinforce the monopoly model through transfer of rights to a single large scale supplier (Solo, 1998; 1999; Troyano, 1999).

Tracing the evolution of ownership structures in the water supply and sanitation sector in four countries, Chenoweth (2004) clearly shows that what are now large water companies in Britain was a result of the merger of small scale local water or sanitation providers. The same report shows that a similar trend occurred in Palestine and later Israel. On the same note, Kariuki and Schwartz (2005), observe that although I&SSWPs may now exist as small operations in many urban centres of developing countries, they may have the potential for becoming local private operators, thus a possible strategy as part of solution to the persistent water supply problem. Furthermore, while others argue that I&SSWPs are temporary and hence may not survive long enough to make them worth nurturing, studies show that some have been active for a long time, in some cases over 70 years (Solo, 2003). Others are as old as the areas or settlements in which they operate (Gulyani et al., 2005).

In contrast, some I&SSWPs have emerged as water supply from official utilities has continued to deteriorate leaving a gap in service provision (Katui-Katua, 2004). Cotton and Taylor (1994), report that to combat deficiencies from the official utility, many individuals, households, and local communities attempt to improve basic services and infrastructure provision. Such initiatives arise in order to satisfy a genuine demand, and the services provided are therefore not only demand led and responsive to genuinely perceived needs, but
also respond to and build upon existing demand, hence residents are ‘willing to pay’ for such services because the benefits are perceived to be correspondingly great.

Reporting on the changes in the sources of water used in East Africa over a period of 30 years, Thompson et al. (2000) observes that the role that vendors (I&SSWPs) play in the water supply market has increased as a result of decline in the services from the public utilities, and suggest that this may be a possible precursor to private sector participation. Some studies have therefore suggested that governments should respond with necessary guidelines and promote best practices where the potential exists, while remaining open and receptive to other ways of increasing access to water (Solo, 1999; Collignon & Vezina, 2001; McGranahan et al., 2006; Katui-Katua, 2004; Kjellen & McGranahan, 2006; Kariuki & Schwartz, 2005).

Troyano (1999), however, suggests that the emergence of I&SSWPs may also only show that faced with water problem people will devise ways of meeting their water needs. And that this happens irrespective of whether a policy frame work is in place to regulate the situation or not, and whether a policy allows it or not where a policy framework does exist. Using this line of argument, in the face of appalling domestic water problem, I&SSWPs can therefore be seen merely as a coping rather than an adaptive strategy.

3.3.1 Consumer perception of the place of I&SSWPs in domestic water supply

Little literature exists on consumer perceptions of I&SSWPs. Oenga and Kurin (2006) suggest that how consumers view I&SSWPs may be shaped largely by their understanding of the context of water delivery. Thus where I&SSWPs provide the capital and infrastructure that makes water available in the otherwise ignored areas including informal settlements, consumers see them as being important and necessary in the supply chain and the price of their water which sometime may seem high are perhaps considered reasonable.

Other factors such as cost, reliability and quality of water supplied to households have also been reported to influence people’s views or attitude towards a water supply or supplier in general (WHO, 2004). Gulyani et al. (2005) found that because of high costs and unreliability, water provision through standpipes was the least preferred option by their
respondents in a selection of preferences for improvements in water supply. However, a study of the role of I&SSWPs in Metro Manila, while concluding that one of the reasons for the need to regulate I&SSWPs is rooted in public health concerns over the quality of water they provide, nevertheless found that the majority of the customers rated the quality of the water as good with about 80% of customers characterizing the water supplied to them as drinkable (WSP, 2004).

3.3.2 The role of I&SSWPs in water supply services
Davis (2005) observes that in developing countries, small private sector entrepreneurs (I&SSWPs) play an important role by supplying water (and sanitation) services to a substantial proportion of the over one billion people who lack access to water supply from the official piped water. In Africa and in Latin America and the Caribbean, I&SSWPs are suggested to provide water services to a substantial number of people, reaching as much as a half or a quarter of the population in urban centres as summarised in Tables 3.2 and 3.3. According to Solo (1999; 2003) about 25 percent of the population in Latin America cities rely on I&SSWPs for their water needs and 50 percent for sanitation, while in Africa the figures are higher with 50 percent for water and about 80-90 percent for sanitation services. Other studies confirm the figures for African cities, with a general estimation of half or more, for example Collignon and Vezina (2000), also report that about 50 to 80 percent of the total population in some ten Africa cities are covered by these providers.

Table 3.2 Estimated proportion of urban population by regions (in developing countries) covered by independent and small scale water providers

<table>
<thead>
<tr>
<th>Author</th>
<th>Region</th>
<th>% of the population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solo (1999; 2003)</td>
<td>Latin America and the Caribbean</td>
<td>25</td>
</tr>
<tr>
<td>McIntosh (2003)</td>
<td>South East Asia</td>
<td>20-45</td>
</tr>
<tr>
<td>WSP (2004)</td>
<td>East Asia</td>
<td>30 -50</td>
</tr>
</tbody>
</table>

In some cities I&SSWPs are the primary water suppliers for some sections of the population, compensating for lack of service from the official water supplier and in some cases the only option available. According to a study done across ten Africa cities, I&SSWPs were found to be the principal source of water for over 75 percent of poor households (Collignon & Vezina, 2000; Oxfam, 2006). But Collignon and Vezina (2000) further report that in some
cities like Bamako in Mali, only a few -about 16 percent- of households are reached by the official water utility, the rest of the market, including the non poor is supplied by the I&SSWPs (Collignon & Vezina, 2000). I&SSWPs are therefore critical as they may be the sole supplier of water for their clients, thereby alleviating the problem of lack of access; with some able to cover all the water needs of the households they serve.

Table 3.3 Selected cities in developing counties showing estimated percentage coverage by independent and small scale water providers

<table>
<thead>
<tr>
<th>Region</th>
<th>City/ Country</th>
<th>Population served (%)</th>
<th>Reference:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa:</td>
<td>Nairobi (Kenya)</td>
<td>60</td>
<td>Collignon &amp; Vezina (2000)</td>
</tr>
<tr>
<td></td>
<td>Conakry (Guinea)</td>
<td>66</td>
<td>Menard &amp; Clarke (2000b)</td>
</tr>
<tr>
<td></td>
<td>Dar-es-salaam (Tanzania)</td>
<td>56</td>
<td>Collignon &amp; Vezina (2000)</td>
</tr>
<tr>
<td>Latin America and the Caribbean</td>
<td>Port-au-Prince (Haiti)</td>
<td>70</td>
<td>Kariuki &amp; Schwartz (2005)</td>
</tr>
<tr>
<td></td>
<td>Santa Cruz (Bolivia)</td>
<td>100</td>
<td>Kariuki &amp; Schwartz (2005)</td>
</tr>
<tr>
<td></td>
<td>Asuncion (Paraguay)</td>
<td>30</td>
<td>Troyano (1999)</td>
</tr>
<tr>
<td>East Asia:</td>
<td>Jakarta (Indonesia)</td>
<td>44</td>
<td>Kariuki &amp; Schwartz (2005)</td>
</tr>
<tr>
<td></td>
<td>Manila (Philippines)</td>
<td>30</td>
<td>WSP (2004)</td>
</tr>
<tr>
<td>South Asia:</td>
<td>Karachi (Pakistan)</td>
<td>40-50</td>
<td>Kariuki &amp; Schwartz (2005)</td>
</tr>
<tr>
<td></td>
<td>Delhi (India)</td>
<td>6-47</td>
<td>Kariuki &amp; Schwartz (2005)</td>
</tr>
</tbody>
</table>

In other cases they complement the official delivery systems, with a good proportion of population still relying on I&SSWPs even in areas with long traditions of private utility operation and where ‘coverage’ by official water provider is believed to be higher. For example in Abidjan, Cote d’Ivoire the private sector (SODECI) has been in operation since 1959; however, notwithstanding the success of SODECI in improving water supply, about 22 percent remain without private/individual connections and get water from I&SSWPs (Menard & Clarke, 2000a). This service was observed to come mainly from the mobile water vendors who truck water from official water utility (but may at times also get water from wells) to unconnected areas (Menard & Clarke, 2000a). In addition, compound owners with a water connection also sell water to their tenants while other individuals sell water to unconnected neighbours, thus allowing poor households to get access to potable water without having to pay access charges or be required to pay regular bills. However, unlike in other cities, I&SSWPs in Cote d’Ivoire operate with the sanction of SODECI. In metropolitan Manila, I&SSWPs are reported to have served 30 percent which translates to 3.3 of the 11 million people, filling the gaps in service coverage left by the public water
utility before privatisation but even after privatisation a number of households still depend on I&SSWPs (WSP, 2004).

I&SSWPs are credited for having the ability to work in difficult conditions. Hence they effectively serve mainly low income residents, slums or illegal settlements usually ignored or left out because they are either in remote or difficult locations un-attractive to the official water utilities or where utilities believe that serving them may be tantamount to officially legalizing such settlements (Troyano, 1999; Solo, 1999; Collignon & Vezina, 2000; WSP, 2004; Kariuki & Schwartz, 2005). In addition they reach out to those squatting on land subject to flooding and marginal sites, and also to the inner parts of the city to residents who cannot afford direct connection. Studies suggest that I&SSWPs tend to serve mainly those who are poor partly because most official utilities, even though having a monopoly and are under contract to provide water to all the urban population in areas they serve, often concentrate on the wealthier customers (Collignon & Vezina, 2000, Bakker, 2007; Kayaga & Franceys, 2007). Since their main market is suggested to be among low income households, I&SSWPs are therefore delivering a much needed service to the poor. Consequently, until either the official utilities find ways of effectively reaching and improving water supply service to the poor or poverty itself recedes, there will always be those in need of the services of I&SSWPs and their role will therefore continue to be important.

I&SSWPs also fill other market niches in general meeting the needs of communities on a broad scale, but all with varying needs (Solo, 1999; Collignon and Vezina, 2000). Hence, they also cater for households of other income levels such as those of middle and high income customers not served by the official utilities as well as supplement water needs for those whose water supply is discontinuous, unreliable or deficient (Solo, 1999; 2003). Among these may be those living beyond the networks reach, as well as in peri-urban communities who though may have ability to pay, are still not served by the official utility, (Valfrey-Visser et al., 2006; Bakker, 2007). It is therefore suggested that I&SSWPs may be dominant in areas where new settlements are coming up, and in peri-urban communities with low market entry since official water utilities due to various reasons as discussed in Chapter 2, are always slow in extending water supply even in areas where a demand exist (Collignon & Vezina 2000; Valfrey-Visser et al., 2006).
In some areas, however, I&SSWPs are reported to have successfully competed with city wide authorities to produce and distribute water (Solo, 2003), thereby creatively and variedly tackling the challenge of water service delivery. Kariuki and Schwartz (2005) suggest that the roles played by I&SSWPs in domestic water supply may be summarised as:

- Gap filler - operating where there is high coverage levels but low service quality (measured by the number of days or hours services are available);
- Pioneer - developing and operating systems in areas where there is no public service but there is customer demand;
- Sub-concessionaire - buying water in bulk and selling it onto customers; and
- Manager - take over small public systems to improve their efficiency

3.3.3 I&SSWPs as investors in the water sector
Available literature suggests that the role I&SSWPs play goes beyond just supplying water to households un-served and those inadequately served to having the potential to invest in and therefore extend water supply infrastructure coverage. For example in Argentina and Paraguay, I&SSWPs have especially invested their own funds in piped network extension (Troyano, 1999). This comes against a backdrop of official water utilities struggling to source grant funding needed for investment, while their tariffs remain insufficient to pay for network extensions (Howard, 2001). Thus in some cases I&SSWPs have reduced the public burden on utilities which are already in deep financial troubles (Collignon & Vezina, 2000).

Mehrotra and Morel (2003) estimated the capital investment in Kibera informal settlement in Nairobi Kenya by each private vendor (mainly kiosk operators) to be about $ 2,000 (or a total of US$ 1.2 million for Kibera; a per capita cost of US$ 2.6), although they note that a quarter of such investment may be paid as bribe. Kariuki and Schwartz (2005) observe that in some cases investment by I&SSWPs in infrastructure accounts for over 85 percent of all private sector investment in water. It therefore compensates for or supplements the limited financial resources of the public sector, suggesting that I&SSWPs may have a big potential as a source of finance for small scale water supplies which would improve supply coverage and increase those with access to water.

However, other studies report that though I&SSWPs may have the potential to invest in piped networks, the majority back away from this because of their ‘illegal’ status (Solo,
1998; Collignon & Vezina, 2000). In a case study of piped network operators in Ghana, Mali, Mauritania and Mozambique, Valfrey-Visser et al. (2006) reports that except in Mauritania, where they have been specifically encouraged, the majority of I&SSWPs have shied away from investing in piped networks because of their informal status, hence in many African countries, only few network operators offer large scale household connections, suggesting that informal status and lack of recognition rather than resources constrain investments by I&SSWPs.

### 3.3.4 I&SSWPs as a source of employment and income

Water provision by I&SSWPs is also important as it, among other benefits, creates employment and generates income to those involved hence it is a means of livelihood, and therefore important in poverty alleviation (Samson et al., 2003; Cameroon, 2008). As observed earlier, Collignon and Vezina (2000) reports that I&SSWPs are part of the significant but less appreciated general informal sector economy—particularly the SMEs that have taken over the economy alongside the private sector as a whole as governments relinquished control, and now employs half or more of labour force in developing countries. Micro enterprises are defined as firms with no more than 10 employees, and a small enterprise as one with 11-50 employees (Mead, 1994; McPherson, 1996). MSEs form a large, vibrant, and growing part of the economies of many developing countries and are an especially significant employment source in sub-Saharan Africa, where according to Mead (1994), they were responsible for 40% of new employment in Botswana, Kenya, Malawi, Swaziland, and Zimbabwe during 1981-90. According to Rakodi (2002) economies, in sub-Saharan countries, are declining resulting in a decrease in employment opportunities in the formal sector. But urban economies were the worst. To address the problem of increase in unemployment a wide range of activities are being employed but these are mainly found in the informal sector (Hansen & Vaa, 2004; Cameron, 2008). In line with this observation Cameron, (2008 p. 94 ) starkly observes that ‘It is to the credit of poorer people that they have maintained low levels of formal unemployment by showing capacity for creating income opportunities with little or non-human resource investment’.

The various forms of employments available among I&SSWPs are summarised in Table 3.4. Whether pipe network operators, water truck drivers, standpipe operators, well and borehole owners or hand carters, they all find employment in the water sector within the wider
informal sector which employs the greatest number, especially the newcomers into the city and residents of low income and unauthorised settlements. Because of a growing appreciation for the role of MSEs in broad-based national economic development strategies, some studies have therefore suggested that allowing I&SSWPs to maximise their potential where such potential exist, would not only provide them with employment security but also serve as an avenue to create employment opportunity for others (Collignon & Vezina, 2000).

Although traditionally women have dominated water collection, McGranahan et al. (2006) reports that water service provision by I&SSWPs tends to be dominated by men. Water vending, especially delivery by hand carters is dominated by young men, some new in a city or recently from rural area. Collignon and Vezina, (2000) suggest that this may be because of the absence of entry restrictions in the sector, and the fact that the work, even though easy to come by, is physically strenuous.

Table 3.4 Summary of various occupations identified among I&SSWPs

<table>
<thead>
<tr>
<th>Employment/occupation</th>
<th>Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standpipe managers</td>
<td>• Public standpipe operator</td>
</tr>
<tr>
<td></td>
<td>• Private standpipe operator</td>
</tr>
<tr>
<td>Household resellers</td>
<td>• Licensed household reseller</td>
</tr>
<tr>
<td></td>
<td>• Unlicensed household reseller</td>
</tr>
<tr>
<td>Water carriers and carters</td>
<td>• Water bearers</td>
</tr>
<tr>
<td></td>
<td>• Hand carters</td>
</tr>
<tr>
<td></td>
<td>• Carters using animal traction</td>
</tr>
<tr>
<td>Water truckers</td>
<td>• Water truck drivers/owners</td>
</tr>
<tr>
<td>Small net work operators</td>
<td>• Network operators/managers</td>
</tr>
<tr>
<td>Producers</td>
<td>• Well/borehole owners, managers and sellers</td>
</tr>
</tbody>
</table>

Modified from Collignon and Vezina (2000)

Standpipe/kiosk operators on the other hand tend to be much older, and could be long time city residents or prominent people in the neighbourhood considered honest and trust worthy and may be traditional elders or local leaders. But some are leased to active investors who have resources to rehabilitate a standpipe that has fallen into disrepair or to take care of past unpaid bills left by previous leaser. Such private standpipe investors can take several standpipes and some may create mini-monopolies by individuals with personal ties to municipal authorities, although in a comprehensive review of I&SSWPs in ten African cities, Collignon and Vezina (2000), suggests that such mini- monopolies do not exist.
Water provision by I&SSWPs is also a source of income. The World Bank (2002) reports that water provision in the informal sector provides employment and hence is a source of the much needed income especially to new entrants in town escaping rural poverty and further suggests that when accompanied by supporting institutional changes, water sector reform and infrastructure can be the basis for growth and opportunities for the poor in various ways. Some studies, however, suggest that individual earnings may be small and may only be enough for subsistence, although some may get re-invested in infrastructure development (Collignon & Vezina, 2000). But other research in Africa suggests that I&SSWPs income may be comparable to the wages of other unskilled labourers (Whittington et al., 1991; Whittington, 1998; Mehrotra & Morel, 2003).

Some studies suggest that I&SSWPs make excessive profits from selling water. In Onitsha Nigeria, water vending was found to be responsible for 95 percent of the sales in the water sector with some I&SSWPs (the mobile vendors) making large profits from water sales and as much as 24 times what they pay for water from the official utility particularly during dry season (Whittington et al., 1999). Collignon and Vezina (2000), report that standpipe/kiosk operators in Nairobi make high profits of between 80-90 percent from water sales. Gulyani et al. (2005), suggests that the reason for high profits is because I&SSWPs buy water from the official utility at a low/ preferential rate, close to the lowest subsidized or social tariff rate and charge a 50 to 90 percent mark-up price, with gross profit amounting to between 30 to 90 percent of the resale price. But other studies report that although kiosk/standpipe owners may make profit, such profit may often end up in the pockets of those who collect illegal payments in the form of bribes (McGranahan et al., 2006).

However, in some cases it has been observed that even where I&SSWPs especially the producers sell water at lower prices, up to a third of that charged by the official water company, they still charge a cost recovery price and also enjoy a high profit margin thus suggesting that I&SSWPs are more efficient and cost effective in their operation (Solo, 1999; Valfrey-Visser et al., 2006). Troyano (1999), further reports that although many I&SSWPs, like the aguateros in Paraguay, operate small systems sometimes serving few (about one hundred) families, they and their families are able to solely depend on income from this activity suggesting profitability of the water supply business by I&SSWPs.
3.4 Business organizations among I&SSWPs

The dominant system in the water supply sector in urban centres of developing countries has been single operator- often large scale monopolistic supplier whether private or public utilities, as were discussed in Chapter 2. These are charged with water supply and waste water removal even for the many heterogeneous settlements that characterizes such urban centres. With the push for private sector involvement, other models have also been promoted as discussed under forms of private sector participation in section 2.2.2.1. But Solo (1999) and Troyano (1999) suggests that the single large scale operator has been the preferred model with evidence that often when problems faced by such a public company force the authorities to privatise, they more often than not tend to pass the company to a single operator even though it is just one model among many. They further observe that as a result the problems of a public utility are perpetuated despite transformation into a private company.

Because of the varied nature of I&SSWPs, their customers, the services they provide and the environment in which they operate, their business practices differ and so does their performance in delivering water supply services. No single business organisation for providing water by I&SSWPs has been identified but studies suggest that a variety exist, each appropriate to fill the circumstance and need it is addressing (Solo, 1999). The following business organisations have been identified: private company, individual enterprise/sole proprietor, self help group, community organization or neighbourhood association, tanker association (professional and/or trade associations) and lessee (Solo, 2003; Kariuki & Schwartz, 2005).

I&SSWPs may operate either in the formal sector - for example some piped network operators - or informal sector depending on their purpose, origin and ownership structure. Currently, however, research suggest that the majority operate mainly in the unregulated and informal contracts in peri-urban and suburban communities, and are mainly single purpose entities established to deliver water prompted by one of the following three reasons (Cotton & Taylor, 1994; Kariuki & Schwartz, 2005):

- Meeting consumer demand, for example individuals asked to provide access to water supply;
- Responding to a crisis, for example neighbourhood associations formed to develop an alternative to failing public systems; and
- As part of a larger business venture e.g. estate/housing developer or landlord.
3.4.1 Independent and small scale water providers and other players in the water sector

The relationship between official water utilities and I&SSWPs may vary from place to place and by provider type. I&SSWPs operating within large urban centres and in peri-urban areas operate in areas where official water utilities often have exclusive rights over water provision. Nevertheless, some studies indicate that, while in most cases official water supply utilities co-exist with community based providers and NGO initiatives (some supported by grants to deliver water to the poor), they have ignored other I&SSWPs, not bothering to find out how such function (Solo, 1999; WSP, 2002; Foxwood, 2005). This is observed to be the case even in cities where reliance on I&SSWPs tends to be much greater and regardless of whether the services are sanctioned or not.

Other studies suggest that like the official water utilities, even current government planning for service delivery by local authorities and donors who support water provision activities also ignore I&SSWPs and the working systems they have constructed (Snell, 1998). However, where the authorities do take notice, some studies suggests that it has been mainly to restrict the activities of I&SSWPs, which may take the form of prohibiting them from drilling water, laying pipes, or limiting the number and location of standpipes. Moreover, in some cases, in order to protect the official water utility, producers, like well and borehole owners, may face administrative harassment or policy restrictions which may totally bar production (Collignon & Vezina, 2000).

Some categories of I&SSWPs operate with the sanction of the official water utility in some cities, even though it is not a common phenomenon. In Abidjan, Cote de l’voire, I&SSWPs, mainly household resellers, are reported to operate with the permission of SODECI- the official private water utility (Menard & Clarke, 2000). Where they operate with the sanction of the official water utility, the official water utility may, for example, contract private operators for the management of standpipes where water is resold by the bucket or jerry can. Under such contracts, resale prices, official hours of operations, terms of payment and conditions for rescinding the contract may be specified (Collignon & Vezina, 2000). In some cases, prices at the standpipe may be regulated but mostly it is left at the discretion of the
standpipe managers; the argument being partly that the variety of different bucket sizes used in collecting water makes it difficult to set a fixed resale price (Howard, 2001).

Discussing the avenues for possible engagement with what he refers to as Non-State water Providers (NSPs), which in the discussion covers I&SSWPs as referred to here but also includes large scale private sector and community based organisations, Samson (2006) points to lack of formal recognition of I&SSWPs as an impediment to more productive engagement. Njiru (2003) and Samson (2006) present two arguments for productive engagement with such providers. On one hand public agencies and NSPs may draw from the same water sources. On the other hand, NSPs may draw water directly from utility network and therefore are in effect customers of the public utility helping the utility to meet their mandate, hence the need for better collaboration to improve services for end users. The authors, however, note that the wide diversity of NSPs ranging from the small cart vendors who carries water to houses to the large private firms may pose a challenge to such engagements. Samson (2006) further proposes five main possible types of engagement: recognition, dialogue, facilitation/collaboration, contracting and regulation.

3.5 I&SSWPs and legal frameworks

Earlier in the debate surrounding access to water, it was pointed out that although the right to water is a prerequisite to meeting basic needs that are all explicitly recognized in the world’s primary human right declarations such as the right to food, health, human well-being and life, the right to water itself does not appear in the primary human rights declaration and covenants (Gleick, 1999). However, it was subsequently argued that because water is essential for the attainment of the other human rights, it therefore can be treated as an implicit part of such rights (UNESC, 2002). UNESC (2002), further argued that the right to water is inextricably related to the right to the highest attainable standard of health, adequate housing and food, and should therefore be seen as an integral part of other traditional human rights, foremost amongst them the right to life and human dignity. The report further pointed out that even though the right to water is not listed as a human right, it is part and parcel of the rights emanating from, and indispensable for the realization of the right to an adequate standard of living as spelt out in Article 11, paragraph 1 of the International Covenant on Economic, Social and Cultural Rights (ICESCR). Moreover, in interpreting Article 11, paragraph 1 of ICESCR the report observes that even though the right to water is not
explicitly stated in the list of rights, the use of the term "including..." when listing other rights implies that the list was not exhaustive and therefore the right to water - being the most fundamental condition for survival - falls within the categories of guarantees essential for securing an adequate standard of living.

In addition to the 1989 Convention of the Rights of the Child (CRC), where it is explicitly stated, other more recent reports now recognize the right to water (WHO, 2003; Langford, et al., 2003). The right to basic resources including water among others is also beginning to be recognised by regional and national conventions and constitutions. In South Africa, for example, the Bill of Rights of the New Constitution adopted in 1994 recognises the right to have access to sufficient food and water (Gleick, 1999; Stein, 2001). A number of international political declarations and resolutions have also included a right to water. Some of these include the Statement resulting from the 1992 Dublin International Conference on Water and Environment which acknowledged that there is a "basic right of all human beings to have access to clean water and sanitation" (Brooks, 2006). The 1994 Program of Action of the International Conference on Population and Development explicitly includes the right to adequate standard of living, including water and sanitation. A UN General Assembly Resolution on the Right to Development 2000 recognised the right to clean water. More recently, the Abuja Declaration adopted as the first Africa-South American Summit in 2006 affirms "the right of our citizens to have access to clean and safe water and sanitation". In 2008, the Human Rights Council adopted by consensus a resolution establishing the mandate of an Independent Expert on the issue of human rights obligations related to access to safe drinking water and sanitation. Some studies, however, suggest that a right to water alone is not sufficient to ensure improvement in access to water for those without (Anand, 2006). Anand (2006) further argues that other indicators of governance such as voice and accountability seems also to be critical in realising improvement in access to water.

3.5.1 Contents of and fulfilling a right to water
The right to water is defined as the right to everyone to "sufficient, safe, acceptable, physically accessible and affordable water" (ICESCR, Para 2). According to the committee access to water must be continuous and the amount of water available must be "adequate for human dignity, life and health" (Para 11) and suffice for drinking, cooking, and for personal and domestic hygiene. Water is also recognised as a "social and cultural good and not
primarily as an economic good” (Para 11). Water must also be of safe quality and “acceptable colour, odour and taste” (Para 12b) (UNESC, 2002)

However, the international declarations and formal conference statements supporting a right to water do not directly require states to meet individuals’ water requirements. Nevertheless, Article 2(1) of ICESCR obligates states to provide the institutional, economic and social environment necessary to help individuals to progressively realize these rights (Gleick, 1999). The core obligation of states is ensuring access to a “minimum essential amount of water”, and creating and implementing a national strategy, and monitoring progress on realizing the right to water.

The role of government in realizing the human right to water and also in achieving the MDG related to water, as well as whether water should be treated primarily as an economic good or a social and cultural good has therefore attracted a lot of debates. In relation to the role of I&SSWPs, in a review of ten African cities, Collignon and Vezina, (2000) observes that in most African countries the law vests ownership of water resources in the state. And because many African countries at independence chose to provide public services such as water through public organisation or departments, often, provision of water in African cities is assigned to one city wide public water authority, or in some cases, following recent wave of privatisation, ownership of such an entity may be dominated by large international cooperation (Collignon & Vezina, 2001; Budds & McGranahan, 2003; Bayliss, 2003). Such single authority is not only given the exclusive rights to operate a city wide piped water system and everyone obligated to hook up, but is in some cases also heavily subsidised by the government so as to be able to meet the water needs of all people.

Valfrey-Visser et al. (2006) observes that in theory, the universal service obligation imposed on an official water utility would be a good reason for a legal monopoly. However, when such a utility continually only serves some urban residents and fails to serve all, then the legal monopoly becomes counterproductive since it may hinder others not served by the official network from getting access to water (a basic human right), from possible alternative providers. This is often worse in cases where the official water provider does not reach many or specific areas - as is the situation in many cities in developing countries - yet the monopolistic rights given to the official water supplier bar alternative providers from abstraction of or access to water resources within those areas or prevent customers from
connecting to other providers if such operate unofficially within the area of jurisdiction of the official water utility. This creates a situation where other providers, especially where there is no cooperation from the official utility, can be banned from drilling for or supplying water so as to protect the official utility.

Solo (1999; 2003) suggests that the core function of national water laws should be: to establish and enforce norms and regulations that foster fair and suitable relationship among all actors without stifling local initiatives, ensuring stable access to water resource, define regulatory mechanism, and establish cost recovery principles for water services. But in many developing countries, especially in Africa, I&SSWPs, particularly those operating in peri-urban and low income areas of urban centres may have no legal recognition, operating unofficially in the gaps left by the official utility.

From the case studies in Latin America, after examining several legal frameworks, Solo (2003) reports that the I&SSWPs are in a ‘legal limbo’ that is the law is not clear on their legal position: in Paraguay the law is ambiguous with respect to the status of I&SSWPs; in Peru the constitution encourages private sector participation in water provision but detailed regulations create obstacles to the operation of I&SSWPs; and in Bolivia the participation in water sector is highly regulated but user cooperatives are allowed (Solo, 2003). However, in some countries, some categories of I&SSWPs are legal. For example, in Guatemala there are fewer legal limits on I&SSWPs participation in the water sector (Solo, 2003) and some piped network operators in small towns in Mauritania and Ghana are legal having been sought out by the public sector to run and expand existing schemes (Valfrey-Visser et al., 2006).

Although the official water utilities are often given a legal control, a natural monopoly, however, should not justify a legal monopoly since efficient monopolistic outcomes should be seen even if governments permit entry (Solo, 2003; Valfrey-Visser et al., 2006). This was observed in British cities in the 19th century, where, multiple pipes were laid by different companies under the same streets, but by middle of the century, competition had died away almost in all cities because of the operation of the market forces (Baker & Tremolet, 2000; Chenoweth, 2004). But worse still, in some cases, in addition to legal monopoly, the legislation may forbid the official utility from delegating responsibilities to other parties, e.g. through subcontracting, further relegating I&SSWPs to a position of illegality.
The risks of legal monopoly may be worse than the risks of competition, yet in addition to legal monopoly some official utilities are also heavily subsidised. But even with monopoly and subsidies, the performance of most official utilities both private and public has been poor, both in number of people served within their exclusive service areas and in quality of service. For example, as discussed in Chapter 2, the provision is often seriously wanting with problems not only of availability and quality, but the service in general, even for those with access to official water supply, tends to be poor and is marked by inadequacy, irregularity and unreliability (Howard, 2001). Solo (2003), therefore observes that when legal barriers to entry remove even the threat of competition, regulation should assume a larger share of the burden of promoting productive efficiency, keeping prices down and maintaining quality.

Tremolet and Browning (2002) suggest that granting an explicit legal status to other operators and organising a clear system for service delegation would lift the biggest barrier to better development and would enhance the emergence and development of I&SSWPs, especially in urban areas where a vast majority remain either without access to or are poorly served with water and where I&SSWPs have already made some effort to provide services. Tremolet and Browning (2002) and Solo (2003) further suggests that limiting the defacto monopoly of official utilities could allow I&SSWPs to compete for contracts and receive subsidies with the main operator on the basis of performance. A supportive legal framework is therefore necessary for proper involvement of I&SSWPs in water provision.

3.6 I&SSWPS and policy and regulatory frameworks

Many cities of developing countries are characterised by an absence of public policy and lack of a clear strategy to deal with urban growth, development of new lands and extension of infrastructure, including for water provision. Foxwood (2005) observes that the lack of a clear government policy framework for working with the other providers (I&SSWPs) has resulted in an uncoordinated provision which can be unsafe to the lives of those served. Furthermore, even though the absence of policy has created opportunities for I&SSWPs to provide water in poorly served and areas not reached by official utilities, Collignon and Vezina (2000), suggest that it may have raised the cost of water provision in such areas even for I&SSWPs.
Where there is a policy in place, it often only recognises the official large scale water utilities. Existing I&SSWPs may therefore not only face policy constraints on issues like drilling for water but sometimes there may be a total ban on water production. Solo (1999) suggest the need for a policy framework that does not constrain the functioning of I&SSWPs in the water sector but that which ensures checks on the quality and price of the services they provide. Where the official utility is slow in extending the network, Valfrey-Visser et al. (2006) suggests that the sector can be opened by introducing competition over network extension service or by allowing for competition for new household connections as has been done through the aguateros of Paraguay and which resulted in the improvement of connections from less than 50 households per year to more than 400. Another option could be to allow the official utility to subcontract for management of customers in the areas served, for example, as SODECI in Abidjan has subcontracted licensed household resellers or the standpipe operators in Port-au-Prince (Haiti). Thus I&SSWPs and official utilities can work together (Samson, 2006) with each assigned its clear role towards providing water needs for the un-served and poorly served areas.

3.6.1 I&SSWPs and regulatory framework

Regulation can be defined as the attempt to influence behaviour with a view to achieve certain purposes. In relation to I&SSWPs, Solo (2003) argues that very few developing countries have regulatory frameworks that acknowledge or encourage the existence of I&SSWPs in the water sector and that regulatory frameworks dealing with water production and distribution were conceived for large monopoly providers. It is therefore suggested that I&SSWPs suffer from water industry regulation which gives monopoly to official water utilities (Solo, 2003), and to protect the official providers, I&SSWPs are harassed by administration (Collignon & Vezina, 2000).

Where an approach to water service regulation is in place, some studies suggests that they focus on the “quality of the services provided to those who are already connected to the network [...] limit the adoption of and innovation in low cost solutions for extending services to the poor [...] raises the cost of access for low income communities and households and results in lower connection rates and lower use levels” (Collignon & Vezina, 2000 p. 5). Other studies further point out that existing regulatory frameworks often condition or prohibit private ownership of infrastructure which consequently puts off
I&SSWPs from getting financing or risking their finances for laying down piping and buying sound technical advice (Solo, 1999; 2003; Collignon & Vezina, 2000). Nonetheless strong public regulation is a key to successful participation of both large scale multinational companies and I&SSWPs in water service provision. In countries where the large scale powerful multinationals companies have succeeded as official water providers, regulation has been a key ingredient although a strong civil service, competitive markets and well-informed consumers also play a critical role (Nickson & Vargas, 2002). Without strong regulation provision of essential services become skewed as well as prone to high inequalities and costs (Oxfam, 2006).

Katui-Katua (2004) notes that while the private sector and other enterprises (I&SSWPs) that have come up to supply water where official utilities have failed has helped in solving the problem of water shortage in some areas, they may exploit the poor since both manual and motorised water vending is not regulated. On the contrary there is a major influence in their service quality where there is regulation (Solo, 1999; Collignon & Vezina, 2000) suggesting that the quality of I&SSWPs services like that of official utility depends on an efficient regulatory system.

3.6.2 Purpose/ function of regulation for I&SSWPs
The focus of traditional regulation has been on single large scale systems. Such systems have traditionally focused on production rather than reaching diverse needs of community, with public policy dictating subsidies if people cannot afford the cost of high standard systems (Tremolet & Browning, 2002; Ferrara, 2008). This, however, often only benefits a minority, usually household with connections but, who paradoxically constitute the wealthier sector of society. The un-served, also often the poor, are left to either pay high prices for water sometimes of questionable quality or buy less water as a result of the high costs.

Some studies suggest that where government regulation exists for the many types of MSMEs of which I&SSWPs are apart, it mostly focuses on regulating entry into the sector and monitoring the inputs used rather than on the quality of services provided. Moreover, even though such regulation may exist, they may not be enforced as long as I&SSWPs remain self-contained and isolated creating fewer legal challenges. However, when there are potentials and chances to scale up, I&SSWPs begin to face requirements like meeting
network connectivity. This may require negotiations on technical standards and decisions to give them a formal legal status (Valfrey-Visser et al., 2006). In Tanzania legal recognition of community owned water service organizations made it easier for the local government to help with repairs and maintenance and monitoring of water quality (Oxfam, 2006).

The need for regulating I&SSWPs partly comes from the perception that they charge high prices, and considerable amount of literature suggests that their tariffs are high. Traditional cost regulation for official water utilities focused on price caps or rate of return regulation (Embid-Irujo, 2005; Ai & Sappington, 2005; Botasso & Conti, 2009) and subsidy issues. For I&SSWPs, the need for regulation of water tariffs charged mainly depends on whether they are seen as excessive; however, there are divergent views on the need for economic regulation. Some studies point out that the fact that the services of I&SSWPs are not regulated creates opportunity for exploiting the poor (Katui-Katua, 2004). On the contrary, WSP (2004) notes that a review of average price per cubic meter of water charged by I&SSWPs gives no evidence that the prices charged are excessive and hence concludes that there may not be a need for economic regulation. Samson (2006) further argues that economic regulation of I&SSWPs would be an inefficient use of resources because the diverse, small and informal nature of their activities would make it impractical for a regulator to take into account the varying costs and regulate them on a fair basis. The scepticism about economic regulation is thus partly due to uncertainty on whether the cost of regulation would exceed its benefits and also the practicality, given their nature of being small size as well as the diverse forms that exist.

Other studies suggest that where I&SSWPs are allowed to operate, the threat of competition, either from the concessionaire or from other providers is a good substitute for economic regulation. Some studies have reported that where they are allowed to operate for example in Paraguay, water charges among I&SSWPs were found to be lower than those charged by the official water company (Troyano, 1998; 1999), although this was attributed not only to competition but also the presence of relatively abundant ground water. However, this may not be realised where I&SSWPs are not operating freely to maximize on their potential and create conditions where market forces can bring down the costs of water. Some studies have therefore suggested the need for water sector reform allowing free entry by small providers especially in places where both needs and conditions are not only varied but also differ from
one neighbourhood and household to another, making a single monopoly scarcely able to satisfy the needs of a full city population.

Another need for regulating I&SSWPs comes from the belief that they provide water of variable quality (but typically of poor quality) which may be unsafe to unsuspecting consumers, as well as transporting water in dirty containers which may lead to contamination of otherwise good quality water. Drinking water that contains pathogenic microorganisms may cause illness as discussed in section 2.3.3, and as such it is important to have some measure that establishes whether water is safe. Traditional water quality regulation and monitoring strategy focused on water as it leaves the treatment works and on the distribution system. Currently the use of microbial parameters has brought reliance on end product monitoring which helps not only in verifying the efficiency of the treatment and disinfection but also detects post treatment contamination (WHO 1993; 1997; 2004). Every country has its own set of guidelines for drinking water quality, however, because they are mainly derived from the WHO Guideline for Drinking Water Quality most of these guidelines are similar for different countries and the same indicator micro-organisms are used to indicate the presence of pathogens.

Generally water service provision has many dimensions and is a more complex subject to regulate; however, the need for quality regulation may be suggested by the presence of ‘market failures’ (Baker & Tremolet, 2002). For the case of water service provision where minimum quality requirements have been defined, consumers do not expect to drink water that will make them sick. But when a water provider fails to meet the minimum standards then such a ‘market failure’ may justify the need for overseeing the quality of service, thus suggesting that market failures in water quality may be worth correcting through regulatory intervention. Drinking water quality regulation and monitoring has two important roles; quality control by the supplier, and independent surveillance by the regulatory body. However, in some developing countries the two roles may be merged resulting in conflict of interest. For example, Collignon and Vezina, (2000) reports that some public authorities test the quality of water distributed by I&SSWPs but hardly ever test water from their piped network. Therefore, for a public entity, oversight should be through a separate unit established for this purpose and independent.
Considerable literature suggests that it is the absence of a regulatory framework that probably makes I&SSWPs charge excessive prices and provide water of poor quality (Collignon & Vezina, 2000). However, other studies suggest that in some areas regulation may already exist but the enforcement of the regulatory provisions may be weak and requires improvement. For example, in metropolitan Manila, water quality regulation was found to be already in place, and included the Sanitation Code of Philippines which requires all municipalities to have a drinking water quality monitoring committee as well as other legislations that provide for routine water safety testing (Baker & Tremolet, 2002; WSP, 2004). Whether such a code applies in the case of I&SSWPs is not clear, but most likely such a requirement would only be for the official water provider and would apply only in theory to I&SSWPs unless they have been officially recognised as water providers.

In some cities the official water utility may contract some I&SSWPs, like private operators, for the management of standpipes where water is resold by the bucket or jerry can. Under such contracts, resale prices, official hours of operations, terms of payment and conditions for rescinding the contract may be specified (Collignon & Vezina, 2000). But in some cases, while some public authorities would like to put an upper limit on the price of water charged by I&SSWPs, especially the producers, on the other hand they have no intention of subsidizing the difference between the maximum price and the cost of providing water, as is done for some official water providers (Solo, 1999; 2003; WSP, 2004). Regulatory instruments, however, have associated regulatory costs, depending on how prescriptive they are. Moreover, in developing countries enforcement of quality standards can be difficult and costly and hence some have argued that quality regulation is a luxury that only rich countries can afford and that the cost of regulating I&SSWPs may not be compensated by potential benefits (Samson, 2006).

Where regulation has been tried, quality control over the source and delivery of water for areas which are served by I&SSWPs varies from one site to another. Sometimes it is provided by the public agencies, while other times it is left to the ingenuity of the provider, perhaps, increasing the risks of abuses in the water quality and the hygienic methods used in the distribution (Troyano, 1999). However, Solo (1999) suggests that a regulatory system based on performance rather than technical standards should be promoted. For example in Paraguay, the health ministry’s water quality division (SENASA), tests water from I&SSWPs who operate piped networks on a regular basis (at least once every six months...
when the *aguateros* pay a commercial tax), and also settles disputes between customers and providers thus offering an office where clients can complain of shut-offs, poor pressure or discontinuous services.

Solo (1999) note that leaving technical standards open has encouraged the *agueteros* to devise best technological system for providing services. For example, they are not forced to conform to the same pipe diameter whether serving 50 or 2,000 customers, hence they use pipes of different diameters based on the number of customers they are serving. The study therefore suggests that leaving technical standards open may encourage I&SSWPs to be innovative in providing water, since regulation which set technological rather than performance standards may do little to encourage innovation, experimentation and also discourage search for better solutions. Moreover, price setting and monopolistic practices should be replaced by monitoring of water quality and service quality and sanctioning of providers who violate their contracts with their customers. This may therefore mean a rethinking of regulatory mechanisms and a shift from the present focus on price caps, subsidy issues and quality control. Generally regulation should aim at improving service delivery, guarantee water quality, and protect the investment of all operators. Solo (2003) suggest that for I&SSWPs, such regulatory function would focus on process and guidelines for tariff setting and revisions (periodicity, information, consultations and recourse and arbitration) and should only be in response to specific needs because regulation may be costly. On the contrary, Troyano (1999) suggests that as long as health agencies test water quality, judicial branches guarantee that fair and open competition exists between operators and settle disputes between customers and operators and between operators, regulation should not be a major concern. Table 3.5 attempts a summary of categories of I&SSWPs and possible issues for regulation as identified in literature.

### 3.6.3 Instruments of regulation

Many instruments exist and have been suggested that may be used in organising, guiding or providing oversight on water service provision by I&SSWPS and include licensing and certification rules, minimum quality standards, provision of information to consumers, quality signalling and liability regimes.
Table 3.5 Summary of possible issues for regulation for I&SSWPs

<table>
<thead>
<tr>
<th>Features, by technology</th>
<th>Dependent (No own source)</th>
<th>Independent (have own source)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Piped Networks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System</td>
<td>Operator buys water in bulk from utility and develops distribution sub-networks connected directly to households, institutions and public kiosks stand posts</td>
<td>Operators develops own water source (wells/boreholes/small treatment works) and connects network to households and other users.</td>
</tr>
<tr>
<td>Organization</td>
<td>Private company or individual, community organization or neighbourhood association</td>
<td>Sole proprietor, cooperative, private land and housing developer, water user association, community based organization</td>
</tr>
<tr>
<td>Regulatory issues</td>
<td>Contract with utility, business licence, customer agreements, bulk rates, customer tariffs</td>
<td>Groundwater abstraction permits, title deeds, resale permits/licences, water quality testing, business licences, rights to own infrastructure and/or to lay networks in public rights of way</td>
</tr>
<tr>
<td><strong>Point Sources</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System</td>
<td>Kiosk or stand post connected to the utility network (could be household supply); buying water in bulk – at a special tariff- or at household tariff.</td>
<td>Water point linked to own source (well or borehole, underground or above ground storage tank) installed privately and operated on a for – profit basis. Water may be purchased from a tanker.</td>
</tr>
<tr>
<td>Organization</td>
<td>Individual, enterprise, self help group</td>
<td>Neighbourhood association, micro-enterprise, community based organizations</td>
</tr>
<tr>
<td>Regulatory issues</td>
<td>Contract with utility, licence/permit, customer tariff, bulk purchase price, performance incentives</td>
<td>Groundwater abstraction permits, licences, water quality testing,</td>
</tr>
<tr>
<td><strong>Mobile Distributors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System</td>
<td>Tankers or truckers or carters obtain water in bulk from the official utility and deliver it directly to the customer, public utility water storage tanks, communal cisterns, or individual households and institutions</td>
<td>Tankers, truckers or carters develop source or obtain water from a private well for distribution to households, public utility water storage tanks, communal cisterns, or institutions</td>
</tr>
<tr>
<td>Organization</td>
<td>Sole proprietor, tanker association, lessee, informal sector</td>
<td>Sole proprietor, tanker association, lessee, informal sector</td>
</tr>
<tr>
<td>Regulatory issues</td>
<td>Transport licences, business licences, tanker cleanliness, bulk rate, utility contract, customer tariff</td>
<td>Transport licences, business licences, water quality testing, abstraction permits</td>
</tr>
</tbody>
</table>

Modified from Kariuki and Schwartz, 2005
3.6.3.1 Licensing and certification rules

These are commonly used to regulate market entry; this may differ from case to case but require some degree of flexibility to stimulate innovative capacities and make full use of expertise. Licensing I&SSWPs to operate as private companies and public service providers has been used as a tool to identify, recognise and oversee the operation of I&SSWPs, for example for tanker truckers in Ghana, standpipe operators in Mali, Mauritania and Mozambique; re-sellers in Ivory coast and rural network operators in Mauritania (Valfery-Visser et al., 2006). It offers a means for developing code of conduct and provides the environment for improving standards, for example, where renewal of license can require such things as safe source, certain minimum levels of service. It can also require periodic testing of water quality like for the *aquateros* in Paraguay (Solo, 1999). This requires an in-depth and comprehensive understanding of how each urban water market works.

The advantages of licensing include improvement of awareness of I&SSWPs and service standards, as well as integrates I&SSWPs into the formal economy (may include paying taxes and more of their staff are brought into the formal economy). However potential disadvantages may also arise such as:

- I&SSWPs unable to raise licensing fee due to scarce resources may quit leading to a brake in supply thus affecting those depending on them
- may create additional opportunities for corruption where they may be asked to pay bribes to obtain licences
- problem of shortage/lack of bureaucratic capacity to oversee the license process (staff, legal capacity and IT resources) (Valfery-Visser et al., 2006)

3.6.3.2 Minimum quality standards and provision of information

Minimum quality standards and provision of information to consumers are other important regulatory instruments which may be used when there is market failure especially for ‘experience goods’ (i.e. goods whose quality the consumers can only tell after they have used or received). For ‘experience goods’ like water, market failure leading to the problem of imperfectly informed consumers becomes critical when health and safety are at risk as in the case of water where consumers cannot easily determine whether the water they are consuming is contaminated. Hence it may be useful for governments (or someone) to intervene to provide information about the quality or to impose minimum quality standards,
although in a competitive environment, public diffusion of information acting through reputation and hence competitive position may be a more effective way of ensuring provision of quality. In some cases this may take the form of strong consumer lobby (Baker & Tremolet, 2002; Tremolet & Browning, 2002). Samson (2006) suggests that making information on the performance of providers publicly available, thus relying on the regulating effects of reputation could work. For example, publicising the price of water that vendors pay at the location where they collect water may enable customers to see the price mark-up when water is sold to them thus operating as a form of price regulation by making information about service performance transparent.

3.6.3.3 Quality signalling, self regulating associations and liability regimes

Quality signalling by private providers, such as the establishment of reputation through brand names or the setting of self regulating producers’ associations may be useful regulatory instruments where government capacity is weak (Baker & Tremolet, 2002). Supplier associations may choose to regulate the quality of their members, by granting them certificates for compliance which make quality a competitive characteristic of the providers. Even suppliers enjoying a monopolistic position may voluntarily choose to increase their quality commitment to provide a signal to their customers. Some studies suggest that in most countries the concept of self (independent) regulation is not yet well established (Fairman & Yapp, 2005) and would be especially difficult to apply to a large number of small decentralised systems like those of I&SSWPs (Baker & Tremolet, 2002; Samson, 2006).

In some cases little oversight has been attempted through requiring I&SSWPs to join or form professional and trade associations/organizations. Samson (2006) proposed the use of self-organization by the private water providers and suggested formation of professional and trade association as a useful means of regulating I&SSWPs. Mehrotra and Morel (2003), reported the formation of an association for enabling and regulating operation of water kiosks - the predominant type of I&SSWPs in Kibera, in Nairobi, Kenya. Other examples of such associations include: water-tanker association in Ghana, the association of water-resellers called ARE_QUAPCI in informal settlements in Ivory Coast, The Union of vacuum-truckers USV in Benin, and the Aguateros’ Federation in Paraguay (Valfery-Visser et al., 2006). The study further suggests that because informal operators in Africa have a long history of creating trade-union structures to defend collective interests or develop
networks, promoting professional association or some form of self regulation would thus be possible among I&SSWPs.

The experience with formation of professional and trade associations has been varied. For the *aguateros* of Cordoba, recognition by official water utility only came after formation of a trade association which was able to speak for their mutual interest. The success of *aguateros* in Paraguay came partly due to their initial ability to overcome a sense of illegitimacy and guilt, followed by their formation of a trade association, although in an informal way. In Argentina the cooperative movement has succeeded because it was encouraged and applauded by authorities. However, the growth of the small scale operators under the cooperative movement has been stifled through setting of tariff structures that stop operators from charging more than a 25 percent profit margin even in the face of high inflation (Valfrey-Visser *et al.*, 2006).

The mechanism of self organization or use of such associations for self regulation tends to offer some benefits but also pose some risks (see Table 3.6 for summary). An association may enhance the ability of providers to negotiate a level playing field. WUP-Africa (2003) points out that with government authorities recognising legitimacy of such associations, tanker and vendor associations established in countries such as Nigeria and Ghana have enabled small-scale providers to enter into dialogue with utilities, thus improving the terms and conditions under which they work. Such associations can help to improve professionalism and capacity building in the sector by: negotiating with them a framework to govern members' activities by for example establishing common rules and procedures (and promoting their acceptance); recognising and protecting private investments; and creating a forum for dialogue (and collaboration) between the authorities, the utilities and the alternative service providers (who may be too numerous to be handled on an individual basis), as well as advocating for policy and legal changes (WUP- Africa, 2003; Mehrotra & Morel, 2003; Samson, 2006; Valfery-Visser *et al.*, 2006).

The risks on the other hand include possibility of turning into cartels where members set minimum tariffs, restrict membership to limit competition from new entrants and/or create intimidated competition, thus creating the need for the regulatory authority to promote competition and encourage new entrants to the water market (Snell, 1998; WUP- Africa, 2003; Samson, 2006). In addition, some of such associations may turn out to be dominated
by political and administrative agendas with the main purpose of enforcing government or political party policy and therefore may be of less use to I&SSWPs. Furthermore, since many I&SSWPs have emerged out of non-water business, ‘professional water provider associations’ may leave out many potential providers (Collignon & Vezina, 2000).

Table 3.6 Risks and benefits of self-organizing by I&SSWPs

<table>
<thead>
<tr>
<th>Risks</th>
<th>Benefits</th>
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<tr>
<td>1. Formation of Cartels</td>
<td>1. Sustainable as driven by enlightened self interest</td>
</tr>
<tr>
<td>2. May not lead to a price benefit to end users</td>
<td>2. Effective as regulated through peer pressure</td>
</tr>
<tr>
<td>3. Still dependent on central utility</td>
<td>3. Uses an incentive and penalty approach</td>
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Other instruments of regulation include liability regimes (for product or service failures) and officially recognising the role of the citizens in public oversight institutions, with a right to register complains and refer to a higher body, and the right to review official information. Troyano (1999) suggests the need for participation of the users and of the local authority in regulation of I&SSWPs. Apart from community oversight, effective regulation is also enhanced by sound contracts and business plans, open communication and consultation mechanisms and external auditing and bench marking (Baker & Tremolet, 2002).

3.7 A summary of key features of I&SSWPs

I&SSWPs are known for several qualities in the water market. In the literature the qualities of I&SSWPs tend to be set against the background of the problems, as discussed in Chapter 2, faced by single large scale public or private operators which have been the dominant players in the urban water market. The characteristics can be seen in the light of strengths (advantages) and weaknesses and are summarised in Table 3.7 and 3.8 below. In addition Table 3.9 and 3.10 provide opportunities and threats I&SSWPs face. However, because I&SSWPs are very varied the key features may at times apply only to a specific type and not all the types.
3.7.1 Key strengths

Strengths describe the positive attributes, tangible and intangible, internal to an organization, in this case I&SSWPs. These are attributes within their control and include what they do well, the resources they have and advantages over their competitors. Strengths may be evaluated by area such as marketing, finance, manufacturing, and organizational structure and include the positive attributes of the people involved in the business, including their knowledge, backgrounds, education, credentials, contacts, reputations, or the skills they bring. Strengths also include tangible assets such as available capital, equipment, credit, established customers, existing channels of distribution, copyrighted materials, patents, information and processing systems, and other valuable resources within the business. Thus strengths capture the positive aspects internal to a business that add value or offer a competitive advantage; hence strength analysis is an opportunity to identify the value existing within a business. Table 3.7 below presents a summary of possible strengths of I&SSWPs as identified in the literature.

**Table 3.7 Key strengths**

- Individual innovation and enterprising thus offer flexibility and adaptability to the water market in terms of: technical options e.g. adoption of water disinfection technologies; introducing innovative market approaches by developing simpler, appropriate and flexible charging and payment strategies tailored to local needs and resources e.g. charging no connections fees, differing connection costs, offering clients credits/loans for hook-up connections, charging on a daily basis thus better placed to supply those disadvantaged in paying infrequent large bills; organizational structure and administrative systems e.g. have devised simple contracts with communities to guarantee service in return for exclusivity- a form of mini concession – on a neighbourhood basis.

- Self financing- mobilize capital for and assume the full risks of own investments with main sources of funds coming mainly from family savings, brother, father, maternal uncle, saving clubs, or forward payment by households to be served by water network, and own profits.

- Develop own sources of water- access to good quality water source requiring no expensive treatment making investments free from treatment costs e.g. wells, boreholes, but some also abstract and purify water from natural sources in small water treatments.

- Serve mainly marginal socio-economic groups- e.g. lower-income/slums/illegal settlements; difficult/high commercial risks e.g. high elevation and areas prone to flooding; high population densities and remote regions/ peri-urban neighbourhoods but also serve upper and middle income groups in areas with low coverage levels or ineffective official utilities

- Efficient in their production and operation system e.g. able to set fees that include/ recover costs and virtually have no unaccounted for water (UfW)

- Constantly developing with clear evolutionary patterns: in business - e.g. hand carter save to buy a truck then add another; water trucker supply households then move to a small
network; small network operators expand resulting in network overlaps competition and fall in prices; in ownership and organization e.g. from owner-operators of privately funded systems to developer-operator of formal systems; in more efficient technology e.g. from scoop well using bucket to medium scale type using hand pump and to large scale water supply using motor to pump water to raised storage tanks.

- Adapt to local conditions and/or by simplifying standards e.g. where network exist connections are made using PVC pipes, a meter and a stop-valve which enables them to bring capital costs down to the affordability of poor households; offer cheap/huge cost savings in construction and maintaining or extending service coverage

- Exhibit market behaviour including good knowledge of markets and consumer habits: e.g. free entry; open competition for clients and business environments (competitive characteristics); offer varied services or sell other related products; respond quickly to user and changes in demand; capacity to grow i.e. increasing service delivery as demand grows; reach out/look for and find new and emerging customers e.g. in new settlements

- Good at personal and public relations and customer service: e.g. have good personal knowledge of customers; create and win customers loyalty; rapidly respond to technical problems as well as maintenance of equipment; flexible-ready to listen to customers with difficulty in meeting payment; make payment easier and/or give advance credit and discounts when customers need; listen to complain if service quality is not satisfactory thus customers feel respected and valued (creating customer loyalty)

3.7.2 Weaknesses
A weakness or constraint in this context is used to describe factors that are within a business control that detract from the ability to obtain or maintain a competitive edge. Weaknesses focuses on areas within a business that might need improvement and might include lack of expertise, limited resources, lack of access to skills or technology, offering inferior services, or the poor location of a business. Like strengths they are factors under control by a business but which for a variety of reasons are in need of improvement to effectively accomplish marketing objectives. It captures the negative aspects internal to a business that detract from the value offered, or place the business at a competitive disadvantage. They are areas that need to be enhanced in order to compete with the best competitor. A review of literature suggests that I&SSWPs may have several weaknesses. Again because of variety in type and services, specific weaknesses may apply only to specific types and below (Box 2) is a summary of possible weaknesses identified in literature.

Table 3.8 Weaknesses

<table>
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<th>Weakness</th>
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<tr>
<td>• Higher tariffs than comparable network services yet serving mainly poor households who therefore pay higher prices per unit volume</td>
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<tr>
<td>• Providing water of questionable quality or inadequately treated</td>
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<td>• Transport water in inappropriate containers posing the potential for contamination</td>
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<tr>
<td>• Poor quality service marked by frequent interruptions and uncertain water supply; irregularity/discontinuity in supply; and general shortages.</td>
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</table>
• Small size and scale of operation which cannot allow establishment of large scale water production and treatment works, water provided is therefore not adequate to be relied on as the sole source to meet demand of rapidly increasing populations

• High operating costs (for those relying on official utility for water supply) mainly as a result of huge water bills or from penalties accumulated for non payment of water bills which also lead to disputes and time wastage in settling disputes;

• Inadequate capital base to finance their investments thus cannot undertake intensive capital investments (well drilling, purchase of water tanks and pipes) thereby only make incremental /smaller investments or borrow from money lenders/ credit suppliers whom they pay at high interest rates

• May operate as mini spatial monopolies or collude to establish monopoly zones, stake out geographic territories and a captive clientele or organize themselves to protect rent seeking advantages, set prices and thus form a complex network of middlemen linked to people in or connected to official water supplier, and with mafia like control of water and organized crimes at times characterized by intimidation of competing vendors, customers, and police and city officials who attempt to eradicate informal water vending practices

• Water vending may involve hard manual work which is both strenuous and uneconomical

3.7.3 Opportunities

Opportunities assess the external attractive factors that represent the reason for a business to exist and prosper. These are external to a business and include opportunities that exist in a market, from which a business can hope to benefit. The opportunities reflect the potential that can be and may be the result of market growth, lifestyle changes, resolution of problems associated with current situations, positive market perceptions about a business or the ability to offer greater value that will create a demand for services provided. Although often they are external to a business, sometimes people may identify "opportunities" that are internal and within an organizations' control, but such should be classified as strengths.

Table 3.9 Opportunities

• Failure and inability of the large scale official water utilities to meet water needs/requirements of millions of urban populations especially the poor and those in the peri-urban areas- creating a water supply gap

• Urban populations growing rapidly by absolute numbers but also by increase in density of existing settlements and expansion at the peri-urban fringe - all faster than improvements to water availability by official utilities

• Several barriers to uptake of water service provided by official water utilities especially by the poor/low income;

• Drastic decline/deterioration in access to water even for those formerly served by official water utilities mainly due to capacity constraints of the utility's infrastructure.

• Costs of providing conventional utility water services remain prohibitive, while prevailing economic situation means huge financial outlay/resources required by official utilities for conventional infrastructure expansion to improve services is either
inadequate or not available

- Availability of good water sources especially abundant good quality ground water source hence easy access to cheap and good quality water sources

- Variability in settlement characteristics/heterogeneous nature of urban settlements where needs and conditions are varied as well as differ by neighbourhood and households e.g. poor may need little and not bulk water supply at a time and may desire to pay for it by instalments instead of lump sum billings and payments

- Appreciated by their satisfied customers who highly value services offered partly because they are respected, treated as valued and have no difficulty in being heard if they complain about unsatisfactory service quality, or those disadvantaged in paying infrequent lump-sum bills who are offered flexible payment plans by I&SSWPs

- Main market are the poor and current high poverty levels are unlikely to disappear soon

- Liberalisation of the water market and policy reforms in the water sector which allows for participation of other water providers

- Need to leverage local funds for investment in the water sector

- High unemployment rates - water provision in the informal sector create opportunities for employment and for growth and particularly for the poor

<table>
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<th>3.7.4 Threats</th>
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<tr>
<td>Threats as used in this study refer to factors beyond a business control that could place a business itself or marketing strategy at risk. Threats, like opportunities are external – as a business has no control over them, but may benefit by having contingency plans. Like the other characteristics, each threat may not apply to all the categories of I&amp;SSWPs identified earlier but to a specific type. Box 4 below presents a summary of threats identified in the literature.</td>
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Table 3.10 Threats

<table>
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<th>Threat Description</th>
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<tr>
<td>Lack of fair recognition and communication with public and the official water authorities thus continuously ignored or not consulted in areas where they are knowledgeable e.g. when locating new standpipes</td>
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<tr>
<td>Absence of an appropriate public policy framework or exclusion from existing planning practices for water service delivery by water and or municipal authorities and donors</td>
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<tr>
<td>Regulatory and policy environment that constrains expansion e.g. absence of national policy on standpipe water delivery and policies prohibiting resale of water arriving at a private household. Lack of an independent regulatory authority where one exists.</td>
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<tr>
<td>Exclusive rights over water resources, supply and sale given to official utilities and consumers compelled to connect to official utility network hence prohibiting I&amp;SSWPs from pumping or selling water, thus I&amp;SSWPs remain ignored or considered illegal</td>
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<tr>
<td>Difficulty in obtaining or lack of access to financing/credit e.g. to larger loans from donor agencies, banks thus I&amp;SSWPs only undertake little capital investment</td>
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<tr>
<td>Insecurity for investment/ownership of infrastructure (caused by unclear or absence of an appropriate institutional and legal framework) constrains investment as risk of legal expropriation of property make I&amp;SSWPs undertake investments recoverable within a short time since they lose investments and customers as official utility services expand</td>
</tr>
<tr>
<td>Face excessive political interference and/or corruption, pressure from some</td>
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government agents /public authorities e.g. they impose fines (bribery), put an upper limit on the price of water or show open bias

- Obscure procedures for obtaining a licence or connection for those dependent on official water supply network
- Limited access to industry, technical and managerial knowledge and information e.g. lack access to civil/public works contracts like bids for extension of water network
- Those dependent on official utility suffer from poor water management leading to interruption in service, low water pressure, and arrears arising from penalties for non-payment of water bills but which is often caused by irregular meter readings, inaccurate meters, and frequent billing mistakes resulting in time wastage in billing disputes
- Lack of good sources and or low yields from boreholes/well sunk to reach groundwater
- Technical and operating standards for water service involve highly detailed quality and engineering standards meant to protect consumers but which raise tariff levels (and which they in turn pass on to the consumers in the form of higher prices)
- May lack voice or professional associations to represent them
- Hostile attitude from other stakeholders in the water sector
- Negative popular perception about them, their pricing and service quality e.g. they are temporary only filling the gaps until services improve thus will not be there long enough to make them worth encouraging, charge high prices and offer service of low quality.
- Robbery and illegal connections to their water sources/networks
- Face unfair competition e.g. subsidization of official utilities capital costs or outright confiscation of property
- Price fixing–tariff restriction in some countries which may discourages them

3. 8 Conclusion

The literature reviewed in this chapter has shown that I&SSWPs have emerged to fill the gaps in water supply providing water services supplementary to, or alternative to, those provided by the official water utilities. I&SSWPs can broadly be classified in to two main categories –those without own sources and producers of their own water. It has further been shown that the perception of I&SSWPs and their role in the water sector vary. At one extreme end they may be viewed as exploitative opportunists, transitory and temporary, a coping rather than an adaptive strategy and therefore not worth nurturing. On the other hand they are acknowledged as playing an important role in supplying the water needs where official utilities have failed or are unable to cope with the demand, and without which millions of people un-served and those inadequately served may be worse off in terms of basic access to water. They may, therefore, neither be trivial nor a transitory phenomenon in the water sector.
It was further argued that they may be the SMEs or MSMEs version of the water sector, providing not only employment but the much needed income in the face of appalling unemployment levels and poverty, although such a view may not be popular with water authorities. This chapter has further shown that I&SSWPs are already serving in different parts of the water service provision. They may serve mainly the poor but also reach out to non poor and may have several strengths. However, they may also have several weaknesses and face several threats. Literature reviewed here further suggests that there are many options that can be used to regulate the general operation and services of I&SSWPs. However, the choice of such an instrument would depend on local circumstances under which they operate and the perception or acceptability of I&SSWPs as suppliers of portable water as well as the purpose the instrument aims to achieve.

The question, however, still remains as to whether the services of I&SSWPs can be recognized and integrated into the formal water supply in order to improve water service provision. To further examine this, the next chapter looks at the various water supply indicators and relates them to water supply provision by I&SSWPs.
Chapter 4 Review of available water supply indicators: I&SSWPs and water service provision

4.1 Introduction
Throughout the previous chapters the terms ‘access’ ‘poor’ ‘inadequate’, ‘quantity’, ‘quality’ ‘cost/price’ among others have been used in relation to water supply. These are the dimensions or indicators of water supply. For water provision, access, quantity available, cost of water, quality, continuity, reliability and convenience are the main indicators of the level of service (WHO, 2004). Once these are taken into account, the value which sets one water service apart from the others is the ease with which the customer can resolve problems (Troyano, 1999). Satisfaction rate is another important indicator, even though it may be influenced by the most basic indicators such as price, quantity, access or time spent in collection and reliability/continuity (Gulyani et al., 2005). This chapter provides a brief review of literature on these and other indicators of water service provision. It examines water supply indicators and relates them to water service by I&SSWPs. The chapter will review available indicators of water supply to provide a context for understanding why I&SSWPs are important in the domestic water supply provision and therefore the need for their services to be integrated in official water supply provision. It is organised as follows: section 4.2 discusses water sources, while access and use of water from different sources is presented in section 4.3. Section 4.4 looks at water quantity and water use whereas continuity is discussed in 4.5. The role of costs is explained in 4.6, whilst water quality is the subject of section 4.7. A brief discussion of unaccounted for water is given in section 4.8 and section 4.9 provides the conclusion.

4.2 Water sources
Urban households unserved and poorly served often may have no choice but to rely on a wide array of water sources and suppliers available, thus using multiple water sources to meet their water needs (Howard, 2001; Thompson et al., 2001; Makoni et al., 2004). The sources vary and include use of individual household connections to the official water network, yard taps, standpipes/kiosks, private household well, neighbours tap or well, boreholes, springs, rivers, dams, canals, collecting rain water and water carriers and other sources including bottled water (Howard, 2001; Gulyani et al., 2005).
These source water supplies can be classified as either improved or unimproved based on the construction of the delivery system at the water source and how well it prevents contamination entering the water. Sources classified as improved include household connections to pipe networks, public standpipes, boreholes, protected dug wells, protected springs, and springs connected via a pipe system to a tap, as well as rainwater collection. Unimproved sources on the other hand are those regarded as unsafe and include unprotected wells, unprotected springs, vendor-provided water, rivers as well as tanker truck provision (WHO, 2000; WHO & UNICEF, 2000; Gundry et al., 2004).

Although direct household connection to official piped water would be expected to be the main source of water, due to various reasons (Chapter 2), it is rarely adequate, typically unreliable if not totally absent. Those without private connections to the official pipe networks may have access to piped water in the form of public water points like yards taps and standpipes/kiosks (Diallo & Woodon, 2004). Some studies suggest that yard taps and standpipes/kiosks mostly get their water from the official utility network and hence may be taken to imply that coverage by piped water supply from the official utility is high. However, studies by Gulyani et al. (2005) and McGranahan et al. (2006) reported that the services received are often of inferior quality, characterised by irregular and unreliable supply making them unsatisfactory to those who rely on them as a primary source. Other studies suggest that in most cases, it is the poor who depend on such water sources, with estimates that about 50 and 77 percent of the poor are served by yard taps and kiosks respectively. In general, both the poor and non poor not having household connections may use shared yard taps and standpipes/kiosks.

In some areas a centralised piped system may not be available. Households therefore have to rely on other sources like groundwater abstracted and made available through private household wells and boreholes or provided by I&SSWPs otherwise referred to as producers in Chapter 3. Some wells and boreholes may be used by individual households and selling may be rare or only on a seasonal basis. But such private boreholes and wells may also become important points of water sale (Drangert et al., 2002) to households lacking their own and therefore an important source of water. Several sources are used as summarized in Figure 4.1.
Because of availability of multiple sources, some studies (e.g. Solo, 2003) therefore suggest that households decide daily where to get water from. Their choices and decisions of which water source to use may be based on factors such as where water is available, distance or ease of access, time available for collection or spent at the source, income, cost of water, quantity required, quality (which include respondents perception of taste of water), and the use it is intended for, among others (WSP, 2004; Gulyani et al., 2005). A study by Nyong and Kanaroglou (2001) reported that in response to a question on the factors that influenced which source a household used, proximity (distance) to the home ranked the highest, followed by how clean and well maintained the source was, the number of the people that used the source and the perceived quality of water from the source. According to this study, people were three times more likely to use a particular water source of poor quality that was close to their homes than good quality water source at a farther distance. Thus households trade off between using good-quality water sources and the effort it takes to obtain it.

Whittington et al. (1991) examined households’ source choice decision based on a sample of 69 households. In this study households could choose from three sources: a vendor, a well or a kiosk and the attributes considered were price, time spent at the source, and
respondents’ perception of taste of the water (bad or good) from the three sources. The study concluded that a household chooses a water source independent of the quantity of water they intend to use. Another study concluded that the time it takes for a household to collect water from a particular source and the number of women in the household significantly affects a household decision on which source of water to use (Anand, 2006). Although other factors such as maintaining good relations with neighbours and quality factors such as taste and clarity of water may also influence decisions on which source to use, Collignon and Vezina, (2000) cautions that there is a tendency in many studies to over-stress the importance of the quality factors while ignoring proper analysis of other factors.

4.3 Access to water sources

Access to water sources has been defined as the ease by which water may be collected. In this sense it may refer to the distance to the source or the equivalent of time spent to collect water or waiting time at communal water sources (WHO, 1999). However, recently there has been some debate on the need to standardise the definition of ‘access to water’. At a country level, three factors- distance, time and water quantity are variously used. According to Aiga, (2003) of 45 countries jointly reviewed by WHO and UNICEF in 1996, 42 used distance based definitions, 38 used water quantity based definitions and two used time based definitions, implying that 37 countries defined access using a combination of these factors.

In relation to measuring access to water, WELL (1998), suggested three broad service levels: water supplied within the home through multiple taps; water supplies to a single tap on the plot; and communal sources external to the home. Communal sources external to the home may further be differentiated by source type since they may provide water of different reliability, costs, and quality and hence have different economic, social and health impact on the user. Different source types provide further information regarding the nature of the socio-economic status of the users (Satterthwaite, 1997). Anand (2006b) suggests that inequality in access to water reflects the embedded inequality in opportunity in the urban economy.

Accessibility to water has a bearing in household decisions or selection of water sources. Research suggests that where households have no connection to official water supply either in the house or through yard taps, they tend to get water from alternatives available and easily accessible, possibly multiple sources (Laurie & Marvin, 1999; Howard et al., 2002).
Moreover, time demands for water collection increase pressure to utilise more accessible, albeit potentially contaminated nearby sources (Nyong & Kanaroglou, 2001). Furthermore, time and energy costs of fetching water govern people’s perception of the importance of water use for hygiene and also influence decisions on whether to directly collect water or purchase water including that delivered at the door by some I&SSWP s. Accessibility is therefore a major determinant of choice of water source and the quantity collected for use.

4.4 Water quantity and uses

Howard and Bartram (2003) suggest that estimation of quantities of water required may only be possible when different domestic uses of water are considered. WHO and UNICEF (2004) report that water is used for various purposes: consumption, which includes for drinking and food preparation (cooking, food washing and processing etc); personal and domestic hygiene, which include bathing and washing; recreation, like boating and swimming; and irrigation of food crops (Machingambi & Manzungu, 2003; WHO, 2006). In relation to domestic water supply alone, White et al., (1972) suggested three types of uses:

- consumption (drinking and cooking);
- hygiene, covering basic needs for personal and domestic cleanliness; and
- amenity use, which includes car washing, lawn watering among others.

In recent studies, suggestions have been made for inclusion of another category of ‘productive use’, which has been identified to be important for poor households in developing countries (Thompson et al., 2001; McGranahan et al., 2006; Katsi et al., 2007). The studies argue that meeting basic water needs is not just about health and hygiene and that providing water security can play a wider role in poverty reduction and improving livelihoods as safe and secure water is essential not only to poor people’s health but survival. This category includes uses such as brewing, animal watering, construction and small-scale horticulture which studies show are very important as sources of livelihood to low income households (Katsi et al., 2007).

Studies suggest that access to water source as measured in distance or time spent collecting or waiting at the water source has been suggested as the most important factor affecting not only source selection but also the per capita water used by households (Howard, 2002; Howard & Bartram, 2003). Other factors identified as possible determinants of water use in
general and per capita (levels of) water use in particular include availability, costs, regularity and reliability in supply (Thompson et al. 2001; Gulyani et al. 2005; Anand, 2006) quality as well as the purpose for which it is used.

With regard to water quality some studies suggest that where households use water from multiple sources, the purpose to which water is put may vary between sources. The decision or judgements by households to use different sources for different uses has been referred to as ‘the rationality factor’ (Almedon & Odhiambo, 1994). This concept taken from economists assumes that individuals are rational actors who generally choose activities that offer economic advantages in terms of private rates of return (Cameron, 2008). It presumes that rational action conveniently aligns individual and social decision-making criteria. Households are therefore assumed to behave like a rational individual and decisions are benign in terms of protecting members’ well-being. In terms of water use it implies different sources may be used for different purposes based on household judgements as to the acceptability of the source for each use (Solo, 1999; 2003). Therefore, households make rational decisions on the usages of water from different sources when they are not sure of the quality of water supplied by I&SSWPs. They may use the water for non consumption uses such as washing and flushing toilets where flush toilets exist, but resort to water from the official supply for drinking thus resulting into a differentiation in use of water in terms of perceived quality of the source. This view is also supported by Snell (1998). But Snell (1989) further argues that although poor urban residents maybe aware of the health benefits of better quality water, for reasons of convenience or poverty they may choose to drink lower quality water or reserve better quality water for drinking only. Other studies have found that differentiation in use may be seen only between protected and surface water (Ahmed et al., 1998; Howard et al., 2002).

4.5 Continuity
Continuity in water supplies, usually with regard to piped water supply, is often defined as the proportion of time (considered in terms of hours per day and days per year) that water supply is available for use (WHO, 1993; 1997; 2006).

Research suggests that continuity in supply is highly valued by consumers and is therefore one of the critical measures of adequacy in water supply (Howe & Smith, 1994; Koss &
Khawaja, 2001). It also indicates consumer satisfaction with a water supply system (Gulyani et al., 2005). Lack of continuity in water supplies may have several impacts. Firstly, it may result in increased water storage (WHO, 1997). But water storage may result in deterioration in water quality in several ways. Poor hygiene in water handling for example during transfer of water between collection to storage (e.g. Lindskog & Lindskog, 1988) and storage practices, for example, storage in unclean containers (WHO, 2002b), has been shown to result in deterioration in water quality. Size of storage vessel mouth (e.g. Mintz et al., 1995), hand-water contact and dipping of utensils (e.g. Hammad & Dirar 1982; Trevett et al., 2005), and bacterial regrowth within the storage container (e.g., Momba & Keleni, 2002) are also factors which contribute to recontamination of water in the home. Studies have also shown that pathogenic organisms can prosper in bio-films in containers (Jagals et al., 2003).

Through use of poorly constructed water storage containers, for example, evidence indicate that drinking water storage vessels designed without considering Dengue risks, may be breeding grounds for mosquito vectors that cause Dengue and Dengue Haemorrhagic fever and that some 2.5 billion people are now at risk from Dengue (WHO, 2002b).

However, the poor are at greater risk first because they may not be able to afford storage equipment. But they may also suffer because lack of means to buy storage equipment, may make them, in the case of piped water, to be the first to rush to take water that comes immediately after re-charging of the system which often tends to be of low quality. However, even where water storage is done, there are risks of water contamination in several ways as shown above and literature is full of evidence of stored water becoming contaminated at the point of storage (Esrey, 1996). Discontinuity may also force households to cut on the amount of water used (Thompson et al., 2000b; Gulyani et al. 2005). This may result in poor personal hygiene (WELL, 1998). There are also suggestions that frequent interruptions and unreliability in water supply force people including I&SSWPs serving them to use alternative sources leading to health risks where such alternative sources are of poor quality (WHO, 1997; Laurie & Marvin, 1999). Menard and Clarke (2000b) report that 50 percent of households which had access to piped water reported using well water as their alternative source of drinking water during times when the water system was not functional. In the same area well water was found to be heavily polluted, with well water samples having a mean of over 30,000 faecal coliforms/100ml; a contaminant level far higher than WHO guideline for bacteriological contamination of water set at zero faecal coliforms per
100ml of water, and even higher than the alternative system by Feachem (1980) that suggests that any water with over 1000 faecal coliforms/100ml is seriously hazardous.

Anand (2006) further points out that discontinuity in water supply may restrict functioning of households. The study argues that although households may take all appropriate care with regard to securing and storing drinking water as well as economise by lowering standards of hygiene e.g. in flushing the toilets (where such toilets exist) or in washing up (which though may lead to bacteriological contamination causing diarrhoeal or other diseases), when water supply is rationed and there is no certainty as to the hours/time when water will be supplied, a member of the household is forced to stay at or close to home, lest they miss out when water is delivered. Lastly, discontinuity may force people to buy from alternative providers or bottled water usually charged at high prices and is especially unaffordable to the poor.

4.6 Water costs

In urban areas most households rely either on official utilities or I&SSWPs and therefore pay a monetary cost for their water. A few may have self provision or collect water from free sources. This may be in contrast to rural areas where input through labour may be the only cost incurred by households and communities for access to water supply source (WHO, 1993). The cost of water is an area of interest in the study of water supply in general and for I&SSWPs in particular both in terms of unit cost and affordability of the water. Unit cost of water can be computed in two ways, first, is by dividing the reported total expenditure on water by the total water use, and the second method is by determining the unit cost/price of water from a given source (Howard, 2001; Collignon & Vezina, 2000).

Several studies (e.g. Lloyd et al., 1991; Lewin et al., 1996; Kayaga et al., 2003) suggest that the cost of water is considered by consumers as an important factor and therefore has a significant influence on household decisions or choice of water source and whether to commit to purchasing water from suppliers. Furthermore, the cost of water is suggested to have an impact on the quantity of water purchased and hence amount available for use. Merret (2002) distinguishes between two basic ways by which households may pay for water services. First is by means of a unit price, where payment is made based on the quantity of water received and second is by means of a fixed charge per unit time period of access to a service. The study suggested that in the first, households will adjust downwards the quantity
purchased the higher the price, while in the second there is a maximum charge above which the user will decline the service.

Literature indicates variation in water costs across the different types of sources and I&SSWPs, hence prices may vary according to source or provider type. It is further suggested that that high cost of water may bar some, especially the poor from getting access to water (World Bank, 2002; UNDP, 2006). Snell (1998) noted that the highest prices were charged by the mobile vendors (water truckers and carters) even though they also commanded the highest volume and were able to provide the most tailored service since their mobility gave them a choice over water sources. Solo (1999) found that trucked water was the most expensive in Latin America but was only four to ten times higher rather than 20 to 400 times common in literature. Oenga and Kuria (2006) also found that domestic users who bought water directly from mobile vendors paid more and Gulyani et al. (2005) observed that though the average cost for water supplied by I&SSWPs was high, it was the same for water from all types of mobile vendors who delivered water at the door.

Some reports have suggested that among I&SSWPs, local entrepreneurs and water truckers, who charge the highest tariffs, also tend to be the ones serving the highest proportion of the poor thus putting the poor at a disadvantage (World Bank, 2002; 2004; UNDP, 2006). But Collignon and Vezina (2000) in a review of ten Africa cities found that the customers of trucked water were mostly high income families, and high consumers with cisterns (private villas, government and business office buildings) or generally wealthier areas not reached by the official utility. In metropolitan Manila customer profiles for households that rely on the water truckers varied and were found not to be necessarily poor (WSP, 2004).

The high cost of water from tanker and other mobile vendors, could be due to a number of reasons. Solo (1999) observes that the cost of water from mobile sellers goes up in direct relation to the distance they travel and the number of alternative water sources available within the city, charging the same amount charged for the subsidised water from official utility where competition is high, but twelve times or more for customers living in outlying peri-urban areas where they are the sole suppliers. Collignon and Vezina (2000) add that the high cost, (US$ 2 to 8/m³) observed in their study for water delivered by water tanker trucks and hand carters was probably due to transport and labour input costs. However, high costs could also be due to high price paid for bulk water at the source (McGranahan et al., 2006).
Some studies suggest that standpipes/kiosks rank second in charging high prices. Gulyani et al. (2005) notes that where households buy water from standpipes/kiosks they tend to incur higher unit costs relative to prevailing utility price. Collignon and Vezina (2000) reporting on the costs of water for 10 African cities observes that standpipe water costs consumers close to the highest tariff rate where they pay about US$ 1 per cubic meter. A study conducted in Uganda by Howard (2001) reports that the cost of a 20 litre jerry can (0.02m³) of water purchased from public taps represents one of the most expensive forms of domestic water provision, with Uganda’s National Water and Sewerage Company supplying water to public taps at minimum charge of Ugandan shillings (UShs.) 30,000.00 (US$20; based on an exchange rate of 1500 UShs. to 1US$), for an equivalent of 75m³ or UShs. 9.36 per 20 litres (0.02m³) and the same is sold at UShs 33.33 per 20 litre (0.02m³). Gulyani et al. (2005) found that the average cost of water sold at standpipes/water kiosks in Kenya was Kenya shillings (Kshs.) 4.1 per 20 litre (0.02m³) jerry can which translates to Kshs. 205/m³ or US$ 2.7/m³. Oenga and Kuria (2006) further reports that the general price of water rises from US$ 0.15/m³ which kiosk owners pay the official utility, to US$ 2/m³ paid by households collecting directly from the kiosk.

### 4.6.1 Water affordability or per capita water expenditure

Affordability or ability to pay is a measure of the amount a household spend on water as a percentage of their monthly income (WSP, 2000; WSP, 2004). Anand (2006) suggests three elements of expenditure on water comprising direct expenses (such as payment made to water vendors), expenditure in terms of time spent collecting water and expenditure to improve the quality of water. In the literature, however, there seems to be confusion between affordability and willingness to pay (Merret, 2002; 2003; Bakker, 2007) among the poor, as discussed in section 2.3.1. For a consumer to be able to afford to pay water bills, they should be earning an income that covers basic needs. Affordability of bills thus depends on income and consumption or amount spent on living expenses. A lower percentage of income spent on water indicates that water supply is affordable and the poor have more to spend on other essential goods and services. High levels of poverty therefore correspond with low levels of affordability, making income a strong predictor of availability of water for households (Lawrence et al., 2002; Ntengewe, 2004). On average studies indicate that household in
developing countries may spend from 3 to 19 percent of their income on water (Thompson et al., 1997; Whittington et al., 1999; MacGranahan et al., 2006; Oenga & Kuria, 2006).

4.7 Water quality
Based on improved scientific understanding of the relationship between water and health, including the impacts from drinking water on human health, quality of water is of particular concern and water for domestic use should be safe. Safe or drinking water is defined as water having acceptable quality in terms of its physical, chemical, and bacteriological parameters so that it can be safely used for drinking and cooking (WHO, 2004). It is now well understood that potable water should be free from pathogenic (disease causing) microorganisms and chemicals that are harmful to human health. Safe drinking water should also meet the standard guidelines for taste, odour and appearance (Kirkwood, 1989; Gadgil, 1998; WHO, 2006).

4.7.1 Microbiological quality of water
The most common risk to human health associated with water stems from the presence of pathogenic micro-organisms and the most common and deadly pollutants in drinking water in developing countries are of biological origin. WHO (2006) notes that ‘the potential health consequences of microbial contamination are such that its control must always be of paramount importance and must never be compromised’. The great majority of evident water-related health problems and widespread health risk associated with drinking water are therefore a result of microbial contamination (WHO, 2006). In the case of microbes, health effects arise from acute exposure - a single glass of water may contain an infectious dose and lead to disease. Microbiological quality of drinking water is therefore a common concern to consumers, water suppliers, regulators and public health authorities because of the potential of drinking water to transport microbiological pathogens to great numbers of people resulting into illness (WHO, 1993; 2000; Ashbolt, 2004). Many of the water-borne microorganisms that are pathogenic originate from water contaminated with human excrement and to some extent, animal excreta. The greatest risk from microbes in water is therefore associated with drinking water that is contaminated with human and animal excreta, although other sources and routes of exposure (for example contact with it during washing or bathing) may also be significant (Gadgil, 1998).
4.7.1.1 Indicator organisms
The role of indicator parameters in drinking water is to act as an index (signal) of faecal contamination and therefore the likely health risk. It is therefore possible to minimise disease risk by defining the maximum allowable concentration of an indicator organism in drinking water. Such an indicator organism should have certain characteristics as discussed in other studies (Gadgil, 1989; WHO, 1993; Grabow, 1996; Ashbolt et al., 2001; Ashbolt, 2004; Clapham, 2004). Although no organism exactly fits all the required criteria, coliform organisms especially *Escherichia coli* (*E. coli*), have been widely used as indicators of faecal pollution (Gadgil, 1998; Ashbolt et al., 2001).

4.7.1.2 Other indicators
Apart from indicator bacteria, other simple parameters have been identified that are useful for analysing microbiological quality of water. WHO (2004), and LeChevailler and Au (2004) further recommends the use of turbidity and pH, and also chlorine residuals in chlorinated water supplies, in water quality monitoring programmes. These parameters are considered important as they may directly control microbiological quality (chlorine) or may influence disinfection efficiency (turbidity). High turbidity or very low chlorine may be a cause of concern as they imply reduced protection against contamination even in the absence of faecal indicator bacteria, while high turbidity may also indicate that sanitary integrity has been compromised (WHO, 1997; LeChevailler et al., 1981).

4.7.2 Sanitary Survey
Sanitary surveys or inspection deals with assessment of the likely hazards and risks a water supply may be exposed to in relation to faecal contamination (Lloyd et al., 1991; Lloyd & Bartram, 1991). The method employs a combination of visual assessment and interviews using questionnaires. According to WHO (2004) the questions in a sanitary survey are structured in a ‘Yes’ and ‘No’ format such that a ‘Yes’ shows that a risk is present while a ‘No’ indicates absence of a risk. When the answer for a question on a risk is ‘Yes’ a score of 1 is allocated while a ‘No’ answer gets a zero score, allowing determination of overall risk for a given water source.

The origins of sanitary inspection can be traced back to the earliest attempts to monitor and control microbial quality of water (Bartram, 1996). However, they remain an effective tool
for monitoring microbial quality and has been consistently promoted not only by WHO (WHO, 1976; 1993; 1997; 2004; 2006) through the Guidelines for Drinking Water Quality as part of Water Safety Plans, but also by regulatory bodies (USEPA; 1999) and in texts on standard methods (APHA et al., 2000; WHO, 1976; 1985; 1993). Water safety plans is by preference developed for each drinking-water systems. However, as this is unrealistic for small systems, specified technology water safety plans or model water safety guides for their development are in use. These may also include guidance on household water storage, handling and use as well as be linked to a hygiene education programme and advice to households in maintaining water safety (Water, Sanitation and Health Team, 2003).

4.7.3 Chemical water quality
Although the great majority of evident water-related health problems are the result of microbial contamination, an appreciable number of serious health concerns may occur as a result of the chemical contaminants in drinking water (WHO, 1993; 1997; 2004; Gadgil, 1998). However, chemical constituents may cause adverse effects only after prolonged periods of exposure unless there is massive accidental contamination of drinking water supply (WHO, 2004). And although mass poisoning of water by chemical contaminants does occur, the concentration level required for many chemicals to induce acute effects cause significant bad taste and/or colour which would lead consumers to reject it (WHO, 1993; 2004). Consequently, even though many chemicals may be found in drinking water, the chemicals which are of immediate health concern are fluoride, nitrate and arsenic for which there is evidences of strong health risk (Murray, 1986; WHO, 1997; 2001; 2004).

4.7.3.1 Fluorides: sources, effects, measurements and guideline values
Fluorides originate from the weathering of fluoride-containing minerals and thus may occur naturally (WHO, 2001; Fewtrell, et al., 2006). The concentration may vary from trace levels to several milligrams per litre (Dinesh, 1998; WHO, 2006). Fluoride enters surface water with run-off, but concentration is usually low ranging from 0.01 to 0.03 mg/l (Msonda et al., 2007). However, WHO (2001) points out that some natural water ways particularly rift valley lakes, may contain concentrations of between 0.05 to 100 mg/l or even higher. Levels of fluoride may therefore be a problem in ground water sources in Kenya and Ethiopia given that they are part of the Great Rift Valley. The effects of fluoride on human health are shown in Table 4.1.
Table 4.1 Effects of fluoride on human health

<table>
<thead>
<tr>
<th>Fluoride concentration (Mg/L)</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1.5</td>
<td>Safe limit (WHO Guideline limit)</td>
</tr>
<tr>
<td>1.5 – 3.0</td>
<td>Dental fluorosis (discoloration, mottling and pitting of teeth)</td>
</tr>
<tr>
<td>3.0 – 4.0</td>
<td>Stiffened and brittle bones and joints</td>
</tr>
<tr>
<td>4.6 – 6.0 and above</td>
<td>Deformities in knee and hip bones and finally paralysis making the person unable to walk or stand in straight posture, crippling fluorosis</td>
</tr>
</tbody>
</table>

4.7.3.2. Nitrate and Nitrite: sources, effects, measurements and guideline values

Due to soil leaching nitrate occurs naturally in groundwater although this rarely exceeds 0.1 mg/l (Fewtrell, 2004; WHO, 2006). Other sources of nitrate include application of fertilizers, which has the potential for increasing the nitrate concentration to very high levels. Leaching of waste water and other organic wastes into surface and groundwater are also major sources particularly in areas where there is a lot of development on the surface (Cronin et al., 2006a; 2006b).

Determination of nitrate plus nitrite in surface waters gives a general indication of the nutrient status and level of organic pollution. High levels of nitrate in water, poses potential health risk some studies (Fewtrell, 2004; WHO (2006) suggests that it should also be measured in drinking water sources. Nitrate and nitrite in water has been associated with methaemoglobinemia, also known as “blue-baby syndrome” where nitrate is reduced to nitrite in the stomach of infants and nitrite is able to oxidise haemoglobin (Hb) to methaemoglobin (metHb), which is unable to transport oxygen around the body, especially in bottle-fed infants (Clapham, 2004; Fewtrell, 2004; WHO, 2004; 2006). Excess nitrate is known to cause several effects like holes in the heart, discours the skin and impairs the digestive system among others. The WHO recommended guideline value for nitrate is 50 mg/l for nitrate (11 mg/l NO3-N).
4.7.4 Source water quality and household response

It is often considered that the source of water used makes I&SSWPs provide water of variable and especially poor quality. However, WHO (2004) observes that some I&SSWPs may also transport water in inappropriate containers, which has the potential to increase contamination. The potential for water quality to deteriorate after collection is well documented in many water quality studies (Esrey et al., 1985; 1991; Esrey, 1996) and as discussed in section 4.5.1. Consequently some studies have suggested that source water quality may not therefore be as important as the quality at the point of use (Esrey et al., 1991; Esrey, 1996). However, recent meta-analysis of several studies (Fertwell et al., 2005a) shows that quality of water at the source still remains important especially considering the health implications of using water of poor quality. Furthermore, studies show that good quality water has significant effects on reduction of diseases associated with poor quality water especially cholera, the leading child killer. In addition, while post source or treatment contamination may only affect a few people, for example, members of a household, source contamination usually affects a larger population and hence put a very large number of people at risk.

Collignon and Vezina (2000) argue that the quality of water provided by I&SSWPs is the same as that of water from the mains and may be better than that drawn and carried home by buckets. The report observes that where I&SSWPs get water from official network, the quality of water they deliver mainly depends on the quality of water in the network which in turn depends on effective treatment at source, as it leaves the reservoir and reducing pressure loss, which may lead to contamination through infiltration of waste water.

4.8 Conclusion

For water provision, source of water, access to water source (as measured in distance from the source or time taken to collect water), quantity available, the use water is put to, continuity (measured in hours of service) or reliability, cost of water as shown in unit cost and affordability, and quality are the basic indicators of water supply. Due to lack of or poor water services by official utilities, households resort to using various sources. These may include piped water available through shared yard taps and in some cases through water selling points like standpipes/kiosks, which are part of I&SSWPs described in Chapter 3 as sellers/vendors without own sources. Other sources are those abstracted from groundwater.
through boreholes, wells, and springs, thus private producers among I&SSWPs as described in the previous chapter. Due to the absence, poor service, or deterioration in water supply from official water utilities, use of multiple water sources, including those from I&SSWPs, may therefore be a common phenomenon, but I&SSWPs if considered only as water vendors, are currently considered an unimproved source.

With multiple water sources available, households decide daily where to get water from. Decisions or choice of water source may be determined by water availability, ease of access, quantity required for use, perceived quality, which may include colour, odour, and taste, and the use it is intended for. The review has suggested that, quantity of water and use is closely interlinked and that quantity of water collected is mainly determined by the use it is intended for. In domestic water supply, three main types of uses include consumption (drinking and cooking); hygiene, covering basic needs for personal and domestic cleanliness, and amenity use. Recent studies have suggested the inclusion of a category of 'productive use', where water is used in small-scale daily subsistence activities important for meeting basic needs and enhances people's livelihood options through multiple benefits such as income, food security, improved nutrition and health, which assist in the fight against hunger and poverty.

It has further been argued and shown that among other factors, access especially as measured in terms of distance or time taken to get to a water source has influence on choice of water source and therefore the possible use of sources including the use of I&SSWPs. It is further suggested that households show willingness to trade off using good-quality water sources with the effort it takes to obtain it. Access also influences the quantity available for various uses. But quantity of water collected and used by households from a water source may also be influenced by the cost of water and service level as measured in terms of continuity or reliability. The last two mostly presented as a measure of adequacy in water supply but may also be an indicator of consumer satisfaction.

Water costs—both unit cost and affordability, is an important indicator of water supply, and a major determinant of uptake of piped water services but also source of water to be used where multiple sources are available. High cost may lead to several impacts including lack of connection due to depressed affordability which in turn leads to water storage and the potential for contamination related to handling and storage, reduced amount for consumption...
and hygiene, and use of alternative sources of poorer quality and the attendant health effects. There is variability in costs depending on the source.

In terms of quality, majority of evident water-related health problems are the result of microbial contamination, but an appreciable number of serious health concerns may occur as a result of the chemical contaminants in drinking water. Microbiological quality of water can be determined using indicator organisms with *E. coli* (or as an alternative, thermotolerant coliforms) as the preferred indicator organism for monitoring drinking water quality or bacterial contamination of drinking water. Some water sources including I&SSWPs may provide water of questionable quality in terms of its physical, chemical, and bacteriological parameters such that it is unsafe for some uses. However, among I&SSWPs, it is also argued that mobile vendor suppliers may transport water in inappropriate containers which can result in contamination of otherwise good quality water. The literature also suggests that when there are several sources, the choice of water source and water use may be subject to quality, with suggestion that where multiple sources are available, households will select source based on the use its intended for. It is argued that households will behave like rational individuals and make decisions on the usages of water from different sources hence different sources may be used for different purposes based on household judgements as to the acceptability of the source for each use. Further there are suggestions that, actual health risks from water consumed by households may be substantially different from apparent risks if the purpose for which water is used does not predispose the users to any risks or if households take measures to improve water quality at home/point-of-use.

For chemical quality, even though many chemicals may be found in drinking water, the chemicals which are of immediate health concern are fluoride, nitrate and arsenic for which there are strong health risk evidences. Although arsenic as a problem in drinking water is also important it has been documented only in specific areas. Fluorides and nitrates, however, tend to be widespread and should be determined particularly in instances of use of groundwater by households. The next chapter presents materials and methods used in collecting and analysing data related to these indicators with regard to household un-served or inadequately served and who may be dependent on I&SSWPs and among I&SSWPs.
Chapter 5 Materials and methods used in the field study

5.1 Selection of study sites in the two case study areas
Consultations and discussions were done with representatives from the official water authorities; AAWSA in Addis Ababa and KIWASCO in Kisumu, and other stakeholders including related government agencies/ministries and NGOs, to establish areas which met the criteria of being poorly served or un-served by the official utilities. In addition reviews were done on available records and documents to further corroborate the accuracy of areas identified. Lists of possible target areas were generated after these initial discussions and review of available documents. Equipped with the list of the target areas, reconnaissance surveys or rapid urban appraisal (Chambers, 1994) was conducted in the identified areas during which poor water supply services by the official utility, the main sources of water used, including possible use of other sources and hence possible use of I&SSWPs, were further confirmed.

5.1.1 Stratification of study sites
In consultation with people on the ground including representatives from the official water utilities and others as indicated above for Kisumu, two levels of stratification were used with water availability defining the first level of stratification and socio-economic status the second level. The main method of stratification was done based on water service level or water availability. The water availability measure, also known as water economy, was composed of an estimation of the proportion of households using piped water supply (Howard, 2002; Anand, 2006). Water economy was used to categorise estates by the water source used. Categories of water economy/availability were defined as shown in Table 5.1 below. Areas that were identified as poorly served by the official water utility, hence most likely to use I&SSWPs, other or non-piped sources were deemed the right focus and were selected for the study.

Estates identified from consultations and reviews with official water authorities and key stakeholders and through stratification by water economy were many and so could not all be covered within the time limits available for the study. To further focus on areas suitable for inclusion in this study, the city was further stratified according to level of income. This was
undertaken by reviewing census data to identify the various income levels and locate each area/estate in the right socio-economic group. Urban centres in Kenya are divided into discrete zones based on existing national definition of urban socio-economic strata by the Central Bureau of Statistics (CBS, 1999). The Poverty Analysis and Research Unit in CBS stratify major urban areas in Kenya into five categories of living standards: upper, lower upper, middle, lower middle and low. This classification is based on income or calculation of the cost of buying the ‘necessities’ calculated as needed by different types of households to maintain physical efficiency and other socio-economic indicators such as housing type (GOK, 2004). This is done using a very comprehensive Core Welfare Indicators Questionnaire, which after close scrutiny based on what was suggested in the literature was deemed adequate. Households whose total income is insufficient to enable them to purchase these necessities are described as low income. For this study, the socio-economic status was therefore used to broadly define different areas into poor (the last two: lower middle and low) and non-poor (upper, lower upper and middle according to CBS). Using this criterion estates falling under same income level were grouped together as poor or non-poor and numbers were assigned to each and a random sample was picked for the study. The areas selected were thus considered representative of the two groups.

Table 5.1 Categories of water availability/economy

<table>
<thead>
<tr>
<th>Category</th>
<th>Reconnaissance/Rapid urban Appraisal</th>
<th>Reviews and discussion with official utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainly used piped water</td>
<td>No point sources</td>
<td>Most households have own connection and 50% may get water regularly</td>
</tr>
<tr>
<td>Mixed use of piped and point</td>
<td>Own connections, point sources and PWTs/standpipes recorded</td>
<td>Households have connections but may not get water</td>
</tr>
<tr>
<td>water sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mainly using other or point</td>
<td>Few report using own connections, PWTs/standpipes and other point sources recorded</td>
<td>Few or no own households connections and may not get water</td>
</tr>
<tr>
<td>sources</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Addis Ababa on the other hand has a mixed development where poor and non poor live in juxtaposition, owing to its origins and general lack of planning. After discussions and review of records during the first fieldwork visit, water service provision level based on the number
of connections to the official network was used to classify the kebelles (smallest city administrative units) and a list generated for poorly served areas. The list generated, however, automatically targeted the new, some upcoming and other recent settlements, which according to connection reviews and discussion with stakeholders were poorly served or estimated to have less than twenty percent of households with direct tap connections. Based on the lists generated a random sample was picked using same method as above. Areas selected were of mixed socio-economic status, although, some were predominantly poor and others non-poor. Table 5.2 gives a summary of areas in Kisumu (estates) and Addis Ababa (kebelles) selected for the study during the first fieldwork visit, while figure 5.1 and 5.2 show their locations in Kisumu and Addis Ababa respectively.

Table 5.2 Areas selected in each case study city during the first field visit

<table>
<thead>
<tr>
<th>City</th>
<th>Estate/kebelle</th>
<th>Income level</th>
<th>Main water supply sources used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kisumu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manyatta</td>
<td>Poor (informal / slum)</td>
<td>Point sources, few taps, mobile vendors and standpipes/kiosks recorded</td>
<td></td>
</tr>
<tr>
<td>Migosi</td>
<td>Non Poor</td>
<td>Point sources, few taps standpipes/ kiosks and mobile vendors recorded</td>
<td></td>
</tr>
<tr>
<td>Nyamasaria</td>
<td>Non Poor</td>
<td>Mainly point sources, two standpipes/kiosks and mobile vendors recorded</td>
<td></td>
</tr>
<tr>
<td>Obunga</td>
<td>Poor (slum)</td>
<td>Mainly standpipes/kiosks recorded few other point sources</td>
<td></td>
</tr>
<tr>
<td>Addis Ababa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kebelle 01 (Ayer Tena)</td>
<td>Mixed mainly poor</td>
<td>Taps, yard taps and public water taps (PWTs)/bonos recorded</td>
<td></td>
</tr>
<tr>
<td>06- (Betel)</td>
<td>Mixed mainly non-poor</td>
<td>Taps, and PWTs/bonos recorded</td>
<td></td>
</tr>
<tr>
<td>Keranio</td>
<td>Mixed mainly poor</td>
<td>Taps, yard taps and PWTs points/bonos recorded</td>
<td></td>
</tr>
<tr>
<td>Kebelle 01 (Lebu)</td>
<td>Mixed mainly non-poor</td>
<td>Mainly taps but few PWTs/bonos recorded</td>
<td></td>
</tr>
<tr>
<td>Woyera</td>
<td>Mixed mainly low income</td>
<td>Few taps, yard taps and PWTs</td>
<td></td>
</tr>
</tbody>
</table>
Figure 5.1 Map of Kisumu with areas selected for this study highlighted.
Source: Improved from base map obtained from UN-HABITAT (2005)
Note: The whole city is subdivided into smaller units known as sub-cities and kebellees. The kebellees' boundaries are only shown for the sub-city areas which were sampled. 00 codes indicates kebellees whose codes were unclear from the source maps.

Figure 5.2 Map showing sub-city areas and kebellees selected for the study in Addis Ababa.
Source: Improved from base map provided by the City Government of Addis Ababa

5.2 Water usage study
The water usage study was undertaken in the selected estates/kebellees shown in Table 5.2, figures 5.1 and 5.2. As a core part of the water usage study water sources used by
households including use of various categories of I&SSWPs, criteria for selection of water source/suppliers and continuity or reliability of the sources used were determined. In addition, water usage and factors considered in selecting water obtained from various sources for different uses, quantity collected, costs and socio-economic characteristics of the respondents were also determined. Other reports (McGranahan et al., 1997; UNICEF, 1995) suggest that broad spectrum surveys using a household questionnaire was appropriate to obtain the information required hence a questionnaire (shown in Appendix A) was developed for the study.

5.2.1 Research questionnaire development
The questionnaire for household survey (Appendix A) was developed by the researcher using background knowledge obtained from literature review and with reference to other available questionnaires used in other studies on water sources and water use. Questionnaires/checklist of questions were also developed for each category of I&SSWPs, one for water sellers without their own sources (Appendix B) and another for those with own sources or producers (Appendix C) and used during the study. There were no previous questionnaires for I&SSWPs and only background information gathered from literature was used in developing the questions.

Questions focusing on the key areas outlined above were included in the questionnaires. The questionnaires included the likely sources and categories which were subdivided further to account for the variety in source types and of I&SSWPs as had been revealed in literature review and also to ease data collection by simply ticking the appropriate choice. The questionnaire also included a number of predetermined categories covering domestic uses, costs and reasons for the selection of the source and for source use, but also allowed free responses to a set of questions regarding the same to capture any information that may have been left out by the preset questions and also where it was felt that no pre-set categories could be defined. In addition, data was also collected on socio-economic characteristics, which family members collected water, household response to perceived quality (i.e. whether water was treated within the home).

The questionnaire was sent out for comments among colleagues and people with knowledge on questionnaire development. After the comments were incorporated, a sample of about
twenty questionnaires were sent for pre-survey testing amongst the households in the case study cities (eight in Addis Ababa and twelve in Kisumu) and five were sent to professionals with knowledge of the case study areas (two in Addis Ababa and three in Kisumu) for their expert views. The corrections and views that could be accommodated were incorporated before commencement of data collection. Data source triangulation for the questionnaire data was done by interviews and observations (Stake, 1995; McGranahan et al., 1997, Fielding et al., 2002).

5.2.2 Questionnaire administration
Using the preset questionnaire, a survey of households from different socio-economic backgrounds was carried out. In Kisumu the questionnaire was also translated in Swahili but was administered in both English and Swahili depending on the language the respondent was most familiar with. In Addis Ababa due to language limitation, a research assistant fluent in English and local language (Amharic) was recruited and trained. The questionnaire was translated in Amharic to provide the research assistant with a clear understanding of the questions and reduce the need to translate while conducting interviews which would have been more time consuming. Both translations were back translated to English to ensure accuracy in translation. The Amharic version was only used while interviewing respondents. Answers were afterwards re-recorded in the English version by the same research assistant who conducted the interviews to ease data analysis later by the researcher. The translations were further counter-checked for accuracy by a second person.

5.2.2.1 Criteria for selection and number of participants for household questionnaire administration
The target population were households living in areas classified as un-served or poorly served by the official water utility and thus were likely to use I&SSWPs or other sources available as well as representative of the various socio-economic groups. In Kisumu households were selected using systematic random sampling procedure (Barnett, 1991), which allowed for unbiased representation and ensured quality control of the gathered information. From an initial central starting point, the interviewer moved along a transect line through the estate. Access roads used in the settlement were used and every 20th house on the right or left on alternating days was picked and approached to answer questions as outlined in the questionnaire. In Addis Ababa finding respondents proved difficult using the
systematic random sampling procedure. This was partly due to the unwillingness of most households to participate in the study. Starting from a randomly selected sampling point in the settlement, the researcher and her assistant had to often use referral or snowball sampling (Sturgis, 2008), where a respondent who accepted to participate would in turn help in introducing the researcher to the next respondent they thought would be willing to participate thus helping in getting other respondents.

For those who accepted, at each household the participant was given a participant information sheet to read and if they agreed to participate, they signed a consent form to demonstrate informed consent. The participant information sheet (Appendix D) contained the name of the researcher, the purpose of the study, how the data would be used and guaranteed confidentiality as well as an avenue for complaints if any participant was not happy with how they were handled during the study. For the households picked, preset questions were administered to any respondent present and willing to answer the questions. If a household declined to answer questions, the next house that agreed to do an interview was selected to replace it, and this was done so as to adhere to ethical guidelines for research that households were free to accept or refuse to participate. Although women were the preferred respondents for the household survey as literature generally suggest that they are the principal household water managers, an adult male or children over the age of 14 response to questionnaire was also deemed appropriate. They were considered knowledgeable enough to answer questions related to water usage.

5.2.2.2 Criteria for selection and number of I&SSWPs participants
Independent and small scale water providers were identified during the household water usage study by households being asked to identify where they sourced their water from. Those identified were later approached to establish if they were willing to participate in the study. Care was taken to include appropriate number of the various types that were identified. For those who accepted, the same procedure in signing consent form as with households was followed. In Addis Ababa although reselling of water supplied to households was identified as a source of water, even appearing as a first or second choice of water for some households during the water usage study, the household sellers approached were generally reluctant to answer questions in the questionnaire and therefore mainly unstructured interviews were used in their case.
5.2.3 Interviews

Interviews were conducted with selected I&SSWPs from the various categories, officials of the water companies, other stakeholders from NGOs, government ministries, some households and local authorities. Questions for interview guide were developed guided by the research objectives and based on background information gathered from the literature review. Examples of interview schedules used are shown in Appendix E. Open ended questions were asked to stimulate and provide interviewees with the freedom to talk in order to provide important information. For I&SSWPs the questions asked were aimed at how they operate, their customers or markets, how their businesses functioned and the environment in which they operated including the different sources they got their water from, their customers, their attitude towards the services they provided, including the quality and costs of water.

For other stakeholders, interviews were used to gain more understanding of their view points, attitudes and perception of the role of I&SSWPs or water vending in domestic water supply and the potential for improving water supply provision through I&SSWPs. Information concerning any involvement with I&SSWPs as well as any policies and plans related to working with I&SSWPs were also established during the interviews. The researcher ensured that the purpose of the research was clear to each participant before each interview. With permission of interviewees, voice recorders were used to record the interviews.

Other personal or semi-structured interviews and observations were also used to collect data. The semi-structured interviews were conducted with selected household respondents following the household surveys. The interviews were used to follow up the questionnaire and as a methodological triangulation to improve on the reliability of data gathered through questionnaires. They were also used with I&SSWPs when water sampling and sanitary survey for water quality monitoring were conducted. The information from semi-structured interviews and observation was used to evaluate the reliability of the data obtained through the questionnaire and to assess any bias. This was done by checking whether there were discrepancies between questionnaire data and data from observation and interviews (Openheim, 1992), thus validating data from the various sources. To further reduce any
errors, discussions with research assistants were used to re-check and clarify ambiguous responses from interviews. The recorded interview data were later transcribed word for word and any points deemed important but unclear were followed with the interviewees to seek clarifications.

5.2.4 Focus group discussions
Another tool used in the field for gathering data was focus group discussions (FGDs). Three FGDs were held, two with handcart vendors and one with producers (well owners) in Kisumu. The purpose of FGDs was mainly to understand the environment in which the participants operated, pre-water selling activities, what pushed them/motivation to join water selling, how they got into water selling, the perception of their work in comparison with other informal jobs, how they operate for example in getting customers to sell water to, their relationship with each other and customers and to establish if there was any collusion in their operation for example in setting price. Benefits from their work, what they felt are their challenges and how they felt their services could be improved were also established. For well owners, discussions focused on getting the general view of their role as providers of water, their relationship with other water providers, their feelings/attitudes towards the service they provide particularly quality of water and possibility of improving their services in water supply. No FGDs was conducted for standpipe operators in both case studies as it proved difficult to organise, therefore individual interviews were used for this group.

For the handcart vendors the two focus groups were conducted in two different hired halls within Migosi in Kisumu on separate days during the second fieldwork. For the well owners the FGD was conducted at a hired community hall (in Manyatta) which was accessible to all. Each FGD was conducted in the afternoon, when the vendors had sometime they could spare as morning times were very busy. Each participant registered upon arrival with a research assistant giving details of their names and areas they served. The researcher facilitated the discussions which were recorded using digital voice recorders with permission of the participants.

5.2.5 Workshops
After first and second field work visits, data analysis was done and reports prepared on the findings. These were shared with stakeholders at two workshops, one in each of the case
studies. The workshop participants included representatives from all groups that participated
in the study, officials from various institutions dealing with water supply and water
resources management and policy issues as well as NGOs and the academic world.
Following presentations of the results from the researcher and other key players in the water
sector, questions and comments as well as discussions were conducted. Throughout the
workshops data were taken down in point/note forms by two appointed participants.

5.3 Themes/areas of data collection
Data was collected on various aspects of water supply from a household perspective using
water supply indicators as further shown below. Data was also collected from I&SSWPs on
various aspects of the water supply business. Although many of these aspects like costs
overlapped, collecting data both from a household perspective and that of I&SSWPs was
important as they concentrated sometimes on different aspect but at other times was a
validation as well as a source triangulation.

5.3.1. Water sources
Methods used to collect data on access and sources of water involved:

- Discussions and interviews with official water suppliers and review of existing data
  on piped water supply availability including number and different types of
  connection to water covering households with water
- Identification of water sources available to the population without direct connection
  to their house or plot;
- Studies of water usage using questionnaire

The first two sets of data relate solely to the availability of infrastructure as a means of
determining which water sources were available for use by the population and, therefore,
where data on other indicators were of interest. The third set of data related to the actual
uptake of services within the urban areas.

5.3.2 Discontinuity in water sources
Discontinuity was defined as the physical absence of water flowing from a water source that
usually provided water but not as a result of disconnection due to non payment. In addition
to interviews with official water suppliers, to ascertain whether there was a systematic rationing of water supply, discontinuity data on water sources were collected in three different ways to reflect the different causes, predictability and frequency of occurrence. As literature had suggested that households were likely to use more than one source, they were asked questions regarding whether their first and second water sources ever experienced supply interruption and followed by how often this occurred with responses categorised as either: everyday; at least once a week; at least once a month; in the dry season; or only occasionally (part B section 1 of Appendix A).

During questionnaire administration as well as interviews with I&SSWPs, both producers and sellers were asked if there were times when they were not able to provide water to their customers and the reasons why. Sellers were asked if their sources were reliable (provided water all the times). They were further asked about the frequency of discontinuity, whether daily, monthly, seasonally or occasionally. Seasonally and occasionally were differentiated by their predictability, with seasonal shortage reflecting an event that occurred every year or most of the year(s) and occasionally being an unpredictable event. Data on discontinuity of different sources used were also collected during sanitary inspections, with respondents asked whether they had experienced interruption in supply within the previous one week. Any positive answer was taken as indicating failure or discontinuity.

5.3.3 Water usage
Data collected on water use was twofold. The first aspect was the purpose for which water was used. The second dealt with the amount/quantity of water used or per capita water use.

5.3.3.1 Water use: purpose of use
This involved establishing the sources and water usage, and for each source, the purpose for which the water was collected (usage/uses), factors considered in selecting source for a given use and thus establish whether there was a differentiation in use of water by source type, and identify the reasons for using particular water sources for given uses. The following questions were used to guide data collection and thus the framing of questions in the questionnaire:

• For what purposes is water used?
• Which source of water was used for what purpose?
• What factors influence households' choice of water sources and/or suppliers and usage of water from different sources?

5.3.3.2 Quantity of water used: per capita water use
Where households buy water, the quantity of water collected is also important in determining the amount households spend in buying water and hence its affordability. The collection of data on water quantity was done through water usage studies. As shown in the household questionnaire (part B section 1 of Appendix A). The participants were asked the size of container used to collect water and how many containers were collected and used by the family each day from each source where multiple sources were used, but free sources were not included. Data were also collected on the number of people residing in the house (Section 3 of Appendix A). A per capita figure of water consumption was obtained for each household using equation 5.1 below (Howard, 2002).

\[
V_{pc} = \frac{V_c \times N_c}{N_h}
\]

Where:
- \(V_{pc}\) = Volume per capita collected
- \(V_c\) = Volume per container used
- \(N_c\) = Number of containers collected per day
- \(N_h\) = Number of people residing in the house

The calculation was based on water collected from the two main sources because most households relied on multiple water sources. This data was also important in helping to estimate daily expenditure on water, hence water affordability.

5.3.4 Water costs
The study was designed to examine water costs and rank water use in the household budgets, thus affordability of water. Data was collected on cost paid by households for water, the selling price of water at the different sources or collection points and also that of water delivered at the doorstep by mobile I&SSWPs where they existed.

During water usage studies respondents were asked how much they paid and for what volume of water and the equivalent cost per standard 20-25 litre jerry can (the most common container used for collecting water) was calculated. They were also asked if they paid
different amounts for water from different sources and if the costs changed at different times. Since different supply chains were identified, the cost was followed along the different supply chains. The purpose was to determine how price increased at the different points in the various supply chains and if households were disproportionately charged.

Data on costs were further collected from I&SSWPs, as a data source triangulation method to establish if water costs remained the same. For I&SSWPs with own sources of water (producers) they were asked how much they sold the water and if the sale price changed by customer type and at different times. Water sellers without their own sources (non-producers) were asked how much they bought the water at the source, sold the water to their customers, if the price changed and what made them to change the price. This was validated against data collected from households, and also from producers such as well and borehole owners and other sellers like standpipe operators. Apart from establishing the cost to household and thus corroborating data gathered on the same from households, the data from producers and sellers was also used in assessment of the water selling business.

The cost for piped water supplies was done in each case study through review of official utility records. Data on costs were collected from the water companies (AAWSA and KIWASCO) regarding the tariffs applied for different levels of service to act as a comparison to the data collected on water costs at the point of collection. Some of this data was available and was obtained via leaflets from AAWSA and KIWASCO. It was also obtained from review of company records and from interviews with water company representatives.

Within costs, affordability or ability to pay, a measure of the amount a household spent on water as a percentage of their monthly income (WSP, 2000; WSP East Asia- 2004), was determined. For a consumer to be able to afford and pay water bills, literature reviewed in Chapter 4 had suggested that they should be earning an income that covers basic needs such as food, clothing and shelter, education for children, health care and energy. To determine affordability data was collected on income from households during the water usage study. However, since it is not easy for households to keep track of or break down their expenditures on every item of basic need especially food and clothing, data on average house rents (shelter) where available and average incomes were the proxy indicators that were felt could easily be remembered and hence were used during data collection. Data was also
collected from secondary sources, including average per-capita income for the study sites, average consumption, and general poverty and food poverty levels. In addition data were collected on average quantities of water used by households as shown above to help determine expenditure on water. A lower percentage of income spent on water indicates that water supply is more affordable and the poor have more to spend on other essential goods and services.

5.3.5 Socio economic status of those served by I&SSWPs
Socio-economic status of respondents was determined during the study. This was determined by reviewing population census data initially to determine areas to be targeted by the study. In addition to water availability, estates in Kisumu were therefore selected based on their socio-economic status to represent various income levels that were un-served or poorly served. However, since urban centres may be more complex than captured by census data, further data on socio-economic status was collected. Furthermore in Addis Ababa the kebellles selected were of mixed income owing to the mixed development nature of the city and therefore this research needed to also collect data on income levels.

Based on the information available and gathered from the literature review, a range of possible variables were identified to be included in the questionnaire. However, after reviews of documents from case study sites and comments from questionnaire testing only six variables deemed as most sensitive to the socio-economic status within an urban context were finally included in the questionnaire. In addition to estimates of household income, data on socio-economic status were therefore collected on roof material type, floor material type, persons per room, educational attainment, main source of livelihood, and average household size as captured in section 3 of the household questionnaire in Appendix A.

5.3.6 Assessing perception and satisfaction with I&SSWPs
Data on perception of I&SSWPs were collected during water usage study using questionnaires and also in interviews and FGDs. In the questionnaires open question were included asking respondents whether there was anything they liked about their water sources or I&SSWPs and what it was that they liked. The literature reviewed suggested that views about water source or suppliers like I&SSWPs would be based on the context of water supply (i.e. whether I&SSWPs provide the capital and infrastructure that makes water
available in the otherwise ignored areas) as well as specific aspects of water supply such as cost of water, quantity of water available per capita, reliability/continuity and quality. Water users were therefore asked their opinions and satisfaction with these aspects for their first water sources specifically and with general water supply provision by I&SSWPs. In the household questionnaire such questions were scattered in each section dealing with each aspect of water supply. For example those dealing with water sources were in question seven through 14 in part A of section one, those dealing with quantity, reliability and cost were in question seven in part B of section one and those dealing with quality were in question five of part D of section one.

5.4 Monitoring of water quality
An assessment of the quality of water -both microbial and chemical- from the different water sources identified by households as their main sources including I&SSWPs, within the case study areas was carried out. During the household survey, respondents were asked to identify the water sources they used. Samples were picked from these sources for determination of source quality. The principal focus of water quality monitoring were the critical parameters identified by the WHO (1993; 1997; 2004) and as discussed in section 4.7. The parameters analysed were thermotolerant coliforms (TTC), turbidity, pH, nitrates, fluorides, free residual chlorine and total chlorine. Nitrates and fluorides were determined only for groundwater sources. Chlorine residual and total were determined only in piped supplies.

5.4.1 Sampling programme
Water sampling from various sources was done based on descriptions given in section 4.7.1.7. Water quality monitoring requires data collection to take into account significant temporal and spatial variations. Two sampling programmes were defined for wet season and for dry season to provide a reasonable estimate of the water supply conditions and variations over time and season. Sanitary inspections were undertaken whenever samples were collected. During the second field study water quality monitoring was not done for Addis Ababa.
5.4.1.1 Piped water supplies
Samples (500ml) were taken from existing water points (e.g. standpipes or public water points, household taps) where households’ access water for use and mobile vendors, where they existed, frequently collected water for sale. In both Addis Ababa and Kisumu some taps outside the target estates/kebelle were visited and samples collected from points around the two cities to put the key areas studied in the context of general city water quality. Where respondents with taps in houses and household resellers allowed, water was also taken from their taps within the households. Given that the areas selected for study focus were those unserved or poorly served by the official piped network and the limitations experienced, sampling for piped water supplies could not therefore be based on population as recommended by the WHO in the guidelines for drinking water quality (WHO, 1993; 1997; 2004) but on practical considerations of the number of samples that could be taken from available outlets under those conditions. Samples were stored in ice before processing to allow for overnight incubation. Processing was, however, done within six hours.

5.4.1.2 Point water supplies
Water samples (500ml) were collected from the various point sources used by households as a main or second water source within each estate/kebelle selected for study. The sources were mainly wells, boreholes, as well as mobile vendors (hand carters) particularly in Kisumu. Two sampling programmes were defined for wet season and dry season to provide a reasonable estimate of the variations over time and season.

5.4.1.3 Household water storage
The sampling and monitoring of quality of water stored in household containers was undertaken in selected households within the target estates/kebelle during the two field studies in Kisumu and the first field study in Addis Ababa. From each household samples of water were drawn from containers in a similar manner with how each household usually did. Where storage jars had taps water was collected from the tap and where there were small containers used for drawing water from the storage container, water was drawn from the container using the same jar. The desire was to collect samples in the same manner as the users and therefore obtain the quality of water as was possibly obtained by the users. In Kisumu different storage containers were used based on where water was obtained from,
hence samples were picked from each storage container to determine the household quality of water obtained from the different sources.

5.4.1.4 Sampling water from mobile I&SSWPs: the supply chain analysis

I&SSWPs at standpipes connected to the official network had their samples picked as described under piped water supplies. For I&SSWPs providing point source water, sampling followed that described for point sources above. For water quality monitoring among mobile water sellers, a supply chain approach was used.

Water samples were collected from the different sources where mobile vendors got water, the containers used to distribute water and also from household storage containers. The approach is illustrated in Figure 5.3.

![Figure 5.3 An illustration of supply chain approach for water sampling among mobile vendors](image)

When sampling water from vendor jerry cans the containers were tilted and the flowing water collected in a sampling container. This was the same method the vendors used when emptying their jerry cans into those of households.

5.4.2 Microbiological parameters

The main focus of water quality monitoring to describe microbiological quality and sanitary inspection was thermotolerant coliforms (TTC). TTC was thus used as an indicator of faecal contamination and water hygiene (WHO 1993; 2004). In addition data was collected on pH, chlorine residual and total, and turbidity.
5.4.2.1 Sampling procedure

Prior to going to the field all materials to be used in sampling including sampling bottles and the sampling cup were sterilised. At the field, before taking samples, the sample cup was rinsed three times with the water to be analysed to remove any residual traces of methanol that might inhibit the growth of bacteria. Because it was desired to obtain the quality of water as collected by users, samples were collected in a manner consistent with how users collect, hence the sample point were not sterilised before sampling. In line with recommendations regarding sampling of water supplies, where samples were collected from taps, the taps were left to run for two minutes, the same was done for deep wells and boreholes fitted with electric/motor pumps. For deep wells and boreholes with hand/foot pumps, water was pumped and allowed to flow for two minutes prior to sampling (WHO, 1997; 2004). For wells without hand or electric pumps a sampling cup suspended on a string was used. 500ml sample water was taken at each sampling point. Prior to collecting any subsequent samples after the first one, the sampling cup was always sterilised through burning of methanol which inactivates bacteria through a combination of direct heat and the release of formaldehyde gas when burnt in restricted oxygen (RCPEH, 2000).

5.4.2.2 Micro analysis for thermotolerant coliforms

Samples of water collected were kept on ice until processed. Samples were transported to and analysed in the laboratory space provided by Universal Medical College in Addis Ababa and VIRED- International Kisumu and respectively. All samples collected were processed within six hours of sampling.

Enumeration of TTC was carried out using the membrane filtration (MF) method (Anon, 1982) and membrane lauryl sulphate broth (MLSB) (Oxoid, Basingstoke, UK) as the selective medium. For each sample, 100ml or an appropriate dilution was filtered under vacuum through a 0.45μ nitro-cellulose filter (the Gelman membrane filter). The filtration unit was sterilised between each sample processing through burning of methanol which inactivates bacteria through a combination of direct heat and the release of formaldehyde gas when burnt in restricted oxygen. The unit was left for 5-15 minutes to allow for full sterilisation and allowed to cool before another usage.
The membrane filter was then placed face upwards on a Gelman absorbent pad pre-soaked in MLSB in an aluminium Petri dish. The prepared plates were pre-incubated at ambient temperatures (25-30°C) for a minimum of one hour and a maximum of 4 hours to enhance resuscitation of target organisms (WHO, 1997; RCPEH, 2000). The plate was then incubated at 44°C +/- 0.5°C for a minimum of 14 hours, but more typically 16 to 18 hours in a Delaqua kit portable incubator (RCPEH, 2000). After incubation, all yellow colonies between 1mm and 3mm diameter found on the filters were counted as thermotolerant coliforms within 15 minutes of removing the plate from the incubator.

The standard method of reporting for results of TTC analysis is the number of colony forming units (CFUs) per 100ml volume (Anon, 2000). Where the sample was turbid, previous results had indicated or it was suspected there would be very high levels of contamination, a smaller volume of 10ml was diluted and filtered through the membrane filtration unit to minimize the number of results too numerous to count. This was mainly for groundwater (particularly well) sources. Where smaller sample volumes were used, the number of colony forming units were normalised by the volume of water processed and multiplied by 100 to get a standardized presumptive total count per 100ml.

### 5.4.2.3 Analysis of other parameters

The turbidity and pH of water from various water sources were also measured. Turbidity was determined using turbidity tubes calibrated against both the nephelometric turbidity unit and Jacksons turbidity unit (TU) scales (RCPEH, 2000). In this method, water was added to the tube until the marker (black circle) on the base could no longer be seen. The turbidity was then read from the graduations on the tube. Where the meniscus fell between two graduations, an estimate was made. The tubes had a range of 5 to 2000TU, results at extreme level were recorded as <5 or >2000 as appropriate. No further tests were done to check accuracy, however, during analysis validation was done by comparing the researcher’s readings with those made by others present in the laboratory. Earlier during training there were exercises to ensure reasonable comparability of readings obtained with the trainer.

A pH comparator (Palintest, Gateshead, UK) was used for determination of pH from water supplies. The pH of the water was analysed in the comparator using a Phenol Red Tablet following the method prescribed by the suppliers. The Tablet is added to a fresh sample in
the chamber, and the container is gently turned up and down to aid dissolving of the Tablet. An immediate reading is taken by being matched against the reference colours on the comparator. Validation was carried out by comparing reading between users - the researcher, laboratory technician and research assistant. The appearance of water was assessed for all samples and categorised as clear, unclear or coloured. For both taste and odour, allowances were made and captured by questioning people at the water source and comments made on the report sheets.

Free and total chlorine residuals in samples from treated water supplies were measured with a simple comparator using DPD Tablets following the method prescribed by the suppliers (Palintest, Gateshead, UK). Free chlorine was analysed using a DPD 1 Tablet that was added to the sample water in the chamber and gently turned up and down to dissolve. The reading was taken immediately the Tablet was dissolved and obtained by matching the colour in the test chamber with reference colours on the comparator. After the reading for free chlorine, total chlorine was measured by adding a DPD 3 Tablet to the same sample in the chamber and reading obtained after the added Tablet had dissolved and left to stand for ten minutes.

On each day of sampling results were recorded on a data record sheet. The sheet included details on the time of sampling and the sample volumes used for thermotolerant coliform analysis, which allowed a check to be made on reported microbiological results.

5.4.3 Sanitary Inspections

A qualitative risk assessment of the water sources and supply chains was conducted using appropriately adapted sanitary inspection forms (SIF) (Appendix I 1-5). The forms were adapted from those published in the WHO Guidelines for Drinking water Quality (1993; 1997; 2004). Available forms were evaluated by the researcher with guidance from experts. Copies of the forms were sent to and tested using selected people from the case studies to assess whether they adequately described the likely principal risks in the case study areas after which modifications were made. As is usually recommended, for each technology SIFs were standardised to ensure comparability (Bartram, 1991; WHO, 1997; 2004). The sanitary survey combined with water quality analysis aimed at determining possible sources of contaminants.
Previous examples of SIF for household water storage facilities and handcart vendors were not available. Information gathered from the literature review on possible hazards, risks and the pathway factors that water from mobile vendors and household water would be exposed were used to develop and test forms for these categories. However, in developing the household SIF form, it became apparent when assessing the range of factors that could potentially affect water quality, that it was more difficult to define a range of Yes/No answers. Therefore although an attempt was made and forms were developed for trial, the results could not be relied on and they are excluded from detailed analyses. For handcart vendors the SIF results are used to show just the general trends but excluded from detailed analysis.

5.4.4 Chemical parameters

Nitrates and fluorides concentration were measured in groundwater sources using the methods prescribed with Palintest Photometer Model 5000 (Gateshead UK). For nitrates a tube was filled with 20ml of water sample. One level spoonful of Nitratetest powder was added followed by one Nitratetest Tablet and the tube shaken for one minute before being allowed to stand for another one minute. The tube was then gently inverted three to four times to aid flocculation after which it was allowed to stand for slightly more than two minutes to ensure settlement. 10ml of the clear solution was then decanted into a round test tube; one Nitrocol Tablet added, crushed and mixed to dissolve. The mixture was allowed to stand for 10 minutes, after which readings were taken using a Palintest Photometer Model 5000 (Gateshead UK) and the reading converted to concentration in mg/l according to manufactures instructions. The limit of the detection of the method was 0.1 mg/l.

Determination of fluoride was also undertaken using Palintest Photometer Model 5000 (Gateshead UK). A test tube was filled with a 10ml water sample, after which, one Fluoride No 1 Tablet was added, crushed and then mixed to dissolve. A Fluoride No 2 Tablet was then added, and also crushed and mixed to dissolve. The test tube was left to stand for five minutes and reading was taken using the photometer and converted to mg/l using Tables provided by the manufactures. The limit of detection of the method was 0.5 mg/l.
5.5 Data analysis and interpretation
The data collected were both qualitative and quantitative. The questionnaire data contained both qualitative and quantitative data, while data from interviews, FGDs and observations were mainly qualitative. Quantitative data was entered in and analyzed using computer software package- Statistical Package for Social Sciences (SPSS), while other methods like content analysis was used for qualitative data.

5.5.1 Qualitative data
Data from interviews, focus group discussions, observations and some parts of the questionnaires were transcribed and analysed by qualitative content analysis. Content analysis is a method to create valid inferences from textual material by using a set of paraphrased statements (Silverman, 2006). Because it is systematic and objective, this approach can be used to determine relevant characteristics of messages. An example of application of this method include coding open-ended questions in survey, disclosing the attention of group, explaining attitudinal and behavioural responses of communicator among others (Weber, 1990; Riffe et al., 2002). As an example of coding, data from interviews and open ended questions in the questionnaire were analysed and categories of answers were defined by creating codes to cover a cluster of responses with the same meaning, a commonly used technique in social surveys (Nicholson, 1991). For example responses such as ‘water is good’; ‘the water is safe’; ‘the water is clean’ were categorised as ‘quality’. As the aim of content analysis is to reduce textual material to manageable data, it is essential to paraphrase material that is related to the research question and generalise the statement. Similar generalised statements are categorised and connected to develop concepts and theories that describe the findings (Daymon & Holloway, 2002; Flick, 2006). However, it has been observed that emphasis on statements which are related to the research questions is a weakness in this method of analysis (Silverman, 2006).

5.5.2 Quantitative data
Appropriate standard statistical methods were used to analyse the quantitative data. Distributions were defined by the mean, median and standards deviation as appropriate to the data that was being displayed. The following statistical methods were used:
• Kolgomorov-Smirnov Test (K-S) with Lilliefors correction or Shapiro Wilks Test\textsuperscript{4}.
• Pearson’s Chi-square Test ($\chi^2$)
• Kruskall Wallis Test
• Wilcoxon Signed-Rank Test
• Kendall’s Tau Test
• Man Whitney Test (U)
• Spearman’s rank ($r^2$) correlation
• Friedman’s ANOVA ($\chi^2$) Test

Water quality data was mostly presented in box plots and analysed mainly by using non-parametric tests. The statistical tests further done are made considering the presence and the absence of outliers/extreme values.

The microbiological water quality data were non normal and even by transforming them to log values (a constant of 0.5 was added where the actual value was zero to allow for log transformation) it was determined using the K-S and Shapiro Wilks tests that it did not follow a log normal distribution.

5.6 Conclusions
Using various methods, data were gathered on the various aspects of household water usage and water services by I&SSWPs. These included questionnaires, interviews, focus group discussions, observations, materials gathered from secondary sources, and water quality monitoring combined with sanitary inspections. As has been widely stated in this section the various methods used provided methodological and data source triangulation. Using both methodological and data source triangulation techniques was important for the case studies given that the subject of the research- the informal water sector - in the case studies had little information available in documentation. The next chapter presents data collected from household water usage study as well as results of the analyses.

\textsuperscript{4}Shapiro Wilk test- tests the null hypothesis that a sample $x_1...x_n$ came from a distributed population. It was published in 1965 by Samuel Shapiro and Martin Wilk. Lilliefors test/correction is used to test the null hypothesis that data came from a normally distributed population, when the null hypothesis does not specify which normal distribution, i.e. does not specify the expected value and variance.
Chapter 6 Household water usage and water quality monitoring results

6.1 Introduction
This chapter presents results and examines the extent to which households in the selected areas within the case studies depend on independent and small scale water providers for water and the importance of such providers using various water supply indicators. The data is mainly drawn from household water usage survey and water quality monitoring results. The chapter also draws from data gathered from interviews, observations, FGDs and workshops. Demographic and socio-economic characteristics of respondents are presented in section 6.2, availability and access to water sources in 6.3, continuity/reliability of source 6.4, while use of water in 6.5, and costs of water in section 6.6. Water quality results are presented in section 6.7 and 6.8 gives the conclusions.

6.2 Demographic and socio-economic characteristics
Water usage questionnaires were administered to respondents with a wide range of socio-economic characteristics in both case studies during two field studies conducted in both case studies in each case. The number and distribution by city and by fieldwork trip is shown in Table 6.1. The Table shows that majority of respondents were from Kisumu. The relatively few respondents from Addis Ababa were attributed to reasons explained in section 5.2.2.1. The number of respondents from each estate/kebelle in percentage is shown in Table 6.2. The Table shows that the total number of households who participated varied by estate/kebelle.

<table>
<thead>
<tr>
<th>Study area</th>
<th>Respondent type</th>
<th>No. of respondents per field work trip</th>
<th>Total responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1st (April-June 2007)</td>
<td>2nd (Sept.- Jan. 2009)</td>
</tr>
<tr>
<td>Kisumu</td>
<td>Water users/ Households</td>
<td>78</td>
<td>131</td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>Water users/ Households</td>
<td>35</td>
<td>66</td>
</tr>
<tr>
<td>Total</td>
<td>All</td>
<td>113</td>
<td>197</td>
</tr>
</tbody>
</table>
Table 6.2 Respondents by estate/kebelle in each case study (in percentage)

<table>
<thead>
<tr>
<th>City</th>
<th>Estate/kebelle</th>
<th>Respondents %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kisumu</td>
<td>Migosi</td>
<td>34.9</td>
</tr>
<tr>
<td></td>
<td>Manyatta</td>
<td>42.1</td>
</tr>
<tr>
<td></td>
<td>Obunga</td>
<td>9.6</td>
</tr>
<tr>
<td></td>
<td>Nyamasaria</td>
<td>14.4</td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>Woyera</td>
<td>22.8</td>
</tr>
<tr>
<td></td>
<td>01 (Lebu)</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td>01 (Ayer Tena)</td>
<td>22.8</td>
</tr>
<tr>
<td></td>
<td>06 (Keranio)</td>
<td>21.8</td>
</tr>
<tr>
<td></td>
<td>Bethel</td>
<td>25.7</td>
</tr>
</tbody>
</table>

Table 6.3 presents a summary of socio-economic data for all respondents from both case studies. In terms of gender the majority of the respondents were female. A split of the data for each case study by gender further shows that the majority were still females.

Table 6.3 Summary of socio-economic data (in %) of all respondents

<table>
<thead>
<tr>
<th>Respondent characteristics</th>
<th>Classification</th>
<th>All N=310</th>
<th>Kisumu N=209</th>
<th>Addis Ababa N=101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
<td>80.6</td>
<td>86.6</td>
<td>68.3</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>19.4</td>
<td>13.4</td>
<td>31.7</td>
</tr>
<tr>
<td>Age</td>
<td>Child 14-18</td>
<td>19.7</td>
<td>25.8</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td>Adult</td>
<td>80.3</td>
<td>74.2</td>
<td>93.1</td>
</tr>
<tr>
<td>Level of formal Education</td>
<td>Primary</td>
<td>29.7</td>
<td>35.4</td>
<td>17.8</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>55.8</td>
<td>56.5</td>
<td>54.4</td>
</tr>
<tr>
<td></td>
<td>Post secondary</td>
<td>8.7</td>
<td>7.7</td>
<td>10.9</td>
</tr>
<tr>
<td></td>
<td>University</td>
<td>2.3</td>
<td>0.0</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>3.5</td>
<td>0.5</td>
<td>9.9</td>
</tr>
<tr>
<td>Size of household</td>
<td>1-5</td>
<td>36.5</td>
<td>40.8</td>
<td>27.8</td>
</tr>
<tr>
<td></td>
<td>6-10</td>
<td>56.2</td>
<td>53.8</td>
<td>61.1</td>
</tr>
<tr>
<td></td>
<td>Over 10 people</td>
<td>7.3</td>
<td>5.4</td>
<td>11.1</td>
</tr>
<tr>
<td>Estimated household income</td>
<td>&lt;Kshs. 5000 or 600 Birr</td>
<td>31.8</td>
<td>40.9</td>
<td>12.9</td>
</tr>
<tr>
<td>income per month</td>
<td>Kshs.5000-10,000 or 601-1000 Birr</td>
<td>23.1</td>
<td>26.6</td>
<td>15.6</td>
</tr>
<tr>
<td></td>
<td>&gt; Kshs. 10,000 / 1001 Birr</td>
<td>45.2</td>
<td>32.5</td>
<td>71.9</td>
</tr>
</tbody>
</table>

The age of respondents varied, however, the data shows that majority (80.3%) for all the data combined were adults above 18 years of age while the rest were between 14 to 18 years old. The later age was considered mature enough and able to understand and respond to issues related to water, but only in cases where an adult member was not available and an appointment could not be set for a later date due to time limitations. For each study site the data shows that a higher percentage both in Kisumu and Addis Ababa was made up of adults and only a few were between 14-18 years. In terms of education, 96.5% of the respondents...
had formal education. Disaggregated by each study site, the data shows that those lacking formal education were mainly in Addis Ababa and were about 10%.

The average household size in Kisumu was six members and was one above the national average of five. This could be as a result of families staying with extended family members (relatives) or households coming from low income areas which generally tend to have large families. The smallest households had three members, while the largest had 20 members, but majority (75%) of the households had between three and six members. For Addis Ababa the average household size was five members, same as the national average of five. The smallest households had four members, while the largest had 32 members, however, the majority of the households had between four and seven members. In both sites observation suggested that the majority could be children. The large maximum number of family size was probably due to what would be several families living together.

The data indicates that income level of respondents varied by town. In Kisumu, the data indicate that majority of respondents (67.5%) could be considered poor. The official poverty line in Kenya is Kshs. 10, 000 (US$ 150 5). This was unexpected given that estates considered non-poor in Kisumu, were included in the study and had nearly half (49.5%) of respondents. However, this may suggest that urban centres may be more complex than normally categorised in terms of income levels.

The data for Addis Ababa indicate that only about 28% of questionnaire respondents could be considered poor since the official figure for the poverty line for Ethiopia was Birr 1,075 (US$110.82) (MoFED, 2006). This may be due to the mixed nature of development in Addis Ababa, where poor and non-poor live in close proximity in mixed settlements making areas poorly served by the official water utility not exclusively either poor or non-poor. Among those falling below poverty line about 12.5 % fell below the extreme poverty line (US$ 806.27) (MoFED, 2006).

Other socio-economic indicators determined during the study were material used for housing including floor, roof and wall material as well as number of rooms occupied by households.

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5 Throughout this research the exchange rate is 1 US$= Kenya shillings (Kshs.) 67, the rate as at first fieldwork, April 2007, and 1 US$ = Ethiopian Birr (Birr) 9.7, the rate during first fieldwork as at July 2007.
A summary of the results is shown in Table 6.4 below. The data for roofing material suggest a higher proportion of respondents in Kisumu may be from low income households and confirm income data above. For Addis Ababa, the near equal split in number in the type of roofing material used may indicate equal proportions of poor and non-poor in areas poorly served by the utility and suggest mixed incomes for those living in these areas and confirm the reported levels of income in the paragraph above. For floor material, the higher percentage using stone/cement/brick/wood may suggest that areas served are not exclusively poor in Kisumu and may have been a result of inclusion of estates with different income levels. For Addis Ababa the data again suggest mixed income level for respondents and may also be an indication that those living in inadequately and/or un-served areas are not exclusively those who are poor.

Table 6.4 Other socio-economic indicators for respondents (%)  

<table>
<thead>
<tr>
<th>Other socio-economic indicators</th>
<th>All (%)</th>
<th>Kisumu (%)</th>
<th>Addis Ababa (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flooring Material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cement/screed</td>
<td>74.2</td>
<td>82.6</td>
<td>56.6</td>
</tr>
<tr>
<td>Earth</td>
<td>19.3</td>
<td>10.2</td>
<td>38.4</td>
</tr>
<tr>
<td>Concrete/bricks</td>
<td>5.3</td>
<td>6.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Wood/stones or both</td>
<td>1.2</td>
<td>-</td>
<td>1.0</td>
</tr>
<tr>
<td>Roofing Material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron sheet</td>
<td>85.4</td>
<td>98.5</td>
<td>48.6</td>
</tr>
<tr>
<td>Tile/concrete</td>
<td>14.3</td>
<td>1.5</td>
<td>50</td>
</tr>
<tr>
<td>Asbestos</td>
<td>0.3</td>
<td>-</td>
<td>1.5</td>
</tr>
<tr>
<td>Walling Material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone/cement/block/wood</td>
<td>56.1</td>
<td>59.9</td>
<td>49.5</td>
</tr>
<tr>
<td>Pole and mud</td>
<td>37.4</td>
<td>31.6</td>
<td>49.5</td>
</tr>
<tr>
<td>Burnt bricks</td>
<td>3.9</td>
<td>5.3</td>
<td>-</td>
</tr>
<tr>
<td>Unburnt bricks</td>
<td>1.9</td>
<td>1.9</td>
<td>-</td>
</tr>
<tr>
<td>Mixed</td>
<td>0.7</td>
<td>1.2</td>
<td>1</td>
</tr>
<tr>
<td>No. of Rooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mean</td>
<td>3</td>
<td>2.91</td>
<td>4.34</td>
</tr>
<tr>
<td>Maximum</td>
<td>16</td>
<td>10</td>
<td>16</td>
</tr>
</tbody>
</table>

For number of rooms, over 75% had less than four rooms but there was some variation for each city. The majority (75%) in Kisumu and 50% from Addis Ababa had between one and four rooms. For Addis Ababa the other half had more than four rooms. The results suggest that the number of rooms was higher for those in Addis Ababa than Kisumu. Higher number
of rooms may suggest that those not served or inadequately served were not all poor. For Addis Ababa, this could be due to a higher percentage of respondents with better incomes but also the mixed nature of settlements.

6.3 Availability and access to water: sources used by households
Data were collected on all sources of water used by households but the main interest was on the main/principal sources where multiple sources were used.

6.3.1 Household results on first water sources
Data was gathered on first water sources used by households. Results for Addis Ababa presented in Figure 6.1 show that piped water from the official network available to households through public water taps (PWTs)/standpipes or sale points locally known as ‘bonos’ (51.4%) was the main water source with 90% confidence that 10.48-59.66% of the households used PWTs/standpipes as their first water sources. The data also indicates that a connected neighbour/household resale followed PWTs/standpipes (20%) as a first water source with 90% confidence that 9.08-30.52% of households used household resellers as their first water sources. However, about 14% each used piped water from a shared tap in the yard or individual household connections (taps in their houses) as their first water sources with 90% confidence that 8.20-70.41% of households used these two as their first sources.

In Kisumu, data presented in Figure 6.2 indicates that overall wells (67.9%) were the first source with 90% confidence that 14.84% -73.25% of households used wells as their first source. Wells were followed by water from the official supply which was mainly available through PWTs/standpipes (24.4%), with 90% confidence that between 14.01-18.89% of households used standpipes as a first water source. Some households relied on handcart delivery or direct tap connection as a first water source. Piped water that sold from ‘other standpipe’ from a private producer served fewer people, which further examination of data established that came from one estate (Nyamasaria). Overall the data in both figures shows that the use of household taps and PWTs/standpipe as first water sources were the only common features in the two study cases. However, proportionally a significant number of

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6 First source of water refers to source where household got the largest proportion of water
7 ‘Other standpipe’ in this research refers to standpipes not connected to official utility water network and were confined in one spot and served by water from a small scale producer in Kisumu
households in Addis Ababa (14.3%) used taps in their houses as a first water source than in Kisumu (1.28%).

Figure 6.1 First water source reported by respondents in Addis Ababa

Figure 6.2 First water source reported by respondents in Kisumu

6.3.2 Second water sources used by households
For second water source, data and results from analysis are shown in Table 6.5. The Table shows the percentage of households that used a given source as a first source and 90%
confidence level for CI. The data suggest that in Addis Ababa, the majority relied on water from the official authority (AAWSA) through PWTs/standpipe, followed by resale from neighbours and tap in the yard. But there were also households using other sources including rain, boreholes, river/stream and tanker. In Kisumu the main second water source was PWTs/standpipe followed by handcarts and wells. But few reported use of unprotected springs, own household taps and rain.

Table 6.5 Percentage of households selecting a source type as their second water source and CI at 90% confidence level

<table>
<thead>
<tr>
<th>Second water source</th>
<th>Addis Ababa % N= 101</th>
<th>Cl at 90% confidence level</th>
<th>Kisumu% N=209</th>
<th>Cl at 90% confidence level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Official piped network</td>
<td>Household connection</td>
<td>14.3</td>
<td>8.2-19.51</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>Yard tap</td>
<td>8.8</td>
<td>4.3-13.6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Household resale</td>
<td>20</td>
<td>13.3-26.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>PWTs/standpipe</td>
<td>34.3</td>
<td>25.9-41.4</td>
<td>32.1</td>
</tr>
<tr>
<td></td>
<td>'Other standpipe'</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Wells</td>
<td>0</td>
<td>0</td>
<td>25.6</td>
</tr>
<tr>
<td></td>
<td>Handcart</td>
<td>0</td>
<td>0</td>
<td>29.8</td>
</tr>
<tr>
<td></td>
<td>Rain</td>
<td>20</td>
<td>13.3-26.3</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>Boreholes</td>
<td>2.8</td>
<td>2.8-5.7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>River</td>
<td>2.9</td>
<td>2.6-5.6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Tanker</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Unprotected spring</td>
<td>0</td>
<td>0</td>
<td>5.1</td>
</tr>
</tbody>
</table>

For Addis Ababa the data indicates that with a 90% confidence that proportionally more households (8.2-19.5%), used house tap connections as a second water source compared to Kisumu (2.72-7.8%). Use of rain water as a second source was more common in Addis Ababa but not in Kisumu. The data shows an apparent popularity of PWTs/standpipe as the second water source both in Kisumu (32.1%, CI 26.7-37.4%) and Addis Ababa (34.3%, CI 25.9-41.4%). Further analysis using Chi square showed that there was no significant difference in the number of people using standpipe as a second source of water, $\chi^2 (1) = 0.208$, $p = 0.3079$ as shown in Table 6.6 below.
Table 6.6 Results of $\chi^2$ analysis on proportion of people using PWTs/standpipes as a second source by city

<table>
<thead>
<tr>
<th>City</th>
<th>Use of standpipe as a second water source N=305</th>
<th></th>
<th></th>
<th>X², p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>%</td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Frequency</td>
<td>Frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kisumu</td>
<td>67</td>
<td>32.1</td>
<td>142</td>
<td>67.9</td>
</tr>
<tr>
<td>Addis</td>
<td>35</td>
<td>34.3</td>
<td>66</td>
<td>65.3</td>
</tr>
</tbody>
</table>

The data for first and second water sources also shows that household resale as a source of piped water was available in the areas studied in Addis Ababa but not Kisumu. Interviews in Kisumu suggested that households who have tried to sell their water end up with huge bills that they often cannot pay since water selling pushes their consumption to high tariff bands. This often led to disconnections. The high bills and extra costs to get reconnected may have discouraged this practice (Interv. Commercial Manager KIWASCO May, 2007).

6.3.3 Multiple source use
Most households reported using more than one source. Taken as a whole, multiple source use was common and was practised by 82.9% of all households, and by 84.3% in Kisumu and 82.2% in Addis Ababa. The average number of sources used by households was two and the range was one to five. Use of a third water source or more was also reported by households in both case studies, although by relatively fewer respondents. Analysis was undertaken to assess whether there was any difference in the proportion of households using multiple sources between the two case studies with a null hypothesis that there would be no significant difference. The result of the analysis is shown in Table 6.7.

Table 6.7 Results of $\chi^2$ analysis of multiple source use by city

<table>
<thead>
<tr>
<th>City</th>
<th>Multiple source use N= 292</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>%</td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Frequency</td>
<td>Frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kisumu</td>
<td>176</td>
<td>84.3</td>
<td>24</td>
<td>15.7</td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>83</td>
<td>82.2</td>
<td>18</td>
<td>17.8</td>
</tr>
</tbody>
</table>

The analysis indicates that there was no significant difference between the use of multiple sources between the two cities, $\chi^2 (1) = 1.894$, $p = 0.116$. This appears to suggest that multiple source use was generally widespread in areas studied in both cities. The data for water sources were analysed using $\chi^2$ test to assess whether there was a relationship between the
most commonly reported first water source types with use of multiple water sources. The results of this analysis are shown in Table 6.8 below.

<table>
<thead>
<tr>
<th>First source</th>
<th>Use of multiple water source by first source N=310</th>
<th>$\chi^2$, p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap in the house</td>
<td>Yes: 57, No: 7</td>
<td>$\chi^2=17.15$</td>
</tr>
<tr>
<td>Standpipes/ PWTs</td>
<td>Yes: 69, No: 8</td>
<td></td>
</tr>
<tr>
<td>Neighbours</td>
<td>Yes: 58, No: 6</td>
<td></td>
</tr>
<tr>
<td>Handcart Yes</td>
<td>Yes: 44, No: 10</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Yes: 34, No: 17</td>
<td></td>
</tr>
</tbody>
</table>

The data shows that there was a general significant relationship between the most commonly used first sources with multiple source use. Evidence gathered from interviews, observations and focus group discussions indicated that where second sources were used, they were typically used several times per week and there was little overall differentiation in frequency of use between first and second sources. But those who indicated using rain water as a second source only did so during the wet season. In order to evaluate the importance of different water sources, the numbers of households that reported using each source as a first or second source was calculated. The results are shown in Table 6.9 below. The data also shows CI of the percentages at 90% confidence level.

The data and results of analysis appears to indicate that in Kisumu wells, followed by standpipes and carts were the most commonly used as first and second sources. In Addis Ababa PWTs/standpipes, followed by neighbour or household resale and yard taps were the most commonly used as first and second sources of water.

The data from Kisumu were analysed using $\chi^2$ to investigate whether there was a significant difference in the proportion of households using and not using multiple sources of water in selected estates. The null hypothesis was that there would be no significant difference in the number of people that used multiple sources and those that did not. Only estates that had adequate data for use or no use of multiple sources were included in the analysis. Obunga and Manyatta were therefore excluded as all respondents indicated using multiple sources.
This obvious use of multiple sources in Obunga and Manyatta could have directly suggested that low income estates were more likely to use multiple sources; since estates selected for the research in Kisumu represented different socio-economic groups and the two were representative of the low income estates. The results of the analysis are shown in Table 6.10.

Table 6.9 Aggregate use of particular source types as first and second source by city

<table>
<thead>
<tr>
<th>City</th>
<th>Source type</th>
<th>1st (%)</th>
<th>2nd (%)</th>
<th>Aggregate (%)</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kisumu N=418</td>
<td>PWT/Standpipes</td>
<td>52</td>
<td>67</td>
<td>118</td>
<td>28.2</td>
</tr>
<tr>
<td></td>
<td>Wells</td>
<td>142</td>
<td>53</td>
<td>195</td>
<td>46.9</td>
</tr>
<tr>
<td></td>
<td>Handcart</td>
<td>8</td>
<td>62</td>
<td>70</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>In house taps</td>
<td>3</td>
<td>11</td>
<td>14</td>
<td>3.3</td>
</tr>
<tr>
<td>Addis Ababa N= 202</td>
<td>PWT/standpipe</td>
<td>52</td>
<td>34</td>
<td>86</td>
<td>42.6</td>
</tr>
<tr>
<td></td>
<td>Neighbour/resale</td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>19.8</td>
</tr>
<tr>
<td></td>
<td>In house taps</td>
<td>14</td>
<td>14</td>
<td>28</td>
<td>13.8</td>
</tr>
<tr>
<td></td>
<td>Yard tap</td>
<td>14</td>
<td>8</td>
<td>22</td>
<td>10.89</td>
</tr>
</tbody>
</table>

Table 6.10 Results of $\chi^2$ analysis on households using multiple sources of water by selected estates in Kisumu

<table>
<thead>
<tr>
<th>Estate</th>
<th>Use of multiple sources</th>
<th>$\chi^2$, p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Migosi</td>
<td>21</td>
<td>52</td>
</tr>
<tr>
<td>Other</td>
<td>14</td>
<td>122</td>
</tr>
<tr>
<td>Nyamasaria</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
<td>145</td>
</tr>
<tr>
<td>Migosi</td>
<td>21</td>
<td>52</td>
</tr>
<tr>
<td>Nyamasaria</td>
<td>11</td>
<td>19</td>
</tr>
</tbody>
</table>

When compared against all respondents, the results show that there was a significant difference in the number of households using multiple sources in Migosi, $\chi^2 (1) = 11.627$, p<0.001, and in Nyamasaria $\chi^2 (1) = 8.871$, p<0.05. From the numbers, proportionally more households from other estates used multiple sources or put another way proportionally fewer households from these two estates used multiple sources. When compared against each other, the result of the analysis was not significant $\chi^2 (1), =0.620$ p=0.485 and shows that no
significant difference was seen between Migosi and Nyamasaria in the number of households using multiple sources. This indicates that proportionally same number of households from the two estates used multiple sources.

Analysis was done for both case studies to establish if there was any significant difference between multiple source use and income group based on reported income levels. The data and results of the analyses are shown in Table 6.11 below.

<table>
<thead>
<tr>
<th>Respondents</th>
<th>Income</th>
<th>Use of multiple sources</th>
<th>$\chi^2$, $p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Respondents</td>
<td>&lt; Kshs. 10,000 / Birr 1001</td>
<td>140 Yes 24 No</td>
<td>$\chi^2 = 0.611$, $p = 0.448$</td>
</tr>
<tr>
<td></td>
<td>&gt; Kshs. 10,000/ Birr 1001</td>
<td>108 Yes 27 No</td>
<td></td>
</tr>
<tr>
<td>Kisumu</td>
<td>&lt; Kshs. 10,000</td>
<td>119 Yes 17 No</td>
<td>$\chi^2 = 4.483$, $p = 0.043$</td>
</tr>
<tr>
<td></td>
<td>&gt; Kshs. 10,000</td>
<td>50 Yes 16 No</td>
<td></td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>&lt; Birr 1001</td>
<td>21 Yes 7 No</td>
<td>$\chi^2 = 0.081$, $p = 0.388$</td>
</tr>
<tr>
<td></td>
<td>&gt; Birr 1001</td>
<td>58 Yes 11 No</td>
<td></td>
</tr>
</tbody>
</table>

The results indicate that the difference was only significant in Kisumu $\chi^2 (1) = 4.48$, $p < 0.05$. The proportion of households using multiple sources was high among the low income groups (< Kshs. 10,000) in Kisumu. This finding confirms the results of the previous analysis based on estate as representative of different income groups. No significant difference was noticed for all respondents combined or for respondents from Addis Ababa.

### 6.3.4 Use of rain water

Rainwater collection was practised in most households in Addis Ababa (86%) and Kisumu (84.15%). But relatively more households used improved methods (guttering and a tank) for rainwater collection in Addis Ababa (78%) than in Kisumu (61%) as shown in Figure 6.3 below. As there appeared to be a difference, the data were analysed using $\chi^2$, with a null hypothesis that no significant difference would be seen. The results presented in Table 6.12 shows that a significant difference was found $\chi^2 (1) = 9.473$, $p < 0.001$. This seems to represent the fact that based on the odds ratio, households in Addis Ababa were 2.32 times more likely to use guttering and tanks than those in Kisumu. The null hypothesis was thus rejected. The number of households using guttering and tanks was higher in Addis Ababa.
Figure 6.3 Proportion of households using guttering and tank for rain water collection by city

Table 6.12 Results of $\chi^2$ analysis for rain water use

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Town</th>
<th>Yes</th>
<th>No</th>
<th>$\chi^2$, p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainwater use Kisumu and Addis Ababa</td>
<td>Kisumu</td>
<td>175</td>
<td>33</td>
<td>$\chi^2=0.182$</td>
</tr>
<tr>
<td></td>
<td>Addis Ababa</td>
<td>86</td>
<td>15</td>
<td>p =0.404</td>
</tr>
<tr>
<td>Use of guttering &amp; tank Kisumu &amp; Addis Ababa</td>
<td>Kisumu</td>
<td>120</td>
<td>77</td>
<td>$\chi^2=9.473$</td>
</tr>
<tr>
<td></td>
<td>Addis Ababa</td>
<td>76</td>
<td>22</td>
<td>P&lt;0.001</td>
</tr>
</tbody>
</table>

6.3.5 Reasons for selection of water source

The research sought to establish priority factors considered by households in selecting water source and/or supplier. Data were collected on the reasons given by respondents for selection of different sources in both Kisumu and Addis Ababa. Combined results for both cities are shown in Figure 6.4. The data shows that distance was the main reason followed by quality/safety, costs, 'only source available' and reliability.
Figure 6.4 Main reason for selecting first water source both cities

For first water sources disaggregating of the data by each city, shows that 'distance' was the most common reason given in both Kisumu (Figure 6.5) and Addis Ababa (Figure 6.6). However, quality followed in Kisumu while for Addis Ababa 'only source' was the second most common reason given.

Figure 6.5 Reason for selecting first water source- Kisumu
The split of data by each case study further reveals that although quality of water as a selection factor was cited by many people and hence came second overall, it was a decision criterion only in Kisumu. The data also shows that all the cases where ‘only source available’ (availability) was the criterion for the selection of a water source were in Addis Ababa where it was cited by 28.6% of the respondents, this may suggest limited alternative choices available. Further analysis was done on responses obtained in relation to the reasons for selecting particular water sources as first or second sources for the most commonly reported sources. A summary of the data is given in Tables 6.13 and 6.14. The data are provided on the percentages of households citing reasons for source selection by the source of water used. Table 6.13 and 6.14 indicates that in both Kisumu and Addis Ababa, distance seemed to have been the main criteria for selection of a first water source regardless of the source type. The data further shows that only a few factors were important overall, although particular reasons seem to predominate for individual source types. The data reveals that distance and only source/availability predominate in selection of first water sources in Addis Ababa. In Kisumu in addition to distance other important considerations were quality and cost for standpipe, quality and reliability for handcarts and reliability for wells.
Table 6.13 Percent reporting of reasons for selecting first source of water by source type in Kisumu

<table>
<thead>
<tr>
<th>Source — Reason —</th>
<th>Well N=142</th>
<th>PWTs/standpipe N=51</th>
<th>Cl at 90% level</th>
<th>Handcart N=8</th>
<th>Cl at 90% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>83.3</td>
<td>77.9-88.3</td>
<td>36</td>
<td>24.3-46.3</td>
<td>34.3-90.6</td>
</tr>
<tr>
<td>Cost</td>
<td>0</td>
<td>0</td>
<td>28</td>
<td>17.2-37.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Quality</td>
<td>0</td>
<td>0</td>
<td>29.3</td>
<td>18.9-39.9</td>
<td>24.4</td>
</tr>
<tr>
<td>Reliability</td>
<td>16.7</td>
<td>11.7-22.1</td>
<td>1.3</td>
<td>-</td>
<td>9.8</td>
</tr>
<tr>
<td>Available</td>
<td>0</td>
<td>0</td>
<td>2.7</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Only source</td>
<td>0</td>
<td>0</td>
<td>2.7</td>
<td>-</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 6.14 Percent reporting of reasons for selecting the most commonly used first sources of water by source type in Addis Ababa.

<table>
<thead>
<tr>
<th>Source — Reason —</th>
<th>PWT/standpipe N=52</th>
<th>Cl at 90% level</th>
<th>Neighbour N=20</th>
<th>Cl at 90% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>66.7</td>
<td>56.6-78.0</td>
<td>47.8</td>
<td>26.7-63.3</td>
</tr>
<tr>
<td>Cost</td>
<td>0</td>
<td>0</td>
<td>8.7</td>
<td>-</td>
</tr>
<tr>
<td>Quality</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Reliability</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Available</td>
<td>0</td>
<td>0</td>
<td>4.3</td>
<td>-</td>
</tr>
<tr>
<td>Only source</td>
<td>33.3</td>
<td>26.0-47.4</td>
<td>39.1</td>
<td>22.0-58.0</td>
</tr>
</tbody>
</table>

Results for second water sources are summarized in Table 6.15 and 6.16 below.

Table 6.15 Percent reporting of reasons for selecting second water source by source type in Kisumu

<table>
<thead>
<tr>
<th>Source — Reason —</th>
<th>Standpipe (%) N=67</th>
<th>Cl at 90% level</th>
<th>Handcart (%) N=62</th>
<th>Cl at 90% level</th>
<th>Well (%) N=53</th>
<th>Cl at 90% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>83.3</td>
<td>76.1-91.0</td>
<td>50</td>
<td>39.5-60.4</td>
<td>63</td>
<td>51.3-73.2</td>
</tr>
<tr>
<td>Cost</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>22.5</td>
<td>13.2-32.1</td>
</tr>
<tr>
<td>Quality</td>
<td>0</td>
<td>-</td>
<td>26</td>
<td>16.7-34.9</td>
<td>2.7</td>
<td>-</td>
</tr>
<tr>
<td>Reliability</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>21.7</td>
<td>11.6-22.9</td>
</tr>
<tr>
<td>Available</td>
<td>16.7</td>
<td>9.0-23.8</td>
<td>0</td>
<td>-</td>
<td>0.8</td>
<td>-</td>
</tr>
<tr>
<td>Only source</td>
<td>0</td>
<td>-</td>
<td>24</td>
<td>15.2-33.1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

From the results distance appears still to be the main reason for selecting standpipe, handcart and wells as second water sources in Kisumu. For standpipe another major reason for selection was availability while for handcart ‘quality’ and ‘only source’ were also other reasons for selection. Quality was the second most common response provided overall for using handcarts as a second source. In addition to distance, selection of wells as a second
source is indicated to be due to 'cost' and 'reliability'. From the Table distance was the main reason for using PWTs/standpipes as a second water source in Addis Ababa while 'available' was the most common reason for the use of neighbours’ connection (household resale).

Table 6.16 Percent reporting of reasons for selecting the two main second water sources by source type in Addis Ababa

<table>
<thead>
<tr>
<th>Source Reason</th>
<th>PWT/standpipe N=34</th>
<th>Cl at 90% level</th>
<th>Neighbours N=20</th>
<th>Cl at 90% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>50</td>
<td>35.9-64.1</td>
<td>24.5</td>
<td>9.1-40.9</td>
</tr>
<tr>
<td>Cost</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Quality</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Reliability</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Available</td>
<td>15</td>
<td>8.5-24.7</td>
<td>57.3</td>
<td>36.7-73.3</td>
</tr>
<tr>
<td>Only source</td>
<td>30</td>
<td>16.6-42.3</td>
<td>18.2</td>
<td>-</td>
</tr>
</tbody>
</table>

The data on reason for source selection that were provided most commonly were analysed to investigate whether there were any significant differences between Kisumu and Addis Ababa. When investigating the differences in reporting for particular source types, only the data for PWTs/standpipes could be analysed between the two case study sites, as the other sources were very different. Furthermore, only distance seemed to have been important in selection of PWTs/standpipes in both case studies. The data were analysed using $\chi^2$ test with a null hypothesis that no significant difference would be found in the proportion of households reporting distance as the main reason for selecting PWTs/standpipes as a first or second water source between the two case studies. The results of the analyses are shown in Table 6.17.

Table 6.17 Results of $\chi^2$ analysis on number of people selecting distance as the reason for selection of PWTs/standpipes as a first or second water source in both case studies

<table>
<thead>
<tr>
<th>Source/City</th>
<th>PWTs/Standpipe as first source</th>
<th>PWTs/Standpipe as second source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td>Kisumu</td>
<td>Yes</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>134</td>
</tr>
<tr>
<td>Addis</td>
<td>Yes</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>34</td>
</tr>
</tbody>
</table>

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The analysis produced a significant result $\chi^2 (1) = 25.436$, $p<0.001$ for standpipe as a first source. This seems to represent the fact that based on the odds ratio, households in Addis Ababa were 3.51 times more likely to report distance as the main reason for selecting PWTs/standpipe as a first water source. Households reporting distance as the main reason for using PWTs/standpipes as a first water source was significantly high in Addis Ababa. The result for the analysis for second water source was also significant $\chi^2 (1) = 36.718$, $p<0.001$. The number of households reporting distance as the reason for selecting PWTs/standpipe as second water source was significantly higher in Kisumu than in Addis Ababa. Households in Kisumu were 4.87 times more likely to report distance as their main reason for selecting standpipe as a second water source.

6.4 Continuity/reliability of source
Respondents were asked whether they ever experienced interruption in supply at their main or second sources. The data are summarised in Table 6.18. The data shows that in both the case studies the majority of households reported discontinuity in their first and second water sources. The data shows that discontinuity was most commonly reported for taps and standpipes than those who used wells when used as first source in Kisumu. As a second source, high level of discontinuity was reported by those who used standpipes or other sources. Discontinuity experienced by those using handcarts (only in Kisumu) was, however, higher for those who used it as a second source compared to those who used it as a main source. There were generally high levels of reporting of discontinuity from households using PWTs/standpipes as a main or second source. Those using household resale and own tap connections as a first source in Addis Ababa experienced the least interruptions. However, disruption was high for those who used household resale as a second water source compared to those who used it as a first water source. In Kisumu generally wells showed less discontinuity whether used as a first or second source compared to Addis Ababa. In Kisumu where many households also depended on independent sources, there was variation in discontinuity between standpipes connected to official utility and non piped sources. Overall proportionally more standpipe sources showed more interruption of supply than other sources. Further data collected on frequency of discontinuity are summarised in Table 6.19.
Table 6.18 Percent of households reporting being unable to get water (discontinuity) from their first and second source by source type and city

<table>
<thead>
<tr>
<th>Source</th>
<th>Household source use category</th>
<th>Kisumu N=209</th>
<th>Addis Ababa N=101</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>CI</td>
<td>%</td>
</tr>
<tr>
<td>First sources</td>
<td>All using 1st source</td>
<td>79.5</td>
<td>74.8-84.0</td>
</tr>
<tr>
<td></td>
<td>House taps</td>
<td>97.6</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>PWTs/standpipes</td>
<td>84.7</td>
<td>75.9-92.7</td>
</tr>
<tr>
<td></td>
<td>House resale</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Wells</td>
<td>67.2</td>
<td>60.4-73.4</td>
</tr>
<tr>
<td></td>
<td>Handcarts</td>
<td>73.7</td>
<td>49.8-98.1</td>
</tr>
<tr>
<td></td>
<td>Other sources</td>
<td>74.4</td>
<td>50.6-99.4</td>
</tr>
<tr>
<td>Second sources</td>
<td>All using 2nd source</td>
<td>75.1</td>
<td>69.6-80.4</td>
</tr>
<tr>
<td></td>
<td>PWTs/standpipes</td>
<td>80.3</td>
<td>73.6-89.4</td>
</tr>
<tr>
<td></td>
<td>House resale</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Handcarts</td>
<td>81.8</td>
<td>74.3-90.2</td>
</tr>
<tr>
<td></td>
<td>Wells</td>
<td>39.4</td>
<td>28.7-50.7</td>
</tr>
<tr>
<td></td>
<td>Other sources</td>
<td>99</td>
<td>94.8</td>
</tr>
</tbody>
</table>

Table 6.19 Reported occurrence of discontinuity (%) for first and second sources in Kisumu and Addis Ababa and CI at 90% level

<table>
<thead>
<tr>
<th>Source</th>
<th>Level of interruption</th>
<th>Kisumu N=209</th>
<th>Addis Ababa N=101</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(%)</td>
<td>CI</td>
<td>(%)</td>
</tr>
<tr>
<td>First source</td>
<td>Daily</td>
<td>12.4</td>
<td>8.7-16.2</td>
</tr>
<tr>
<td></td>
<td>Weekly</td>
<td>2.9</td>
<td>0.9-4.8</td>
</tr>
<tr>
<td></td>
<td>Monthly</td>
<td>10.2</td>
<td>6.6-13.5</td>
</tr>
<tr>
<td></td>
<td>Seasonally</td>
<td>62.0</td>
<td>56.7-67.7</td>
</tr>
<tr>
<td></td>
<td>Occasionally</td>
<td>12.4</td>
<td>8.7-16.2</td>
</tr>
<tr>
<td>Second source</td>
<td>Daily</td>
<td>15.2</td>
<td>10.9-19.8</td>
</tr>
<tr>
<td></td>
<td>Weekly</td>
<td>1.5</td>
<td>0.1-3.3</td>
</tr>
<tr>
<td></td>
<td>Monthly</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Seasonally</td>
<td>45.5</td>
<td>39.3-51.6</td>
</tr>
<tr>
<td></td>
<td>Occasionally</td>
<td>37.9</td>
<td>32.0-44.0</td>
</tr>
</tbody>
</table>

The data presented in Table 6.19 shows that occurrence of discontinuity varied by case study. The data indicate that water sources used as first and second sources in Kisumu (wells, PWTs/standpipes and handcarts) and Addis Ababa (PWTs/standpipes, household resale, yard taps and private connections) suffered regular discontinuity. Interruption in piped water was primarily reported as being daily, while well sources were reported as
showing seasonal interruption. Water supplied by a small scale producer was recorded as only having occasional interruption in supply and was therefore more reliable.

In Addis Ababa discontinuity for main source was mainly reported as weekly, daily and monthly while for Kisumu was seasonally, daily and occasionally. The discontinuity for piped water supplies whether available through taps or PWTs/standpipes, was often found on a daily basis in both case studies. Thus piped water sources were the most commonly affected. For second sources in Addis Ababa the majority reported discontinuity as experienced occasionally, followed by weekly and monthly and for Kisumu the majority reported occasionally, followed by seasonally and daily.

6.5 Water usage by households
Data was collected on the use of water from each source. Use of water was ascertained for both first and second water sources. The use categories were as follows: drinking, cooking and food preparation, personal hygiene (e.g. bathing), general hygiene (e.g. cleaning of house and laundry), water for animals, water for gardens and other uses.

6.5.1 Use of water
Piped water available either through a tap but mainly through standpipes or public water taps appeared to be the preferred option for drinking and cooking in Kisumu as reported by 55.9%, followed by wells (39.9%) and rain/others (3.6%). But households report that reasons such as, shortages and high cost where piped water was available through handcart vendors, may force household to also use other sources for drinking. Results indicate that well water is preferred (52.5%) for non-consumptive purposes like personal and general hygiene, but it was also used for cooking and drinking due to reasons given as persistent shortages and scarcity in piped water supplies. In Addis Ababa, households appeared to be non-selective on use of different forms of piped water provision e.g. tap in yard, public water taps and household resale for different purposes. Sources such as streams and unprotected springs were only mentioned in relation to uses for general or personal hygiene.

The data for the purposes to which water from main sources was used were analysed to assess whether there was a differentiation in the use of water from different sources that would indicate that there was a rationality factor in selection of water source for specific
uses especially whether specific sources were used for drinking and cooking. The data on sources used for drinking, and cooking and food preparation and results of analysis are shown in Table 6.20.

Table 6.20 Results of $\chi^2$ analysis for selection of water source for given uses by city

<table>
<thead>
<tr>
<th>City</th>
<th>Source</th>
<th>Use for drinking</th>
<th>Use for cooking and food preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Kisumu</td>
<td>Tap/Standpipe</td>
<td>91</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Well</td>
<td>70</td>
<td>125</td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>Piped sources</td>
<td>53</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>5</td>
<td>67</td>
</tr>
</tbody>
</table>

In Kisumu, the data shows that main sources selected as used for drinking and for cooking and food preparation were piped sources (tap/standpipe) and wells. The data were analysed using $\chi^2$ to investigate whether there was a difference in number of people using either source for uses indicated. The null hypothesis was that there would be no significant difference in the proportion of households using water sourced from standpipes for drinking, and for cooking and food preparation compared to water sourced from wells. The test gave a significant result for drinking $\chi^2 (1) = 4.665$, p<0.05 and a result significant above the 99% confidence level $\chi^2 (1) = 36.163$, p<0.001 for cooking and food preparation. This seems to represent the fact that based on the odds ratio households in Kisumu were 1.57 times more likely to use water from standpipe rather than well for drinking and 3.58 times more likely to use water from standpipe for cooking and food preparation than water from wells. There was a comparatively lower use of piped water (from PWTs/taps/standpipes) for general hygiene including household cleaning than from wells.

The data shows that in Addis Ababa there seemed to be a differentiation in use of sources for example streams and unprotected springs. The data suggest that most households using non piped sources did not use the water for drinking and for cooking and food preparation. This suggests that in Addis Ababa a rationality factor was in operation and differentiation was found in the use of piped and non piped sources. Only piped sources were used for drinking and cooking/food preparation.
6.5.2 Quantity of water used by households

Data were gathered for the quantities of water collected and used by household from the various sources in Kisumu and Addis Ababa. The interest was mainly in the first and second water source; however, this excluded quantities of water used by those with their own connection to the piped water supply.

Water was bought or collected using jerry cans with a variety of sizes but majority (67%) of respondents used a 20 litre capacity, while 20% used 25 litres capacity. The rest used a variety of sizes, with four percent using containers with a capacity less than 20 litres, this could probably be due to involvement of children in water collection in some households. Some nine percent used jerry cans with a capacity greater than 25 litres. The mean number of jerry cans of water collected from the first source was 4.23 and 4.78 in Kisumu and 2.33 and 3.54 in Addis Ababa for wet season and dry season respectively. The data are summarised in Figure 6.7 (number of jerry cans per day) and Table 6.21 (litres per day).

Figure 6.7 Daily mean numbers of jerry cans of water collected from first source by city

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*When converting the amount of water collected to litres, a capacity of 20 litres per jerry can is used as this was the size used by the majority*
The bars in Figure 6.7 above represent 95% confidence interval for mean which is indicated by centre circle. The data suggests that there was variation in the mean number of jerry cans of water and therefore the volume of water collected per day between the two case studies and seasons from first source. The mean of lowest amounts was collected in the wet season in both case studies. The data also shows that the mean of the amounts of water collected from first source increased considerably in dry season. Although the minimum amount collected was low in both case studies, the range of amounts collected varied, with higher maximum quantities collected in Kisumu compared to Addis Ababa.

Table 6.21 Daily mean and range of volumes of water collected by households from first source in litres

<table>
<thead>
<tr>
<th>Town</th>
<th>Season</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kisumu</td>
<td>Wet season</td>
<td>84.6</td>
<td>60</td>
<td>20</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>Dry season</td>
<td>95.6</td>
<td>80</td>
<td>20</td>
<td>600</td>
</tr>
<tr>
<td>Addis</td>
<td>Wet season</td>
<td>46.6</td>
<td>40</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Dry season</td>
<td>70.8</td>
<td>60</td>
<td>20</td>
<td>120</td>
</tr>
</tbody>
</table>

When converted to per capita water use, using equation 5.1 as shown in section 5.3, the data shows that the mean amount of water used from first source was very low, 16.92/lcd and 19.12/lcd in Kisumu, and 9.32/lcd and 14.1/lcd in Addis Ababa for wet and dry season respectively. The data were analysed in terms of amount collected from first and second source during wet and dry season to determine whether there was any increase in the mean volumes collected and therefore per capita water used. Variation between the per capita volumes collected and used in dry and wet season was also established. The data is summarised in Table 6.22.

The data suggests that when the first and second sources are taken into account, the mean quantity of water collected per day increased to 160 and 180 litres in Kisumu, and 80 and 116 litres in Addis Ababa for wet and dry season respectively from the figures for first water source alone shown in Table 6.21. This increases the mean capita water use overall to 32/lcd and 36/lcd in Kisumu and 16/lcd and 23.2/lcd in Addis Ababa for the wet and dry season respectively. The mean per capita water use and the maximum amounts used was still higher in Kisumu. As a whole, like first water sources, the data still indicates that the quantity bought increased in the dry season.
Table 6.22 Daily average amount and range of volumes of water collected per household from first and second source in litres by city

<table>
<thead>
<tr>
<th>Town</th>
<th>Season</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>Wet</td>
<td>162.6</td>
<td>140</td>
<td>40</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td>Dry</td>
<td>179.4</td>
<td>140</td>
<td>40</td>
<td>620</td>
</tr>
<tr>
<td>Kisumu</td>
<td>Wet</td>
<td>160</td>
<td>140</td>
<td>40</td>
<td>540</td>
</tr>
<tr>
<td></td>
<td>Dry</td>
<td>180</td>
<td>140</td>
<td>40</td>
<td>620</td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>Wet</td>
<td>80</td>
<td>60</td>
<td>60</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Dry</td>
<td>116</td>
<td>100</td>
<td>80</td>
<td>180</td>
</tr>
</tbody>
</table>

Table 6.23 shows the aggregated quantity of water used when quantities used in wet and dry season for first and second source are considered separately and when combined. The Table suggest that the quantity of water used from first and second source separately and when combined was different in the two case studies. The data were analysed to determine if the differences observed for the sources between the two case studies were significant. As explained in section 5.6.2 Kolgomorov- Smirnov test (K-S) with Lilliefors correction and Shapiro Wilk test showed that all the data sets were non normal. The Man Whitney test (U) was used for the analysis. The analyses yielded a significant result for first source U = 770.500, p<0.05, second source U = 3295.500, p<0.05 and both combined U = 2971.500, p<0.001. From the median values shown in the Table, the quantity of water used from first and second source separately and both combined was significantly higher in Kisumu.

Table 6.23 Quantities of water used per day by households from first and second source separately and combined (in litres)

<table>
<thead>
<tr>
<th>Source</th>
<th>City</th>
<th>Mean</th>
<th>Median</th>
<th>Min.</th>
<th>Max.</th>
<th>Std dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Kisumu</td>
<td>89.3</td>
<td>80.0</td>
<td>20.0</td>
<td>300.0</td>
<td>54.3</td>
</tr>
<tr>
<td></td>
<td>Addis Ababa</td>
<td>58.0</td>
<td>50.0</td>
<td>40.0</td>
<td>90.0</td>
<td>19.2</td>
</tr>
<tr>
<td>Second</td>
<td>Kisumu</td>
<td>84.6</td>
<td>74.6</td>
<td>20.0</td>
<td>400.0</td>
<td>67.6</td>
</tr>
<tr>
<td></td>
<td>Addis Ababa</td>
<td>44.0</td>
<td>40.0</td>
<td>30.0</td>
<td>60.0</td>
<td>15.2</td>
</tr>
<tr>
<td>All</td>
<td>Kisumu</td>
<td>86.9</td>
<td>80.0</td>
<td>25.0</td>
<td>300.0</td>
<td>47.8</td>
</tr>
<tr>
<td></td>
<td>Addis Ababa</td>
<td>51.0</td>
<td>40.0</td>
<td>40.0</td>
<td>90.0</td>
<td>16.0</td>
</tr>
</tbody>
</table>

The data for Kisumu were analysed in terms of amount collected from first sources for each source type to establish whether there was any variation between the volumes collected between different source types and seasons. The data are summarised in Table 6.24. The data
suggests that the minimum amounts were collected in wet season from all source types. The mean amount of water collected from standpipes and handcarts was not very different in wet and dry season but the amount collected from wells was least in the wet season but also the highest in the dry season.

Table 6.24 Average and range of volumes of water collected in number of jerry cans per day by first source type in Kisumu

<table>
<thead>
<tr>
<th>Source type</th>
<th>Season</th>
<th>Mean</th>
<th>Median</th>
<th>Std dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standpipe</td>
<td>Wet season</td>
<td>4.0</td>
<td>4.0</td>
<td>2.2</td>
<td>2.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Dry season</td>
<td>4.5</td>
<td>2.0</td>
<td>4.9</td>
<td>2.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Well</td>
<td>Wet season</td>
<td>3.2</td>
<td>2.0</td>
<td>2.6</td>
<td>2.0</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>Dry season</td>
<td>8.0</td>
<td>8.0</td>
<td>4.4</td>
<td>2.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Handcart</td>
<td>Wet season</td>
<td>4.3</td>
<td>4.0</td>
<td>2.8</td>
<td>1.0</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Dry season</td>
<td>4.5</td>
<td>3.0</td>
<td>4.4</td>
<td>1.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

The source type data for Kisumu were aggregated for average quantities of water used in wet and dry season for first source, second source and both combined. Table 6.25 shows the data and results of the analyses.

Table 6.25 Average and range of volumes of water collected in litres per day by first and second sources and both combined for Kisumu

<table>
<thead>
<tr>
<th>Source\City</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
<th>(\chi^2), p</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Source</td>
<td>Standpipes</td>
<td>86.9</td>
<td>70.0</td>
<td>40.0</td>
<td>300.0</td>
</tr>
<tr>
<td></td>
<td>Well or other</td>
<td>84.9</td>
<td>75.0</td>
<td>40.0</td>
<td>350.0</td>
</tr>
<tr>
<td></td>
<td>Handcart</td>
<td>106.9</td>
<td>100.0</td>
<td>60.0</td>
<td>300.0</td>
</tr>
<tr>
<td>Second Source</td>
<td>Standpipes</td>
<td>70.7</td>
<td>60.0</td>
<td>20.0</td>
<td>300.0</td>
</tr>
<tr>
<td></td>
<td>Well or other</td>
<td>89.3</td>
<td>80.0</td>
<td>20.0</td>
<td>400.0</td>
</tr>
<tr>
<td></td>
<td>Handcart</td>
<td>94.5</td>
<td>70.0</td>
<td>20.0</td>
<td>330.0</td>
</tr>
<tr>
<td>All</td>
<td>Standpipes</td>
<td>85.8</td>
<td>80.0</td>
<td>30.0</td>
<td>350.0</td>
</tr>
<tr>
<td></td>
<td>Well or other</td>
<td>81.4</td>
<td>70.0</td>
<td>25.0</td>
<td>300.0</td>
</tr>
<tr>
<td></td>
<td>Handcart</td>
<td>100.9</td>
<td>90.0</td>
<td>40.0</td>
<td>270.0</td>
</tr>
</tbody>
</table>

The data suggest that the mean and median quantities of water used from the different source types were different. The data were analysed to find out if the difference observed among the source types was significant. All the data sets were non normal for all water source types and
therefore the Kruskall Wallis ($\chi^2$) test was used for comparing several independent groups. The results were significant for second source $\chi^2 (2) = 6.636, p<0.036$ and all sources combined $\chi^2 (2) = 6.071, p<0.049$, but not for first source. For first and second source combined, the analyses suggest that those who used handcarts used significantly higher amounts (Mdn=90) than well/other sources (Mdn=80) and standpipes (Mdn=70). The results suggest that as a second source those who used wells or other sources used significantly higher amounts (Mdn=80), followed by handcart (Mdn=70) and standpipe (Mdn=60) respectively.

6.6 Water costs

Data on the cost of water was collected through household water usage questionnaires, interviews and review of utility tariffs. The interviews and water usage data provided data on the actual price of water when purchased at the point of collection by users from the different sources and providers, while the review of utility tariffs provided the charges levied by utilities as a means of comparison.

Nearly all sources required payment by the user. Virtually all respondents reported paying for water from their first source except where a well source within a shared compound was used in Kisumu and there was an arrangement with the landlords for tenants to collect water for free. However, such cases were few, totalling to less than five percent of those who used a well as a first water source, which in turn is only a small percentage of the total. Thus the majority of households (96.6%) reported paying for water from their first source in Kisumu, and in Addis Ababa all first sources required payment. Almost all those using a second source of water reported paying for the same except where the second source was indicated as rain water or where an institution with a borehole for its own use supplied water during periods of scarcity to its neighbourhood in Addis Ababa. Those using wells in a shared compound as a second source also did not pay, but these were again few since where wells were found in a shared compound it tended to be the first rather than second source. Therefore majority of households (98%) in Kisumu and about 75% in Addis Ababa reported that they paid for water from their second sources.
6.6.1 Costs as reported from household in the water usage study

The cost of water was the same from a source whether it was used as a first or second water source. The cost of water varied by source type as well as by seasons. The cost of water from first and second source by season in Kisumu is as shown in Table 6.26 below. The data shows that the mean cost of water from first and second sources changed by season with highest costs in the dry season.

Table 6.26 A comparison of cost of a 20 litre jerry can of water from first and second water source for wet and dry season- Kisumu (cost in Kenya shilling (Kshs.))

<table>
<thead>
<tr>
<th>Source</th>
<th>Season</th>
<th>Number</th>
<th>Mean</th>
<th>Median</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Wet</td>
<td>196</td>
<td>3.5</td>
<td>2.0</td>
<td>1.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Source</td>
<td>Dry</td>
<td>180</td>
<td>5.2</td>
<td>4.0</td>
<td>1.5</td>
<td>24.0</td>
</tr>
<tr>
<td>Second</td>
<td>Wet</td>
<td>174</td>
<td>5.4</td>
<td>3.0</td>
<td>1.5</td>
<td>25.0</td>
</tr>
<tr>
<td>Source</td>
<td>Dry</td>
<td>170</td>
<td>8.5</td>
<td>5.0</td>
<td>1.5</td>
<td>35.0</td>
</tr>
</tbody>
</table>

Households obtained water from different sources and the costs varied by source type. A disaggregation of data by source type gives a clearer picture of the costs and is shown in Table 6.27 below. The data shows that the mean cost of water from all sources except ‘other standpipe’ changed by season with highest costs in dry season and well water as the cheapest while handcart vended water was the most expensive.

Table 6.27 A comparison of cost of a 20 litre jerry can of water from first water source for wet and dry season- Kisumu (cost in Kshs.)

<table>
<thead>
<tr>
<th>First water source/supplier</th>
<th>Costs in wet season</th>
<th>Costs in dry season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Mdn.</td>
</tr>
<tr>
<td>Well</td>
<td>2.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Handcart</td>
<td>7.9</td>
<td>8.0</td>
</tr>
<tr>
<td>Standpipe</td>
<td>4.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Other standpipe</td>
<td>2.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

As shown in Table 6.28 below, when the costs for the two seasons are lumped together for each source, the data shows that handcart vended water was still the most expensive. Piped water sourced from standpipe and well water followed as second and third most expensive respectively. The data shows that the cost of handcart vended water was much higher than the rest. The cost of water from standpipes appeared different from well/other. The data were
analysed further using the Man Whitney test to investigate whether the difference observed between the average cost charged by standpipe sellers and those charged at well/other sources was significant. The null hypothesis was that no significant difference would be seen. The analyses produced a significant result $U = 2019$, $p < 0.001$. As seen from the median values, the results indicate that the price of water purchased from standpipe ($Mdn = 3.2$) was significantly higher than that purchased from well/other ($Mdn = 2.2$).

<table>
<thead>
<tr>
<th>Source</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>First and second Source</td>
<td>Standpipe</td>
<td>4.2</td>
<td>3.2</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Well/other sources</td>
<td>2.5</td>
<td>2.2</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Handcart</td>
<td>10.1</td>
<td>9.0</td>
<td>7.0</td>
</tr>
</tbody>
</table>

In Addis Ababa, payment for water varied by source type as well as the method that was used in paying as further shown in details in Chapter 7. The mean cost of water sourced from PWTs/standpipes, neighbours (household resellers) and shared yard taps as reported by households in the survey are summarised in Table 6.29. The data shows that the highest cost was for water sourced from household resellers.

<table>
<thead>
<tr>
<th>Type of source</th>
<th>Median</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWT/standpipe</td>
<td>0.13</td>
<td>0.15</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>Household resellers</td>
<td>0.54</td>
<td>0.56</td>
<td>0.50</td>
<td>0.60</td>
</tr>
<tr>
<td>Yard tap</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
</tr>
</tbody>
</table>

### 6.6.2 Utility tariff

The data on utility tariffs from both case studies are shown in Table 6.30. Both utilities charge their water using increasing block tariffs and the maximum and minimum tariffs in each category are shown in the Table and compared with actual data on cost to users at selling points as collected from household survey. In the Table an attempt is made to show the costs in US $ per cubic metres. The cost for households charged on a per container basis, as this was the standard method used in determining amount of water collected and payments even if payment was made at the time of collection, or on a monthly basis like in the case of yard taps in Addis Ababa, are all converted to costs per cubic metres.
Table 6.30 A comparison of utility charges for different consumers and cost of utility water when bought from selling points by households, and water from independent sources in US $ for both case studies

<table>
<thead>
<tr>
<th>Provider Source</th>
<th>AAWSA tariffs/m³</th>
<th>Cost to households per m³</th>
<th>KIWASCO tariffs/m³</th>
<th>Cost to households per m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>Min 0.18</td>
<td>-</td>
<td>0.49</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>Max 0.39</td>
<td>-</td>
<td>0.89</td>
<td>-</td>
</tr>
<tr>
<td>Commercial/</td>
<td>Min 0.34</td>
<td>-</td>
<td>0.74</td>
<td>-</td>
</tr>
<tr>
<td>Institutional</td>
<td>Max 0.18</td>
<td>-</td>
<td>1.04</td>
<td>-</td>
</tr>
<tr>
<td>PWTs/standpipes</td>
<td>Min 0.15</td>
<td>0.51</td>
<td>0.82</td>
<td>1.86</td>
</tr>
<tr>
<td></td>
<td>Mean -</td>
<td>0.77</td>
<td>Flat rate</td>
<td>2.23</td>
</tr>
<tr>
<td></td>
<td>Max -</td>
<td>2.06</td>
<td>-</td>
<td>2.98</td>
</tr>
<tr>
<td>Yard taps</td>
<td>Min -</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Mean -</td>
<td>0.67</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max -</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Household</td>
<td>Min 0.18</td>
<td>2.54</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>resellers</td>
<td>Mean -</td>
<td>2.88</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max -</td>
<td>3.09</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Handcart</td>
<td>Min -</td>
<td>-</td>
<td>-</td>
<td>5.97</td>
</tr>
<tr>
<td>Vended tap water</td>
<td>Mean -</td>
<td>-</td>
<td>-</td>
<td>6.72</td>
</tr>
<tr>
<td></td>
<td>Max -</td>
<td>-</td>
<td>-</td>
<td>14.92</td>
</tr>
<tr>
<td>Well/other</td>
<td>-</td>
<td>-</td>
<td>1.15</td>
<td>-</td>
</tr>
<tr>
<td>sources</td>
<td>Other standpipe</td>
<td>-</td>
<td>-</td>
<td>1.86</td>
</tr>
</tbody>
</table>

The Table illustrates that the mean cost of water for household purchasing piped water by jerry cans from PWTs/standpipes in Addis Ababa was 5.2 and 4.3 times the charge collected by AAWSA from PWTs/standpipes and domestic connections respectively. It was even 2.3 times the lowest charge levied by AAWSA on commercial/institutional connections. Households buying water from shared yard taps paid 3.2 times the charge AAWSA collected from those with domestic connections, 4.5 times the price paid by PWTs/standpipes and 1.7 times the highest rate commercial connections pay to AAWSA. The Table further illustrates that the average cost of water for household purchasing from household resale in Addis Ababa was 16 times the charge collected by AAWSA from domestic connections, 19.3 times the charge collected from PWTs/standpipes and 8.5 times the lowest rate commercial connections pay to AAWSA.
For Kisumu the table shows that the mean cost of water for households when purchased from standpipes was 4.5 times the charge collected by KIWASCO from households with connections and 2.7 times that collected from standpipe. The table illustrates that the average price of water for household purchasing from handcart vendors was 12.1 and 7.3 times the charge collected by KIWASCO from domestic connections and standpipes respectively. The data further reveal that the cost of water sourced by I&SSWPs from the official utility network, when purchased by households at any water selling point was frequently higher than the charges levied by KIWASCO on commercial/institutional users and was even higher than the highest charge levied by KIWASCO on commercial users. A comparison of utility tariff and cost of water obtained from independent sources further shows that the cost of water sourced from ‘other standpipe’ was lower than the average though equivalent to the lowest charge to households at standpipes fixed on piped network.

Interview with the independent and small scale producer of treated surface water who provided water through ‘other standpipe’ in Kisumu and his tanker customers shows that tankers collecting water for commercial use were charged a rate of Kshs. 80/m³ (US$ 1.19/m³). Thus further analysis shows that the charges levied on households for water by I&SSWPs sourcing water from the official network was even much higher than the rates levied by the independent small scale producer of treated surface water on tankers collecting water for commercial use. The mean cost of water in the wet season for households buying from handcart vendors (Kshs. 450/m³ or US$ 6.72/m³) was over six times and that of the dry season (Kshs. 1000/m³ or US$ 14.93/m³) was 9.4 times that paid by tanker trucks from commercial companies to the independent small scale producer of treated surface water. Although well water was the cheapest for households, it was still almost three times the rates paid to KIWASCO by household with a connection to piped water supply.

6.6.3 Expenditure on water
Data was collected on quantity of water collected daily and costs. Expenditure was estimated based on the amount of water collected and the unit cost. Results on average household daily expenditure on water during wet and dry season for Kisumu are shown in Table 6.31.
Table 6.31 Quantity of water collected from first water source by seasons and the estimated household daily and monthly expenditure in Kisumu (in Kshs. and US $ (in brackets))

<table>
<thead>
<tr>
<th>Season</th>
<th>Mean No. of jerrycans</th>
<th>Handcart</th>
<th>Standpipe</th>
<th>Other standpipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>season</td>
<td></td>
<td>3.2</td>
<td>4.3</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (0.03)</td>
<td>8 (0.12)</td>
<td>3 (0.05)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.34 (0.10)</td>
<td>34.16 (0.51)</td>
<td>12 (0.179)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>190.2 (2.84)</td>
<td>1024.8 (15.29)</td>
<td>360 (5.37)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.0</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.63 (0.04)</td>
<td>15 (0.24)</td>
<td>3.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21.04 (0.31)</td>
<td>66.69 (0.99)</td>
<td>13.77 (0.20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>631.2 (9.42)</td>
<td>2000.7 (29.86)</td>
<td>413.1 (6.16)</td>
</tr>
<tr>
<td>Dry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>season</td>
<td></td>
<td>8.0</td>
<td>4.5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.63 (0.04)</td>
<td>15 (0.24)</td>
<td>2.50 (0.04)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21.04 (0.31)</td>
<td>66.69 (0.99)</td>
<td>12.5 (0.19)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>631.2 (9.42)</td>
<td>2000.7 (29.86)</td>
<td>375 (5.60)</td>
</tr>
</tbody>
</table>

The results indicate that households’ expenditure on water was generally high but much higher during the dry season. Expenditure on water during the dry season was US$ 0.31 daily (US$ 9.42 monthly) for well water and US$ 0.20 daily (US$ 6.16 monthly) for standpipes fixed on the official water network. High expenditure on well water in dry season was basically due to higher amounts collected from this source during dry season. Highest expenditure was on handcart vended water at about US$ 0.99 daily (US$ 29.86 monthly). The least expenditure on water in dry season was for water collected from ‘other standpipe’ which was US$ 0.19 daily (US$ 5.60 monthly). When the data is lumped together (not presented in the table), the average expenditure on water from all sources was Kshs. 16.25 (US$ 0.24) daily or 487.50 (US$ 7.28) per month and Kshs. 28 (US$ 0.43) daily or Kshs. 855 (US$ 12.76) per month respectively for wet and dry season. The data suggest high expenditures on water.

Data on mean expenditure on water in Addis Ababa is shown in Table 6.32. The calculation is based on the average number of 2.33 and 3.54 jerry cans of water collected in the wet and dry season respectively and an average cost of water from all sources of Birr 0.28 per 20litre jerry can, since it is the quantity rather than water cost that changed by seasons. The data shows that average expenditure was highest for those using household resale and lowest for those using yard taps.

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Table 6.32 Estimated mean daily and monthly household expenditure on first water source in Birr and US $ (brackets) in Addis Ababa by water source type and combined

<table>
<thead>
<tr>
<th>Season/source type</th>
<th>PWTS/Standpipes</th>
<th>Yard taps</th>
<th>Household resale</th>
<th>All sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Season Daily</td>
<td>0.35 (0.04)</td>
<td>0.30 (0.03)</td>
<td>1.34 (0.13)</td>
<td>0.65 (0.07)</td>
</tr>
<tr>
<td>Wet Season Monthly</td>
<td>10.48 (1.08)</td>
<td>9.09 (0.94)</td>
<td>39.14 (4.03)</td>
<td>19.57 (2.02)</td>
</tr>
<tr>
<td>Dry Season Daily</td>
<td>0.53 (0.05)</td>
<td>0.46 (0.05)</td>
<td>1.92 (0.20)</td>
<td>0.99 (0.10)</td>
</tr>
<tr>
<td>Dry Season Monthly</td>
<td>19.96 (2.06)</td>
<td>13.81 (1.42)</td>
<td>57.77 (5.95)</td>
<td>29.7 (3.06)</td>
</tr>
</tbody>
</table>

Further analysis was done based on minimum and maximum possible expenditures for Addis Ababa. The lowest expenditure was Birr 7.5 (US$ 0.77) monthly by those using a minimum of three jerry cans daily collected from community initiated PWTs/standpipes. On the other hand, the highest expense was Birr 0.60 per 20ltr jerry can purchased from household resellers in predominantly non-poor areas. As earlier shown in Figure 6.7 and Table 6.23, the maximum number of jerry cans reported as could be collected per day was 6 (120litres) in wet season thus giving an expenditure of Birr 3.6 (US$ 0.37) daily or Birr 108 (US$ 11.13) monthly. For dry season, the maximum that could be collected was 9 jerry cans (180litres) giving an expenditure of Birr 5.4 (US$ 0.56) daily or 162 (US$16.70) monthly. Household expenditure on water in Addis Ababa was therefore in the range of a minimum of Birr 7.5 (US$ 0.77) to a maximum of Birr 162 (US$16.70) per month.

For each case study, further analysis was done for proportion of household income spent on water by low income households based on all sources combined and what a household would spend or spent if using specific source types. In Kisumu income for most poor households was in the range of Kshs. 3,000 - 4,000 (US$ 44.78-59.70). In Addis Ababa, low income households had a monthly income range of Birr 114-203 (US$11.55-20.93) and a mean of Birr 193 (US$ 94.12). Summary for the data is shown in Table 6.33.

The data shows that in Kisumu average expenditure on water for all sources combined amounts to 12.2-16.3% of the monthly income of poor households in the wet season and 21.5-28.4% in the dry season. When considered separately, expenditure on well water was the least and the data shows that if only using well water, low income households would spend an average of 4.7 - 6.3% and 15.8-21.0% of their monthly earnings in the wet season and dry season respectively. The data further illustrates that expenditure on handcart vended
water both during the wet season and dry season was high with that of the dry season rising to 50-66.7% of monthly incomes of poor households, if they only used this source. This, however, is a substantial proportion of income for poor households and thus may indicate that poor households are unlikely to be major customers of handcart vended water. Expenditure on water from the independent small scale producer (‘other standpipe’) was higher than that of wells and standpipes in the wet season and took 5.9 -12.5% of income of poor households in the wet season. This was due to less water collected from wells and standpipes in the wet season, probably because of use of rain water. This, however, changed in dry season when more water was collected from these sources, particularly from wells.

Table 6.33 Estimated proportion of household monthly income spent on water by case study, source type and season in Kisumu and Addis Ababa

<table>
<thead>
<tr>
<th>Case study</th>
<th>Source type</th>
<th>Wet season (US$)</th>
<th>% of income spent</th>
<th>Dry season (US$)</th>
<th>% of income spent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kisumu</td>
<td>All</td>
<td>7.3</td>
<td>12.2-16.3</td>
<td>12.8</td>
<td>21.5-28.4</td>
</tr>
<tr>
<td></td>
<td>PWT/standpipe</td>
<td>5.4</td>
<td>9.0-12.0</td>
<td>6.2</td>
<td>13.3-17.8</td>
</tr>
<tr>
<td></td>
<td>Well</td>
<td>2.8</td>
<td>4.7-6.3</td>
<td>9.4</td>
<td>15.8-21.0</td>
</tr>
<tr>
<td></td>
<td>Handcart</td>
<td>15.3</td>
<td>25.6-34.2</td>
<td>29.9</td>
<td>50.0-66.7</td>
</tr>
<tr>
<td></td>
<td>Other standpipe</td>
<td>5.6</td>
<td>9.5-12.5</td>
<td>5.6</td>
<td>9.5-12.5</td>
</tr>
<tr>
<td>Addis</td>
<td>All</td>
<td>2.0</td>
<td>9.6-17.2</td>
<td>3.0</td>
<td>14.6-26.0</td>
</tr>
<tr>
<td>Ababa</td>
<td>PWTs/standpipe</td>
<td>1.1</td>
<td>5.2-9.2</td>
<td>2.1</td>
<td>9.8-17.5</td>
</tr>
<tr>
<td></td>
<td>Yard taps</td>
<td>0.9</td>
<td>4.3-8.0</td>
<td>1.4</td>
<td>6.8-12.1</td>
</tr>
<tr>
<td></td>
<td>Household resale</td>
<td>4.0</td>
<td>19.3-34.3</td>
<td>5.9</td>
<td>28.5-50.7</td>
</tr>
</tbody>
</table>

Although some households in the study were from areas classified as non-poor income group, like some from Migosi and parts of Nyamasaria, the expenditure on water still indicate that generally household spent relatively high amounts on water. As earlier shown in Table 6.32, the expenditure on handcart vended water which primarily served such areas was the highest Kshs. 1024.8 or US$ 15.3 and Kshs. 2000.7 or US$ 29.9 monthly in the wet and dry season respectively. The data on water quantity also shows that those who used handcarts used the highest amounts. These results should, however, be treated with caution given the few number of respondents in the study.
The majority (67.5%) of respondents in Kisumu as earlier indicated in Table 6.3 reported earning less than Kshs. 10,000 (US$ 150) monthly income and therefore could be considered poor. Low income households’ monthly house rent was about Kshs. 300 (US$ 4.48) in Obunga and amounts to 7.5-10% of their income. In Manyatta the house rent was between Kshs. 500-1000 (US$ 7.46 -14.93) which totals to 16.7-33.0% of their income. A comparison of this with the estimated average monthly expenditure on water for all sources combined by low income households for the wet (12.2-16.3%) and dry season (21.5-28.4%) shows that in Kisumu expenditure on water during the dry season was slightly higher than what households spent on house rents in Obunga but was within the same range as what was spent on house rent in Manyatta. However, households used more than one source based on a combination that best meet its needs.

For Addis Ababa the data shows that the proportion of household expenditure on water was lowest among those using yard taps at a range of 4.5-8.0% or a mean of 4.7% of income of poor households in the wet season. The average highest proportion of income was spent by those using household resale which totalled to between 19.3-34.3% (mean of 20.3%) and 28.5-50.7% (mean of 30.0%) of the income of poor households in the wet and dry season respectively for all the sources combined.

Analysis using the possible minimum of Birr 7.5(US$ 0.773) and maximum of 162 (US$16.70) monthly figures on expenditure on water for Addis Ababa shows that low income households paid a minimum of 3.7-6.6% and a maximum of 78.0-142.1% of their income on water. However, since the maximum expenditure rise above the actual incomes for low income households, it is unlikely that low income households used the maximum number of jerry cans from household resale which give the maximum expenditure above their income. Based on the data on average monthly expenditure for all sources, low income households with a mean monthly income of Birr 193 (US$ 94.13) spent an estimate of 10.2% and 15.4% of their income on water in wet and dry season respectively.

6.7 Water quality monitoring results
The quality of water from various sources identified by households as used either as first or second source in the case study areas was analysed with respect to the presence of thermotolerant coliforms (TTC) as indicators of faecal contamination and hygiene. In
addition, pH, turbidity, chlorine residual and total, and in ground water nitrates and fluoride were also determined. Water stored in the house was also analysed to determine its quality and was compared with that of the original source. Sanitary surveys on the risks water sources are exposed to were carried out during water quality monitoring and compared with presence of TTC. The data obtained were analysed based on various guidelines for water quality as set by the WHO, Kenya (Kisumu) and Ethiopia (Addis Ababa) as summarised in Table 6.34.

<table>
<thead>
<tr>
<th>Guideline standard</th>
<th>WHO</th>
<th>Kenya</th>
<th>Ethiopia</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTC Cfu/100ml</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking water 1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Drinking water 2*</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Community sources</td>
<td>-</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Fluoride mg/l</td>
<td>1.5</td>
<td>1.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Nitrate mg/l (NO₃-N)</td>
<td>11.3</td>
<td>10</td>
<td>11.3</td>
</tr>
</tbody>
</table>

*Suggested relaxed guideline value by the WHO for countries where it is difficult to achieve the zero guideline value for drinking water source

### 6.7.1 Microbiological quality

A total of 414 samples, 318 from Kisumu and 96 from Addis Ababa from various sources used by households were analysed for the presence of TTC. Summary results for the two case studies are shown in Table 6.35.

<table>
<thead>
<tr>
<th>Water sources</th>
<th>N</th>
<th>Positive TTC detects (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Combined</td>
</tr>
<tr>
<td>All samples</td>
<td>414</td>
<td>73.7</td>
</tr>
<tr>
<td>Tap (standpipes/ house taps)</td>
<td>81</td>
<td>23.5</td>
</tr>
<tr>
<td>Well</td>
<td>98</td>
<td>96.9</td>
</tr>
<tr>
<td>Handcart container</td>
<td>39</td>
<td>69.2</td>
</tr>
<tr>
<td>Household storage</td>
<td>184</td>
<td>86.4</td>
</tr>
<tr>
<td>Borehole</td>
<td>6</td>
<td>66.7</td>
</tr>
<tr>
<td>Tanker</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Spring</td>
<td>4</td>
<td>50</td>
</tr>
</tbody>
</table>

* There was only one well sample from Addis Ababa
The data shows that overall more samples in Kisumu were positive for TTC than in Addis Ababa. The data further shows that a larger number of samples from wells had presence of TTC. Piped water (collected from PWTs/standpipes and taps in house) had better microbial quality with the majority of samples having no TTC. The data indicate that handcart vendors also had a high failure rate. There were few samples from tanker trucks, borehole and springs, but, no sample from tanker trucks had TTC, while half from springs and boreholes had. The data shows that all samples from households in Kisumu had presence of TTC compared to 51.9% for Addis Ababa.

All the data from both case studies were further analysed in terms of those meeting guidelines set by the WHO and the case study standards. The data for the samples meeting or exceeding guideline and standards by source type are shown in Table 6.36.

<table>
<thead>
<tr>
<th>Source type</th>
<th>≤0 cfu/100ml (WHO guideline)</th>
<th>1-10 cfu/100ml (Relaxed WHO guideline)</th>
<th>11-50 cfu/100ml (exceeding relaxed WHO guideline)</th>
<th>&gt;50 cfu/100ml (Exceeding case study guideline for untreated sources)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap</td>
<td>64 (79)</td>
<td>12 (14.8)</td>
<td>0</td>
<td>5 (6.2)</td>
</tr>
<tr>
<td>Household storage</td>
<td>23 (12.5)</td>
<td>35 (19)</td>
<td>12 (6.5)</td>
<td>114 (62.0)</td>
</tr>
<tr>
<td>Well</td>
<td>2 (2.0)</td>
<td>0</td>
<td>0</td>
<td>96 (98)</td>
</tr>
<tr>
<td>Handcart</td>
<td>12 (30.8)</td>
<td>3 (7.7)</td>
<td>0</td>
<td>21 (61.5)</td>
</tr>
<tr>
<td>Borehole</td>
<td>4 (66.7)</td>
<td>1 (16.7)</td>
<td>1 (16.7)</td>
<td>0</td>
</tr>
<tr>
<td>Tanker</td>
<td>3 (100)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Spring</td>
<td>1 (33.3)</td>
<td>1 (33.3)</td>
<td>0</td>
<td>1 (33.3)</td>
</tr>
</tbody>
</table>

The table shows results in numbers and percentage (in brackets) for all samples from both case studies. The data shows that majority of samples from wells (98%), households (62%) and handcart (61.5%) had TTC cfu/100ml above the WHO guideline, relaxed guideline and even case study country standards for untreated community sources. The majority of tap sources complied but the 6.2% that did not comply were even above the WHO relaxed guideline value. Although samples from boreholes from both cities were few, where TTC were found majority complied with ≤10/100ml the relaxed guideline value by WHO and also
with \( \leq 50 \text{cfu/100ml} \) standard for untreated community water sources by the case study countries. The data on values of TTC cfu/100ml were high and varied depending on source. This made the mean and the standard deviation values high and unreliable. The data were converted into log scale and distribution test by Kolgomorov- Smirnov test (K-S) with Lilliefors correction or Shapiro Wilks tests for fewer samples showed that they were non-normal even in log scale. The log scale values, median and non-parametric tests where necessary are used for further analysis. A summary of the levels of TTC cfu/100ml when they were present for both case studies are shown in Figure 6.8.

In the box plot the outline of the box represents the inter-quartile range (25-75), the solid line shows the median and the whiskers are lines that extend from the box to the highest and lowest value, excluding outliers (Helsel & Hirsch, 1992). The figure shows median value for all samples by city. The data shows that where found the levels were higher in samples from Kisumu than samples from Addis Ababa although a few samples from Addis Ababa also had high counts. Kisumu had significantly higher levels of TTC cfu/100ml than Addis Ababa.

![Box plots showing levels of thermotolerant coliforms cfu/100ml for all samples by city](image)

Figure 6.8 Box plots showing levels of thermotolerant coliforms cfu/100ml for all samples by city

The data on levels of TTC cfu/100ml was further disaggregated by point of sampling and is shown in Figure 6.9. The data shows that water sampled from wells had higher levels of
TTC cfu/100ml, followed by household storage and handcarts respectively. Samples from tankers and taps had the least counts of cfu/100ml and therefore were likely of better quality but taps had several above the median. Although samples from boreholes and springs were few, those analysed from borehole had low levels of TTC counts. Samples from springs also had low levels of TTC contamination.

Further analysis was done for wells, handcarts and households (boreholes and springs were very few in number to be subjected to any further analysis) to test whether the difference observed in levels of TTC cfu/100ml was significant, with a null hypothesis that no significant difference would be found. The data were non-normal and therefore to compare three independent groups the Kruskall Wallis test was used. The analysis gave a significant result $\chi^2 (2) = 169.325, p<0.001$. However, to establish if individual groups were significantly different the Man Whitney test was used to follow up this finding, thus comparing two independent groups at a time. The results were significant when individual samples from each point of sampling were compared to each other. Water samples from wells had significantly higher counts of TTC cfu/100ml, followed by handcart containers and household storage respectively and each was significantly different from the others.

Figure 6.9 Levels of thermotolerant coliforms cfu/100ml for all samples by source type from both case studies
Samples from Kisumu came from a variety of sources as shown in box plots in Figure 6.10 as opposed to Addis Ababa where all sellers ultimately got their water supplied from the official utility network. Further analysis was done for samples from Kisumu to test whether the differences observed was significant. For further analysis below boreholes and tankers were excluded due to insufficient samples. The distribution for each data set was non normal even in log scale and therefore to compare several independent groups the Kruskall Wallis test was used. The analysis yielded a significant result $\chi^2 (3) = 121.453, p< 0.001$. The levels of TTC cfu/100ml were significantly different for water samples from piped sources (taps and all standpipes), household storage, wells and handcart containers. Follow up tests on this finding using the Man Whitney test showed significant differences when individual samples from each point of sampling was compared to each other. Piped water from taps and PWTs/standpipes showed significant difference when compared individually to household storage, well and handcart. Household storage was significantly different from well and handcart, and well and handcart also showed significant difference.

Figure 6.10 Levels of TTC cfu/100ml for all samples from Kisumu by point of sampling
For piped water samples alone, a summary of the number of samples taken for microbiological analysis from each case study and the number of samples that met the WHO guideline of zero TTC cfu/100ml by each case study are shown in Table 6.37.

Table 6.37 Piped (PWTs/standpipe/tap) samples without thermotolerant coliforms cfu/100ml compared to all samples

<table>
<thead>
<tr>
<th>Samples by city</th>
<th>N</th>
<th>Samples without TTC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
</tr>
<tr>
<td>All samples</td>
<td>414</td>
<td>109</td>
</tr>
<tr>
<td>All PWTs/standpipe</td>
<td>81</td>
<td>62</td>
</tr>
<tr>
<td>Kisumu only</td>
<td>46</td>
<td>34</td>
</tr>
<tr>
<td>Addis Ababa only</td>
<td>35</td>
<td>28</td>
</tr>
</tbody>
</table>

The data shows that the majority of PWTs/standpipe samples in each city had no TTC cfu/100ml. The data suggests that compliance rate was higher in Addis Ababa (80%) and different from that of Kisumu (73.9%). The data were analysed using χ² test to test whether this difference was statistically significant. The analysis shows that the difference was not significant χ² (1) =0.410, p=0.603 and therefore the null hypothesis is rejected. Although Kisumu had a slightly lower compliance rate than Addis Ababa, the difference was not statistically significant.

For well samples, there were generally high levels of TTC cfu/100ml. Those from Kisumu were analysed separately for quality for wet (N=33) and dry season (N=63). The results are shown in Figure 6.11. The data shows high levels of TTC cfu/100ml and a difference between the wet and dry season. The level of TTC cfu/100ml for wet season (Mdn log₁₀=3.49) appeared different from dry season (Mdn log₁₀= 3.28). Further analysis was done to test whether the difference observed for wet and dry season samples was significant. For this analysis to test the difference between the wet and dry season, the Man Whitney test was used. The analysis produced a significant result. The data indicate that TTC levels were higher during wet season than dry season and the difference was statistically significant, U =595, p< 0.001.
Some wells (26) were sampled repeatedly in Kisumu, three times over the course of the research; once and twice during first and second fieldwork visits respectively. These were the most productive wells and tended to remain relatively active in the dry season (during second fieldwork visit) even when others had very little water or had dried up. They were important sources of water both to households collecting directly and handcart vendors selling to households. Results for this are shown in Table 6.38 and suggest a difference in levels of contamination at each of the three sampling occasions.

Table 6.38 Comparing well water quality (Log₁₀ thermotolerant coliforms cfu/100ml) over different sampling occasions

<table>
<thead>
<tr>
<th>Sampling round</th>
<th>N</th>
<th>Median</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Std dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fieldwork 1</td>
<td>33</td>
<td>3.54</td>
<td>3.55</td>
<td>2.78</td>
<td>4.66</td>
<td>0.42</td>
</tr>
<tr>
<td>Fieldwork 2 First sampling</td>
<td>27</td>
<td>3.27</td>
<td>3.30</td>
<td>2.00</td>
<td>5.18</td>
<td>0.68</td>
</tr>
<tr>
<td>Fieldwork 2 Second sampling</td>
<td>26</td>
<td>3.27</td>
<td>3.23</td>
<td>2.60</td>
<td>5.18</td>
<td>0.61</td>
</tr>
</tbody>
</table>

As there were three sampling occasions and were repeated in the same (26) wells each sampling occasion, to assess if the difference was significant among these three related groups the data were analysed using Friedman’s ANOVA test statistic ($\chi^2_F$). The analysis
produced a significant result $\chi^2_F (2) = 29.250$, $p<0.001$, suggesting that levels of TTC cfu/100ml for wells where sampling was repeated was different over the three sampling occasions. To further compare two related groups Wilcoxon signed rank test (W) was used to follow up on this finding. Wilcoxon test was more appropriate for comparing the two groups because the samples were taken from same wells each time and so were related. Individual groups were compared and the results are shown in Table 6.39.

Table 6.39 Results of Wilcoxon’s signed rank test for comparing Log_{10} thermotolerant coliforms cfu/100ml for well water source for different sampling occasions in Kisumu

<table>
<thead>
<tr>
<th>Sampling occasion</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>$z$, $p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second fieldwork first sampling Vs First fieldwork sampling</td>
<td>27</td>
<td>3.27</td>
<td>3.30</td>
<td>z = -3.268, $p&lt;0.001$</td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>3.55</td>
<td>3.56</td>
<td></td>
</tr>
<tr>
<td>Second fieldwork second sampling Vs First fieldwork sampling</td>
<td>26</td>
<td>3.27</td>
<td>3.23</td>
<td>z = -3.099, $p&lt;0.001$</td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>3.55</td>
<td>3.56</td>
<td></td>
</tr>
<tr>
<td>Second fieldwork first sampling Vs Second fieldwork second sampling</td>
<td>27</td>
<td>3.27</td>
<td>3.30</td>
<td>z = -2.029, $p=0.042$</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>3.27</td>
<td>3.23</td>
<td></td>
</tr>
</tbody>
</table>

The analysis suggests that the levels of TTC cfu/100ml for wells for first fieldwork sampling (Mdn log_{10} = 3.56) was significantly different from second fieldwork first sampling (Mdn log_{10} = 3.30), $z = -3.268$, $p< 0.001$. The median values show that TTC cfu/100ml for first fieldwork was higher. The TTC cfu/100ml levels for wells were also higher in first fieldwork sampling than second fieldwork second sampling (Mdn log_{10} = 3.23), $z = -3.099$, $p<0.001$. The results indicate higher levels for TTC cfu/100ml in the wells during the wet season compared to dry season. No significant difference was seen between the levels of TTC cfu/100 ml for the two samplings conducted during second fieldwork visit in dry season.

Well water samples were analysed based on the area/estate it came from within Kisumu. The median value were Mdn log_{10} = 3.30 for Migosi, Mdn log_{10} = 3.38, for Obunga and Mdn log_{10} = 3.32 for Manyatta. The median values appeared same and further analysis was done using Man Whitney test with null hypothesis that no difference would be seen. The analysis showed that there was no significant difference between Migosi and Obunga.
p=0.173, Migosi and Manyatta U=4770, p=0.314 and between Obunga and Manyatta U=584, p=0.291. The data were further analysed on the levels of TTC cfu/100ml presence in household water by city and is shown in Figure 6.12.

![Box plots showing TTC cfu/100ml in household water by city](image)

Figure 6.12 Box plots showing TTC cfu/100ml in household water by city

The data indicates that levels of TTC in household water were much higher in Kisumu (Mdn log_{10}= 3.23) and significantly different from Addis Ababa (Mdn log_{10}= 0.30). Since in Addis Ababa water was mainly sourced from piped sources, the data may suggest influence of source quality in household water.

In Kisumu, due to many sources used by households, it could be considered likely that the quality of water stored in the home would be influenced by the quality of the source water. Further analysis was done for water by original source to investigate if the quality of original source probably influenced the levels of TTC in the household water. A systematic analysis of the data was possible to undertake because most samples of the households could be paired with the source of water used. This was partly because households had separate storage containers for water from different sources. The levels for household water sourced from wells (Mdn log_{10}= 3.38) were different from that obtained from piped sources (Mdn log_{10}= 0.95) and the difference was significant at 99% confidence level; U= 266.50, p<0.00,
r=-0.6649. Water obtained from wells and stored in the house had significantly high levels of TTC cfu/100ml than tap water stored in the house.

In the water usage questionnaire households were asked whether they ‘ever treated’ their water. Overall 58.8% indicated that they treated their water. When disaggregated by city 74.4% of households in Kisumu indicated that they treated their water. From Addis Ababa a relatively smaller proportion 26.7% indicated that they treated their water. For those who indicated that they treated their water, they were asked about the methods they used for treating drinking water and results are shown in Table 6.38. When lumped together, the data shows that as a whole use of chlorine was the main method followed by boiling. A spilt of data by city, however, shows that boiling was popular in Addis Ababa, while use of chlorine was mainly popular in Kisumu. The chlorine used in Kisumu (locally known as water guard) was available as a mixture of 1.2% Sodium hypochlorite in a 150 ml bottle.

<table>
<thead>
<tr>
<th>Method of treating</th>
<th>All</th>
<th>Kisumu (N=166)</th>
<th>Addis Ababa (N=37)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boil</td>
<td>44.8</td>
<td>36</td>
<td>86</td>
</tr>
<tr>
<td>Use chlorine</td>
<td>50.7</td>
<td>61.4</td>
<td>2.7</td>
</tr>
<tr>
<td>Filtering</td>
<td>4.5</td>
<td>2.6</td>
<td>10.8</td>
</tr>
</tbody>
</table>

It was considered that the quality of water from the household would have improved due to boiling or use of water guard/chlorination. However, the results of the household water testing in Kisumu do not provide evidence that chlorination, boiling or any treating is practised by such a large proportion of household, or if they do then there is possible considerable post treatment re-contamination. It is notable, however, that for Addis Ababa just a small proportion indicated treating (boiling). The results of water quality tests show that the proportion of household having no TTC cfu/100 ml was slightly higher (48.1%) than the proportion of household stating that they boiled their water before drinking (26.7%).

6.7.2 Microbiological quality along supply chains

Water from different sources in Kisumu was followed along their supply chains as described under methodology. The quality was determined at the source, in the transportation containers for handcart sellers and at the household.
6.7.2.1 Microbiological quality for piped water (PWTs/standpipes) along the supply chain in Kisumu

The result for supply chain analysis for tap water is shown in Figure 6.13. TTC cfu/100 ml for tap water sampled from household storage (Mdn log10=0.95) was higher than from tap water sampled at the source (Mdn log10= -0.30) and the difference was significant U=167.50, p<0.001, r= 0.722. The results suggest that deterioration in quality for tap water occurred within the household. The deterioration was major, as shown by r value which shows a high effect size. No significant difference was noticed between tap water sampled at the source and that in the handcart container, U= 329.50, p =0.735 and tanker, U=36, p= 0.640 suggesting that deterioration in quality may not have occurred during transportation by handcarts and tanker and that transportation by handcarts or tankers did not make the quality of piped water worse.

Figure 6.13 Microbiological quality along the supply chain with tap water as the original source

6.7.2.2 Microbiological quality for well water along the supply chain

Water obtained from wells was analysed along the supply chain. Water samples were picked from wells, containers for transportation by handcart vendors and water stored in the household. The data is shown in Figure 6.14. The results suggest that the levels of TTC cfu/100ml in well water sampled from household storage (Mdn log10=3.38) and that sampled...
directly from wells (Mdn $\log_{10}=3.33$) were similar. Although both were high, the data suggest that the deterioration that took place in the house may not have been substantial and there was no difference in the levels of TTC cfu/100ml for well water sampled at source and from household storage.

The level of TTC cfu/100ml in well water sampled from handcart container (Mdn $\log_{10}=3.14$) seemed to be different from that sampled from wells (Mdn $\log_{10}=3.33$). The data for handcart container were few (24) and therefore to test the difference between the two groups analysis was done using Kolmogorov-Smirnov test which is more powerful with samples less than 25. The results of the analysis show that the difference was not significant $Z=1.141$, $p=0.102$ and may indicate that although well water sampled from source appeared to have higher TTC cfu/100ml count than that sampled from handcart container, there was no difference. Transportation by handcarts did not lead to deterioration in quality.

Figure 6.14 Microbiological quality along the supply chain with well as the original source
6.7.3 Chlorine data

Samples from piped sources (taps and PWTs/standpipes) that were taken for microbiological analysis were also analysed for free chlorine residual and total chlorine. The data on chlorine was compared with the WHO (2004) recommended level of 0.2 mg/l of free chlorine. Summary of the data on the percentage of samples meeting the recommended level is shown in Table 6.42.

<table>
<thead>
<tr>
<th>City</th>
<th>N</th>
<th>&gt;0.2mg/l free chlorine (in %)</th>
<th>&gt;0.2mg/l total chlorine (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kisumu</td>
<td>43</td>
<td>16.3</td>
<td>34.9</td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>31</td>
<td>61.3</td>
<td>71</td>
</tr>
<tr>
<td>Total</td>
<td>74</td>
<td>35.1</td>
<td>50</td>
</tr>
</tbody>
</table>

The data suggest that both case studies were not able to maintain free chlorine residual at levels recommended by the WHO. However, for the data set from both case studies, 35.1% of the total samples tested for free chlorine had concentration levels above 0.2 mg/l and half of those tested for total chlorine had above 0.2 mg/l of free chlorine. But marked variation was noticed. Compliance with at least 0.2 mg/l of free and total chlorine was higher in Addis Ababa. However, in both cases some of the samples lacked adequate free chlorine residual. The number of samples tested was small, and therefore these data should be treated with some caution.

6.7.3.1. Relationship between chlorine data and microbiological quality

Analysis of data on the associations between the presence of less than 0.2 mg/l of free or total chlorine and microbial contamination shows that there was an association between lack of adequate free chlorine and the presence of TTC for the data from the two case studies. In all the samples where adequate free (35.1%) or total chlorine (50%) was found there were no presence of TTC cfu/100ml. However, there were some cases which did not have adequate free (41.89%) or total chlorine (27%) where contamination was not found as well.
6.7.4 Sanitary inspection
Sanitary risk inspections using appropriately adapted forms (appendix II A-E) were done for each source. Table 6.41 shows the risk score data by city and source type. The data shows that Kisumu had higher median risk values (Mdn=40) than Addis Ababa (Mdn =20). The risk scores data for each city and by source type were both non normal. Man Whitney test was used for further analysis to test whether the difference in median risk score observed between the cities was significant. The results were significant U= 990, p<0.001, r= -0.431. However, source types were different and a large number of inspections were carried out in Kisumu compared to Addis Ababa. When the data is split by city, only risk scores for piped sources had adequate samples for further analysis. Man Whitney test was done and showed that there was a significant difference in median risk values for PWTs/standpipes between the cities U=260.5, p<0.05, r= 0.4123. Because of few (25) inspections carried out in Addis Ababa, the Kolmogorov-Sminorv test was also done and produced a significant result, Z=1.47, p<0.05. However, inspections carried out were few and the results again should be treated with some caution. For the most commonly used sources in Kisumu: standpipes and wells, the data showed that wells had higher median risks (45%) than taps (PWTs/standpipes) (30%).

<table>
<thead>
<tr>
<th>City/source type</th>
<th>No. of Inspections</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kisumu- all</td>
<td>175</td>
<td>40</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>Addis Ababa- all</td>
<td>34</td>
<td>20</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td><strong>Source type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PWTs/standpipes</td>
<td>65</td>
<td>30</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td>Well</td>
<td>98</td>
<td>45</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Handcart</td>
<td>36</td>
<td>40</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td>Borehole</td>
<td>5</td>
<td>20</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Spring</td>
<td>4</td>
<td>20</td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

6.7.4.1. Relationship between sanitary risk and microbiological quality
Data on the general relationship between sanitary risk and TTC cfu/100ml for different sources for all samples from both case studies are shown in Figure 6.15. The results for all sources seemed to suggest that there was no direct relationship between risk score and TTC cfu/100ml. The data also shows that wells had high scores but they were no exception. Their
counts were high regardless of the risk score. The data were analysed further to establish whether there was a relationship between risk score and the presence of TTC cfu/100ml for all samples, each city and also for different source types. In each case the null hypothesis was that no relationship would exist between sanitary risk score and the presence of TTC cfu/100ml. As recommended by Tillet et al., (2001) analyses were done using the spearman’s rank correlation ($r^2$). But Kendall’s Tau test which has better power with smaller sample sizes (Field, 2007) was used where samples were few. Aggregated data by each case study is shown in the box plot in Figure 6.16. Handcart container was excluded from these further analyses because the form used could not be relied upon. The figure shows that risk scores were high when TTC was found.

Figure 6.15 Relationship between TTC cfu/100ml and sanitary risk score by source type
Analysis of the data showed that there was a positive relationship significant at the 95% confidence level between the risk score and presence of TTC ($r_s = .48$, $p < .05$) and thus the null hypothesis is rejected. The data indicate that median risk score was higher when contamination was found (40%) compared to when contamination was absent (30%). Despite the significance of the result, the value of $r_s$ indicates a medium rather than a strong relationship. The aggregated data from all sources for each case study were analysed separately. The analysis showed that there was a positive relationship between TTC presence and sanitary risk score for Kisumu significant at 99% confidence level, $r_s = .33$, $p < .001$, and the null hypothesis was rejected. Median risk score for Kisumu was 40% when contamination was found compared to 30% when contamination was absent. Although there was a positive relationship for Addis Ababa, it was not significant ($r_s = .27$, $p = .125$). However, the $r_s$ values for both cities are low, suggesting a weak relationship. Combined data for piped sources (PWTs/taps/standpipes) are shown in the box plots in Figure 6.17.
Analysis showed a positive relationship between risk score and presence of TTC, $r_s = .31$, $p<.05$ significant at the 95% level. The data shows that median risk score was higher (for piped sources combined) when contamination was found (30%) compared to when absent (20%). Separate analysis was done for data from piped sources (PWTs/standpipes) for each city. The data are shown in the box plot in Figure 6.18. Some taps in Kisumu were in very high risk areas as shown in the example in Figure 6.19. Results of analysis shows that there was a positive and significant relationship at the 95% level between risk score and presence of TTC for Kisumu, $r_s = .30$, $p<0.05$, but not for Addis Ababa, $r_s = .422$, $p = .065$. 

**Figure 6.17** Box plots for sanitary risk score for tap sources from both cities when thermotolerant coliforms were found compared to when they were absent
Analysis for relationship between risk score and TTC cfu/100ml presence in wells was done for Kisumu (Figure 6.20) alone since there was only one well sampled in Addis Ababa. The data shown were analysed further to assess whether there was a relationship between risk score and the presence of TTC cfu/100ml for well samples. The null hypothesis was that no relationship would exist between overall sanitary risk score and the presence of TTC. The analysis shows that there was a positive but non significant relationship $r_s = .49, p=.630$.

The data from wells were further grouped following the categorisation of risk scores suggested by Lloyd and Bartram (1991) and UNICEF & WHO (2005). The percentage of wells categorised as low risk ($\leq 20\%$), medium risk (30-40%), intermediate to high risk (50-70%), and very high risk ($\geq 80\%$) are plotted in Figure 6.21 below. Based on this system the figure shows that majority of wells were in the medium to very high risk categories.
Figure 6.19 Photograph of partly broken pipes leading to a standpipe in a low income estate in Kisumu
During the second fieldwork visit it was found that due to outbreaks of cholera in the preceding months, attempts were being made to address the poor quality of water from wells in Kisumu. The Public Health Department of Kisumu City Council together with the Kenya Red Cross by the time of second fieldwork had conducted two trainings for well owners in
which 60 well owners participated. The training covered: water borne diseases and their management, laws that governs issues concerning the health of the general public, health law (Cap 242 of the laws of Kenya), which for example states that in locating wells, a shallow well should be sited at least 100 metres away from any possible source of contamination; water treatment methods including traditional and modern methods and demonstration to the participants how chlorine pots are used for disinfecting wells to keep the water safe for human consumption; and possible responsibilities of well owners.

Figure 6.22 shows how in this effort the city has been zoned for easy identification of wells, estimated total number of wells, number visited and given chlorine by the concern team. However, results from second fieldwork water testing have not provided any evidence for any improvements in water quality for well water.

### 6.7.5 Chemical quality

A total of 226 samples obtained from groundwater sources either through wells, boreholes or springs were analysed for fluorides and nitrates. Majority of the samples were from Kisumu (207) with the rest (19) from Addis Ababa.

#### 6.7.5.1 Fluorides

A summary of the data for fluorides is shown in Table 6.42. The data shows that fluoride concentration for the water samples collected range from less than 0.05 mg/l up to 13 mg/l. Kisumu had higher concentration reaching up to a maximum of 13 mg/l while samples from Addis Ababa had very low concentrations.

<table>
<thead>
<tr>
<th>Source/city</th>
<th>N</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>225</td>
<td>1.10</td>
<td>&lt;0.5</td>
<td>13</td>
</tr>
<tr>
<td>Kisumu</td>
<td>207</td>
<td>1.10</td>
<td>&lt;0.5</td>
<td>13</td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>19</td>
<td>0.60</td>
<td>&lt;0.5</td>
<td>1</td>
</tr>
</tbody>
</table>
Figure 6.22 Subdivision and chlorination efforts undertaken for wells in Kisumu

<table>
<thead>
<tr>
<th>Source Municipality Databases</th>
<th>and fieldwork - 2001/02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads.shp</td>
<td></td>
</tr>
<tr>
<td>Trunk roads.shp</td>
<td></td>
</tr>
<tr>
<td>No of wells visited and given cl pots.shp</td>
<td></td>
</tr>
<tr>
<td>Kisumu City sublocation Boundaries.shp</td>
<td></td>
</tr>
<tr>
<td>Northern Zone.shp</td>
<td></td>
</tr>
<tr>
<td>Western zone.shp</td>
<td></td>
</tr>
<tr>
<td>Southern zone.shp</td>
<td></td>
</tr>
<tr>
<td>Eastern zone.shp.shp</td>
<td></td>
</tr>
<tr>
<td>Lake victoria k.shp</td>
<td></td>
</tr>
</tbody>
</table>

- Approximate total No. of Wells in Kisumu: 800
- Total No. of Wells Visited: 400
- Total No. of Wells Visited and given Chlorine: 224
Analysis was done using the guideline value of ≤1.5 mg/l (WHO 2006) and the results are shown in Table 6.43 below. The data shows that all the samples from Addis Ababa and majority from Kisumu (71.5%) were within the recommended guideline value. For Addis Ababa all the samples were also within the country standard set at 3.0 mg/l.

Table 6.44 Number and percentage (in brackets) of groundwater samples meeting recommended fluoride guidelines by the WHO and standards for case study countries

<table>
<thead>
<tr>
<th>Source/city</th>
<th>N</th>
<th>≤1.5 mg/l,</th>
<th>1.5-3.0 mg/l</th>
<th>3.01-4.6 mg/l</th>
<th>4.61+ mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>225</td>
<td>167 (74.2)</td>
<td>6 (2.7)</td>
<td>21 (9.3)</td>
<td>32 (14.2)</td>
</tr>
<tr>
<td>Kisumu</td>
<td>207</td>
<td>148 (71.5)</td>
<td>6 (2.9)</td>
<td>21 (10.1)</td>
<td>32 (15.5)</td>
</tr>
<tr>
<td>Addis</td>
<td>19</td>
<td>19 (100)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

When the data is disaggregated by source or point of sampling, as shown in Table 6.44 the data shows that the highest concentrations were found in wells with a mean of 2.77 mg/l and a maximum of up to 13 mg/l, boreholes generally had low concentration with all samples not exceeding 1 mg/l and a mean of 0.6 mg/l. Springs on the other hand had concentration between 0.50 and 0.80 mg/l. All spring and borehole samples were within the recommended guideline value.

Table 6.45 Fluoride concentrations (mg/l) by sampling point for groundwater sources for both case studies

<table>
<thead>
<tr>
<th>Source type</th>
<th>N</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well</td>
<td>93</td>
<td>1.15</td>
<td>&lt;0.5</td>
<td>13</td>
</tr>
<tr>
<td>Household storage</td>
<td>95</td>
<td>1.10</td>
<td>&lt;0.5</td>
<td>12.50</td>
</tr>
<tr>
<td>Handcart</td>
<td>25</td>
<td>1.10</td>
<td>&lt;0.5</td>
<td>6.00</td>
</tr>
<tr>
<td>Borehole</td>
<td>6</td>
<td>0.61</td>
<td>&lt;0.5</td>
<td>1.00</td>
</tr>
<tr>
<td>Spring</td>
<td>4</td>
<td>0.78</td>
<td>0.50</td>
<td>0.80</td>
</tr>
<tr>
<td>Tap⁹</td>
<td>4</td>
<td>0.65</td>
<td>&lt;0.5</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Further analysis was done for samples for Kisumu on its own with the data disaggregated by source type or point of sampling. Addis Ababa was excluded because fluoride concentration for all samples was within the safe limits as recommended by the WHO guidelines and also the country standard. The data as shown in Table 6.45 indicates that majority of samples

---

⁹ These were samples collected from tap outlet but piped from well field/springs in Addis Ababa
from Kisumu had fluoride concentration levels within the WHO guideline and Kenya standard of 1.5 mg/l. From the data there appeared to be no difference based on source type.

The data was analysed using Kruskall Wallis test with a null hypothesis that no significant difference would be found. Samples from borehole were excluded due to few numbers. The result indicate that there was no significant difference in fluoride concentration in water samples from wells, handcart and household storage ($\chi^2 (1) =1.293$, p=0.524, possibly because water sampled from household storage and handcart were obtained from wells.

Table 6.46 Fluoride levels (mg/l) for ground water samples by source type and the proportion meeting recommended guidelines in numbers and percentage (in brackets) in Kisumu

<table>
<thead>
<tr>
<th>Source</th>
<th>Median (mg/l)</th>
<th>≤1.5 (mg/l)</th>
<th>1.51-3.0 (mg/l)</th>
<th>3.01-4.60 (mg/l)</th>
<th>≥4.61 (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well</td>
<td>1.15</td>
<td>65 (69.9)</td>
<td>1 (1.1)</td>
<td>8 (8.6)</td>
<td>18 (19.4)</td>
</tr>
<tr>
<td>Boreholes</td>
<td>&lt;0.5</td>
<td>2 (100)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Handcart</td>
<td>1.10</td>
<td>14 (56)</td>
<td>3 (12)</td>
<td>3 (12)</td>
<td>5 (25)</td>
</tr>
<tr>
<td>Household storage</td>
<td>1.10</td>
<td>68 (76.4)</td>
<td>2 (2.2)</td>
<td>10 (11.2)</td>
<td>9 (11.1)</td>
</tr>
<tr>
<td>Total (%)</td>
<td>1.10</td>
<td>149 (71.5)</td>
<td>6 (2.9)</td>
<td>21 (10.1)</td>
<td>32 (15.5)</td>
</tr>
</tbody>
</table>

To assess if there was a possible influence of source quality on water found in the household or handcart, supply chain analysis was done for fluoride concentration. Man Whitney test was used to test whether water sampled from household or handcart container was different from that of the original well source. The analyses produced non significant results. Water sampled from well had slightly higher concentration (Mdn=1.15mg/l) than water stored in household (Mdn=1.10mg/l), or that in handcart (Mdn=1.10mg/l), but the difference was not significant from that in the house, U= 3756.500, p=0.229 or in the handcart, U=1048.50, p=0.647. Neither was there a significant difference between fluoride concentration in handcart water and water stored in the household, U= 1020.00, p=0.678 as would be expected.

6.7.5.2 Nitrates
A summary of the data for nitrates (Nitrate as Nitrogen NO$_3$-N) are shown in Table 6.46. The data shows that nitrate concentration for the water samples collected range from a
minimum of <0.1 mg/l up to 45 mg/l. Kisumu had the highest concentration reaching up to the maximum of 45 mg/l while samples from Addis Ababa had very low concentrations.

Table 6.47 Levels of Nitrate as Nitrogen (NO$_3$-N) in mg/l for groundwater samples from Kisumu and Addis Ababa

<table>
<thead>
<tr>
<th>Source/city</th>
<th>N</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>226</td>
<td>1.00</td>
<td>&lt;0.1</td>
<td>45.00</td>
</tr>
<tr>
<td>Kisumu</td>
<td>207</td>
<td>1.00</td>
<td>&lt;0.1</td>
<td>45.00</td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>19</td>
<td>1.00</td>
<td>&lt;0.1</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Overall the majority of the samples, about 71%, in Kisumu and all the samples from Addis Ababa were within the guideline (≤11.3 mg/l) suggested by WHO and also the standard used by Ethiopia as the data in Table 6.47 shows. For Kisumu the majority (62.7%) of samples were also within the Kenya standard of ≤ 10 mg/l, which was slightly stricter, than the WHO guideline value.

Table 6.48 Number and percentage (in brackets) of ground water samples from both case studies meeting WHO guidelines and standards set by the case study countries

<table>
<thead>
<tr>
<th>Source/City</th>
<th>N</th>
<th>≤10 mg/l</th>
<th>10.01-11.30 mg/l</th>
<th>≥11.31 mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>226</td>
<td>160 (70.8)</td>
<td>5 (2.2)</td>
<td>60 (26.5)</td>
</tr>
<tr>
<td>Kisumu</td>
<td>207</td>
<td>142 (68.6)</td>
<td>5 (2.4)</td>
<td>60 (28.9)</td>
</tr>
<tr>
<td>Addis</td>
<td>19</td>
<td>19 (100)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

When the data set is split by source type or point of sampling as shown in Table 6.48, the data shows that the mean for samples from wells, household storage and handcart had higher concentration compared to boreholes or springs. However, both the mean and median values for all samples were within the WHO and case study country recommended guidelines. All samples from taps, spring and borehole were within the recommended guideline value. Further analysis for samples for the whole data split by source type or point of sampling based on meeting given standards/guidelines are shown in the last column of Table 6.49. The percentages are shown in brackets. The data shows that of about 26 % overall exceeding safe limit guideline of ≥11.31 mg/l, 13.8% were from wells, 12.4% were samples from household storage and one (0.4%) was from a handcart.
Further analysis was done for samples for Kisumu with the data disaggregated by source or point of sampling. Addis Ababa was excluded because concentration for all samples was within the safe limits and also because of fewer samples, for example, all samples from wells except one came from Kisumu and so proper analysis of the well samples required Kisumu data to be analysed on its own. The results for the analysis are shown in Table 6.48. Percentages are shown in brackets.

Table 6.49 Levels of Nitrate as nitrogen (NO$_3$-N) in mg/l and number and percentage (in brackets) in the last column of those exceeding WHO guideline by source type for both cities

<table>
<thead>
<tr>
<th>Source type</th>
<th>N</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
<th>≥11.31 mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells</td>
<td>94</td>
<td>1.28</td>
<td>&lt;0.1</td>
<td>45.00</td>
<td>31 (13.8)</td>
</tr>
<tr>
<td>Household storage</td>
<td>94</td>
<td>1.00</td>
<td>&lt;0.1</td>
<td>45.00</td>
<td>28 (12.4)</td>
</tr>
<tr>
<td>Handcarts</td>
<td>24</td>
<td>0.93</td>
<td>0.06</td>
<td>25.30</td>
<td>1 (0.4)</td>
</tr>
<tr>
<td>Boreholes</td>
<td>5</td>
<td>1.00</td>
<td>0.90</td>
<td>1.00</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Springs</td>
<td>4</td>
<td>0.26</td>
<td>0.11</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>Taps</td>
<td>4</td>
<td>0.73</td>
<td>&lt;0.1</td>
<td>3.00</td>
<td>0</td>
</tr>
</tbody>
</table>

The data shows that as a whole the majority of samples from Kisumu were within the WHO recommended guideline of ≤11.30 mg/l. About 68.4% were within the Kenyan standard of ≤10 mg/l. Of the 31.5% that exceeded the Kenyan standard, 16.5% were from wells while 14.6% were from household storage, although latter were also originally from wells.

Table 6.50 Levels in mg/l, number and percentage (in brackets) of samples meeting standards for Nitrate as nitrogen (NO$_3$-N) for water samples by source type in Kisumu

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Median</th>
<th>≤10</th>
<th>10.01-11.30</th>
<th>≥11.31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells</td>
<td>93</td>
<td>1.00</td>
<td>59 (28.6)</td>
<td>(3) 1.5</td>
<td>31 (15.0)</td>
</tr>
<tr>
<td>Household storage</td>
<td>88</td>
<td>1.00</td>
<td>58 (28.2)</td>
<td>2 (1.0)</td>
<td>(28)13.6</td>
</tr>
<tr>
<td>Handcarts</td>
<td>25</td>
<td>0.93</td>
<td>23 (11.2)</td>
<td>0 (0)</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>All</td>
<td>207</td>
<td>1</td>
<td>141 (68.4)</td>
<td>5 (2.4)</td>
<td>60 (29.1)</td>
</tr>
</tbody>
</table>

Further analysis was done to assess if there was any significant difference between well water sampled from wells and those sampled from household storage and handcart containers. The data were analysed using Kruskall Wallis test with a null hypothesis that no significant difference would be found. The result indicate that there was no significant difference $\chi^2 (1) = 0.618$, $p=0.734$, and the null hypothesis was accepted. There was no significant difference
in nitrate levels for water sampled from wells (Mdn=1.0mg/l) and wells water sampled from household storage (Mdn=1.0mg/l) or handcart container (Mdn = 0.93). The results show that chemical quality of water did not change in the household storage or handcart container as would be expected. Further analysis was done for NO₃-N levels based on area (estate) where water was sampled from. The results are shown in Table 6.50. The data shows that the levels were higher in low density settlements (Manyatta and Obunga).

Table 6.51 Levels in mg/l, number and percentage (in brackets) of samples meeting standards for Nitrate as nitrogen (NO₃-N) for water samples by area of sampling in Kisumu

<table>
<thead>
<tr>
<th>Area</th>
<th>N</th>
<th>Median</th>
<th>≤10</th>
<th>10.01-11.30</th>
<th>≥11.31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migosi</td>
<td>87</td>
<td>0.85</td>
<td>83 (95.5)</td>
<td>3 (3.4)</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>Manyatta</td>
<td>103</td>
<td>2.8</td>
<td>52 (50.5)</td>
<td>2 (1.9)</td>
<td>49 (46.7)</td>
</tr>
<tr>
<td>Obunga</td>
<td>12</td>
<td>21.0</td>
<td>4 (33.3)</td>
<td>0 (0)</td>
<td>8 (66.7)</td>
</tr>
</tbody>
</table>

6.8 Conclusion
The results presented in this chapter shows that households living in un-served and poorly served areas in the two case studies use several water sources. Multiple source use was common regardless of the type of source used as a first source, with an average of two sources. Very few households had direct household tap connection to the official water supply in both case studies but it was still the main source of water in Addis Ababa hence the most selected as the first and second water source although it was mainly available through PWTs/standpipe sale points ‘bonos’, household resale and tap in the yard. I&SSWPs sourcing their water from the official utility network were therefore a crucial source of water for a section of the Addis Ababa population living in areas that were selected for this research. In Kisumu in the areas selected for study, a variety of sources were used.. Overall, wells, followed by standpipes connected to official network and handcarts were the most popularly used as first and second sources. Use of mobile vendors in the form of handcart delivery was also common. Therefore apart from sellers dependent on the official water utility, independent sources were also important sources of water for households in Kisumu.

A combination of factors influenced household selection of their water sources but only a few factors were important overall. Measures of access particularly ‘distance’ predominated in selection of first and second water sources regardless of the source type. The use of other water sources or I&SSWPs even those thought to be expensive or unsafe appear to be
primarily as a result of them being the sources accessible to users as defined by various measures of access. But other factors, especially quality/safety, reliability and costs seem to have also been important consideration for selection of some sources in Kisumu. Quality was, however, not mentioned as a factor influencing choice of water source by respondents in Addis Ababa suggesting a perception that the water sources available were safe. For Kisumu the mention of quality may be due to the availability of a variety of sources including those perceived not to be safe.

Household are involved in ongoing decisions on water use particularly on what sources but mostly a combination of sources for given uses. Although a rationality factor appears to be in operation, other key measures of access like distance and availability seems to be more pressing and may result into the use of some sources for purposes they would not otherwise be used for. Quantity collected for use by households in both cases studies vary by source and season but generally appears low although this improves in cases where I&SSWPs with own sources are available. The price of water sold at standpipes fixed on official utility network is higher than for water households obtained from I&SSWPs with own sources. The use of handcart vendors, however, results into drastic increase in supply throughout all supply chains. The quality of water from some sources including those supplied by I&SSWPs may not be safe. Water from wells was the most contaminated. Water stored in household also showed poor quality. But tanker and tap water were of better quality although deterioration was seen for tap water once transportation and storage was undertaken. For chemical quality, 44% of all samples had more than the maximum recommended fluoride concentration value of 1.5mg/l, compared to 14.4% for nitrates. The nitrate concentration levels were greater for samples from Kisumu compared to Addis Ababa and within Kisumu in areas with high density settlement which could be an indication of the potential influence of development on the surface on the quality of ground water.

The data has shown that there may be a concern with some indicators of water supply like the quality of water from some sources, the use of water from such sources, as well as high costs, to the households un-served and poorly served by official water utilities. But these I&SSWPs are an important source of water, sometimes the only sources available, and without which some households would not be able to meet their basic water needs. The next chapter presents data and examines in details the other operational and management aspects of these providers.
Chapter 7 Analysis of Independent and small scale water providers

7.1 Introduction
In Chapter 3 it was shown that several categories of independent and small scale water providers prompted by various reasons have emerged to fill the water supply gaps that are left by the official water utilities. However, it was argued that they tend to operate unofficially and the services they provide often tend to be either ignored or characterised negatively. In Chapter 6 data from household water usage survey showed that households living in areas un-served and poorly served in the case studies use several sources of water, including those provided by I&SSWPs. However, as this data was principally gathered from the perspective of households, certain aspects of these providers could not be established from household survey but required a follow up of I&SSWPs identified during household water usage study. Analysis of I&SSWPs was therefore necessary as a means of confirming and further examining the types that were identified during the household water usage study. This chapter presents the data and results on I&SSWPs. The data is drawn from semi-structured questionnaires and observations that were used as well as from interviews, FGDs and workshop notes as was explained in section 5.3.1, 5.3.2, 5.3.3 and 5.3.4 under methods.

Some of the general socio-economic characteristics of respondents from both case studies are reported together after which each of the two case studies is reported separately. Data on demographic and socio-economic characteristics are presented in section 7.3. Section 7.4 presents I&SSWPs in the Kisumu case study and 7.5 present data from I&SSWPs in Addis Ababa while section 7.6 provides the conclusions.

7.2 Type and number of I&SSWPs who participated in the study
A total of 100 semi-structure questionnaires were administered to a selected number of I&SSWPs available in both case studies during the two fieldwork visits conducted in 2007 and 2008. A summary of some of the methods used and the number and types of I&SSWPs who participated in the study are shown in Table 7.1.
Table 7.1 Type and number of I&SSWP s who participated in the study

<table>
<thead>
<tr>
<th>Study area</th>
<th>Respondent type</th>
<th>Questionnaire respondents</th>
<th>Interviews</th>
<th>Focus groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kisumu</td>
<td>Standpipe operators</td>
<td>54</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Handcart sellers</td>
<td>28</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Well owners</td>
<td>71</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Own small scale water treatment</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>Public water taps/standpipes</td>
<td>28</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Household resellers</td>
<td>-</td>
<td>4</td>
<td>-</td>
</tr>
</tbody>
</table>

The table shows that in Addis Ababa main sellers available were those selling water at PWTs/standpipes and households (on-sellers/resellers) selling water supplied by the official water utility to neighbours. Although during the household survey household resellers were identified as a source of water, even appearing as a first or second source of water for some households in Addis Ababa, those approached were generally reluctant to be involved in the study as explained in Chapter 5 and only four were willing to participate.

7.3 Demographic and socio-economic characteristics of water sellers

In terms of gender, 81% of the respondents were males and 19% were females, suggesting that water selling in general is dominated by males. A split of data by type of provision shows that men dominate water provision through handcart (98.1% male and 1.9% females) and standpipe (63.2% males and 36.8% females). However, a disaggregation of data by city shows that in Addis Ababa females dominate water selling at PWTs/standpipes (66.7% females and 33.3% males) and also in household resale even though respondents involved in household resale were few. The data was corroborated by interview results where seven of the 11 interviewed among sellers in Addis Ababa were females. Three out of four household resellers interviewed in Addis Ababa were also females.

With regard to education for water sellers, overall 94.9% of the respondents had at least some formal education, 46.9% had only primary education while, 45.9% and 2% were educated to a secondary or post secondary level education respectively. Only 5.1% had no
formal education, and were mainly in Addis Ababa. The majority of water sellers at public water taps, also known as public tap attendants, in Addis Ababa had primary education (38.9% up to grade four and, 33.3% had eighth grade education) while 5.6% had secondary and post secondary education. However, unlike Kisumu a slightly higher number, 22.2 % had no formal education.

7.4 II&SSWPsis in the Kisumu case study
In Kisumu the target areas had sellers (without own sources) mainly in the form of handcart and standpipe sellers. Producers (sellers with own sources) were available in the form of well/borehole owned mainly by individuals and few by community and an individual with small scale surface water treatment plant. Sellers without own source who participated in the study were made up of 81% males and 19% females while for producers, 48.6% were males and 51.4% were females, suggesting that males may be dominant among sellers without own source while females dominate in water selling among those with own sources. In terms of educational attainment, 98.8% of water sellers (without own source) had formal schooling. Those with primary and secondary level education were equal in numbers at 48.8% each. Those with post secondary education were 1.2% and the rest had no formal schooling. For water producers, 98.6% of the respondents had at least some formal education, with 18.1% and 54.7% having primary and secondary level education respectively. About 24.3% had post secondary education and 10% had university level education. Only 1.4% had no formal education.

7.4.1 Ownership and management of water selling points/sources and means of delivery
Water selling points were mostly standpipes and wells, while the most common means of water delivery found among sellers were handcarts and jerry cans. 51.85 % of sellers had ownership of means of delivery (handcarts and jerry cans). Among standpipe operators who participated in the study (operating outside the delegated management model10) only two had ventured into laying own pipe network distribution but only over short distances of about 1km and 2.5km each for the examples that were followed up and was purposely done to bring water from utility mains to the point of standpipe location rather than distribution from their standpipes.

10 The model is discussed later in section 7.4.2.2
Within individual type ownership of means of delivery was high among handcart sellers with more than half (54.7%) having ownership. More than half (53.6%) of standpipe operators did not have ownership of the points they sold water from. The generally high ownership levels among sellers may therefore be due to the widespread use of handcarts to deliver water to households. The lower ownership level among standpipe operators may be a reflection of the dominant type of standpipe used. In the majority of cases the water company brought water up to a point, installed and secured its meter and the standpipe operator only fixed flexible plastic tubing (hose) from where water was sold, thus so far there seemed to have been very little in terms of asset investment on means of distribution and therefore little to claim ownership for among the majority of standpipe operators.

For water producers, ownership of infrastructure was high with the majority (88.7% of the respondents) indicating having ownership of infrastructures they used; basically wells, and various pumping devices fitted to the wells. The high ownership levels among producers could be due to nature of land ownership. In the estates selected for study in Kisumu it was established that land ownership was under individual interest or freehold tenure. This is a type of land ownership where one has ownership of land until such a time when all in the family line (descendants) have died. Once an individual has a freehold title, not only does he own the land but any infrastructure he puts/builds on it also becomes rightfully theirs.

Apart from inadequate water supply from the official water utility, ownership of land seems to have partly encouraged individuals to dig wells/boreholes in their compounds. During an interview with one well owner who had two wells in his compound, the researcher asked why he dug the well and why he had two instead of one. He responded that ‘I put up my first well in the 1980s because we were dependent on water from the municipality which was not enough and sometimes was only available at night in kiosks far away from us. This [collecting water at night in far kiosks] was unsafe for some people so people started digging wells for their own use. Once we had the wells we also started helping our neighbours by selling to them water. The demand became too much and because the land is mine, I only needed money for well diggers in order to have two and so the first well gave me money for the second well’ (Interv. Well Owner, 2008).
The size of container used in water selling business was a 20 or 25 litres jerry can; however, majority of sellers (75%) used 25 litres jerry-can as opposed to the 20 litre jerry-can commonly reported as used by households. For handcart sellers, 45.7% owned jerry cans as a means of delivering water to households, while 54.3% mainly standpipe operators, did not own any. Disaggregation of data by seller type shows that among handcart vendors 42% owned jerry cans while 58% did not own any. For those with ownership of water points or delivery facilities, they were asked how many they owned. The data on ownership of jerry cans and handcarts is summarised in Table 7.2. The data shows that among handcart water sellers the number of handcarts owned ranged between a minimum of one to a maximum of seven with a mean of two handcarts and 24 jerry cans. The data shows that among producers (well/borehole owners), who owned handcarts; they had an average of two handcarts (61.4%), with a range from one to 40 handcarts. Some water producers (well/ borehole owners) also owned jerry-cans, with the minimum number owned at 12, enough for one handcart. The maximum number was 360, enough for 30 handcarts.

<table>
<thead>
<tr>
<th>Sellers</th>
<th>Jerry cans/ handcarts owned</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handcart water sellers</td>
<td>Jerry cans</td>
<td>24</td>
<td>12</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>Handcarts</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Borehole/ well owners</td>
<td>Jerry cans</td>
<td>15</td>
<td>12</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td>Handcarts</td>
<td>2</td>
<td>1</td>
<td>40</td>
</tr>
</tbody>
</table>

The mean cost of buying each jerry can was Kshs. 242 (US$ 3.61) with a median of Kshs. 250 (US$ 3.73). But the cost of owning or buying handcarts varied. Mean cost as reported by sellers was Kshs. 6, 437 (US$96.08). Producers gave a mean cost of buying a handcart as Kshs. 6, 000 (US$89.55). Results from interviews and FGDs show that the most common cost of buying a hard cart was Kshs. 6, 800 (US$ 101.49), which was higher than the mean cost as reported in questionnaires by producers and sellers. However, from interviews and FGDs it was reported that those who bought handcart by instalments could pay more and therefore the likely cause of higher as well as the varied average costs reported. The data suggests that producers were more likely to buy handcarts by single instalments suggesting that they perhaps had better resources which enabled them do so, however, they also paid the
lower cost, while sellers (handcart pushers) were likely to buy by instalments suggesting little resources to make a single payment but paid the higher cost.

For the standpipes operators majority (59.3%) owned one selling point, 11.1% had two, 3.7% had three, 14.8% had four, 7.4% had six, and another 3.7% had above six. Although interviews with standpipe operators suggested that there were clear procedures for owning and operating a standpipe, a general opinion emerged that some individuals who had connection to employees and influential people in the former Kisumu City Council Water and Sewerage Department were able to influence and therefore owned several standpipes. Such standpipes were seen to be strategically located away from the middle income areas they are suppose to serve so that they could serve handcart vendors who in turn served middle income estates. It was further suggested that the current water company had not done anything to correct the situation and that people with connections to influential individuals in the present company may be doing the same. One interviewee observed that ‘why do handcart vendors have to go all the way to Kibuye or Kaloleni to get water to sell in Migosi? Those standpipes belong to people who are known some in the former department and some in KIWASCO. If they wanted to serve us using standpipes we would have some in Migosi estate but even the few in Migosi are at the periphery, why? They just want to get our money through the handcart vendors’ (Interv. Migosi resident, May 2007).

The cost for starting and owning standpipe varied. Majority of standpipe owners, however, only needed to buy flexible plastic tubes (hoses) which they in turn fixed on the piped water network at points where the official water utility had installed meters for the individual standpipes. Table 7.3 shows that the estimated total cost of owning or starting a typical standpipe was Kshs. 15,200 (US$ 226.87).

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost in Kshs. (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fee for application form to run a standpipe</td>
<td>200 (2.99)</td>
</tr>
<tr>
<td>Connection costs</td>
<td>4000-5000 (59.70- 74.63) depending on meter size</td>
</tr>
<tr>
<td>Water deposit</td>
<td>10,000 (149.25)</td>
</tr>
<tr>
<td>Estimated* total</td>
<td>15,200 (226.87)</td>
</tr>
</tbody>
</table>

* Excludes those who had to lay pipes to reach water mains
However, some standpipe operators had to lay down pipes to bring water from the authority mains to their water selling points. These sellers, found to have been in the water selling business for over seven years, laid their pipes before the current water company (KIWASCO) took over (as described below the present utility is now deliberately attempting to work with standpipe operators and therefore lays pipes up to a point where the utility meter is fixed). The costs for starting up a standpipe for such sellers included additional costs such as that of pipes and labour to lay it down. The length covered was 1km for the example taken in Migosi and 2.5km for the example in Nyamasaria with an estimated mean cost of Kshs. 250 (US$ 3.73) per meter. In addition some standpipe water sellers had storage tanks. The average capacity of such tanks was 10,000 litres with an average cost of Kshs. 20,000. Thus a large scale standpipe operator (Figure 7.1) who had brought water over a distance of 1km and also bought tanks (three tanks) had incurred substantial costs estimated at Kshs. 320,150 (US$ 4,778.35) as shown in Table 7.4.

For the few standpipe sellers who had undertaken investments in pipe network, the average investment costs incurred by private individuals in establishing their water selling points compared well with those reported in community owned standpipes laid down by SANA
International (an NGO) in Obunga, where they have extended pipes and put up standpipes to enable those living in this low income area get access to water from the official piped network (as shown in section 7.4.2.6).

<table>
<thead>
<tr>
<th>Item</th>
<th>In Kshs.</th>
<th>In US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter rent</td>
<td>150</td>
<td>2.24</td>
</tr>
<tr>
<td>Deposit</td>
<td>10,000</td>
<td>149.25</td>
</tr>
<tr>
<td>Pipe buying and laying (Average of Kshs. 250/meter)</td>
<td>250,000</td>
<td>3731.34</td>
</tr>
<tr>
<td>Tank cost (20,00 each)</td>
<td>60,000</td>
<td>895.52</td>
</tr>
<tr>
<td>Total</td>
<td>320,150</td>
<td>4,778.35</td>
</tr>
</tbody>
</table>

The majority of standpipe owners did not own handcarts or other means of delivery. Seven of the ten standpipe owners interviewed indicated that they were not keen to undertake distribution mainly due to uncertainty as to whether the distribution part would improve their small scale businesses. However, others indicated that they were not allowed by the official water utility to own storage tanks or to lay distribution lines. Interview with the small scale producer with his own surface water treatment indicated that he is only licensed for bulk supply as this is what he applied for. But he was also of the view that other reasons discouraged him including: the prohibitive cost of laying pipe distribution network; lack of financing as it is difficult to convince banks that the venture is profitable though it is; laying pipes would also mean removal of waste water which require heavy investment yet the sunk cost would be lost once official piped network is laid down in those areas. During interview he observed that ‘I want to avoid that [laying pipes] in principle....my interest is to survive as long as they have not covered this area....I only operate as long as their reticulation has not reached here....the issue is the environment is not suitable...it is not good to be told that when KIWASCO lines reaches here you will not be allowed to supply water....I think the law is an impediment to private sector participation’ (Interv. May 2007)

Those who did not have ownership were questioned to establish who had ownership of the standpipes, other equipments/means of delivery used and water itself. For ownership of equipments and other means of delivery, respondents reported private individuals (80%), SANA International (11.4%) and community groups (8.6%). Ownership of water itself remained unclear, with 96% among the producers (mainly well owners) suggesting that the
groundwater they exploited was 'free and belonged to none'. Surprisingly the LVSWSB, the custodian of the water resources in this area on behalf of the government and the asset holder for water supply infrastructure was not mentioned as owner of water. The official utility (KIWASCO) contracted to supply water, was mentioned as owner of water sold by standpipe operators but not water selling points.

The cost of hiring facility/equipment for those who did not own the facilities was investigated. When all sellers are grouped together the mean cost for hiring/leasing was given as Kshs. 68 (US$ 1.01), with a maximum cost of Kshs.150 (US$ 2.34) and a minimum of Kshs.50 (US$ 0.75). When this data is split by seller type, it shows that renting was a phenomenon mainly for handcart water vendors who did not have own carts. The average amount for hiring as was reported from questionnaires was Kshs. 69.57 (US$ 1.034) per day among the handcart vendors with a maximum of 150(US$ 2.34) and a minimum of Kshs. 50 (US$ 0.75). However, the majority- about 75%, hired at Kshs. 50 (US$ 0.75). It was largely confirmed during the interviews and FGDs that the most common cost to hire a handcart for those who did not own was Kshs. 50 (US$ 0.75) per day but one could pay more if hiring both handcart and containers. Standpipe operators on the other hand paid a meter rent of Kshs. 150 (US$ 2.34) monthly to the water authority.

7.4.2 Detailed results on I&SSWPs types
The sources and owners of water sources used by I&SSWPs or sellers (without own sources) in the case study estates within Kisumu were established during the study and the results are shown in Figure 7.2. The data shows that sellers use a combination of sources. Apart from water from official pipe network, private individuals (well/borehole and a small scale private producer of treated surface water) and an NGO were also reported as suppliers of water to sellers.

7.4.2.1 Detailed analysis of water selling at standpipes (kiosks)
Figure 7.2, shows that 37.80% of water sellers, mainly standpipes operators reported that they got their water from official pipe network. Except for multiple standpipes put up at the site of the small scale producer with own surface water treatment, most standpipes had connection to and therefore got their water from the official utility (KIWASCO) pipe water network. According to information gathered from documents and interviews
standpipes/kiosks are playing an important role in helping the water companies in Kenya, including KIWASCO to achieve their benchmarks (these are Government of Kenya benchmarks, set by the Water Services Regulatory Board (WASREB). The WASREB accepts standpipes in the figures of coverage though as a lower level of service.

Of the current 159,000 (31.8%) of the population estimated as having access to water those covered by standpipes/kiosks are included. The number of standpipes in the whole of Kisumu was estimated at 235 with five which are public managed by Kisumu City Council and the rest managed by individuals as private standpipes/kiosks as was shown in Chapter 6 Table 6.8. An interview with a KIWASCO representative, indicated that the use of standpipes/kiosks is perceived as a 'strategy' for water provision, adopted not only for low income areas but also to 'fill the gap' in service provision in non-poor areas that are currently inadequately served. In an interview, an official from KIWASCO noted that 'our problem which made us think of this [standpipe] strategy...was the issue of the gap in service delivery...the strategy worked, and I can say it still works well for us because in my calculation of the people I reach, I include the role of kiosks in that' (Interv. Commercial Manager KIWASCO, 2007). However, for the non-poor areas standpipes are seen as a 'temporary' measure as improvement in service through both rehabilitation and expansion of the water supply system is undertaken by LVSWSB. The view is that standpipes/kiosks is a short term strategy for non poor areas which hopefully will disappear as they get forced out.
of business due to lack of customers once supply is improved and households are able to connect to piped water supply (Interv. Commercial Manager KIWASCO, 2007). However, the water company plans to continue with standpipes/kiosks in low income areas and has adopted a ‘delegated management model’ of water supply for use with standpipes/kiosks in such low income areas as shown below.

7.4.2.2 Delegated management model of water supply
KIWASCO has recently adopted the use of ‘delegated management model’ (DMM) of water supply through kiosks/standpipes as a means to extend and improve water service provision ‘while reducing careless consumption, waste and theft’ (Interv. Commercial Manager KIWASCO, 2007). The DMM is currently on trial in one low income informal settlement (Nyalenda). In the DMM the water company lays pipelines connected to and metered from KIWASCO mains in a given low income area. The company then contracts a resident or a CBO to manage a line. The resident who is subcontracted is called a master operator (MO). The MO connects residents to pipeline under his jurisdiction, meters and bills customers, collects the revenue from the residents and may also perform minor maintenance. The MO may also set up own standpipes to sell water from. The company has a master meter which measures what the MO has sold or distributed to those connecting to the managed pipeline, hence that is what the MO is billed for and pays the company. Table 7.5 summarises the relationship between LVSWSB, KIWASCO, MO and consumers.

In an effort to provide water that is affordable to those living in the low income area, KIWASCO sells bulk water to the MO at a flat rate of Kshs. 25/m³ (US$ 0.373) where a normal household consumer would pay about Kshs. 33/m³ (US$ 0.493). The aim is such that the MO may not only sell water cheaply to the customers but also be able to retain any surplus revenue as income. It is envisaged that under the DMM the MOs are not only able to recover their expenses, thus a profit making enterprise but the retail prices would be low allowing consumers to get water at more affordable prices (regulation of the end price to consumers). Interview with water users, however, suggests that the actual water price per jerry can at the standpipes under DMM remain similar to other standpipes not operating under the same arrangement and who buy bulk water from KIWASCO at a higher tariff rate (Kshs. 55/m³ or US$ 0.821). This may suggest lack of compliance with recommended retail prices by the sellers. For the target customers, the DMM currently may make water available
but individual low income households have not started benefiting in terms of reduced water costs from this arrangement. However, the model is still on trial.

Table 7.5 Current stakeholders in the DMM and their roles and responsibilities

<table>
<thead>
<tr>
<th>Representative</th>
<th>Actor</th>
<th>Roles/Responsibilities</th>
<th>Relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td>The state</td>
<td>Lake Victoria South Water Services Board (LVSWSB)</td>
<td>Asset holding organization; Licenses service providers in the region; Monitors and evaluates service providers;</td>
<td>Contractual with service providers; Non-contractual with community through forums;</td>
</tr>
<tr>
<td>The Provider</td>
<td>Kisumu Water and Sewerage Company (KIWASCO)</td>
<td>Service provider within the city of Kisumu; NWSP implementer</td>
<td>Contractual with LVSWSB; Contractual with master operator and individual standpipe operators</td>
</tr>
<tr>
<td>Citizens/clients (Characteristics of both)</td>
<td>Nyalenda Water and sanitation committee</td>
<td>Represents community interests and promotes participation; Advises in appointments of Master Operators</td>
<td>Elected by the community; Non contractual with KIWASCO; Non contractual with Master Operators;</td>
</tr>
<tr>
<td>The Provider/Citizen (Characteristics of both)</td>
<td>Master Operator (MO)</td>
<td>Manages water services in Nyalenda; Potentially extends network with guidelines and authorization;</td>
<td>Contractual with KIWASCO; Contractual with Community; Client/service provider relationship with community;</td>
</tr>
<tr>
<td>Citizens</td>
<td>Nyalenda Community</td>
<td>Protects the assets of LVSWSB; Pays for water services/consumption;</td>
<td>Customer contract with Master Operator</td>
</tr>
</tbody>
</table>

Source: WSP (2009)

Other benefits envisaged of the DMM are: decentralised services to the community level; reduction of non-revenue water to the official utility; increased revenue for water utility; improved customer orientation of services since the MOs are readily available to their customers and lastly the MOs may be allowed to invest in expansion of the network, thus allowing for private investment in the network.
7.4.2.3 Water selling through mobile handcart water vendors

Another category of sellers found in Kisumu were the mobile handcart water vendors. Handcart vendors have improvised and use specially built pull/push-carts (Figure 7.3). Within the handcart water sellers, distinction can be made with regard to those who have ownership of the handcarts they use, and those who do not. 54.7% of those who responded to questionnaires owned their handcarts. Of those interviewed, 53% had their own handcarts while 54% of those who participated in focus group discussions indicated that they had their own handcarts. Those without own hand carts reported that they usually hired carts and paid Kshs. 50 daily for hiring.

The handcart vendors collect water in twelve 20-25litre jerry cans (400-625 litres) and sell to their customers, mainly households, at the door in several estates. Majority of the handcart vendors (78%) reported that their customers were mainly individuals from middle income households living in areas where households do not have water connections or have connections but do not receive reliable water supply or get enough water from the official piped network. But some (22%) indicated that they also served, although to a limited extent, some relatively low income estates.

Figure 7.3 Handcart vendor pulling while supported by another by pushing a handcart up a sloping surface in Migosi in Kisumu
Interviews with handcart vendors revealed that other than standpipes on the official water network, they also sold water obtained from groundwater sources that were available through privately owned wells and boreholes\(^\text{11}\). This was confirmed during household surveys as some respondents indicated that they also bought water which handcart water vendors obtained from sources other than piped network. In addition, some handcart vendors also sourced water from the private producer of treated surface water, and although this was confined in one estate, water sourced from here was distributed widely in other estates.

It was reported by the handcart vendors that when households buy water they ask for and therefore rely on information given by the vendors about the source of the water. This was partly because water from tap and the alternative sources available were clear and both households and vendors reported that it was not easy to make a judgement on the source and safety of water. It was also confirmed during water quality monitoring that water sourced from wells was as clear as tap water.

Interviews and FGDs with the handcart vendors also suggested that in some areas there was specialization on water supply based on source. Under such circumstances specific handcart vendors indicated that some only collected and sold water bought from standpipe/kiosk operators connected to official water supply network while others only bought and sold water from the alternative sources- mainly deep wells/boreholes. However, there was no further evidence for this. But respondents from household survey reported suspicion that during scarcity or times when water was not available from the official utility network, vendors -even those who claimed to only sell water drawn from standpipes- sold to them water obtained from other sources (wells) as tap water.

During FDGs, handcart pushers observed that although there was a general preference for tap water amongst their household customers, most of them collected and sold water from wells to households. Of the ten participants who attended one FGD, three said that they sold water sourced from taps and the rest sold well water. The higher number dealing in well water said they preferred to sell well water due to several reasons. For example one participant stated and it was repeated and emphasised by others that "tap water is limited, and many people want it, so when we go there we have to wait in the line for a long\(^\text{11}\) Water selling from wells and boreholes is discussed later.
time... but well water is nearby and you fill your handcart faster... also there is always a shortage in tap water... '(FGD1, Sept. 2008) According to the handcart vendors it would take the same time to supply two handcart of water from a standpipe as it takes to supply 10 handcarts of well water. Average waiting time at standpipe was reported 55 minutes besides delivery time but sometimes even longer almost two hours but even up to six hours in the dry season or shortage time. This was due to several reasons, reported by sellers as few standpipes with some located far from the areas they served and where water problem was most felt, inadequate and irregular water supply from the official piped network to the standpipes, poor water supply to areas they felt were of relatively average income, whose members were often at work and hence lacked time to directly collect water but needed much water for use for example in flushing toilets.

7.4.2.4 Selling of water from wells/boreholes

In many of the poorly serviced areas individual residents have resorted to exploitation of groundwater to meet their water needs. Well and boreholes owned by individuals and whose owners sell water are a common phenomenon in areas with water supply problem in Kisumu. These were another major category of water sellers and a major source of water for households. An earlier mapping study estimated that two estates, Manyatta and Migosi, had 321 and 58 dug wells giving a density of 66 and 171 wells per sq. km respectively (Drangert et al., 2002). Current figures estimate that Kisumu City as a whole may have up to 800 such wells (Interv. Public Health Officer, 2008) the majority of which are located in areas unserved and inadequately served by the official water utility such as Migosi, Manyatta, Obunga, Nyalenda and Bandani. During the survey households identified several of these sources as the main or second sources of water; however, only 56 wells and 2 boreholes in Manyatta, Migosi and Obunga were visited by the researcher.

Many well owners have converted their wells into commercial water selling points- even though selling of water from these wells (to above 20 households ) is not permitted\(^{12}\), and sell water not only to neighbours and individual but also to handcart vendors, who in turn sell to consumers. But wells seemed not to be officially recognised as a source of water supply within the city. One interviewee observed that “I consider the desire to regulate these

\(^{12}\) According to the Water Act 2000, supplying of water to more than 20 households or more than 25,000 litres requires that one should obtain a water permit/license
people [water vendors] a bit premature because once you do so you institutionalise them yet this is not the direction the industry would like to go” (Interv. CEO KIWASCO, 2007). A workshop participant observed that ‘KIWASCO has signed a legal agreement with the water service board and has a monopoly’ (Workshop notes, 2009).

The types of wells that were common are traditional shallow or scoop wells and deep wells/boreholes. For the deep wells many well-owners were very innovative and many clever variants of water lifting technologies have been adopted for extracting water from the wells. A range of devices were used from foot (Figure 7.4) and hand pumps to motor/electric pumps (Figure 7.5), although some shallow open wells still used ropes and buckets (7.6). Such shallow wells where ropes and buckets were used for drawing water were, however, mainly found to be used by the owners and those with whom they share a compound as well as households within its vicinity. They were not used by handcart vendors, mainly because of difficulty they may have in filling their water jerry cans and the time it may take to do so.

![Figure 7.4 Well fitted with a foot/peddle pump for lifting water in Migosi- Kisumu](image)

The production for wells varied with open scoop wells producing just a few litres per day—estimated at 100 jerry- cans or 2,000 litres ($2m^3$) to $20m^3$ per day for deep better yielding wells in Migosi. Migosi alone, however, had over 10 deep better yielding wells identified during this study, up from four (4) recorded in 1999 (Okotto-Okotto, 1999). This suggests
that the deep wells in Migosi alone may produce over 200\(\text{m}^3\) per day besides several other shallow wells available.

Figure 7.5 An electric pump fitted to a well for pumping water in Migosi in Kisumu

Figure 7.6 A boy drawing water from an open/scoop well using a rope tied to a container for lifting water in Manyatta- Kisumu
An earlier study estimated the total annual yield from about 379 deep and shallow wells in Migosi and Manyatta to be 664,000 m³/yr (Drangert et al. 2002). With current estimates of up to 800 deep and shallow wells (Interv. Public Health Officer, 2008), and with varying hydrogeological and lithological conditions and increasingly different levels of sophistication in drawing water to meet the demand, the total yield from wells could be substantial and therefore probably the source of water filling the deficit from the official water utility and sustaining the vibrant water vending activities. In addition to improved water lifting technologies, some well owners with high yielding wells have invested in storage tanks commonly of 10,000 litre capacity and above (Figure 7.7) to increase their ability to serve more people, and others have fixed multiple points from where water is sold, suggesting high demand and possible profitability of the well water selling business.

![Figure 7.7 A raised storage tank owned by a well owner in Migosi-Kisumu](image)

However, some of the wells seem to be located on a shallow and unconfined aquifer indicated by marked drops in water levels in the dry season. During the second data collection fieldwork visit, which was conducted in the course of the dry season, about 63% (35) of the wells visited were found to either have very little water or dried up at least every day. The drying of some of the wells may be due to their being shallow with mean depth reported of about 6 meters, hence limiting their productivity in the dry season when the
water table drops. But there were some deeper wells and few boreholes which retain their productivity during the dry periods and remain as water selling points when others have dried up. Consumers therefore not only crowd for water but waiting time for water was reported to increase from about 10-20 minutes during wet season to up to 47 minutes-1 hour in the dry season.

Commercialization of wells has, therefore, been very successful. It exists and is sustained through selling water both to individual households able to collect water directly and also to handcart vendors who in turn transport and sell to customers especially those in middle-income estates unable to collect directly but suffer from lack of or inadequate quantities from the official utility water network. Most well owners with deep wells fitted with quicker water abstraction devices like motor pumps that were interviewed estimated that about a third to a half of water produced is taken by handcart water vendors. Thus only a small portion of the wells are used by the individual households. Interviews and FGDs with handcart water vendors revealed that they sourced water from the wells because of reasons stated earlier.

Observations and interviews revealed that well owners have shied away from laying pipe networks. However, part of the revenue obtained from water selling was used to maintain the wells, with well owners reporting that several wells have undergone incremental improvements from shallow scoop wells to motor pumped wells. From the interviews well owners indicated that for those who have dug wells, there is currently free\textsuperscript{13} entry in water selling resulting in many private producers/suppliers of well water with varying degrees of sophistication. The free entry in well water selling has brought competition among the many suppliers of well water and may have contributed to keeping (regulating) the price of well water as it is currently the cheapest (apart from those served by Wandiege community) for households as shown in section 6.6, but seems not to have protected water quality.\textsuperscript{14}

Interviews with well owners suggested that a well owner can make a living from a properly run commercial well. One interviewee observed that ‘I have had this well for a long time and it has really helped me in many ways, from it I feed my family and am even able to send some support to my parents back home’ (Interv. with a well owner Manyatta, May 2007).

\textsuperscript{13} Although the Water Act 2002 requires wells/boreholes serving more than 20 households or supplying more than 25, 000 litres to have permit none of the wells had such by the time of this study

\textsuperscript{14} See section 6.7 on water quality
Many well owners have taken up the challenge of providing water resulting into different degrees of sophistication in ensuring production of adequate water for sale, storage and in dealing with their customers. For example, in addition to adoption of improved methods of pumping of water to increase production for sales, well owners were found to be giving handcart vendors special discount prices or allowing them to take water on credit and pay latter, a strategy aimed at possibly improving sales by attracting and retaining handcart vendor customers, who forms the bulk of customers for the deep high yielding wells. Some well owners have also formed what can be considered as mini co-operative societies or welfare groups for their regular handcart vendor customers, a possible way of ensuring customer loyalty.

7.4.2.5 Water selling by a small scale surface water producer

The Kisumu water market also benefits from water supplied by a private small scale producer\textsuperscript{15} who abstract river water and treat on a small scale (Figure 7.8) using a combination of conventional methods involving sedimentation, sand filtration and chlorination. Average production stood at 50m\textsuperscript{3} (2007 figures) daily but increased to 100m\textsuperscript{3} during peak demands in the dry season, while lowest sales reported as 30m\textsuperscript{3} were realised during rainy season. Although the supplier (Nyamasaria water works) is located in and principally served an informal area (Nyamasaria) without the official utility network, the water from here reach various parts of Kisumu.

Main customers of this water supplier were reported as handcart vendors and tankers (Figure 7.9). The handcart vendors sell water to individual households and small scale business premises, but the tankers were found to be privately owned, majority by large companies, businesses and hotels within the city, whose operations typically require large quantities and regular supply of water. However, they turn to this source for water because although they are connected to the official utility network, the water they receive was reported as both insufficient to meet their needs and further characterised by frequent disruptions. Individual households also collected water by jerry cans directly from multiple standpipes erected within the premises of the supplier. This may explain the 2.6% of respondents in the household water usage study (as shown in sections 6.3.4) who indicated that this was their first water source. However, no individual connections to households were found.

\textsuperscript{15} The producer has an informal sole proprietor business license for bulk water supply
The business has a total of five employees and water is sold to tankers at Kshs. 80/m³ (US$1.194) and at Kshs. 2.50 and 1.50 per 20 litre jerry can or Kshs. 125/m³ (US$ 1.866)
and 75/m³ (US$ 1.119) to households and handcart vendors respectively. From the providers perspective the business is viable with very good profits\textsuperscript{16}. Tanker operators reported that the presence of this small scale supplier has moderated the price at which the official utility supplies them with water from an initial Kshs. 120/m³ to 60/m³ (US$ 1.791-0.896). Ironically it is to the piped water supply network of the same official utility which their businesses are directly connected, but has failed to supply them with adequate and reliable water for their operations forcing them to obtain water from this source using tankers.

\textbf{7.4.2.6 Contribution from other water suppliers to water supply in Kisumu}

As earlier shown in Figure 7.2, some few sellers (3.66\%) reported specifically that they got their water from an NGO SANA-international. The research found that some NGOs and CBOs e.g. SANA International and Undugu society of Kenya have also helped low income areas (particularly in Manyatta and Obunga) to get access to water. This is partly done through extension of pipes and construction of standpipes connected to the official water network. For example, in Obunga, SANA has helped to lay down extension pipes of about 3.5 km in length and construction of three standpipes/kiosks to help those in some sections of this low income area to access water from the official network. It is estimated that 3,000 people are served. The ownership of such standpipes is handed over to the community (even though they still refer to it as belonging to SANA), who in turn assigns or nominates an individual to take charge of daily operations of the standpipe. The individual in charge is expected to cover their expenses mainly money for payment of water bills, any minor repairs and their wages from water sales. However, although proper records could not be found, interviews with those responsible for such standpipes suggested that they could hardly cover their expenses, and instances were reported where they could be temporarily closed due to high bills unless the NGO that assisted in putting them up raised money to pay for the high bills. A lady who managed one of the standpipes observed that ‘this standpipe just started operating again two months ago, it had been disconnected by KIWASCO due to a bill that had gone up to over Kshs. 10,000 (US$ 149.25) and the group could not pay...but we were lucky SANA was told and they helped us to pay the bill’ (Interv. with a standpipe operator, 2007).

\textsuperscript{16} The details of the levels of profits cannot be disclosed due to confidentiality
Apart from extension of pipes and constructing standpipes dependent on the official utility network, SANA International has also funded the sinking of boreholes in order to supply water to un-served areas. One such example is the Wandiege Community Water Project (Wandiege) located in Manyatta B and is estimated to serve about 10,000 people out of a population of 25,000 in addition to others from neighbouring areas. The water is supplied from a borehole that was initially drilled with donation from the French Government, while a latter donation (Kshs. 6 million) from CORDAID- a German charity organisation enabled the community to upgrade the borehole, erect elevated storage tanks and improve the reticulation system. The borehole is 110m deep and the yield is estimated at 27m³/hour with a safe yield of 18m³/hr. The borehole has been fitted with a submersible pump (SP 17/13) and water is pumped into two elevated tanks with a combined storage capacity of 20m³ before it flows into a reticulation system by gravity. Total length of pipes laid is estimated at seven to ten kilometres and there are 72 individual connections, four institutional connections (schools and churches) and 11 standpipes/kiosks, seven run by the CBO and four by individuals. The water is charged using increasing block tariff as shown in Table 7.6.

The table shows that community standpipe/kiosks charge Kshs. 1 for a 20 litre jerrycan and therefore probably the cheapest water available from a standpipe within Kisumu. Households with connections pay Kshs. 20/m³. A cheaper rate compared to those connected to the official pipe network. Individual connections to households are charged a connection fee of Kshs. 2,175 (US$ 32.468) which includes a meter cost.

Table 7.6 Water tariffs for Wandiege community water supply system

<table>
<thead>
<tr>
<th>Tariffs</th>
<th>Domestic tariffs</th>
<th>Individual/standpipe tariffs</th>
<th>CBO standpipes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume Rates/m³</td>
<td>Volume Rates/m³</td>
<td></td>
</tr>
<tr>
<td>First block</td>
<td>0 to 6m³ Kshs. 20</td>
<td>1-180m³ 27.50</td>
<td>Flat rate Kshs. 35 for 240-300litres</td>
</tr>
<tr>
<td>Second block</td>
<td>6 to 20m³ Kshs. 25</td>
<td>180-250m³ 31.50</td>
<td></td>
</tr>
<tr>
<td>Third block</td>
<td>20 to 40m³ Kshs. 35</td>
<td>-</td>
<td>(0.24m³)</td>
</tr>
</tbody>
</table>

7.4.3 Water supply reliability

Water sellers were asked whether they were able to get and therefore supply adequate (the amount of water they required) and reliable water to their customers. From the responses, 60% of sellers without own source (handcart vendors) reported that there were times they
did not get the amount of water they required from their main sources and therefore had to change their sources. During FGD with handcart vendors and interviews with standpipe operators main problems singled out were shortages/water scarcity, supply irregularity at standpipes, drying up of some wells thus making it difficult for them to serve customers.

Water from piped network was described as often not available and therefore the sellers were not able to get the amount of water they required. In explaining why they prefer well water one participant at a FGD stated that ‘tap water is limited... the supply is irregular so we often do not find it when we go for it...we wait for long when it is there as the place is always crowded...’ (FGD1, Sept. 2008). Furthermore 64.6% of sellers reported that there were times when there was no water at all and therefore they did not get any water from their main source. Among the producers, 76% of the well owners reported that the amount of water they supplied reduced during dry seasons. However, water supplied from the small scale producer of treated surface water maintained a constant production of 50m³ per day and was increased to 100m³ during dry season. According to the small scale producer there is a potential for producing even more with the licence granted allowing him to abstract at least 369/m³ per day of which he does not utilise fully currently due to limitation in storage capacity. In relation to how often there was no water from their main source, the responses are as shown in Table 7.7 below. The data suggest that interruption in water supply was a common problem experienced by sellers.

Table 7.7 Proportion of sellers reporting, and the frequency of water supply interruption for water sellers in Kisumu

<table>
<thead>
<tr>
<th>How often is there no water at source</th>
<th>Percentage responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least once everyday</td>
<td>42.7</td>
</tr>
<tr>
<td>At least once a week</td>
<td>8.5</td>
</tr>
<tr>
<td>At least once a month</td>
<td>7.0</td>
</tr>
<tr>
<td>In the dry season</td>
<td>19.3</td>
</tr>
<tr>
<td>Only occasionally</td>
<td>19.3</td>
</tr>
</tbody>
</table>

Sellers were further asked if there were times when they were not able to provide their customers with water. 73% of sellers (handcart vendors and standpipe operators) indicated that they were sometimes not able to supply their customers with water. For the producers, 62.3% indicated that there were times of the year when they were not able to supply their customers with water, thus validating the response from sellers. However, 27% of the sellers reported being able to meet their customers’ water needs all the times. Of these sellers
further analysis of the data by provider type shows that 75.9% were handcart sellers and the rest were well owners.

7.4.4 Water charges, profits made and income from water selling

The charges for water from various sources and sellers varied. To enable comparison with their selling prices, a summary of official utility tariffs are shown in Table 7.8. The data shows that standpipes operating outside the DMM were supplied with water by the official utility at a flat rate of Kshs. 55/m³ (US$ 0.82/m³). Households collecting directly from standpipes are charged an average of Kshs. 3 per 20litre jerry can or 150/m³ (US$ 2.34), even though according to the interviews the water company recommends a retail price of Kshs. 2 per 20litre (100/m³ or US$ 1.49) at the standpipes (Interv. KIWASCO Commercial Manager, 2007). Thus standpipes predominantly serving households make a profit of Kshs. 95/m³ (US$ 1.418) about 173% of their buying price for every cubic meter of water sold. This, however, excludes other costs they incurred like meter rents (Kshs.150 or US$ 2.34 per month). Standpipes charged handcart vendors a discounted price of Kshs. 35 for a handcart carrying 12 jerry-cans of 20-25 litres each (240-300 litres). Thus standpipes that predominantly served handcarts would make a profit of about Kshs. 61.67 about 112-146% of their buying price for every cubic meter of water sold.

Table 7.8 Tariffs for water supply connections from the official utility network in Kisumu

<table>
<thead>
<tr>
<th>Item/category</th>
<th>Domestic rates</th>
<th>Private Standpipe</th>
<th>MOs</th>
<th>Standpipes buying from MOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit</td>
<td>Kshs. 1,800</td>
<td>Kshs. 1,800</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>Meter rent</td>
<td>Kshs. 150</td>
<td>Kshs. 1,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First block</td>
<td>0 to 10 m³</td>
<td>Kshs. 33</td>
<td>Flat rate of Kshs. 55/m³</td>
<td></td>
</tr>
<tr>
<td>Second block</td>
<td>11 to 20 m³</td>
<td>Kshs. 40</td>
<td>Flat rate of Kshs. 25/m³</td>
<td></td>
</tr>
<tr>
<td>Third block</td>
<td>21 to 40 m³</td>
<td>Kshs. 50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth block</td>
<td>41 to 60 m³</td>
<td>Kshs. 55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fifth block</td>
<td>61 m³ and above</td>
<td>Kshs. 60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For handcart vendors buying from standpipes, the charge of Kshs. 35/m³ translates to Kshs. 116.80-146/m³ or US$ 1.74-2.18/m³. The handcart vendors sell to households at prices ranging from Kshs. 8-10 per 20 litre jerry can (Kshs. 400-500/m³ or US$ 5.97-7.46/m³) with an average of Kshs. 9 per 20 litre jerry can (450/m³ or US$ 6.72/m³) in wet season or times of no shortage and Kshs. 15-20 per 20 litre jerry can (Kshs. 750 -1000/m³ or US$11.19-14.93/m³) or an average of 17.50 per 20 litre jerry can (875/m³ or US$ 13.03/m³) during dry...
season or times of shortage. The profit made by handcart vendors on water sourced from standpipes therefore varied by season or availability. Some handcart vendors, however, incurred additional costs involving hiring handcarts at Kshs. 50 per day, for those who did not own, and payment of Kshs. 20 per trip to individuals who help them with pushing the handcarts if they had to pass over hilly/rough places as the example in Figure 7.33 shows. The additional costs reduced the profits made as shown in Table 7.9 below.

Table 7.9 Estimated average cost of water to handcart vendors in Kisumu and profits made per trip by those with and without their own cart sourcing water from various sources (in Kshs.)

<table>
<thead>
<tr>
<th>Source</th>
<th>Ownership/Hire</th>
<th>Cost of buying</th>
<th>Pay for support</th>
<th>Total cost</th>
<th>% Profit by season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wet</td>
</tr>
<tr>
<td>Standpipe</td>
<td>(Own)</td>
<td>35.0</td>
<td>-</td>
<td>35.0</td>
<td>208.0</td>
</tr>
<tr>
<td></td>
<td>(Own)</td>
<td>35.0</td>
<td>20.0</td>
<td>55.0</td>
<td>96.4</td>
</tr>
<tr>
<td></td>
<td>50.00</td>
<td>35.0</td>
<td>-</td>
<td>85.0</td>
<td>27.1</td>
</tr>
<tr>
<td></td>
<td>50.00</td>
<td>35.0</td>
<td>20.0</td>
<td>105.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Well</td>
<td>(Own)</td>
<td>16.5</td>
<td>-</td>
<td>16.5</td>
<td>554.5</td>
</tr>
<tr>
<td></td>
<td>(Own)</td>
<td>16.5</td>
<td>20.0</td>
<td>36.5</td>
<td>195.9</td>
</tr>
<tr>
<td></td>
<td>50.0</td>
<td>16.5</td>
<td>-</td>
<td>66.5</td>
<td>62.4</td>
</tr>
<tr>
<td></td>
<td>50.0</td>
<td>16.5</td>
<td>20.0</td>
<td>86.5</td>
<td>24.9</td>
</tr>
<tr>
<td>Other standpipe</td>
<td>(Own)</td>
<td>18.0</td>
<td>-</td>
<td>18.0</td>
<td>500.0</td>
</tr>
<tr>
<td></td>
<td>(Own)</td>
<td>18.0</td>
<td>20.0</td>
<td>38.0</td>
<td>184.2</td>
</tr>
<tr>
<td></td>
<td>50.0</td>
<td>18.0</td>
<td>-</td>
<td>68.0</td>
<td>58.8</td>
</tr>
<tr>
<td></td>
<td>50.0</td>
<td>18.0</td>
<td>20.0</td>
<td>88.0</td>
<td>22.7</td>
</tr>
</tbody>
</table>

For standpipes operating under the DMM, water was supplied to the MOs at a flat rate of Kshs. 25/m³ while the MO charged Kshs. 35/m³ for those connecting to his lines. An MO supplying a standpipe thus makes a 40% profit, exclusive of other costs. However, MOs also had kiosks/standpipes from where water was sold directly to households. The charge was the same (Kshs.3 per 20litre jerry can) with other kiosks/standpipes not under the DMM. Thus when selling to households directly, under the current charges, MOs make a profit of about 500% excluding costs like meter rent and maintenance costs that may have been incurred.

17 Profit is calculated based on average selling price by handcart vendors of Kshs. 9 per 20 litre jerry can (450/m³ or US$ 6.72/m³) in wet season or times of no shortage and 17.50 per 20 litre jerry can (875/m³ or US$ 13.03/m³) during dry season or times of shortage.
The price at the wells varied with households collecting directly charged at Kshs. 2 per 20 litre jerry-can or Kshs. 100/m³ (US$1.49), while handcart vendors were charged bulk prices ranging from Kshs. 15-18 (average of Kshs. 16.50) for a handcart filled (12*20-25 litres), which translates to Kshs. 62.50-75/m³ (US$0.93-1.12) and an average of Kshs. 68.75/m³ (US$1.03). Water is in turn sold to households by handcart vendors at the same price as water drawn from standpipes/kiosks as shown above. Using the average value at which water sourced from wells is sold to households by handcart vendors the estimated profits made by handcart vendors sourcing water from wells are also shown in Table 7.9 above.

Water from a standpipe supplied by the small scale private producer ‘other standpipe’ was sold at a constant price although at different rates for households collecting directly and handcart vendors. Households collecting directly were charged a retail price of Kshs.2.50 for a 20 litre jerry can or 125/m³ (US$1.86) but handcart vendors got at a discounted rate (wholesale rate) of 1.50 for a 20-25litre jerry can (Kshs. 18 per handcart) or Kshs. 75/m³ (US$1.12). The water is in turn sold to households at the same rate as water from other sources. Handcart vendors sourcing water from the small scale producer thus also made profits as shown in Table 7.9 when all their costs are included.

For handcart vendors, the data shows that profits made varied depending on whether one owned a handcart or hired, paid support or not and whether it was dry or wet season as well as the source it was obtained from. However, those who hired handcarts and paid for support made the least profits regardless of the source. In terms of sources, handcart vendors who obtained water from wells were likely to make higher profits. Highest profits were made by handcart vendor with their own handcart obtaining water from wells and the least was made by handcart vendor without own carts, buying water from standpipes and who paid for assistance in pushing the handcart cart over long, rough or hilly areas. A summary of the price increase for water along the supply chain (per cubic meter) from different sources by various users is further shown in Figure 7.10. The data shows a clear increase in price along the supply chain.
The figure shows that water collected by households directly from the various sources was obtained at lower prices. Apart from households with connection to piped water who got their water at Kshs. 33/m³, well water was sold at the cheapest\(^{18}\) price of Kshs.100/m³ (US$ 1.49/m³) which was still over 3 times what households with connection to piped network paid. Water sourced from the small scale producer was sold at 125/m³ (US$ 1.86/m³) and that from standpipe at Kshs. 150/m³ (US$ 2.24/m³). The price increased sharply along the supply chain with charges ranging from Kshs. 400-1000/m³ (US$ 5.97-14.92) and an average of Kshs. 450/m³ (US$ 6.72/m³) and 875/m³ (US$ 13.03/m³) in wet and dry season respectively when delivered to households by handcart vendors. The figure further shows that the price of water supplied by the official utility to private standpipes at 55/m³ and standpipes operating under the DMM at Kshs. 25/m³ increased 13.64 and 30 times

\(^{18}\) Excluding the water managed by Wandienge community.
respectively when delivered to household by handcart vendors. From standpipes to household the price increased 5.16 times. When collected by household directly from private standpipes and those under the DMM, the price of water increased by 2.73 and 6 times respectively. The price of water supplied to handcart from ‘other standpipe’ or wells increased 10 and 10.87 times when delivered to household by handcart vendors.

Costs incurred in terms of time taken to get water or waiting time also varied with season and water availability. During normal/no shortage time average waiting time was 34.07 minutes while during dry/shortage season it increased to 2hrs 8mins at standpipes. The waiting time, however, can be as short as about 10 to 20 minutes- the time it takes to fill up 12 jerry cans at the well or standpipe in the wet season/normal times for handcart vendors to a maximum of up to 6hrs during shortage time at some standpipe outlets. The time and trouble it takes to get tap water and its effects during dry season/time of shortage by handcart vendors was captured by a statement from a participant during FGD1 ‘...you wake up at 5am and go down to Obunga, when they see your strange face at their point they increase the price... you get your water at 11am and then you have to pay two or three helpers because its far and the road is steep...but by the time you reach here [Migosi] and try to explain to customer why you have increased the price they do not understand...they just curse you for overcharging...they tell you to go build a storey house with the money you have overcharged’ (FGD1 Sept. 2008). The average time taken to collect, transport and deliver water to customers by handcart vendors was given as 51 minutes during normal time/no shortage. Distance to customers by mobile water vendors from their water sources was also established. The mean distance was 1.288 km with a minimum of 0.2km and a maximum of 6km. The longer distance seem to have been mainly cited by mobile sellers and could be due to the need, during shortage, to look for water from sources having water supply and often located far away from areas they served. Data on average incomes earned from water selling activities is shown in Table 7.10. The data shows that incomes varied widely from less than Kshs. 1,500 (US$ 22.39) per month profit earned by some standpipe operators with fewer customers in low income areas to Kshs. 30,000 (US$ 447.80) earned by large scale standpipe operators whose main customers were handcart vendors serving primarily non-poor/middle income estates. The minimum earning shown for well owners represents an income of Kshs. 150 (US$ 2.24) per day earned by well owners with traditional open/scoop wells, while the possible maximum shown represent the earning by
some few well owners (with deep wells fitted with motor pump) during dry season when their wells become the main source of water for many households and handcart vendors.

<table>
<thead>
<tr>
<th>Type of seller</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standpipe</td>
<td>6,500 (US$97.01)</td>
<td>1,500 (US$ 22.39)</td>
<td>30,000 (US$ 447.80)</td>
</tr>
<tr>
<td>Well/borehole</td>
<td>6,000 (US$89.55)</td>
<td>4,500 (US$ 89.55)</td>
<td>36,000 (US$ 537.51)</td>
</tr>
<tr>
<td>Handcart</td>
<td>12,000 (US$179.10)</td>
<td>7,320 (US$ 94.33)</td>
<td>55,000 (US$ 828.38)</td>
</tr>
</tbody>
</table>

The earning of handcart vendors was estimated at a minimum of Kshs. 244 per day (Kshs. 7, 320 per month) and a maximum of Kshs. 1,850 (US$ 27.61) per day or Kshs. 55,500 (US$ 828.38) per month, but excluded the other costs. When costs for handcart vendors are included the percentage profits varied as was shown in Table 7.9 and therefore their incomes also varied as summarised in Table 7.11 below.

<table>
<thead>
<tr>
<th>Source</th>
<th>Ownership/Hire</th>
<th>Buy</th>
<th>Support per trip</th>
<th>Total cost</th>
<th>Income by season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standpipe</td>
<td>- (Own)</td>
<td>35</td>
<td>-</td>
<td>35</td>
<td>8,736</td>
</tr>
<tr>
<td></td>
<td>- (Own)</td>
<td>35</td>
<td>20</td>
<td>55</td>
<td>6,336</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>35</td>
<td>-</td>
<td>85</td>
<td>2,754</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>35</td>
<td>20</td>
<td>105</td>
<td>360</td>
</tr>
<tr>
<td>Well</td>
<td>- (Own)</td>
<td>16.50</td>
<td>-</td>
<td>16.50</td>
<td>10,989</td>
</tr>
<tr>
<td></td>
<td>- (Own)</td>
<td>16.50</td>
<td>20</td>
<td>36.50</td>
<td>8,584</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>16.50</td>
<td>-</td>
<td>66.50</td>
<td>4,948</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>16.50</td>
<td>20</td>
<td>86.50</td>
<td>2,595</td>
</tr>
<tr>
<td>Other standpipe</td>
<td>- (Own)</td>
<td>18</td>
<td>-</td>
<td>18</td>
<td>10,800</td>
</tr>
<tr>
<td></td>
<td>- (Own)</td>
<td>18</td>
<td>20</td>
<td>38</td>
<td>8,390</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>18</td>
<td>-</td>
<td>68</td>
<td>4,814</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>18</td>
<td>20</td>
<td>88</td>
<td>2,423</td>
</tr>
</tbody>
</table>

19 Calculation of minimum and maximum income for handcart sellers is based on the lowest (4) and highest (15) number of handcart trips that can be made in a day and also excludes costs that may be incurred by those who have to hire or pay for assistance offered in pushing handcarts.
The table shows that the lowest income was received by handcart vendor without own carts, buying water from standpipes and who paid for assistance to push the cart over long, rough or hilly areas while the highest incomes were received by handcart vendors with own handcart obtaining water from wells and did not pay for any support. The monthly income of water sellers were compared with the average earning in other informal sector employments and those in public service at the lower level cadres as shown in Table 7.12. The data shows that water sellers monthly income generally compares well with the others, but those in formal employment receive other benefits apart from wages that water sellers may not have. In addition, the majority (80.7%) of those involved in water selling business considered it a major source of income for the family and 53.4% were dependent on water selling alone.

Table 7.12 A comparison of monthly earnings for lower cadre civil servants, water vendors and other informal sector employments (in Kshs.)

<table>
<thead>
<tr>
<th>Category</th>
<th>Monthly Salary</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Civil service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job Group A</td>
<td>7,619-</td>
<td>8,039</td>
</tr>
<tr>
<td>B</td>
<td>8,039-</td>
<td>8,519</td>
</tr>
<tr>
<td>C</td>
<td>8,259-</td>
<td>8,819</td>
</tr>
<tr>
<td>D</td>
<td>8,819-</td>
<td>9,721</td>
</tr>
<tr>
<td>Standpipe vendors</td>
<td>1,500</td>
<td>30,000</td>
</tr>
<tr>
<td>Well/borehole owner</td>
<td>4,500</td>
<td>36,000</td>
</tr>
<tr>
<td>Handcart seller</td>
<td>12,000</td>
<td>55,000</td>
</tr>
<tr>
<td>Other informal sector jobs</td>
<td>3,000</td>
<td>4,000</td>
</tr>
</tbody>
</table>

To assess the attitude of sellers towards their income from water selling they were asked to rate the importance/contribution of the money they received towards their general/total income. For 89.6% water selling was the only source of income, and hence earning income was considered as a ‘most important’ reason for engaging in water selling. For 8.3% earning income was rated as an ‘important’ reason for engaging in water selling. The importance of income from water selling was further expressed in FGD where one participant observed that ‘I started selling water in 1989 and so I have been in this business for a long time, from what I get [earn] here, I can feed my family, send my children to school and even send some help to my parents at home’ (FGD1, Sept. 2008). And in FGD2, a participant stated that ‘I have a family, even kids. It is the income I get from water that supports me. I use it to take them to
school, it feeds me, they [my kids] live on it and so water is my livelihood. It is what keeps me here in Kisumu and 95% of my income' (FGD 2, Nov. 2008)

Among those for whom water selling was as supplement to family income, 74.4% rated it as an ‘important reason’ for involving in water selling, while for 25.6% it was rated as ‘most important reason’. Although 46.6% of water sellers had other sources of income or were engaged in other income generating activities, they still considered water selling as their principal source of income. Apart from sustaining their families, money earned from water selling was also used for paying for operation and maintenance for those with wells, which was ranked ‘important’ by 66.7% and ‘most important’ by 33.3%. For those with employees, paying of employees also seem to have been an important use of money as about half of those who had employees ranked it as ‘important’.

Those involved in other income generating activities were investigated further on the other activities they engaged in. For handcart vendors, they also participated in other casual employment but the majority (72.7%) were in small scale self employment and businesses in the informal sector. Those in other employments reported that they also worked as security guards, grounds men and in the construction industry, but mostly in rainy season when water sales was low. Those in self employments reported working also in bicycle taxi or being a cobbler and others owned chairs and tents for hiring out. However, income from water selling was rated by 82% as better compared to earnings from the alternatives, and was even reported to have brought more income than the locally very popular bicycle taxi (locally known as boda boda).

The study sought to establish what motivated the sellers to get involved in water selling. Reasons gathered from literature were preset in the questionnaire, but the sellers were given room to indicate any other reason in order to capture any possible reason which could have been left out. In a five point Likert scale they were asked to rank as ‘most important’, ‘important’, ‘not sure’, ‘less important’ or ‘not important’ several possible reasons why they were involved in the water business. Source of income was ranked ‘most important’ by 72.2% of respondents and as ‘important’ by 27.8% by respondents. None ranked it as ‘less important’ or ‘not important’. The other reasons for involvement in water selling appear to be availability of the work or access to the business as this was ranked ‘most important’ by 44.9% and ‘important’ by 55.6% of respondents. In addition to these, it came out during
interviews with sellers, producers and also in FGDs that ‘the apparent struggle’ by those without water also encouraged sellers to get in to water selling, even where the purpose of digging a well initially was to meet household own water needs. One respondent made this observation twice once in an individual interview and later during the Kisumu workshop that ‘I put up my first well in the 1980s because we were dependent on water from the municipality which was not enough and sometimes was only available at night in kiosks far away from us. This [collecting water at night in far kiosks] was unsafe for some people so people started digging wells for their own use. Once we had the wells we also started helping our neighbours by selling to them water’ (Interv. Well owner, 2008). In a FGD with handcart vendors one participant observed that ‘initially there was water and many household got water then the supply started becoming irregular and not long after it became problematic for people to get water, that is when we thought of how we could get handcarts, buy jerry cans and start supplying water (FDG2, Nov. 2008).

7.4.5 Sellers perception of those served

Water sellers reported that they had regular20 and general customers to whom they supplied water. Overall 91.2% of those interviewed indicated that they had regular customers. A detailed analysis by splitting the data by provider type shows that 90.6% of handcart vendors and 92.6% of standpipe operators had regular customers respectively. The average number of regular customers served by each type of seller was estimated and the results are shown in Table 7.13 below. The data shows the estimated average, minimum and maximum number of regular customers served by individual seller.

<table>
<thead>
<tr>
<th>Seller type</th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handcart</td>
<td>13</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Standpipe</td>
<td>161</td>
<td>29</td>
<td>650*</td>
</tr>
<tr>
<td>Well owners</td>
<td>30</td>
<td>20 (households)</td>
<td>100 (handcarts) and 50 households</td>
</tr>
</tbody>
</table>

* Only one standpipe estimated this high number of customers including handcarts

20 Regular customers were those to whom the sellers supplied water or collected water from in the case of mobile sellers either daily or several times a week and so depended on the seller or the mobile seller depended on for most of their water needs
Generally the number of households served varied but was not easy to determine accurately. For example, for some wells, almost half of the water produced was reported as taken up by handcart vendors. For some standpipes, handcart vendors were the main customers, while for the small scale producer of surface water, a large portion was taken by both handcart vendors and tanker trucks. However, some of the small scoop wells (where rope and bucket method of drawing water was used) served as few as a minimum of 20 households (about 120 people given an average household size of six). Some well owners with very productive wells reported that during the dry season they could serve as many as 100 handcarts per day, besides households estimated at 50 or more who collected water directly.

Sellers were asked about their ability to meet all of their customers’ water needs. There was an equal split with 50% of sellers expressing the view that they were able to meet all their customers’ water requirements, while the other half said they could not. Analysis of data by seller type further shows the same results with 50% of handcart sellers and standpipe sellers indicating being unable to supply all water requirements of their customers. Reasons that were responsible for their not being able to meet all their customer water needs from the sellers’ point of view were also established. A majority (83.7%) of sellers said that not getting enough water to enable them serve all their customers was the main reason. Other reasons that were given were irregularity in supply from some sources, scarcity of water during dry season/shortage time, and some households (customers) not placing a request for water daily. Although broken pumps at well sources or interruption in supply due to power shortages were options given to well owners, the former were not selected as common causes for not being able to supply all of customers water needs. However, standpipe operators reported that often the official utility cited power failures other than any other reason as the main cause of water supply interruption to standpipes.

Sellers (handcart and standpipe operators) were therefore asked if in their view their customers relied on them for all their water needs. 53.2% felt that their customers did not rely on them for all their water needs and cited the presence of a variety of sources and providers which customers can opt to use. The handcart vendors indicated that although they had regular customers whom they served, it was still possible for such a customer to buy water from elsewhere or another seller. The study further investigated from vendors what in their view prevented customers from getting all the water they needed from the seller. 52% of sellers held the view that their customers had other sources they could get water from,
24% believed that the water they supplied was expensive and only 8% percent thought that their customers used the water they provided only for some rather than all uses. Although water quality was in the list where it was given as ‘water is not safe/ or poor quality’, none of the sellers thought it was among the main reasons which prevented customers from getting from the sellers all the water they needed. This may partly be due to their belief that water from different sources is used for different purposes by customers and hence customers get water based on what they need to use it for.

Other reasons sellers thought prevented customers from getting all the water they needed from an individual regular seller (handcart) were given as delays by sellers in delivering water to customers or during general shortages when customers are not guaranteed that the individual seller who supply them will be able to get water and therefore customer could buy water from any other source or supplier/ seller available. Other reasons were that a regular seller was not able to get water in good time, was either absent or sick, or failed to get water from a standpipe and therefore had water obtained from a well while the customer needed piped water. During a FGD a participant observed that ‘if you delay at the point of collection and your customer need water urgently or if they want a lot of water from standpipe but you can only get a few jerry cans of water then they look for water from someone else’ (FGD2, November, 2008). It was also reported that sometimes when prices go up some handcart vendors during those times only sell to their normal customers a few jerry cans of water and sell the rest to non-regular customers as they do not want to sell water at inflated cost to their regular customers.

The study also sought to determine how the sellers perceived their customers in terms of their socio-economic status. 81.7% of sellers believed that their customers were of ‘moderate income’, 8.5% indicated that their customers were ‘poor’ and 7.3% thought the customers they served were a mixture of both poor and those of moderate income. Another 2.4% held the opinion that those they served were ‘very rich’, while only 1.2% each considered their customers to be ‘rich’ or ‘very poor’. The data shows that over 85% of sellers thought their customers were non-poor. It was, however, also reported by handcart sellers that some poor households could also buy a few jerry cans of tap water (sourced from standpipes located far away) from them for drinking during shortage time when local standpipes had no water.
There appears to be a general view among standpipe operators, some well owners (mainly those with deep wells) and handcart sellers getting water from them that the people served by handcart vendors mainly lived in middle income estates, thus non-poor. It was also found that there were generally few standpipes located in such areas (middle income estates) for example Migosi had only three standpipes, while Nyamasaria had only one besides that owned by the small scale producer of treated surface water. Most water sold by handcart vendors in these estates was sourced from standpipes located outside of the estates. As earlier observed, interview with some households showed that in their view the location of standpipes far from the served estates was a deliberate move by standpipe operators with links to people in the former Kisumu water and sewerage department and handcart vendors to create a market for their water. One interviewee observed that ‘why do handcart vendors have to go all the way to Kibuye or Kaloleni to get water to sell in Migosi? Those standpipes belong to people who are known some in the former department and some in KIWASCO. If they wanted to serve us using standpipes we would have some in Migosi estate but even the few in Migosi are at the periphery, why? They just want to get our money through the handcart vendors’ (Interv. Migosi resident, May 2007). This view was also expresses in other forums. For example, during the workshops about three participants made this observation in different ways. One participant observed that ‘Independent water providers... limit the supply of water by the official provider in the areas of their operation in order to maintain their businesses’ (Workshop notes, 2009).

The study sought to determine from sellers what in their view were the reasons why customers bought water they supplied/produced. A list of possible reasons were included as preset options in the questionnaire and respondents asked to rank them using ‘most important’ ‘important’ ‘not sure whether important’ ‘less important’ and ‘not important’ in order of importance in their view.

From the sellers’ point of view ‘good quality’ seemed to have been the main reason why customers bought water from them as it was ranked ‘most important’ by 47.46% of respondents and ‘important’ by 63.16%. The other main reason appears to be supply regularity/reliability as ranked most important by 38.98% and important by 21.05%. Distance also seems to have been of consideration but only by a few. Although other factors such as convenience of delivery, cost, only source available and personal or family reasons were also cited, they seemed in sellers view to be of lesser consideration as each was cited
by fewer (less than 5%) of respondents. However, where they were cited, convenience of
delivery was ranked only as ‘most important, while ‘only source available’ was ranked as
either ‘most important’ or ‘important’, and ‘cost’ was ranked as either ‘most important’ or
‘not sure whether important’ by respondents. In the view of sellers personal/family
consideration seemed not to have been a factor customers considered when choosing a water
seller/supplier or source.

Producers were also asked why in their view customers bought water from their sources. The
results are shown in Table 7.14 below. The data in general suggest that although a
combination of factors were seen as influencing customers’ choice of whom or where to get
water from, from the producers’ perspective, quality may have been the most important
single consideration followed by distance.

<table>
<thead>
<tr>
<th>Reason for getting water</th>
<th>Producers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As alone factor</td>
</tr>
<tr>
<td>Convenience of delivery</td>
<td>-</td>
</tr>
<tr>
<td>Distance</td>
<td>36.7</td>
</tr>
<tr>
<td>Only source</td>
<td>4.2</td>
</tr>
<tr>
<td>Quality</td>
<td>43.7</td>
</tr>
<tr>
<td>Cost-cheap/not expensive</td>
<td>4.2</td>
</tr>
<tr>
<td>Reliability</td>
<td>7</td>
</tr>
<tr>
<td>Personal/family reasons</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
</tr>
</tbody>
</table>

7.4.6 I&SSWPs perspectives on water use and the quality of water
Due to availability of many sources, it was deemed important to establish from sellers
(without own sources) view if customers used different sources for different purposes. 79 %
of water sellers believed that their customers use different sources for different purposes.
The rest held the view that there was no selection of different sources for different uses while
two percent did not know. It was further determined from sellers which sources in their view
were used by customers for different purposes as shown in Table 7.15.
Table 7.15 Percentage of sellers selecting specific water sources as used by their customers for given uses in Kisumu (N=89)

<table>
<thead>
<tr>
<th>Source/Use</th>
<th>Personal hygiene</th>
<th>Cooking/food preparation</th>
<th>Drinking</th>
<th>General hygiene</th>
<th>For animals</th>
<th>Other uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap/standpipe</td>
<td>20.3</td>
<td>51.3</td>
<td>77.0</td>
<td>19.0</td>
<td>6.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Well</td>
<td>70.9</td>
<td>39.7</td>
<td>10.3</td>
<td>74.7</td>
<td>80.6</td>
<td>84.0</td>
</tr>
<tr>
<td>Spring</td>
<td>1.2</td>
<td>0</td>
<td>0</td>
<td>1.3</td>
<td>6.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Handcart</td>
<td>7.6</td>
<td>9.0</td>
<td>10.3</td>
<td>5.1</td>
<td>6.5</td>
<td>0</td>
</tr>
<tr>
<td>Mixed source</td>
<td>0</td>
<td>0</td>
<td>2.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The data shows that from sellers’ perspective piped water was mainly used by households for drinking and food preparation. Few believed it was also used for personal hygiene (20.3%) and general hygiene (19%). It was also cited as used for gardening by 8.0% and for watering animals by 6.5%. The results suggest that from sellers’ perspective, use of piped water dominate in drinking, cooking and food preparation but it could also be used for any purpose.

Well water on the other hand seems to dominate in other uses as was cited by 84.6% for animals, and personal hygiene where it was cited by 80.6% and 70.9% respectively. However, some 39.7% believed it was also used for cooking while 11.4% were of the view that it was used for drinking as well. In the interviews and FGDs, water sellers especially the handcart vendors vividly explained that customers preferred piped water for drinking and cooking (consumptive uses) while water from wells was favoured for other purposes. One participant observed during FGD1 that ‘For uses apart from drinking and cooking they [households] prefer well water....but for drinking and cooking they always ask for tap water....so if a customer wanted a whole handcart....they will tell you to supply eight from well for general uses and four from tap for drinking...but sometimes...tap water is not available so some take well water and boil...’ (FGD1, Sept. 2008). There appears to be a general belief among sellers that there is selection in water use and that households use different sources for different purposes. Nevertheless, because water supply from the official network was irregular and not adequate when available, well water would also be used for consumptive purposes.

Sellers were also asked what reasons in their view made customers use different sources for different purposes. The responses are shown in Table 7.16. The table shows factors as selected by respondents as individual factors and also in combination with other factors since sellers could select more than one option. The data suggests that from sellers’ perspective the cost of water from a source was considered important by customers in determining whether...

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water from a source was used for different uses as reported by 41.30% as a single factor and by 38.46% in combination with other factors. This was followed by 'reliability/regularity' as cited by 32.61% as a standalone factor and by 23.07% in combination with other factors. 'Quality' also appeared as a factor of consideration as cited by 23.91% as a standalone factor. 'Availability' was only mentioned in combination with other factors by 23.03% of respondents while 'Only source' seem not to have been a consideration, perhaps due to various sources and sellers that were available.

Table 7.16 Sellers perception of why customers use different sources for different uses

<table>
<thead>
<tr>
<th>Reason</th>
<th>% reporting as single factor</th>
<th>% reporting factor in combination with others</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>2.17</td>
<td>15.38</td>
<td>5.08</td>
</tr>
<tr>
<td>Some sources are expensive</td>
<td>41.30</td>
<td>38.46</td>
<td>40.68</td>
</tr>
<tr>
<td>Some sources run out at times</td>
<td>32.61</td>
<td>23.07</td>
<td>30.51</td>
</tr>
<tr>
<td>Some sources are of poor quality/unsafe</td>
<td>23.91</td>
<td>23.07</td>
<td>23.73</td>
</tr>
<tr>
<td>Available</td>
<td>0</td>
<td>23.07</td>
<td>5.08</td>
</tr>
<tr>
<td>Only source</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Producers were asked if in their view customers used water from their sources for various uses and why they did. The responses are summarised in Table 7.17 showing percentage of respondents giving specific reasons for the source being used for a given purpose. The data shows that in their view customers used different sources for different uses. Consideration of a source to be used for consumptive uses such as drinking and cooking and food preparation seemed to be overwhelmingly based on quality as reported by 89.7% for drinking and 63% for food preparation and cooking. The results suggest that they also believed that their customers (households) also considered quality in selecting a source for uses for hygiene (55.1%) and general purposes (55.7%).

Table 7.17 Percentage of sellers (producers) giving a reason for why customers use a given source for a specific use/purpose

<table>
<thead>
<tr>
<th>Uses\reasons</th>
<th>Quality/Safety</th>
<th>Only Source</th>
<th>Cost</th>
<th>Distance</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td>89.7</td>
<td>2.9</td>
<td>2.9</td>
<td>1.5</td>
<td>2.9</td>
</tr>
<tr>
<td>Food prep. and cooking</td>
<td>63.2</td>
<td>13.2</td>
<td>17.6</td>
<td>5.9</td>
<td>0.00</td>
</tr>
<tr>
<td>Personal/Hygiene</td>
<td>55.1</td>
<td>14.5</td>
<td>20.3</td>
<td>10.1</td>
<td>0.00</td>
</tr>
<tr>
<td>General uses</td>
<td>55.7</td>
<td>14.3</td>
<td>20.0</td>
<td>10.0</td>
<td>0.00</td>
</tr>
</tbody>
</table>
All water sellers were further asked about water quality to assess their perception of the quality of water they supplied and its safety for all uses. 78% of respondents were of the view that the water they supplied was 'good' (safe) for all uses, while the rest thought that the water could be safe only for certain uses. In addition, 97.5% indicated that they did not do anything to improve the quality of water they sold. Those who did not improve the quality of water gave several reasons for not doing so. 78.1% felt the water they sold was safe and therefore did not require treatment, 11.5% felt that treating water would be expensive, 15.4% saw no need for treating the water suggesting that they may have also believed the water was safe. The rest, about one percent, felt that if they treated water their customers would be suspicious of the water they supplied. The latter may be a reference to the smell and taste which comes with adding chlorine. Those who believed their water was safe were asked how they determined the safety of the water. 77% said they determined safety by looking at the colour, smell and taste of water and therefore any water that was clear, had no odour or any 'salty' taste, was believed to be safe, whereas any that was not clear, tasted salty or had bad smell was believed to be unsafe. In addition, the sellers (handcart vendors) judged quality of wells by looking at method used in drawing water from the well. In FGD1 with handcart vendors a participant observed that '...the wells we get water from are covered...we do not use ropes and buckets which can normally make such water dirty...' (FDG1, Sept. 2008).

Producers (sellers with own source) were further asked whether they had established if the water they supplied was safe/good as a way of gaining further insight into their perception of the quality of water they produced. 51.4% indicated that they had established the safety of water while the rest had not. For those who indicated that they had established the safety of their water, responses as to how the safety of water was established varied, with 27.0% indicating that the Public Health Department occasionally picked samples for analysis and hence believe that the water was safe (even though many said they usually do not get feedback on the results). 10.8% said they have individually taken their water to some unspecified laboratories for analysis and were told that their water was safe (however there was no proof of the same). But 24.5% indicated that they determine safety of water by looking at the colour, taste or smell of water like the sellers above. Thus because the water they produced was clear, had no 'salty' taste or any odour, they believe it to be safe. 25.1% reported that they had come into contact with various NGOs over the years that have tested...
their water and some have given feedbacks showing the quality of their water; with others indicating that the water they supplied may not have been safe at times.

In relation to action they would take if they knew that the water they sold/supplied to customers was not safe for what their customers were using it for, 50.6% of sellers indicated that they would let the customers know and decide whether to buy or not, 34.6% said they would stop supplying, and 7.4% would advise their customers to treat the water. 6.4% said they would supply treatment options if such were available but 1.2% said they would keep quite but stop supplying. On a five point Likert scale sellers were asked to rate their ‘concerned’ that the water they supply may not be safe for all the uses their customers could be using them for. The results are shown in Table 7.18. The data shows that 79% reported that they were ‘very concerned’, but this was not accompanied by any evidence of concerned.

Table 7.18 Sellers rating of their ‘concerned’ for the safety of water for various uses

<table>
<thead>
<tr>
<th>Level of concerned</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Very concerned’</td>
<td>79.0</td>
</tr>
<tr>
<td>‘Slightly Concern’</td>
<td>3.7</td>
</tr>
<tr>
<td>‘Concerned’</td>
<td>14.8</td>
</tr>
<tr>
<td>‘Not concerned’</td>
<td>2.5</td>
</tr>
</tbody>
</table>

To determine their view on responsibility for the safety/quality of water they sold to customers, sellers were asked who they felt should be held accountable. 63.4% of sellers were of the opinion that the official water utility (KIWASCO) should be held responsible for the quality of water, 18.3% felt that well and borehole owners should be held responsible for the water supplied from their sources, 6.1% felt that the various categories of water sellers should each also be held responsible, while another 3.7% thought that those in charge of public health should be accountable for the quality of water sold. The rest (2.2%) felt that the responsibility should not be left to one office, but to a combination of offices. Similar views were further expressed during the workshop. In addition, at the workshop it was proposed that well owners should register with KIWASCO although this seemed not to have been received favourably by the well owners. It was also proposed that well owners should be responsible for the quality and hence testing of their water and as such should buy their own chemicals as a part of business investment. The various responses and suggestions on who should be responsible for water quality may be a reflection of the diverse players in the
domestic water supply sector in Kisumu, but with KIWASCO as the main water provider. It could also be due to a lack of awareness by the sellers (both with and without own sources) of who is responsible for as well as the role in regulation of water use including water quality. During the discussions a representative of WRMA had to clear to participants that the organization only regulates extraction and not service provision or quality. Furthermore during the discussions on which office the well owners should register with or provide an oversight over well owners’ activities, several offices rather than one were proposed.

7.4.7 Interactions and interrelationships among sellers and other stakeholders in the water sector

To establish whether interaction and interrelationships existed among sellers, they were asked whether they collaborated and if yes in what ways they had done so. 53.4% said they had not worked together with other water sellers in any way, while 31% said they co-operated in forming small welfare associations. 13.8% indicated that they sometimes co-operate in determining the price at which they sell water to customers and only 1.7% said they had participated both in forming an association and sometimes agreeing on water selling price. A split of the data by seller type showed that those who collaborated to form small welfare association and agree on price were handcart sellers. A few well owners had also come together to form a well owners association.

In terms of working with the official utility, apart from some relying on the official pipe network for the water they sell and for which they are billed to pay as was cited by 82.5% of standpipe operators, there appears to have been little collaboration between the official water authority and water sellers not working under DMM. However, some standpipe operators indicated that the official water company frequently collects water from their tap outlets to check the quality of water which they believed was part of the official utility’s mandate to monitor the quality of water in order to ensure that the water it supplies meets the set standards. The sellers (well owners) reported that there were various NGOs, for example the Kenya Red Cross, that had shown interest and were beginning initiatives to work together with them to improve water quality by providing training, this however had just started. The other bodies responsible for different aspects of water supply like LVSWSB and WRMA seemed not to have had any contact with water sellers until the time of the workshop. This, however, was explained at the workshop to have been due to the newness of these
institutions, having been established recently as a result of the ongoing water sector reforms. The new institutions are in the process of establishing themselves and beginning to execute their mandate having started with the bigger water companies and are soon to move in to the institutional and small scale water providers (Workshop notes, 2009).

7.4.8 Sellers perspective of their role and challenges

The study sought to establish sellers’ perception of their work and the challenges they face. Majority of sellers (75%) reported that they faced various challenges in their small businesses of selling water. For handcart vendors, their main challenge seemed to be an unfriendly working environment. During the FGD it was repeatedly stated that households were suspicious of vendors entering their houses to deliver water and that they were often the first suspects whenever there were cases of thefts or robbery in the areas they serve. One FGD participant stated ‘...we have many problems in this business of water selling...they [households] do not trust us...I do not know why they look down on us...you go to a house and deliver water ..., but after you, some crooked person passes by and steals from the house...or something is stolen from that house and you are the first suspect...yet for us we give them water and they give us money and that is important for us because it is what we live on...sometimes a street boy or petty thieves pass by and take clothes hanged on a line or...sometimes it’s their children or relatives they live with that take things from their houses but it us who are the suspects, they will report you to the chief who sometimes arrests us and harasses us... I do not know why they despise us and our work yet we help them get water and we are just working to earn a living’ (FGD1, Sept. 2008). There was also the problem associated with the nature of their work; the handcarts were reported as heavy (44.4%) and water selling being physically demanding for handcart pushers (20.9%).’ In one FGD a participant observed that ‘...this work is difficult...we do not do it because we are happy with it but because we lack other jobs....it is hurting to the body...even now there are many of us who are sick...yes, it is our livelihood and from it we sustain ourselves us ...but it is tiring. At the end of the day you are physically strained...a motorised cart or a donkey would be better...’ (FDG1, Sept. 2008).

Other challenges faced were supply irregularity particularly for standpipes dependent on the official utility and which in turn affect handcarts relying on them, drying up of wells in the dry season for well owners with shallow wells, finding it hard to serve customers during
water scarcity (14%), and no clean water, with some (4.7%) indicating that they suspected that some of the sources they were using to supply customers with water were not of good quality. Other difficulties reported by sellers included high cost of water (4.7%) and bills (4.7%) for standpipe operators and wells with electric pumps, pipes leading to standpipes being broken/vandalised (4.7%), and spillage of water by customers during collection but which is metered and the sellers (standpipe operators) have to pay for (2.3%).

7.5 The I&SSWPs in Addis Ababa case study
The main type of sellers found were water vendors/sellers without own sources, that were selling water at PWTs/standpipes locally known as bonos where water was supplied by the official water utility. The majority (55.6%) of those who responded to questionnaires and seven of the eleven interviewed were sellers at PWTs/standpipes. Various types of PWTs/standpipes were found with some having multiple points/outlets for water delivery (Figure 7.11) while others had single taps from where water was sold (Figure 7.12).

Another common form of water selling was through household resellers which were identified and selected by some respondents as a first or second source of water during the household water usage study. Although no water selling was done directly from yard taps, it was also a major source as reported by households during the water usage study.

Apart from direct selling of water, other forms of selling of services within the business of water supply were also found although on a very limited scale. These included those paid to collect and transport water by head/back load (Figure 7.13) or by donkey to households. They did not participate in direct buying and selling of water but were hired by households to collect prepaid water on behalf of a household. They were paid only for their service of transporting water and often used jerry cans owned by households that hired them to deliver water. This form of buying service for water delivery was notably only available in limited areas, especially new or upcoming predominantly non-poor neighbourhoods for example Lebu and Bethel. Observations and interviews suggested that back loaders were mainly young people.
Figure 7.11 a, b, c d Public water taps with multiple points for water delivery—all located in Addis Ababa
Water sellers with own sources or producers as defined in this study were not found in Addis Ababa during this research or if available could not be traced. Efforts to get such producers yielded little results in the form of institutions like churches and monasteries which had their own boreholes or deep wells developed to provide for their own water needs and thus supplement water received from AAWSA, which was reported to be unreliable and therefore inadequate to meet their water needs. However, they also provided water free to those in their neighbourhoods during periods of scarcity. There were suggestions that some high volume users like factories, business premises and foreign embassies also had such sources of water and it is possible that such sources were meant for own use and did not sell water to households thus the possible explanation for a general lack of awareness on the location of such water points. This generally reflects the limitations experienced in finding I&SSWPs with own source (producers) that served households in Addis Ababa and may further be an indication of their absence.

Interviews with some key stakeholders like officers from Water and Sanitation office of the World Bank in Addis Ababa confirmed the absence of water providers with own sources. From interviews further suggestions emerged that the absence of independent production of water and selling could partly be due to the historical context of the growth of Addis Ababa which seem to differ from those of other African cities where water selling activity is predominant.
From information gathered from the interviews, Addis Ababa has simply grown in a ‘natural organic way, unforced and unstructured’. As the population increased over the years, so did the water authority (AAWSA) expand its water supply to all areas, ‘without considering some areas illegal, occupied by the poor or as should not be supplied with water, as is common in cities with colonial heritage where I&SSWPs with own sources exists’ (Interv. Official of World Bank-WSP Addis Ababa office, 2007). Thus it is only the forms of provision adopted by AAWSA that differed based on incomes or ability of individuals to afford household connection. AAWSA therefore embraced yard taps and water provision through PWTs/standpipes as a way of reaching those who could not afford individual connections. This, it was suggested, may have prevented the rise of independent water suppliers/producers. As a result, the forms of water selling existing and predominant in Addis Ababa are the PWTs/standpipes and yard taps and are perceived as forms of utility provision. However, rapid increase in population together with ‘construction boom’ and limited expansion has put pressure on water supply services including the various forms of provision adopted, thus causing some areas especially the new areas of settlements to experience severe water shortage (Workshop notes, 2009).
7.5.1 Ownership and management of water selling points/sources

I&SSWPs available (mainly sellers without own sources) obtained their water from the official pipe network. Of those sellers the majority (88.9%) did not own the water points, and the rest said they owned the water points they operated. Further investigation about, who owned the water points, revealed that 60% were owned by the kebelle (local government administration), hence majority of the PWTs/standpipes visited were under kebelle management. Some 10% reported that they were owned by Community Associations/groups like women’s groups or Board of Trustees and NGOs and another 10% reported that they were owned by private individuals. Another 20% indicated though that they were owned by official water authority (AAWSA) but managed by kebelle or were not sure of the owners and therefore management of some could not be established. Sellers at PWTs/standpipes also referred to as public water tap attendants were found to be mostly employees of the kebelle or appointees of an association where a water point fell under such management. Household resellers interviewed were generally few; three of the four interviewed said they had ownership which was because they owned the houses they lived in and from where they sold water. Those providing other services in the water selling business (donkey) were equally split with half owning the donkeys and half having no ownership.

7.5.2 Water charges and profits by sellers: one city, similar taps different payment systems

Water sold was obtained from the official pipe network. Table 7.19 shows a summary of utility tariffs.

<table>
<thead>
<tr>
<th>Type of connection</th>
<th>Tariff in Birr (US$) per M³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic (household)</td>
<td></td>
</tr>
<tr>
<td>1st block 0-7m³</td>
<td>1.75 (0.18)</td>
</tr>
<tr>
<td>2nd block 7-20m³</td>
<td>3.15 (0.32)</td>
</tr>
<tr>
<td>&gt;20m³</td>
<td>3.80 (0.39)</td>
</tr>
<tr>
<td>PWTs/standpipes (bonos)</td>
<td>1.45 (0.15)</td>
</tr>
<tr>
<td>Commercial e.g. hotels</td>
<td>3.80 (0.39)</td>
</tr>
</tbody>
</table>

Although the official water utility - AAWSA charge for its water using increasing block tariffs, water supply to PWTs/standpipes is at a flat rate of 1.45/m³ Birr (US$ 0.149/m³) and this was lower than the charge for the first block for domestic/residential connections at Birr.

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1.75/m³ (US$ 0.180/m³). Water was in turn sold to households mostly by jerry cans commonly 20 litres in size or buckets of the same size. The methods used to pay for water as well as the selling price varied depending on type and location of the PWTs/standpipe. Three main ways of selling/paying for water were identified: monthly bills, payment using voucher/card system and cash at the time of collection.

7.5.2.1 Voucher/card payment system and profits made
In some parts of the city, for example kebelle 01 in Lebu (Nefas-Silk Lafto sub city) and kebelle 01 in Bethel (Kofe Keranyo sub city) the predominant method of payment was by a voucher /card system. The voucher system was also used in kebelle 15 and 16, two very low income kebelle located within an old established area or what would be considered inner city within Kirkos sub-city that were included in the study during the second field study as outlined in section 5.2.1. The two kebelle are not only very deprived areas but are also enclosed between areas which can be considered as some of the wealthiest within Addis Ababa; for example, the palace occupied by the country’s prime minister and the five star Addis Ababa Sheraton hotel.

In kebelle 01 in Lebu and kebelle 01 and 06 in Bethel the voucher/card was costing Birr 4 and was used to collect twenty jerry cans of water (20*20= 400litres) or 0.4m³. This translates to a selling price of Birr 0.20 for a 20litre jerry can of water or Birr 10/m³ (US$ 1.256) and therefore an estimated profit of 590% for every cubic meter of water sold.

Within kebelle 15 and 16 of Kirkos sub-city, two types of water points/bonos were found. The first types were those built by the government (kebelle) administration and the second were those built by the development section of the kebelle at community initiative and with community support through community contribution. Payment for water from water points put up by the kebelle administration was done through a voucher. A voucher costs one Birr and can be used to buy 10 jerry cans of water; hence the selling price of a jerry can of water was ten cents (Birr 0.10) or Birr 5/m³ (US$ 0.633) and thus an estimated profit of 245% for every cubic meter of water sold. At the water points built by kebelle with the support of the community, water is paid for by cash at the time of collection. Water was sold at 10cents or Birr 0.10 for a jerry can (20 litres) of water, but the cost decreased with increase in the quantity bought such that one Birr enables a household to collect 12 jerry cans of water, two
jerry cans more compared to those paying through voucher as further shown in Table 7.20. This translates to Birr 4.17/m³ (US$ 0.527) and a profit of 188%.

Table 7.20 Comparison of prices at which sellers sold water for households paying by cash and through vouchers in selected kebelles in Addis Ababa

<table>
<thead>
<tr>
<th>No. of 20 litre jerry cans</th>
<th>Cost in Birr</th>
<th>No. of 20 litre jerry cans</th>
<th>Cost in Birr</th>
<th>No. of 20 litre jerry cans</th>
<th>Cost in Birr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.10</td>
<td>1</td>
<td>0.10</td>
<td>1</td>
<td>0.20</td>
</tr>
<tr>
<td>3</td>
<td>0.25</td>
<td>3</td>
<td>0.30</td>
<td>3</td>
<td>0.60</td>
</tr>
<tr>
<td>4</td>
<td>0.35</td>
<td>4</td>
<td>0.40</td>
<td>4</td>
<td>0.80</td>
</tr>
<tr>
<td>6</td>
<td>0.50</td>
<td>6</td>
<td>0.60</td>
<td>6</td>
<td>1.20</td>
</tr>
<tr>
<td>8</td>
<td>0.75</td>
<td>8</td>
<td>0.80</td>
<td>8</td>
<td>1.60</td>
</tr>
<tr>
<td>12</td>
<td>1.00</td>
<td>10</td>
<td>1.00</td>
<td>12</td>
<td>2.40</td>
</tr>
</tbody>
</table>

The data shows that sellers at PWTs/standpipes provided by the community within kebelle 15 and 16 in Kirkos sub-city where water was paid for by cash, sold water at a lower price as the volume consumed increased. The data indicates that although the unit cost for water at community initiated and kebelle provided PWTs/standpipes was the same for a 20 litre jerry can, within the predominantly low income kebelles, community initiated taps were likely to sell water at a slightly lower price as the volume of use increased, suggesting that payment by cash gained bulk discount. Further the data indicate that PWTs/standpipes within kebelles that are mixed but predominantly non-poor e.g. kebelle 01 and 06 in Bethel or kebelle 01 in Lebu, charged twice the price charged in the kebelles that were mainly low-income. These were also the newly settled areas and where scarcity was most felt.

7.5.2.2 Charges at taps in the yard

Some households were served by taps in the yard. Although water was not directly sold from these points, payment was required here as well, but on a monthly rather than on a cash basis. From the official utility reports each tap in the yard was shared by an average of six households but interviews with those using yard taps showed that up to 12 household may share a tap in the yard. The price of water is based on amount of water i.e. number of jerry cans collected per day by a household, with those collecting one, two, and three buckets per day paying four, eight and Birr 12 a month in that order. This translates to a charge of Birr 0.13 per 20litre jerry can or about Birr 6.50/m³ (US$ 0.67). The data indicates that although
cost per unit (20litre jerry can was low) yard taps charged highly per cubic meter as this was higher than charges to households with connections (Birr 1.75 /m³) and even higher than commercial connections (Birr 3.8 /m³).

7.5.2.3 Selling of water by household resellers and profits made

Household resellers charged a range of Birr 0.50-0.60 for a jerry can of 20 litres which translates to Birr 25-30/m³ (US$ 3.09/m³) and a potential profit in range of 1328% to 1614% if AAWSA charge them at the flat rate using the lowest tariff of 1.75/m³ for domestic consumption, or 558-689% if charged at the maximum tariff (3.8/m³) for domestic connections. A comparison of the charges by each water seller type and method of payment is summarised in Table 7.21, while a summary of the increase of price along the supply chain is shown in Figure 7.14.

The data shows that the charge by household resellers was the highest and was almost 20 times the price (Birr 1.45/m³) paid by PWTs/standpipe to the official utility, 17 times the lowest price (Birr 1.75/m³) AAWSA charge household with direct connection or 6.8 times the amount (Birr 3.80/m³) AAWSA charge commercial connections which was also the highest tariff band for domestic connections. Charges for household with connections were the lowest although it was still higher than the charge AAWSA levied on PWTs/standpipes. The data further indicates that PWTs/standpipes charge 3.45 to 6.90 times the price at which they get water from the official utility.

Table 7.21 Comparison of actual charges for water under different payment systems, sellers and other types of piped water provision in Birr and US$ (brackets)

<table>
<thead>
<tr>
<th>Type of provision</th>
<th>Type/frequency of Payment</th>
<th>Approx. charge per 20ltr jerry can</th>
<th>Charge per m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWTs/ bono</td>
<td>Voucher or cash at time of collection</td>
<td>0.10-0.20</td>
<td>5-10 (0.51-1.03)</td>
</tr>
<tr>
<td>Household resale &amp; other standpipes</td>
<td>Cash at time of collection</td>
<td>0.50-0.60</td>
<td>25-30 (2.58-3.09)</td>
</tr>
<tr>
<td>Household connection</td>
<td>Monthly</td>
<td>0.035</td>
<td>1.75 (0.18)</td>
</tr>
<tr>
<td>Tap in the yard</td>
<td>Cash-monthly based on number of jerry cans collected daily</td>
<td>0.13</td>
<td>6.50 (0.67)</td>
</tr>
</tbody>
</table>
7.5.3 Number served and income received from water selling

The general estimates of number of jerry cans of water collected per day given by sellers at PWTs/standpipes varied with some areas recording as many as 500 per day while others recorded less than 20. In terms of the number of households served, 10% of the questionnaire respondents reported that they were serving about 60 daily, while 53% served between 10 and 30 households. About 16% reported that they served less than 10 households. The rest (11%) served about 100 households or more. Sellers at PWTs/standpipes indicated that revenue collected was often less than Birr 15 a day while in some cases it was less than one Birr a day indicating a general low revenue collection. However, where voucher payments were used, it was difficult to establish the amount of revenue collected on a daily basis.

The average payment reported as received by those employed to manage stand pipes in Addis Ababa was Birr 75.71 (US$ 7.81) with a minimum payment of Birr 50 (US$ 5.15) and a maximum of Birr 100 (US$ 10.31) per month. Those getting the average of Birr 75.71 per month (Birr 908.52 per year) were below the government poverty line cut off of Birr 1075.03 (US$ 150) per year and only slightly above extreme poverty line figures set at Birr 806.27. Those who received the minimum pay of Birr 50 per month (Birr 600 per year) fell below the poverty line and even lower than the extreme poverty line set at Birr 806.27 (MoFED, 2006). These incomes were also lower than those estimated for low income households in the range of Birr 193 -203 (US$19.90-22.55) or those who are illiterate and are engaged in informal sector activities Birr 75-84 (US$ 7.73-8.66).
All water sellers at PWTs/standpipes, however, reported that this was the only activity they were engaged in and hence their only source of income. Further investigation showed that the only reason why water sellers engaged in water selling was given as being a source of income. This was likely to be so as most of those engaged in water selling under the kebelle were employed and paid wages. But those operating outside the kebelle managed taps reported that they were paid a third of what they sold. The sellers, however, indicated that they faced some difficulties or challenges in selling water including water shortage caused by irregularity in water supply. One seller observed that ‘if there was enough water to sell even for only five days in a week, I could sell more water and get a better pay’ (Interv. Standpipes operator Oct. 2008). There was also curtailed hours of operation in some kebelles as confirmed below under water supply reliability, while household resellers indicated that water selling from their houses was not allowed and they did it at their own risk.

7.5.4 Water supply reliability
The water supply situation for some of the study areas where the sellers operated from as gathered from AAWSA map (Zerihun, 2005), documents and interviews with official utility
is shown in Table 7.22. The data shows that there was rationing in the piped supply system, with some areas getting water for only six hours a day. Interviews with official utility representatives further indicated that some areas missed water one day in a week. In both cases the data suggest that supply reliability depended on location of the water selling point.

Of the total number of water selling points visited, 60% indicated that they functioned for up to four hours a day and 21% for an hour or less. Some sellers at PWTs/standpipes suggested during interviews that their areas got water for only four hours a day and four days a week and not the six hours and six days given by the water authority therefore a difference between water sellers’ experience of supply reliability and that indicated by AAWSA. The areas where this was most reported were those newly opened for settlement in the eastern and western part of the city. Some of these areas for example, kebelle 01 or 06 (Ayer Tena) in Kolfe Keranyo sub-city are also hilly resulting in very low pressure, which could have been another reason why water was received for less hours than expected.

Table 7.22 Water supply situation in selected sub-cities of Addis Ababa

<table>
<thead>
<tr>
<th>Area/kebelle sampled</th>
<th>Sub-city</th>
<th>Water service hours/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kebelle 14 and Kebelle 19</td>
<td>Addis Ketema*</td>
<td>7-16 (kebelle 14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17-24 (kebelle 19)</td>
</tr>
<tr>
<td>Lebu kebelle 01</td>
<td>Nefas-Silk Lafto</td>
<td>7-16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-6</td>
</tr>
<tr>
<td>Kebelle 01</td>
<td>Bole</td>
<td>7-16</td>
</tr>
<tr>
<td>Ayer Tena Bethel 01 &amp; 06</td>
<td>Kolfe Keranyo</td>
<td>1-6</td>
</tr>
<tr>
<td>Kotabe 90 or 09</td>
<td>Yeka*</td>
<td>1-6</td>
</tr>
<tr>
<td>Kebelle 15 and 16</td>
<td>Kirkos</td>
<td>17-24</td>
</tr>
</tbody>
</table>

* Only visited for reconnaissance survey

However, in some of the old settlements visited like Kebelle 15 and 16 within Kirkos sub-city, although water was available most of the times at the water point, according to water sellers interviewed, hours of operation were controlled and allowed for only a few hours in the day. In an interview with a seller he noted that ‘I am only allowed to sell from 9.00am to 12.00 and from 3.00pm to 5.00pm, I cannot sell outside that time or I may be sent home’ (Interv. PWT/standpipe attendant, 2008). Sellers interviewed suggested that in their view and the most common reason they were given for controlled hours of operation was to
reduce the bills paid to AAWSA. Response of sellers to the question on how often there was no water is shown in Figure 7.15 below.

The data indicate that about 35% of respondents (10 out of 28) missed water supply to their selling points once a week, this confirms findings from AAWSA map and interviews with official authority representative of one day a week rationing. However, 28.6% (8 out of 28) missed water daily. Since 63.6% missed either daily or once a week, this may explain why 60% also said that they were unable to meet their customers’ water needs and were of the view that customers were not getting enough water from their selling points to meet their needs. During the study there were many times when the researcher observed that customers would come to collect water only to find the taps dry and return without water.

![Figure 7.15 Percentage response to how often sellers missed getting water to sell](image)

**Figure 7.15 Percentage response to how often sellers missed getting water to sell**

**7.5.5 Analysis of those served: I&SSWPs customers**

As earlier shown, in terms of the number of households served, 10% of the questionnaire respondents reported that they were serving about 60 households daily, while 53% served between 10 to 30 households. About 16% reported that they served less than 10 households. The rest served about 100 households or more. However, most sellers (68.8%) reported that they had customers who regularly bought water from their water selling points. The average number of regular customers was 45 for standpipes in predominantly non-poor areas and 60 for mostly low-income areas for those who were interviewed. All water sellers who
responded to questionnaires and majority (9) of those interviewed in Addis Ababa said there were times they could not provide water for their customers. 85% of sellers also reported that they were unable to meet all of their customers water needs. From the responses, the main reason for not being able to meet (serve) all their customer water needs was indicated by sellers (60%) as not getting adequate water or shortages caused by supply interruption but others also mentioned controlled hours of operation.

It is one thing for sellers to be able to meet all of a customer’s water needs and another for customers to rely on a seller for all water needs. Sellers were therefore asked if in their view their customers relied on them for all their water requirements. 58.8% of the sellers reported that this was not the case i.e. they believed that their customers were not depending on them for all their water needs. One seller at a PWTs/standpipes stated that ‘...there are other sellers where they [customers] also get their water; they do not come here sometimes’ (Interv. October 2008). In addition an overwhelming majority (90%) believed that their customers used other sources as well. This response from Addis Ababa was puzzling given the apparent lack of a variety of sources, especially alternative providers not dependent on water supply from the official utility mains (with own sources of water) which customers could opt to use. However, from interviews the respondents indicated that their customers could look for water from other alternative sources available like neighbours with connections (household resellers), other PWTs/standpipes, harvest rain water during the rainy season and/or use free sources like streams.

Questions were asked to determine sellers’ attitude/perception of socio-economic status of their customers. The majority (64.7%) of PWT/standpipes sellers in Addis Ababa felt their customers were poor, 29.4% said the people they served were of mixed socio-economic status and only 5.9% thought their customers were very poor. The same views were held by household resellers who felt that majority of their customers were from relatively low income households. Although majority are seen as poor, the results may be a reflection of the complex and mixed nature of settlements in Addis Ababa. They could also confirm as suggested by the AAWSA representative and other stake holders, that areas facing serious water supply problem are mainly the new/upcoming settlements which may not necessarily be only of low income (Interv. Technical Deputy Manager, AAWSA, 2007).
According to sellers' views, in Addis Ababa, the two main reasons why customers bought water from them was because these were either the only sources available or were the nearest hence closest to customers in terms of distance. These responses generally agree with customers views' as shown in section 6.4.2 on reasons for water source selection.

7.5.6 Sellers perspective on water use and quality of water
Sellers were asked if in their view customers used different sources for different purposes. Although all sellers only sold water sourced from the official utility piped network, the majority believed that there was still a selection of water sources for different uses and that their customers used different sources for different purposes. From the sellers' perspective majority felt that water used for drinking, cooking and food preparation and for personal hygiene was obtained from PWTs/standpipes. Although some respondents indicated that water for animals (6.5%) or gardening (8%) could also be obtained from PWTs/standpipes, it was not popular for such uses. River water was indicated as used only for animals (60%) and gardening (40%). Mixed sources given as rain and piped water were indicated as used for personal hygiene, cooking and food preparation and also for general hygiene.

In relation to water safety/quality of the water they sold, all the respondents in Addis Ababa said the water they sold was safe or 'good' for all uses and further a majority (82.4%) indicated that they did not do anything to treat or improve the quality of water they sold. Amongst those who did not do anything to treat the water they sold, reasons given included, the water was safe (78.6%) and the rest (21.4%) stated that there was no need though without stating directly that water was safe. However, a no need to treat may also suggest a perception of good quality. This may be because they only sold water drawn from the official network and may indicate a perception that water from the official network is safe.

However, a few (17.6%) indicated that they did intervene to improve the quality of water. This was unexpected given that the water sold by sellers was sourced from the official water network and the majority seemed to believe that it was safe. However, when asked what they did to 'treat' water, the sellers reported that they would occasionally carry out cloth filtration but only when water from the network appeared cloudy or had particles in it. This may suggest awareness for the need to supply good quality water and a concern for the quality of water sold to customers. This was further indicated by their response to question gauging
their level of concerned for the safety/quality of water for various uses. On a five point Likert scale sellers were asked to rate their concern that the water they supply may not be safe for all the purposes their customers could be using them for. A majority (68.8%) were ‘very concerned’ and 25% were ‘concerned’. The rest were ‘slightly concerned’ (5.6%).

Sellers were asked what action they would take if they knew that the water they sold/supplied to customers was not safe for what their customers were using it for. 41.2% said they would stop selling, 11.8% would advice customers to treat, and 5.9% each would keep quiet and continue supplying or would do a combination of advising them to treat and stop supplying. However, all the sellers who responded to questionnaires and those who were interviewed in Addis Ababa reported that they had not participated in any water and sanitation training.

Asked about the responsibility for water quality, a majority (76.5%) were of the opinion that the water company (AAWSA) should be responsible for the safety/quality of water that the water sellers sold to customers. Some (11.8%), however, held the view that water sellers should also be responsible and the rest, felt that the water company and the public health bureau should be held accountable. This was captured by one of the interviewees who stated that ‘some of the places where water is sold from are not kept clean by the operators and could also make the tap water bad...I think the water authority should teach them to be clean..., but if the authority cannot then our health people should teach them...’ (Interv. PWT/ standpipe operator, Oct. 2008)

7. 6 Conclusion
Various categories of I&SSWPs are actively involved in water supply in Addis Ababa and Kisumu. These cover those without own sources such as sellers at PWTs/standpipes/kiosks, household selling water to neighbours (on-sellers/resellers), handcart mobile vendors. Water sellers with own sources or producers as defined in this study were only found in Kisumu in the form of well/boreholes mostly owned by individuals and few by CBOs and an individual with small scale surface water treatment. Thus while in Addis Ababa all sellers got water from the official water utility, in Kisumu a combination of sources of water variously owned were also used by sellers and in turn by households. Other forms of selling of services within the business of water supply were found.
Majority of the PWTs/standpipes visited in Addis Ababa were under kebele management with a few under Community Associations/groups like women groups or Board of trustees and NGOs as opposed to Kisumu where they were under individual management. Among household resellers, about a third owned their water points suggesting they owned the houses they lived in and from where they sold water. Ownership means of delivery which included containers (jerry cans) and donkeys by sellers was almost nonexistent in Addis Ababa.

Water was mostly sold using a 20 litre size jerry can. In both case studies water charges varied. Methods used to pay for water also varied and included monthly bills, payment using voucher/card system and by cash at the time of collection. In Kisumu well water was sold at the lowest price followed by the small scale producer and standpipe, while handcart vended water was sold at the highest price. But all were higher than what households with connection paid to the official utility and often higher than those paid by commercial connections to the official utility. In Addis Ababa, community initiated PWTs/standpipes sold water at a slightly lower cost as the volume of use increased but household resellers charged the most expensive prices when compared to what the official utility charged PWTs, residential and even commercial connections.

Income received by sellers employed at PWTs/standpipes in Addis Ababa shows that sellers earned very low income although water selling seemed to have been their only source of income. Generally the PWTs/standpipes in Addis Ababa were not managed in a self sustaining way, with revenue collected generally low. Although earnings by sellers in Kisumu were below the poverty line, they generally compares well with the average earning in other informal sector employments and for those in public service at the lower level cadres. Majority of water sellers considered water selling a major source of income for the family with more than half of water sellers dependent on water selling alone, and was the principal source even for those who had other sources of income. Except for a few community managed standpipes dependent on piped network for water, most water sellers in Kisumu indicated that their businesses were able to recover costs thus self sustaining.

Entry to water market seems to be free for most I&SSWPs. Most I&SSWPs had regular customers but the number served varied depending on location. The majority of sellers at PWTs/standpipes and household resellers in Addis Ababa were of the view that their
customers were of relatively low income/socio-economic status. In Kisumu the general perception of the socio-economic status of customers by handcart sellers was that majority of their customers were non-poor or of 'moderate income'. However, for sellers owning wells and standpipes customers were reported as of mixed income.

According to sellers piped water was preferred by households for drinking and for cooking and food preparation although it could be used for any purpose. Well water was preferred for non-consumption uses but was also used for consumption purposes due to problems in piped water supply in Kisumu. Sellers were of the view that consideration of a source for uses such as drinking and cooking and food preparation appeared to be based on quality. In both case studies sellers believed that customers bought water from them majorly because these were the closest to customers in terms of distance with reliability as the second reason in Kisumu and only source available in Addis Ababa. In Addis Ababa, sellers believed that there exists selection in and uses different sources for different uses but the selection is only between piped and water obtained from surface sources.

All water sellers in both case studies were at times not able to provide water for their customers and more than half were unable to meet all of their customers water needs. The sellers were therefore of the view that customers were not depending on any individual I&SSWP for all their water needs. More than half of sellers said they had not worked together except a few who co-operated in the forming of small welfare associations in Kisumu, and a few well owners had also come together to form a well owners association. Challenges faced by sellers were given as shortages/scarcity, rationing, and supply irregularity in the piped supply system and curtailed hours of operation in some kebellles while for household resellers' water selling from their houses was technically considered illegal. In addition to the foregoing, in Kisumu, other challenges mentioned included high water bills by standpipe operators and for electricity for wells with motor pumps, reduced production or drying up of wells in the dry season for well owners with shallow wells, and heavy handcarts as well as water selling being physically demanding for handcart pushers. Handcart vendors also identified negative attitude towards them resulting in a hostile working environment. Some sellers also believed that the water they sold was not safe with some indicating suspicion that some of the water sources where they obtained water from were not of good quality. In both case studies, various responses and suggestions were given on who should be responsible for safety/quality of water sold to customers.

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Chapter 8 Discussions

8.1 Introduction
This chapter presents discussions of the data and results given in the foregoing chapters followed by general findings and conclusions relating to water supply provision by I&SSWPs. This will be followed by recommendations on how existing water provision through I&SSWPs can be improved generally as well as in the specific case studies.

8.2 Discussions
Analysis carried out on I&SWPs in the case studies has produced several interesting findings that can be used to make some generalisations about I&SSWPs and water provision. The results and findings in Chapter 6 and 7 indicate that various business models exist among independent and small scale water providers through which they bring basic as well as improved access to water to some sections of the population unserved and inadequately served by official water utilities. On a broader scale these encompassed water sellers without own sources, and therefore rely on the official utility for water supply to obtain water to sell. These encompassed PWTs/standpipes, households selling water to neighbours (on-sellers or resellers) and handcart mobile vendors. While in some areas these were the most common form of water supply source available for households, in other areas I&SSWPs with own sources were equally important with well and boreholes being significantly used. These sources appear to be more important to households than is currently believed. It should, however, be noted that these were focus areas selected within each case study and not each case study city as a whole. In Addis Ababa the samples were few partly due to the reluctance on the part of households to participate in the study.

The results and analysis has revealed that water provision through I&SSWPs is a complex phenomenon. The various I&SSWPs interact, interrelate and are interdependent forming an intricate water supply system. At one end of the spectrum are I&SSWPs sourcing the water they sell from the official water network (water vendors) while at the other end are those with their own sources (producers). In between are mobile vendors who source water from both sources and sell door to door to households. However, amid this complexity there exists at some points a subtle specialization in individual aspects of the water supply chain.
I&SSWPs seems to be taking advantage of their individual efficiencies as they seem to concentrate only on individual aspects of the water supply chain, as producers largely avoid getting involved in distribution and vice versa.

Clear distinction between formal and informal water provision is blurred by the complex interaction between various types of I&SSWPs. To a large extent the boundaries between informal and formal water provision can be arbitrary, the supply chains for water provision extend beyond individual I&SSWPs or the official water utilities and encompass various types of I&SSWPs. Thus while the source may be formal, the means through which it is delivered (the mobile vendor) may be informal. On the one hand the acceptance of some I&SSWPs like PWTs/standpipes as a lower level of service by some water authorities, their approval by and dependence on the official water utilities suggests that they are already part of the formal water supply system. The same could be said about small scale producers that may have permits to abstract surface water, treat and produce in bulk. But their main customers, which in some cases may be handcart vendors and/or tanker truckers who collect the water and deliver to households, may not be considered to be formal. A community managed water supply, which is registered as a water service provider just like the official water utility could also rightly be concluded to be formal. However, on the other hand, the use of household resellers although reflects wider experience within urban areas of developing countries as also reported by other studies (Morris & Parry-Jones, 1999; Tatieste & Rodriguez, 2001; Howard, 2001) seems often to be done without the approval of water authorities including the official water utilities and thus can be considered as unofficial. Wells may also operate largely unofficially, while for the mobile vendors, like handcarts, the source of water could have been formal like a PWTs/standpipe connected to the official water network but the transportation part by a handcart vendor may be informal. But it may also be the case that both the source and means of delivery could be informal, for example, in the case of a well and the handcart vendor respectively. Understanding the complex interaction between the informal and formal parts of the water supply sector is critical if access to water and water provision by I&SSWPs is to be improved. In the meantime, households un-served and inadequately served by the official water utility depend on this complex system of water provision for access to water. Households are therefore involved in on-going decisions on what sources, but mostly what combination of sources, would best meet their water needs as neither the official utility nor individual I&SSWPs currently seems to be able to meet household water needs on their own.
Household decision processes in selection of water sources also appear to be complex but measures of access appear to dominate. The results and findings in Chapter 6 indicate that households give priority to measures of access, in selection of first water sources and therefore confirm existing scholarship (Howard, 2002; Howard & Bartram, 2003). The importance given to measures of access, particularly distance in the selection of first water sources suggests that, other things being equal, as long as a source (including I&SSWPs) remain closest to the household it will be the preferred option. This research therefore suggests that in terms of distance as a measure of access and the key consideration of households’ selection of a water source, I&SSWPs perhaps provided better access to water to households using them as they seem to have been nearest to households. On the one hand the example of handcarts show that mobile vendors overcome distance and bring water to the door enabling households to get water at their door, thus eliminating long distance that household’s un-served and poorly served would need to cover to reach the official supply network. The use of handcart vendors seems to be households’ way of overcoming the problem of distance they are required to cover to reach to water sources like PWTs/standpipes and wells located far from the houses. Thus the mobile water vendors seemed to have ‘taken over piped water delivery’ to households from the official utility network. Such independent and small-scale water providers effectively provide a “virtual pipe network” expanding the reach of official water providers as well as being the ‘piped network’ to households for water from I&SSWPs with point sources like wells, where such are located far from households. Thus while I&SSWPs with own sources may be preferred because they are located close to households, in the case of the mobile vendors their core competency and business advantage appears to be their ability to overcome distance on behalf of households.

A better continuity in water supply from I&SSWPs with own sources, like wells, and the ability of mobile vendors to change where they obtained water from based on availability of water suggest that they were a more reliable supply to households. Results and findings appear to indicate that supply interruption was low for households using I&SSWPs with own sources, like wells, and also on handcart vendors as a first water source. Ironically, although wells or borehole sources rarely provided home connections with continuous running water, the data suggest that those collecting water from them reported a more regular supply (always got water from the source), with only seasonal interruption, than those using
standpipes dependent on the official utility (daily interruption) suggesting that overall wells had a higher level of supply reliability than PWTs/standpipes connected to the official piped network. I&SSWPs like handcart vendors frequently changed where water was obtained from, also enabling households’ dependent on them to get a more reliable supply of water. This indicates the value of such supplies to households dependent on them. Thus continuity in the sources or reliability in supply was another business advantage for I&SSWPs. The finding on better reliability of wells is not at odds with those reported by Lloyd et al. (1991). This does not, however, indicate that all well sources were maintained properly as shown by high sanitary risk scores and water quality results.

This research has provided some interesting insights on the relationship between continuity/reliability and household selection and use of water sources including I&SSWPs. The results suggest that household connection rates to piped water are only a guide to access and usage of piped water. On their own, connection rates can be misleading as they ignore the continuity (or the lack thereof) of the piped water supply. The results and findings indicate that even where households had their own connections to the official water supply, I&SSWPs were still frequently the main source of water because of better reliability. The results suggest that reliability in supply may also be important in selection of water sources where there are a variety of sources and may have been the cause of the relatively low usage of house taps and PWTs/standpipes connected to the official water utility. It was, however, significant that relatively fewer households directly reported continuity in their selection decisions and although may appear to indicate that it was not important, the fact that a substantial number of these households had own connections but did not select them as their first sources due to discontinuity in supply suggest otherwise. The low direct reporting of discontinuity as a selection criteria therefore could have been because households were not asked why they did not use household connections where they did have one, but rather why they used the sources they did. Thus they did not report reasons for not using own house connections. It is likely that in other settings continuity would perhaps be directly reported as a selection decision. Continuity/reliability of a source appears to be of great value to households and determines whether a source, including I&SSWPs is used as the first or second source. This suggests that even in house access is not a guarantee of usage of piped water as a first or second water source if the supply is not reliable. Household connections to piped water from the official utility water network have to go hand in hand with continuity of supply if the role of I&SSWPs is to be reduced. In many cases, however, this remains a
long-term objective, with I&SSWPs filling the gap, especially in low income areas, in the immediate future. Continuity is also critical if water provision through I&SSWPs like PWTs/standpipes is to be effective. In addition better management is required since the data suggest that the discontinuity experienced by some I&SSWPs (PWTs/standpipes) connected to official piped network was because they were not managed in a way that can enable them to serve households effectively as well as not being self sustaining and correlates with observations made by others (Bond, 2005; Akbar et al., 2007).

Discontinuity resulted not only in water storage being common but also the existence of the many independent water sources (mainly wells) and their higher usage by households as was seen in Kisumu. Other workers have reported the use of wells due to continuity in piped water supply but mainly by low income households (Fass, 1993; Almedon & Odhiambo, 1994; Howard, 2001). However, the water usage data indicates that wells may not only be used by low income households but that they may become popular with handcart vendors who source water from here and supply to non-poor households. Discontinuity seem also to have been the cause of the inability of I&SSWPs operating PWTs/standpipes dependent on the official water utility to be able to provide water for their customers at certain times and being unable to meet all of their customers water needs. In addition discontinuity appears to have partly contributed to low sales and income for I&SSWPs in some areas. For I&SSWPs dependent on official water utility supply, their success in serving households and sustaining their business is inextricably linked to proper services from the official water utility. Hence the need for official water utilities to work together with them to improve supply as also reported by Njiru, (2003) and Samson, (2007).

The results and findings in Chapter 6 shows that there is a marked improvement in the quantity of water collected and used (per capita water use) by households where I&SSWPs with their own independent water sources exist. Small scale producers, like well owners, add, even if on a small scale, to the quantity of water produced and therefore play a valuable role in water supply within urban centres of developing countries also as contributors to the water output, the total water available for distribution. This enables households to improve on what otherwise would be very low water use levels if water from the official utility were to be the only available source. This is because the water supply problem is not due to an inherent scarcity of water in a resources sense but inadequate management and investment in the supply system. It appears that per capita water use level would otherwise be much lower.
without sources other than the official water utility. Results and findings suggest that those who used handcarts or wells used significantly higher amounts than standpipes connected to the official water utility network. Evidence from this research reveals that availability of water provided by I&SSWPs with own sources enabled households to access a better quantity of water and improve on the quantities of water collected particularly those uses related to general hygiene and suggests that if households relied only on water provision through the official utility, perhaps quantities of water used would have been much lower compromising water use for hygiene purposes which is key to reducing disease.

Water provision through I&SSWPs operate competitively. There was competition between the different types in pricing. The cost of water to households varies by source used, season, type of I&SSWPs and how the water reaches the household. Nevertheless some generalisations can be made. The cost of water sourced from I&SSWPs connected to the official water utility supply tends to be higher than those with own sources. Households were therefore expected to pay more for water purchased from I&SSWPs with connection to the official piped network as cost per unit paid was frequently higher than that paid by households with own connections and was even higher than the highest official utility rates charged on commercial/institutional users. This finding is not at odds with other studies (Howard, 2001; Gulyani et al., 2005; Kayaga & Franceys 2007).

The most expensive water comes via mobile vendors regardless of where it is sourced from and appears to be mainly as a result of the costs incurred on inputs rather than charging excessively as is often portrayed in the literature. Results and findings from supply chain analysis indicates that there is a drastic rise in the cost of water along all the supply chains as a result of use of mobile vendors, making mobile water vendors in the eyes of the official utility an unwanted part of the supply chain and to some households, unwanted but indispensable. However, although their price is high and confirms what is commonly reported in the literature (Chapter, 3) the findings of this research suggest that profit margin and income is not high for all when attempts are made to take into consideration their inputs. Moreover, it would not only be impractical to take into account the varying costs and regulate the retail price for handcart vended water fairly but prescribing maximum prices may discourage them from serving areas which costs them highly to serve thus leaving households in such areas without a means of access to water.
The least expensive water is where a household purchase its water directly from a well; however, this is still higher than what is paid to the official utility by households with their own connection to the piped network. The results further suggest that there exist a tendency towards lack of effective price competition within I&SSWP's operating standpipes connected to the official utility piped network. Their prices remained above the retail price recommended by the official utility and which takes into account expected mark-ups. This appears to be as a result of a tacit price collusion whereby they all observe each other's prices and ensure that they remain at similar level-often similarly high rather than similarly low levels. Thus even standpipes purchasing water from the official utility at a discounted rate and are suppose to be a 'pro-poor' strategy, partly aimed at bringing down water costs for the low-income, charge the same price as others. This, however, seems to be done in order to maintain low but viable incomes, rather than for profiteering and without which they cannot continue to operate. Enforcing recommended maximum price (price cap regulation) would therefore result in very low incomes that may force such standpipes to stop operation hence depriving households in such areas with their means of access to water. It may also discourage standpipe operators from taking measures to properly maintain infrastructure within its jurisdiction. Generally the diverse, small and complex nature of operations of most I&SSWP's makes it almost impractical to take into account the varying costs and regulate the retail price of water for households. It is, however, noteworthy that although the various I&SSWP's like PWTs/standpipe, do not lower the actual unit price of water they have other significant benefits including making it possible for low income areas to be served hence providing households with often the only means of access to water. In addition, poor households using standpipes were able to buy only a limited amount of water as per their means and need and hence reduce their expenditure on water and other costs associated with having own connections.

The results and findings indicate that households purchasing water from their neighbours typically paid more than households with a connection to piped supply. Others have reported similar findings in urban areas of developing countries (Franceys, 1997; Johnstone & Wood, 2001; Howard, 2001; 2002; Shirley, 2002; World Bank, 2002, 2004a; UNDP, 2006; Anand, 2006b). The potential effects of this have also been highlighted in previous work (Caincross & Kinnear, 1992; Fass, 1993; Menard & Clarke, 2000; Lawrence et al., 2002; Anand, 2006; Dungumaro, 2007). It is, however, not clear, if, where majority of customers served by
household resellers are poor, household reselling could be used to benefit the poor by way of incentives for resellers to provide water at lower costs to their neighbours, thus regulated vending of household water. Whether such a strategy would be effective and would be easy to monitor and to enforce standards relating to price is also not clear.

Profits made and income received by I&SSWPs tend to be specific to the type of I&SSWPs, the market niche within the domestic water supply, and tariff rates charged by the official utility for those dependent on their water. The diversity of I&SSWPs and the markets they serve permit only limited generalisations about profits and income. For some types of I&SSWPs profits and incomes remain low, even below poverty lines, but are comparable to other informal sector employments. Thus the results suggest that I&SSWPs are contributors to the output within the thriving informal sector economy even if the extent of this contribution could not be determined accurately. For those involved, water selling and its related activities seem to play a valuable role as an important source of employment and income and for sustaining livelihoods. Moreover, the selling of services and hiring of handcarts within water delivery part of the supply chain in the water business by I&SSWPs, further indicates the ingenuity in the informal sector to create a means of livelihood and is consistent with the observations made about general informal sector activities by others (Hansen & Vaa, 2004; Cameroon, 2007). Furthermore, water provision through wells indicates a potential in private participation in water supply by I&SSWPs not dependent on the official water network. The results and findings in Chapter 7 suggest that further improvements in practice could be done as indicated by the incremental improvements undertaken on wells using revenue obtained from sales and resulting into different levels of improved methods in drawing water. This confirms reports by Kyessi (2007).

Handcart vendors' income and profits vary based on costs incurred in relation to ownership (or lack thereof) of handcarts, location of water source (which include distance and topography) and source type. However, the findings of this research suggest that profit margin and income is not high for all when attempts are made to take into consideration their inputs. The results and findings appear to indicate that income and profit for I&SSWPs operating standpipes serving low income areas remained low even where they purchased water from the official utility at discounted flat rates.
General household expenditure on water provided by I&SSWPs takes a substantial proportion of the income of poor households, and in some cases, even higher than house rents suggesting low affordability. However, while previously and still in some cases attempts have been made to address low affordability through subsidies and other methods when dealing with the large official water utilities as was presented in Chapter 4, the results of this research suggests that it might not be practical for the operation of I&SSWPs, especially those with own sources to be subsidised as a means of addressing low affordability by poor households. The current form of 'subsidy' already exist in the form I&SSWPs like PWTs/standpipe operators dependent on the official water utilities receiving water at discounted flat rates, although this has not translated into lower costs (affordability) for low-income households getting their water at such points. This is because such PWTs/standpipes strive to charge prices that can enable them to continue to be operational. The results suggest that providing water at discounted rates to I&SSWPs operating standpipes alone does not result into low cost of water at PWTs/standpipes. Thus there seems to be an inherent conflict in the use of standpipes as a pro-poor strategy targeted at reducing cost to low income households and the income generation that they are meant to be for the operators. For now increasing competition by introducing more PWTs/standpipes should be tried as an option to try to bring down the costs but also has the benefit of reducing distance that needs to be covered to get to the water points. Meanwhile efforts should be taken to look at strategies for addressing the issue of affordability and equity including micro-financing strategies directed at poor households and applicability of some of the strategies used in other countries (Chapter 4).

Household’s decisions indicate that they understand the importance of choosing and therefore using safe drinking water. This, however, can be overridden by considerations of access and availability which in some cases can result in the use of poor quality sources some provided by I&SSWPs, for uses that they would otherwise not be used for. The findings suggest that the latter may also result when unscrupulous handcart vendors pass on water obtained from poor quality sources as those from safer sources. Preference among households to use water from different sources for different purposes is mainly based on perceived quality. This assumption correlates with ‘rationality factor’ noted as occurring among low income communities in both urban and rural areas of developing countries by other studies (Almedon & Odhiambo, 1994; Solo 1999; 2003). Use of piped water for drinking and cooking suggest a perception that water from the piped network was of good
quality and thus safe for all uses regardless of where it was obtained from. The finding that in practice well water was also used for consumptive purposes compares with report by Snell (1998) that for reasons of convenience or factors beyond households, they may also use poor quality sources for consumption.

Transportation of water by mobile vendor does not result in deterioration in the quality of water. This appears to be due to short time taken to transport and deliver water. There would therefore be no reason for concerned and need to regulate handcart vendors if they only sourced their water from good quality sources. With some exceptions, water sourced from I&SSWPs operating standpipes connected to the official piped network is of better microbiological quality, but well-water contamination is frequent and severe. The counts for indicator organisms for well-sources exceeded stipulated quality guideline values indicating that the water might be harbouring pathogenic micro-organisms thus posing a health risk to the consumers. Although awareness among households that the water might not be safe and availability as well as use of ‘avoidance measures’ may be expected to minimise the risks, this is not always the case. Well water is sometimes the only or source most available and therefore can also be used for consumptive purposes. Its quality may not be improved at individual household level due to limited resources among poor households, while for non poor households it could be passed on as tap water by dishonest mobile vendors. These can make households use it for purposes which otherwise they would not. Although shutting such contaminated sources down may appeal to water authorities, specifically regulators, as a means of reducing the risks, this may deprive households of an important source of water and well owners of their income. Some caution must be expressed regarding the strength of conclusion drawn about water quality particularly the relative influence of source water, and transportation by mobile vendors. Although care was taken to ensure matching household water with source this to allow better evidence for the responsibility for the quality of water, it may be possible that in some cases this was not achieved and therefore more studies would be needed to validate these findings. In addition multiple source use was common amongst households and mixing of water from different sources would have occurred even though storage within the household was commonly done in different containers. Even with handcart vendors, the same containers were used to collect water irrespective of the source. There is, however, a need to improve the quality of well water, and sanitary conditions and therefore high risks around the wells and around some standpipes.
Chapter 9 Conclusions and recommendations

9.1 Introduction
This chapter presents general findings and conclusions relating to water supply provision by I&SSWPs, as derived from the data and foregoing discussions. This will be followed by recommendations on how existing water provision through I&SSWPs can be improved generally and in the specific case studies areas as well as possible further research areas.

9.2 General conclusions
Specific conclusions of this research, which are applicable to both case study countries, the region and more generally include:

Various business models exist among independent and small scale providers through which they bring basic as well as improved access to water to some sections of the population unserved and poorly served by official water utilities. These I&SSWPs are currently more important to households than is assumed.

This research has thrown up important new understandings of water supply by informal water providers, particularly in the interaction between the informal and formal parts of the water supply sector. The boundaries between informal and formal water providers can be arbitrary, with these presenting challenges for regulation. Nevertheless, understanding the interaction between the informal and formal parts of the water supply sector is critical if access to water, particularly provision of safe and affordable drinking water by I&SSWPs is to be improved. Amid this complexity there exists at some points a subtle specialization in individual aspects of the water supply chain, with I&SSWPs taking advantage of their individual efficiencies, as producers largely avoid getting involved in distribution and vice versa. This subtle specialization where identified may provide a window of opportunity for possible entry and support to improve current practices.

Selection of water sources by households un-served or inadequately served by official utility network becomes a complex process. But measures of access predominate as the main criteria for choosing main water source.
All other things being equal, in the African urban areas, independent and small-scale water providers bring better access to water to households dependent on them. Mobile vendors overcome distance and bring water to the door enabling households to get water at their door, thus overcoming deficiencies in the official supply network. Thus, independent and small-scale water providers effectively provide a "virtual pipe network" expanding the reach of official water providers.

This study has revealed that household connection rates to piped water are only a guide to access and usage of piped water. On their own connection rates can be misleading as they ignore the continuity (or the lack thereof) of the piped water supply. Piped household connections from the official water utility network have to go hand in hand with continuity of supply from the official network if the role of independent and small-scale water providers is to be reduced. In many cases, however, this remains a long-term objective, with independent and small-scale providers filling the gap, especially in low income areas in both Kisumu and Addis Ababa, in the immediate future.

This is the first study to show the important role I&SSWPs with own sources play in improving per capita water use, particularly making it reach acceptable level even if such levels may still remain relatively low. Quantity of water collected and used by households improves markedly as a result of use of independent and small-scale water providers where these providers have their own independent water source. This helps improve on what would otherwise be very low water use levels if water from official utility were to be the only source to be relied on by households in areas where the official utility services are inadequate. This is because the water supply problem is not due to an inherent scarcity of water in a resources sense but inadequate management and investment in the supply system.

Household decision makers understand the importance of choosing safe drinking water. However, this can be overridden by access and availability criteria which in some cases can result in the use of poor quality sources.

This research has also shown that water selling and its related activities as part of the informal sector economy is an important source of employment and income and for sustaining livelihoods for those engaged, even if incomes for some types of independent and small-scale water providers remain low. Profits made by independent and small-scale water
providers vary and may be high or low depending on the type of independent and small-scale water provider, the area served, and tariff block used for independent and small-scale water providers dependent on the official utility piped water.

Expenditure on water took a substantial proportion of the income of poor households, in some cases, even higher than expenditure on house rent.

Handcart vendors did not lower the water quality. But level of microbial contamination for water sourced from piped network was low compared to well-water whose contamination is frequent and severe.

9.3 Recommendations
This study has revealed a number of issues in water supply provision by I&SSWPs which, if addressed, would assist in improving access to water and water quality.

9.3.1 General recommendations
There is a general need to improve practise among the various types of I&SSWPs. Where I&SSWPs operating PWTs/standpipe connected to the official network are heavily used by households as a means of access to water, there is need to increase competition among them by providing more PWTs/standpipes. This has a double objective of increasing price competition thus lowering prices while also reducing the distance poor households need to cover to reach such water sources.

The official water utilities should improve continuity in water supply to I&SSWPs operating PWTs/standpipes connected to their piped network to reduce the vulnerability of those (especially poor households) using them as a first water source and to improve income of those dependent on them as a source of livelihood. Currently, discontinuity in supply makes them unreliable resulting in shortages, low income and price increases.

Affordability of water for poor households is likely to remain an issue of concern where I&SSWPs are the main means of access to water. While no single option would suit all cases, several options now exist in other countries which could be used depending on what suits each specific case.
Although water provision by I&SSWPs remains an important source of employment and income to those engaged in it, income of some remains low thus those involved in it could still be among those living below poverty line. There is a need to build capacity of I&SSWPs so that they can better manage and expand their businesses to improve their incomes. For example I&SSWPs selling well water could also procure and sell chlorine tablets for point-of-use treatment by households to enhance their income generation while contributing towards improved water quality.

It is important to develop intervention strategies for improving the tertiary infrastructure including PWTs/standpipe points. This can be done through greater interaction between the utility and individual PWTs/standpipes operators and general communities in maintaining such infrastructure.

There is a need to define and adopt guidelines of what should constitute a standpipe. This amounts to regulation of construction through the establishment of norms and best practice and establishing a sanitary code for point of use. Such a sanitary code should specify the minimum sanitary protection requirements even if it excludes materials and methods. At present, in some cases, water in the pipeline and a meter is all that seems to be required. However, some sellers use dirty plastic hoses or other plastic tubes for connections, in some cases, passing through unsanitary conditions even right inside open drainages thus increasing the risk of contamination.

Where I&SSWPs with own point sources are heavily relied on by households, there is need for an adjustment in water supply policy to include improvement in point sources.

For handcart vendors or general mobile vendors, promotion of the use of good quality sources of water as well as good water handling practices may be effective in maintaining the quality of water during transportation.

In the absence of piped water connections to many households resulting in use of sources external to the home and water storage ubiquitous, promotion of household water treatment, also referred to as point-of-use technologies is necessary as water quality deteriorates in the household storage regardless of its original source.
9.3.2 The Kisumu case study
The Kisumu water market is more dynamic involving a variety of I&SSWPs operating under a wider range of business models compared to Addis Ababa. For I&SSWPs operating PWTs/standpipes dependent on the official water utility for water supply a number of actions could make them serve better.

- The official water utility could do well by increasing number of PWTs/standpipes especially in low income areas. The DMM should be extended to cover other areas of Kisumu, most notably poor areas not currently covered. But this ultimately lies in improved services and performance of the official utility.

- The official utility should improve the continuity of water supply to standpipes. Discontinuity of water from standpipes makes poor households to turn to the more expensive handcart-vended water even if to buy only a limited amount of water for drinking and vulnerability to the use of currently poor quality wells.

- Some PWTs/standpipes are currently located in areas with very poor sanitary conditions that add risks that could lead to deterioration in quality. Efforts should be aimed at ensuring that risks posed by drawing water from a standpipe itself and as a result of areas around the standpipes are reduced, rather than closing them. It is important to develop strategies for improving areas around standpipes to reduce risk of contamination from what are currently very poor sanitary conditions in low-income areas where such standpipes are located and are seen as a long term strategy for water provision. Individual sellers or communities may be involved in maintaining such infrastructure as is partly envisaged by the DMM.

- At present, water in the pipeline, utility meter and a seller’s plastic tubing for connection seem to be all that is required for a standpipe. Some of these plastic tubing are very dirty due to unhygienic handling by sellers and generally poor sanitary conditions. What constitutes a standpipe should be established, thus regulation of construction through the establishment of norms and best practice and
establishing a sanitary code for standpipes even if this excludes materials and methods to allow for flexibility and innovation by the sellers.

This research has shown that there is a need for monitoring and control over water supply provision and quality of water from well sources. This should be done alongside other support measures for the well owners to improve the quality of their water. However, the large number of wells in Kisumu yet operating on small scale, not only suggests uncoordinated development, but presents very significant challenges for monitoring and control. But this could begin with the most productive and hence wells most used by households and handcart vendors who obtain water sourced from such wells to sell to households. A well owners’ development group has been started by some well owners. The group could be strengthened by ensuring that it is registered and has good leadership. It might usefully have some representatives of the key stakeholders from the government (water authorities) and non-governmental organisations. Presence of stakeholders other than well owners would ensure that the association does not turn into a cartel as is likely with such associations but rather play a supporting role; being used as a forum for discussion, support and regulation. The well owners’ development group should have clear responsibilities as suggested but not limited to the list below:

- ensuring that all well owners register their wells with the Water Resources Management Authority office in Kisumu
- enrolling of members with wells, with emphasis given to productive wells fitted with generator/motors and serving large numbers of people;
- consulting with law-enforcement authorities, e.g. public health officials, for technical advice, arbitration matters, guidance and for general information;
- ensuring that members properly protect their wells from any possible contamination since, water sources need continued care and contaminated water sources increase the likelihood of contaminated water at point-of-use;
- encouraging members to practice regular well disinfection, and - in conjunction with the Public Health Department and other supportive NGOs- to ensure availability of a stock of disinfection chemicals for members;
- networking with implementing agencies and NGOs, and joint organizing for promotion of basic water and hygiene practices among well owners, including identification of risks around wells and how to reduce them, and sensitising members
where possible to treat the water they provide, including use of other disinfection technologies;
- requiring and ensuring members regularly carry out water sampling and maintain records with the help of those in the network (NGOs, Public Health Department) for quality surveillance;
- dissemination of information about water quality using various methods including for example brochures aimed at water consumers and information via radio and the other media.

These activities may require resources, to which members may contribute, though support is envisaged from other institutions in and through the network group.

9.3.2 The Addis Ababa case study
Currently, PWTs/standpipes pay a subsidised rate but are charging many times above the highest rate set for private connections, contrary to the subsidised tariff rates for communal water services envisaged by the Water Resources Management Policy of Ethiopia. If operation and management remain under the kebelle, a suitable price range should be established and PWTs/standpipes should be required to fix their selling price within the established range. They could further be required to publicly display this information. The aim should be to keep water costs low: the selling price to users could be tailored to the specific conditions of each tap (its location) while ensuring that the range of the mark-up on the buying price from AAWSA is not as wide as it is at present. However, poor households living in non poor areas may still pay more thus there would be a need for specific ways to target them.

Alternatively management should be changed and put under one coordinating body preferably that dealing with micro-enterprises, thus adopting a micro-enterprise strategy in their management to improve their operation and services provided through them. Most PWTs/standpipes under local administration (kebelle) lacked appropriate management thus not serving households effectively and were in most cases characterised by low standards of service delivery, including curtailed hours of service which resulted into low revenues. Once PWTs/standpipes are brought under one co-ordinating body, preferably that dealing with micro-enterprise, the body can in conjunction with AAWSA increase number of standpipes to increase competition with the aim of lowering water costs. The PWTs/standpipes should
be outsourced to individuals in order to promote better management while at the same time providing employment and income generation with preference given to the urban poor. The capacity of sellers, both new and existing, should be built in terms of training and equipping them where necessary with additional facilities to make them sustainable by improving their capability to generate revenue at least sufficient to cover operating expenses and provide their income.

Household resale-water is also used by a substantial number of household even if it was not the most common source. It could still be used for the benefit of the poor by providing incentives for household resellers to provide water at lower costs to their neighbours, thus regulated vending of household water. Trial of such a strategy would generate information about its effectiveness including how to monitor and enforce standards relating to price.

Although water from public water taps in Addis Ababa showed better quality, water sampled from household storage showed contamination indicating that storage can impact subsequent water quality. This could be a result of water contamination after collection, resulting from poor collection methods or handling during transportation or from contamination at storage. Efforts should be aimed at promoting basic water collection hygiene, covering areas related to good water drawing practices, since water drawing is the first stage at which contamination can enter.

Public water tap attendants/sellers should be discouraged and if possible stopped from using hose pipes at water points. The use of hose pipes poses risks of contamination of water as they could be a source of bacterial contamination if connecting hoses are not kept clean or if there is poor hygiene in handling.

9.3.2 Recommendations for further research
Given the current widespread and heavy reliance on various types of I&SSWPs by households further research is needed that focuses on how current practises of the individual types can be improved. Research on strategies for improving water supply through I&SSWPs as well micro financing strategies through which affordability of water by low income households reliant on I&SSWPs can be improved also need to be looked into.
Further research is required to identify threshold levels of source contamination, particularly for wells, beyond which it is not possible to resolve water quality through education of well-water sellers to adopt source treatment or point-of-use treatment by households. As this study was only limited to TTC as indicators of faecal contamination and hygiene. Further research may be needed on other pathogenic microorganisms and where possible epidemiological studies should be carried out.

Despite claims of presence of I&SSWP's with their own sources especially boreholes in Addis Ababa, during this research those actively involved in selling water to households were not found and thus not pursued. Further research may be needed to identify such if they are available and reasons for their reluctance to sell water to households even in the face of appalling water shortages and discontinuity in the official utility water network. The hypothesis that the absence of such sellers could be due to the historical context of the origins and growth of Addis Ababa which is different from cities with colonial heritage would be worth testing.
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Appendixes

A. Water Source and Usage Questionnaire

General Information

<table>
<thead>
<tr>
<th>Town/City</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estate/Kebele</td>
<td>Estate/Site</td>
</tr>
</tbody>
</table>

Respondent: (a) No (b) Gender: Male Female

(b) Age: □ Child 14-18years □ Adult

(c) Highest Educational attainment: □ Primary □ Secondary

□ Post secondary □ University Degree □ None

Section 1: Water Sources and Usage

PART A: Water Sources And Satisfaction With Sources

1. Firstly I Would Like To Know the Different Sources Where You And Your Family Get Your Water From? [TICK. The sources mentioned]

<table>
<thead>
<tr>
<th>TYPE OF SOURCE</th>
<th>TICK</th>
<th>TYPE OF SOURCE</th>
<th>TICK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piped water</td>
<td>Tap in the house</td>
<td>Borehole</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tap in the yard</td>
<td>Well</td>
<td></td>
</tr>
<tr>
<td></td>
<td>From Neighbours connection</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Protected</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unprotected</td>
<td></td>
</tr>
<tr>
<td>Kiosk/Standpipe</td>
<td>Tap Water (not from official network)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tanker</td>
<td>Other Specify</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand carter</td>
<td>Total No. of sources used</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Where Do You Most Often Get Your Water From? [Rank starting with 1 for the source most often used (main source), 2, for Second Water Source etc. If only one source
is given say "Often people get their water from more than one place. I would like to
know if you get your water from more than one place."

<table>
<thead>
<tr>
<th>Rank</th>
<th>Source Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Main Source)</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

3. Why Do You Choose To Get Water From This Place? [TICK EACH answer the person gives for each source, and Rank 1, 2, 3 etc starting with most Important reason for use other If only one reason is given ask "are there any other reasons why you get water from this place?"]

<table>
<thead>
<tr>
<th>TICK</th>
<th>REASONS</th>
<th>RANK</th>
<th>TICK</th>
<th>REASON</th>
<th>RANK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nearest/Distance</td>
<td></td>
<td></td>
<td>Only source</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not expensive/ Cost</td>
<td></td>
<td></td>
<td>Only tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good quality/safe</td>
<td></td>
<td></td>
<td>Personal/family reasons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I can get it when others run out</td>
<td></td>
<td></td>
<td>Other specify................</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Reliability)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Available</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Do You Ever Buy Water From Sellers (Vended Water)?
   □ Yes □ No

5. If Q5 Is Yes, Indicate Type Of Seller(s) (e.g. from Kiosk/Standpipe, Handcart etc)

6. Rate The Extent To Which You Agree or Disagree With The Reasons Below
   Explaining Why You Buy Water From The Seller (Use strongly agree, agree, can’t
decide, disagree, strongly disagree)

<table>
<thead>
<tr>
<th>Rating</th>
<th>REASONS</th>
<th>Rating</th>
<th>REASON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No time to collect</td>
<td></td>
<td>It is the only available/way of getting water</td>
</tr>
<tr>
<td></td>
<td>Water source is far</td>
<td></td>
<td>There are no people who can collect</td>
</tr>
<tr>
<td></td>
<td>I can afford</td>
<td></td>
<td>For convenience</td>
</tr>
<tr>
<td></td>
<td>They are reliable</td>
<td></td>
<td>Other, Specify......................................</td>
</tr>
</tbody>
</table>

7. How Would You Rate Your Satisfaction With Your Current Water Sources?
   (Use- Not at all satisfied, Not Satisfied, Partially satisfied, Satisfied, and Highly satisfied)
   a) Source 1 _____________________________
   b) Source 2 _____________________________

8. How Would You Rate Your Satisfaction With Water Sellers/Vendors? (Use- Not at all satisfied, Not Satisfied, Partially satisfied, Satisfied, and Highly satisfied)

9. Are There Any Things You Like About Water Sellers/Vendors As Water Source/Suppliers?
   □ Yes □ No

10. If Yes Please List what You Like About Water Vendors __________________
11. If No, Please Explain Why?

12. In Your Opinion Do You Think Water Supply Provision Through The Sellers (Vendors) Can Be Improved To Make Their Water Supply Better?
   □ Yes □ No

13. If Q13 Is Yes, How Can This Be Done?

14. If Q13 Is No, Please Explain Why?

15. Do You Ever Collect Rainwater?
   □ Yes □ No

16. Observation Is There Guttering And Tank/Drum For Rainwater Collection?
   □ Yes □ No

PART B: Water quantity, costs and reliability

1. What Kind Of Container Do You Use To Collect/Buy Water And How Big Is the Container? [Ask person to show you if not clear to confirm]
   Type of container   Approximate Litres

2. How Much Do You Pay For (Buy) A Container Of Water? Kshs./Birr:

3. How Much Water Do You Use Per Day And How Much Does It Cost You?

<table>
<thead>
<tr>
<th>Source</th>
<th>No. of Jerry cans of water used/collected per day</th>
<th>Cost per jerry can of water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wet season</td>
<td>Dry season</td>
</tr>
<tr>
<td>Source No.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source No.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q. 4. Are There Times When You Find No Water From Your main Source?
   Yes
   No

Q. 5 How often Is There No Water At Your Main Source
   ‘At least every(once a) day’
   ‘In the dry season’
   ‘At least once a week’
   ‘At least once A month’
   ‘Only occasionally’

Q. 6 How often Is There No Water At Your Source 2

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Q.7. How Would You Rate Your Satisfaction With the following Aspects Of Your First water sources (Use: Not at all satisfied, Not Satisfied, Partially satisfied, Satisfied, and Highly satisfied)

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Source</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>b) Quantity Of Water You Get</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>c) Reliability Of Water Source</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>a) The Amount You Currently Pay For Water</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

7. In Your Opinion What Can Be Done To Ensure That Water People Get From The Main Sources Which You Currently Use Is (a) Adequate (Enough)? Source No. 1 Source No.2  
   b) Affordable? Source No. 1 Source No.2

Part C: Proximity

1. Which Of The Sources You Have Mentioned (Source 1&2) Is Nearest To Your Home, Which Is The Next Nearest And Which Is The Furthest? [Write type of source and name]

<table>
<thead>
<tr>
<th>Nearest</th>
<th>Second Nearest</th>
<th>Furthest</th>
</tr>
</thead>
</table>

2. Approximately How Far Away (Distance) Is: Your Most Frequently Used/Main Source (Source 1) ___________; Second Most Used Source (Source 2) ___________

3. Approximately How Long Does It (Normally) Take You To Get Water From:

   a) Your Most Frequently Used/Main Source (Source 1) Time Taken To Walk To Water Source___________ (Mins) And Waiting Time___________ (Mins)

   b) Second Most Used Source (Source 2); Time Taken To Walk To Source_______ (Mins) And Waiting Time____________(Mins)

4. How Long Does It Take to Get Water During

   a) Shortage Time: Source 1 ____________ (Mins) And Source ____________ (Mins)

   b) Dry Season: Source 1 _____________ (Mins) And Source _____________ (Mins)

PART D: Water Usage and Perception of Quality

1. Do You Use Water From Different Sources For Different Purposes/Uses?
2. If Yes, Which Water Sources Do You Use For The Following Purposes? [Indicate source used for each Purpose and If only one use is given ask “do you use this water for anything else?”]

<table>
<thead>
<tr>
<th>USE</th>
<th>SOURCE</th>
<th>USE</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal hygiene e.g.</td>
<td>Animals</td>
<td>Gardening</td>
<td></td>
</tr>
<tr>
<td>Bathing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking &amp; food preparation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General hygiene e.g.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning / washing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Which Reason Best Explain Why You Use A Specific Source For The Uses Indicated (Some suggestions why people use specific sources for various purposes are given, which one explains best why you use the source for the purpose identified (1 not expensive/cost; 2, the nearest/Distance; 3 the only source available; 4, available when others ran out/reliability; and 5, good quality/safe))

<table>
<thead>
<tr>
<th>USE</th>
<th>REASON</th>
<th>USE</th>
<th>REASON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooking &amp; food preparation</td>
<td>Animals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal hygiene e.g.</td>
<td>Gardening</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bathing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General hygiene e.g.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning / washing</td>
<td>Other........</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Which Source Do You Mostly Use For
   a) Cooking and Food Preparation, Why?
   b) For General Hygiene and Cleaning, Why?

5. How Would You Rate The Quality/Safety Of Water From Your Current Sources? (Use- Bad, Fair, Good)

6. Does It Concern You Whether The Water You Use Is Suitable For The Specific Purposes Or Use?
   □ Yes  □ No

6. If Yes, How Would You Rate Your Concern That The Water You Use May Not Be Suitable For The Specific Uses?
   □ ‘Very Concerned’  □ ‘Concerned’
   □ ‘Slightly Concern’ □ ‘Not Concern’
7. How Do You Judge If The Water You Are Using Is Suitable For The Purpose Listed? (Use the following as indicators of Suitability: 1 for Colour; 2, for information from the seller/source; 3 for Taste; 4 for Odour/smell and 5 for no idea how to judge about its safety)

<table>
<thead>
<tr>
<th>USE</th>
<th>INDICATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td></td>
</tr>
<tr>
<td>Food preparation</td>
<td></td>
</tr>
<tr>
<td>Personal hygiene e.g. bathing</td>
<td></td>
</tr>
<tr>
<td>General hygiene e.g. washing clothes</td>
<td></td>
</tr>
</tbody>
</table>

8. Do You Do Anything To The Water (Treat) For Any Of The Uses Above?
   □ Yes □ No

9. If Yes, What Do You Do?
   (Use 1 for boil; 2 chlorinate; 3 Filter; 4 none; 5 other Specify)

<table>
<thead>
<tr>
<th>USE</th>
<th>METHOD USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td></td>
</tr>
<tr>
<td>Cooking &amp; Food preparation</td>
<td></td>
</tr>
<tr>
<td>Personal hygiene e.g. bathing</td>
<td></td>
</tr>
<tr>
<td>General hygiene e.g. cleaning house, washing clothes</td>
<td></td>
</tr>
</tbody>
</table>

10. If Q8 Is No (Doing Anything/Treat Your Water) What Is The Reason?
    □ Treating water is expensive □ The water is safe
    □ Not sure if there is needs to treat □ Other reason
      Specify_____________________

11. Suppose The Water From Any Of The Sources You Are Currently Using Is Not Suitable For The Uses You Put It To, Would You Like To Know?
    □ Yes □ No

12. If Q11 Is Yes, Why?_______________________________________________________________

13 If Q11 Is No, Explain Why?_______________________________________________________________

14. In Your Opinion Who Should Be Responsible For The Safety/Quality Of Water From The Sources You Use?

15. In Your Opinion What Can Be Done To Ensure That People Get Safe (Good Quality) Water From The Main Sources Which You Use? (Remind Of Sources Indicated as 1 and 2)
    Source No. 1 __________________________
16. In Your Opinion How Can The Quality Of Water From The Sources Listed Below Be Improved?

- Well water
- Borehole Water
- Water sold by handcarters/tankers
- Tap water
- Other sources

17. Given The Amount You Currently Pay For a Jerrycan Of Water (Say the figure ________) Are You Willing To Pay More For Water Of Good Quality?

☐ Yes  ☐ No

18. What Additional Amount Would You Be Willing To Pay For A Jerrycan Of Water If It Is Of Better Quality/Safer Than The One You Presently Use?

<table>
<thead>
<tr>
<th>TICK</th>
<th>KENYA Shillings.</th>
<th>ETHIOPIAN Birr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kshs. 1-2</td>
<td>1-2</td>
<td></td>
</tr>
<tr>
<td>Kshs. 3-4</td>
<td>3-4</td>
<td></td>
</tr>
<tr>
<td>Kshs. 5-6</td>
<td>5-6</td>
<td></td>
</tr>
<tr>
<td>Kshs. 7-8</td>
<td>7-8</td>
<td></td>
</tr>
</tbody>
</table>

PART E: Water Quality and Health Links

1. Has Anyone In Your Family Suffered Any Water Related Diseases Within The Last Two Weeks?

☐ Yes  ☐ No

2. If Yes Specify (Age in Yrs/Mths) ________________________________

3. Has Anyone In Your Family Had Diarrhoea Within The Last Two Weeks?

☐ Yes  ☐ No

Section 2: Water Collection and Storage

I would now like to ask you about how you collect and store your water

1. Which People Collect Water In Your Family?
   (a) Sex
       ☐ Male  ☐ Female
   (b) Persons
       ☐ Children 5-10  ☐ Children 11-17
       ☐ Adults  ☐ Purchase from Vendors

2. Where Do You Keep Or Store Your Water?

312
3. Do You Store Water For Drinking and For Washing/Cleaning Separately?
   □ Yes  □ No

4. Do You Do Anything To Your Water Before You Drink It?
   □ Yes  □ No

If yes what do you do to it?

If No, Please Explain
Why ____________________________

Section 3: Socio-demographic Information

Finally I would like to ask you some information about your household

1. How Many People Live In Your Household?
   No. Women □ No. of Men □ No. of Children □

2. How Many Rooms Do You And Your Family Live In? □

3. Approximately How Much Is Your Family Income Per Month?

<table>
<thead>
<tr>
<th>TICK</th>
<th>INCOME RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;Kshs. 5000 or Birr 600</td>
</tr>
<tr>
<td>2</td>
<td>Kshs. 5000-10,000 or Birr 601-1000</td>
</tr>
<tr>
<td>3</td>
<td>10,000 and above or Birr 1001 and above</td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Section 5: Other Observations

Floor Material

□ Earth  □ Cement Screed
□ Wood/Stone  □ Concrete/Brick

Roof Material

□ Tile/Concrete  □ Iron Sheet
□ Asbestos  □ Papyrus/Grass
Wall material Concrete

- Burnt bricks
- Pole and mud
- Stone/Cement/Block/Wood

- Unburnt bricks
B. Participant /water providers information sheet

My name is Mrs. Lorna Grace O. Okotto. I am a student at the Centre for Environmental Strategy, University Of Surrey, UK. I am doing a study on water and am interested in knowing the various sources of water used, what they are used for, the quantity used/sold per day and how much it costs. I am also interested in establishing the quality of the water from the various sources used in order to know if the water is safe for the uses it is put into. If it is not safe we would like together to think of what we can do about making it safe for use.

In order to do this I have come up with some questions which I would like you to answer. Any information that you give to me will be held in anonymity (using only code numbers) and in confidence and will be used only for academic purposes. I also would like you to allow me to take a little water you use/supply to check its quality. If you would like to know the quality of the water taken you are free to ask using the code number which I will give your source.

If for any reason you are unhappy about how you are treated if you participate in this study, the University of Surrey would want to know. Any complaint or concerns about any aspects of the way you have been dealt with during the course of the study will be addressed; please contact Dr. Jonathan Chenoweth, Principal Investigator by email: j.chenoweth@surrey.ac.uk

If you are happy to take part in this study, could you please sign the attached Participant Consent Form.

Thank you,

Lorna G. O Okotto
Participant consent Form

• I the undersigned voluntarily agree to take part in the study on water supply and independent water providers

• I have read and understood the Information Sheet provided. I have been given a full explanation by the investigators of the nature, purpose, location and likely duration of the study, and of what I will be expected to do. I have been given the opportunity to ask questions on all aspects of the study and have understood the advice and information given as a result.

• I understand that all personal data relating to volunteers is held and processed in the strictest confidence, and in accordance with the UK Data Protection Act (1998). I agree that I will not seek to restrict the use of the results of the study on the understanding that my anonymity is preserved.

• I understand that I am free to withdraw from the study at any time without needing to justify my decision and without prejudice.

• I confirm that I have read and understood the above and freely consent to participating in this study. I have been given adequate time to consider my participation and agree to comply with the instructions of the study.

Name of volunteer (BLOCK CAPITALS)

..........................................................

Signed ..................................................

Date..............................................

In the presence of (name of witness in BLOCK CAPITALS)

..........................................................

Signed ..................................................

Date ..............................................

Name of researcher/person taking consent (BLOCK CAPITALS)

..........................................................

Signed..................................................

Date..............................................
C Questionnaires for Independent Water Providers-Sellers

General Information

Town/City

Date

Estate/Kebele

Area/site

Respondent: (a) No. (b) Gender: Male ☐ Female ☐

(c) Highest Educational attainment: ☐ Primary ☐ Secondary

☐ Post secondary ☐ University Degree ☐ None

PART A: Type of Provision and Ownership of Infrastructure

1. Type Of Provision

☐ Hand cart ☐ Tanker truck ☐ Standpipe/Kiosk (Specify if private

or public) ☐ Household resale ☐ Other Specify_________

2. Do You Own the Cart/Truck/Standpipe? (If Yes Go to Q5, No Go to Q3&4)

☐ Yes ☐ No

3. If No, Who Owns It?

☐ Official Water Supplier ☐ Private Individual

☐ Other Specify____________________________________

4. Which Of These Explains Your Relationship With the Owner?

☐ Employee Estimate Average/Range of Payment You Receive (Indicate if daily/weekly/monthly)

☐ I’ve leased/hired/rented For Use How Much Do You Pay For Leasing/Hiring/Renting (Indicate if daily/weekly/monthly)

☐ Contract/lease

☐ Other (Specify)

5. How Many Standpipes/Hand Carts/Trucks/Do You Own? ________________ About How Much Did Each Cost (to put up)? ______________

6. Do You Have Own Means of Delivery e.g. Jerry cans? (If No Go to Part B)

☐ Yes ☐ No

7. If Yes- Specify Type (e.g. Jerry cans/handcarts etc) __________________________

   a) The Size Of Each ____________________________________________

   b) How Many You Own? _________________________________________

   c) How Much Did Each Cost? ____________________________________

PART B: Water Sources, Reliability and Distance
1. Where Do You Get The Water You Sell From? *(If only one is given ask where else do you get water from and TICK)*

<table>
<thead>
<tr>
<th>TICK</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Official piped network</td>
</tr>
<tr>
<td></td>
<td>Well</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
</tr>
<tr>
<td></td>
<td>Borehole</td>
</tr>
<tr>
<td></td>
<td>Other Specify</td>
</tr>
</tbody>
</table>

2. Which Of The Above is Your Main Source? *(Fill/Rank 1, 2, 3 Starting with the Main Source)*

1) ________ 2) _______________ 3) _______________

3. Who Owns/Supplies Your Main Source Of Water?

☐ Official Water Supplier  ☐ A private Individual
☐ Self  ☐ Other Specify _______________

4. Who Owns/Supplies Water Source 2?  _______________ and 3? _______________ *(Can Use Options In Q3 Above To Answer)*

5. Does Your Main Source/Supplier (s) Change According To Seasons?

☐ Yes  ☐ No

6. Are There Times When You Find No Water From The Main Source/Supplier?

☐ Yes  ☐ No

7. How Often Is There No Water From Main Source?

☐ ‘At least every day’  ☐ ‘At least once a week’
☐ ‘At least once a month’  ☐ ‘In the dry season’
☐ ‘Only occasionally’  ☐ ‘Other specify’

8. How Often Is There No Water At Source 2 _______________ And 3? _______________ *(Use Options Given In Q7 To Answer)*

9. Are There Times When You Are Not Able To Provide Your Customers With Water

☐ Yes  ☐ No

10. How Far (Distance) Is Your Water Source From Your Customers? Source 1 _______________ And Source 2? _______________

11. How Long (Time) Does It Take You To: a) Collect Water And Deliver To Your Customers ____________________________

PART C: Water Quantity and Costs
1. What Is The Type And Size Of Container You Use To Deliver/Supply Water? [Ask person to show you if not clear to confirm]

Type of container ___________________ Approximate Litres ____________

2. How Much Do You Pay For (buy) A Container Of Water At The Source? Kshs./Birr

3. How Much Do You Sell A Container Of Water? Kshs./Birr:

4. Does The Price At Which You Buy and Sell Water Change?
   □ Yes □ No

5. Which Of The Following Make You Change The Price Of Your Water?

<table>
<thead>
<tr>
<th>TICK</th>
<th>REASON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type of source</td>
</tr>
<tr>
<td></td>
<td>Quality/Safety</td>
</tr>
<tr>
<td></td>
<td>Distance from customer</td>
</tr>
<tr>
<td></td>
<td>Change of price at source</td>
</tr>
<tr>
<td></td>
<td>Seasons (dry/wet)</td>
</tr>
<tr>
<td></td>
<td>Other Specify</td>
</tr>
<tr>
<td></td>
<td>Shortage at the source</td>
</tr>
</tbody>
</table>

6. Please Indicate How Water Costs Vary At Different Times

<table>
<thead>
<tr>
<th>Source No.1 (main)</th>
<th>Wet Season</th>
<th>Dry Season</th>
<th>Shortage Time</th>
<th>No Shortage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs Buy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sell</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source No. 2 Costs Buy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sell</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source No. 3 Costs Buy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sell</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. How Long (Time) Does It Take You To Collect Water And Deliver To Your Customers: a) At Normal times ____________________________ b) During Dry Season/Shortage ____________________________

PART D: Customers

1. Do You Have Regular Customers?
   □ Yes □ No

2. Approximately How Many Households Do You Serve As Your Regular Customers?

3. How Many Of These Households Do You Currently Serve Daily?

4. Are You Able To Supply All Your Customers With All Their Daily Water Requirements?
   □ Yes □ No
5. What Reasons Prevent You From Supplying Water Daily To All Your Customers?

- Does not get enough water for all
- Not able to supply all (many)
- Other specify
- Customers do not order daily

6. Do Your Customers Get All The Water They Need From You?

- Yes
- No

7. If No, What Reasons Prevent Your Customers From Getting All The Water They Need From You?

- Have other sources
- Complain water is expensive
- Get Water is for specific uses only
- Water is not safe/poor quality

8. How Can You Describe The Economic Status Of Your Customers?

- 'Very Rich'
- 'Rich'
- 'Moderate Income'
- 'Poor'
- 'Very Poor'
- 'Both'

9. Which Of These Best Explain Why Your Customers Buy Water From You? (Please Rank in Order of Importance Using 1- for Most Important, 2 -for Important 3 Not Sure, 4 Less Important, 5 Not Important etc)

- Convenience of Delivery
- I supply regularly (Reliability)
- The Other sources are far
- Only tap
- Good quality/safe
- Personal/family reasons
- Not expensive
- Other specify
- Only Source available to them
- ........................................

PART E: Water Use, Perception/Awareness of Quality and Responsibility for Quality

1. Do You Think Your Customers Use Different Sources For Different Uses?

- Yes
- No
- Don't Know

2. If The Above Is Yes, In Your Opinion Which Of These Reasons Best Explain Why Your Customers Use Different Sources For Different Uses (TICK)

- Distance
- Only source
- Some sources are expensive/ Cost
- Only tap
3. Which Source Of Water Do You Suppose Your Customers Use For Purposes Shown? [TICK and Indicate which source e.g. Tap Well etc for what use]

<table>
<thead>
<tr>
<th>TICK</th>
<th>USE</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Personal hygiene e.g. Bathing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cooking &amp; food preparation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drinking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General hygiene e.g. Cleaning house, washing clothes</td>
</tr>
</tbody>
</table>

4. Is The Quality Of Water You Sell Is Safe For All The Uses Above?

- [ ] Yes
- [ ] No
- [ ] Don’t Know

5. Do You Do Anything To (Treat) The Water You Supply To Your Customers?

- [x] Yes
- [ ] No

6. If Yes What Do You Do?

- [ ] Chlorinate
- [ ] Other Specify: __________

7. If You Don’t Do Anything To The Water What Is The Reason?

- [ ] Treating is expensive
- [ ] No need
- [ ] Water is safe
- [ ] Other specify: __________

8. What Action Would You Take If You Found Out That The Water You Supply/Sell To Your Customers Is Not Safe?

- [ ] Stop supplying
- [ ] Keep quite continue supplying
- [ ] Supply treatment options
- [ ] Let them know and decide
- [ ] Advice them to treat
- [ ] Other Specify: __________

9. How Would You Rate Your Concern That The Water Your Customers Get From Your Water Source May Not Be Safe/Of Poor Quality?

- [ ] Very Concern
- [ ] Concern
- [ ] Slightly Concern
- [ ] Not Concern
10. Have You Participated In Any Of The Following In Relation To Handling Of Water?

- Training
- Seminar/Workshop
- None
- Other Specify ________________

11. In Your Opinion Who Should Be Responsible For The Safety/Quality Of Water You Sell/Supply To Your Customers?

<table>
<thead>
<tr>
<th>RESPONSIBILITY FOR WATER QUALITY</th>
<th>TICK</th>
</tr>
</thead>
<tbody>
<tr>
<td>The well/borehole owner</td>
<td></td>
</tr>
<tr>
<td>The users/customers</td>
<td></td>
</tr>
<tr>
<td>The water seller e.g. vendor</td>
<td></td>
</tr>
<tr>
<td>The official water company (AAWSA/KIWASCO)</td>
<td></td>
</tr>
<tr>
<td>The public health department/bureau</td>
<td></td>
</tr>
<tr>
<td>The regulator (those in charge of water safety for water company)</td>
<td></td>
</tr>
</tbody>
</table>

PART F: Benefits and Income from Water Selling Business

1. Which Of The Following In Your Opinion Best Explain Why You Are In Water Selling Business (Please rank Using 1- Most Important, 2-Important, 3- Less Important, 4 Not Important etc)

- Source of Income/financial reward
- To Occupy My Time As I Wait To Get Employment
- Provide Water For Those Without Water
- It Is The Only Work I Could Find To Do
- Other Reason (Specify)

2. Are You In Any Other Employment (Have Another Source Of Income)?

Yes   No

3. If Yes, Please Indicate Which One? _____________________________

If No, Explain Why? ____________________________________________

4. Do You Consider Water Selling Business A Major Source Of Income For Your Family?

- Yes
- No

5. Some Ways In Which You Use Benefit From Selling Water Are Stated Below (Please Rank In Order Of Importance Using. 1 for Most Important, 2 for Important 3 Not Sure, 4 less Important, 5 Not Important, Strongly Agree, Agree, Slightly Agree, Not Sure Disagree, Strongly Disagree)
Only Source of Income/Livelihood
Supplement Household Income
Pay Salary for water sales attendants
Pay for Operation and Maintenance
Pay for Money Borrowed
Upgrade Water System
Replication or Upgrading to Better technologies

PART G: Relationship with Other Water Suppliers, Official Water Utility and Other Institutions

1. In Which Ways Do You Relate/Work With Other Suppliers/Sellers like You?
   - Setting Price Of Water
   - None
   - Formation of an Association
   - Other specify

2. In Which Ways Have You Worked/Related With The Official Water Supplier?
   - Check the quality of water
   - I supply them/their water tankers
   - I Buy their Water
   - Other specify

3. In Which Ways Have You Worked/Related With The Official Water Supplier?

4. As A Water Supplier/Seller Which Other Bodies/Organizations/Government Departments Have Worked With?

5. Explain The Nature Of Work Done With Those Stated In No. 3 and 4 Above

6. Do You Face Any Difficulties/Problems In Selling Water?

7. If Yes Please, Explain
D. Questionnaires for Independent Water Providers - Producers

General Information

Town/City __________________________  Date ______________________

Estate/Kebele __________________________  Area/Site __________________________

Respondent: (a) No. __________________________  Gender: Male ☐  Female ☐

(c) Highest Educational attainment:
☐ Primary  ☐ Secondary  ☐ Post secondary  ☐ University Degree  ☐ None

PART A: Water Sources, Ownership And Cost Of Infrastructure

1. Type Of Provision (TICK)
☐ Well  ☐ Borehole  ☐ Other specify __________________________
☐ Stream abstraction/dam  ☐ Other specify __________________________

2. Do You Own The Water Source? (If Yes, go to Q3, No go to Q4)
☐ Yes  ☐ No

3. If Two Above Is Yes, How Many Employees Do You Have? __________

<table>
<thead>
<tr>
<th>TICK</th>
<th>4. If No, Which Of These Explains Your Relationship With The Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>I'm an Employee Estimate Average/Range of Payment You Receive</td>
</tr>
<tr>
<td></td>
<td>(Indicate if daily/weekly/monthly)</td>
</tr>
<tr>
<td>☐</td>
<td>I've leased/hired/rented For Use How Much Do You Pay For leasing/Hiring/renting</td>
</tr>
<tr>
<td></td>
<td>(Daily/Weekly/Monthly)</td>
</tr>
<tr>
<td>☐</td>
<td>Other (Specify)</td>
</tr>
</tbody>
</table>

5. Which Of The following Best Explain Why The Water Source Was Put Up?
☐ To provide water for family  ☐ To sell/ source of income
☐ Other reason (Please Specify) __________________________

6. Approximately How Much Did It Cost To Put Up? __________________________

7. Where Did You Get Money For This Investment?
☐ Personal/retirement savings  ☐ Loan from a bank
☐ Family member specify ______  ☐ Other specify __________
8. Technology For Lifting/Distributing Water (TICK)
   a) Well/borehole-
      □ Hand pump/windlass □ Foot pump
      □ Bucket with ropes □ Other Specify
   b) If Using Motor/ Electric Pump- Source And Cost Of Power For Pumping Of Water
      □ Electricity, average monthly bills
      □ Own Generator, average monthly bills
      □ Other (Specify type) Bills
   c) Distribution:
      □ Piped network, length in Km Estimated Cost per Km
      □ Tanker trucks, How many? Estimated Cost of Each
      □ Handcarts, How many? Estimated Cost of Each
      □ Jerry cans, How many? Estimated Cost of Each

9. Do You Have Any Ownership Problem Concerning The Infrastructures (Well/standpipe/Pipes) You Have Laid Down?
   □ Yes □ No
   If Yes Explain The Nature Of The Problem

PART B: Water Quantity, Reliability and Sales

1. What Is The Approximate Production/Yield Of Your Water Source Per Day?
   In Litres/__________________
   Test Pump Quantity in litres
   Jerrycans
   M³

2. Does The Amount Of Water You Produce/Supply Change In Different Seasons?
   □ Yes □ No

<table>
<thead>
<tr>
<th>3. Approximately How Much Water Do You Sell Per Day?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Season</td>
</tr>
<tr>
<td>Dry Season</td>
</tr>
</tbody>
</table>

4. Do You Have A Storage Tank? Yes □ No □
   If Yes What Is (a) The Capacity (b) Purchase Price?

5. Is There Any Time Of The Year When You Are Not Able To Meet The Water Supply Demand/Needs Of Your Customers?
6. Where Does Your Customers Get Water When You Are Not Able To Supply Them?

7. Approximately How Many Households/Customers Are Served By This Water Source?
How Many Additional Households Can Be Served?

8. Which Of The Following Best Explains Why Households Get Water From This Source?
(TICK)
- Only source available
- Available when others run out
- It is of good quality/safe
- It is the nearest source
- Cheap/not expensive

PART C: Water Usage and Quality

1. Do People Use Water From This Source For Any Of The Following Uses? (TICK)
(For explanations to why, use 1-Quality, 2-only Source, 3-Cost, 4-Distance, 5-Not reliable)

<table>
<thead>
<tr>
<th>USE</th>
<th>YES</th>
<th>NO</th>
<th>WHY?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food preparation and cooking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal hygiene e.g. bathing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General uses like washing clothes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All of the above</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don’t Know</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Have You Established If Water From This Source Is Suitable (Safe) For All The Uses?

- Yes
- No

3. If Yes, How Did You Establish That The Water Is Suitable For Use? (TICK)
- I took samples for analysis (State, where it was done)
- The public and/or health department monitors its quality
- The water company (KIWASCO/AAWSA) checks if it is safe.
- I judge by the (a) colour (b) taste (c) smell
- I have not established/don’t know

4. If The Suitability (Quality) Of Water At The Source Has Been Determined Before, Who did it? Why was it done?

5. Do You Do Anything To (Treat) The Water You Supply?

- Yes
- No

6. If Yes, What Do You Do?
7. If You Don’t Treat The Water, What Is The Reason?
- Treating is expensive
- Not sure if I need to treat

8. Does It Concern You That The Water You Provide Could Be Unsuitable (Not safe) To The Users?
- Yes
- No

9. How Would You Rate Your Concern That The Water You Provide May Not Be Suitable (Safe) For The Specific Uses?
- ‘Very Concerned’
- ‘Concerned’
- ‘Slightly concerned’
- ‘Not concerned’

10. Who Should Ensure That Water Users Are Aware Of The Safety Of The Water You Provide?
- The owner of the well/borehole/dam/standpipe manager
- The people in charge of water provision (Water Company)
- The public health authority/department/bureau
- Water seller e.g. carter/tankers
- Water users (consumers)
- Other (Specify) _________________________________________________

11. What Can You Do To Improve The Quality Of Service You Provide Including Safety And Cost Of Water For Your Customers

12. What Can Other People Do To Improve The Quality Of Service You Provide Including The Safety Of The Water?

PART F: Income from Water Selling/Business (Livelihood)

1. Which Of The following In Your Opinion Are The Most Important Reason Why You Are In Water Selling Business (Please indicate Using True or False)
- Source of income/financial reward
- To Occupy My Time As I Wait To Get Employment
- Provide Water For Those Without Water
- It Is The Only Work I Could Find To Do
- Other Specify

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2. Are You In Any Other Employment (Have Another Source Of Income)?

☐ Yes ☐ No

3. If Yes, Please Indicate Which One? ___________________________________

4. Do You Consider Water Selling Business A Major Source Of Income For Your Family?

☐ Yes ☐ No

5. Some Ways In Which You Use The Income You Get From Water You Produce Are Stated Below (Please Rank Using 1, 2, 3 etc In Order Of Importance e.g. 1 for Most Important, 2 for Important 3 Not Sure, 4 less Important, 5 Not Important, Strongly Agree, Agree, Slightly Agree, Not Sure Disagree, Strongly Disagree)

Only Source of Income
Supplement Household Income
Pay Salary for water sales attendants
Pay for Operation and Maintenance
Pay for Money Borrowed
Upgrade Water System
Replication or Upgrading to Better technologies

PART G: Relationship With Other Water Suppliers, Official Water Utility and Other Institutions

1. In Which Ways Have You Related/Worked With Other Suppliers/Producer Sellers like You?

☐ Setting Price Of Selling Water ☐ Formation of an Association

☐ None ☐ Other specify__________________________

2. In Which Ways Have You Worked/Related With The Official Water Supplier?

☐ Check the quality of water ☐ I supply them/their water tankers

☐ None ☐ Other specify__________________________

3. As A Water Supplier/Seller Which Other Bodies (e.g. Government Departments And Other Organizations) Have Worked With?

4. Explain The Nature Of Work Done With Those Stated In 3 Above

5. In Which Other Ways Do You Think You Can Work With Those Mentioned Above To Improve Water Supply/Provision

6. What Are The difficulties/Challenges You Currently Face In Providing Water?

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Other Questions For Further Probing/In-depth Interviews

1. As A Water Provider What Do You Consider As Your Main Strengths?

2. What Do You See As Your Main Weaknesses?

4. How Would You Describe Your Relationship With?
   (a) The Official Water Provider?
   (b) Other Providers Like You?
   (c) Other organizations/government departments working in water supply provision?

The previous chapters have shown that a large number of the population living in urban centres of developing countries lack access to safe drinking water provided through official water utilities. It has further been shown that in some cases even where water is available through the official water utilities: the supply is not only inadequate but is also bedevilled by many other challenges. It was further argued that the other providers have emerged to fill the gap in water supply provision.
E Example of a check list of questions for interview schedules for other stakeholders

Role
What is the role of your agency/department as far as water supply services (In Kisumu/Addis Ababa) are concerned?
How do you work with others (including government organs) concern with water supply?
How do you work with the water service regulator (If not water service regulator)?

Current State of water Supply
How can you describe the current state of water supply in Kisumu/Addis Ababa in terms of:

- Proportion of the population currently served by the official water supply
- Water provision service level, including coverage/access, quantity available, reliability of the water supply, and quality and costs of the water supply

Kindly describe the main group of people supplied and those not supplied with official water provider?
Where do people not supplied get their water from?
Apart from the official water provider which other water providers exists?

Unofficial (independent) water providers
Have you heard about independent (unofficial) water providers? What does unofficial water providers mean to you
Which types of unofficial providers are found in this city?
Which areas do they cover?
Where do they get the water from?
How do they provide water service?

How do they finance (source of funds) their investments in the water supply services?
How important in your view is the role of such providers/What is the role played by such providers in terms of:

- Population covered/how many households do they serve?
- Approximate number/proportion of people they employ, and
- What is the volume of their business/investment in water sector/infrastructure?
- Are there any other importance?
Do you think such investments are important for the water supply? (How?)
What do you see as their main advantages/strengths?
What are their disadvantages/weaknesses?
What obstacles do they face in water supply provision?
How can these obstacles be removed and their services improved (i.e. what would be done to improve their services) to benefit the urban consumers they serve?
What kinds of relationships do they have with your organisation/department/local authorities and official water providers/how are independent providers treated?
Have you done any work on or with independent water providers? (Explain more)
What in your opinion is the position of independent water providers in water supply, are they/should they be allowed to supply water? (Explain why/why not?)
Is there any room for working together/in cooperation with independent water providers to improve water supply? Explain further
How can their services be incorporated in the formal water supply system to improve water supply?
What should be done to improve their services as well as incorporate them in regular water supply system?
How would their services be regulated in order to improve their services including costs and quality for both their benefits and of those whom they currently serve?
What problems have you/would be encountered in working with independent water providers including regulating their services?
What initiatives/potentials for improvements are there for independent water providers?
What threats are there for water provision by independent water?

Specifically For official water suppliers

Water supply

Current Situation regarding water supply
How is the water currently being supplied?
Which are the main sources of water supply for the city?
What is the actual present production? Does it differ from the absolute potential?
What is the current demand? What proportion of this demand is currently being met?
What proportion of the population is covered by piped water network?
What is the average connection rate?
What proportions of households get water through individual household connections?
How do household living in areas covered by the official water provider but without household connections obtain their water?
What hinders such households from getting connected to the piped water network?
Which other forms of connections are there and what proportion of the population are covered e.g.
   By connections in the yards
   Public taps in open places (are there private standpipes?)
   Household resale (licensed or unlicensed?)
How significant (in number) are such households (those who are not connected to the official water supply system)?
Which areas of the city are connected to piped water network/characteristics?
What proportion of the city is not covered by piped network and why?
Which areas are not / characteristics of areas are not covered by the official water provider and why?
Where (sources) and how do people living in the areas not covered by the official water provider obtain their water?
Which options do they have apart from the official water supply?
Do they use multiple sources/more than one source?
What are the measures taken to ensure that the poor are able to access water?

Water Service level & quality
How does the water supplier maintain the quality of water from the piped water supply? (Treatment methods etc)
Is there any minimum quality standard applicable to the official and other water providers?
Is there a controlling system for service quality/what water quality standards are used?
Who is responsible for quality regulation for water supplied by the official water supplier?
Who is empowered to control?
How frequently is the water quality monitoring done, at what points and by whom?
What are the measures taken to ensure that residents are provided with safe and adequate water?
Does the official water supply experience any problems/challenges/difficulties in supplying water?
Technical problems
Social problems?
Economic problems?
Are there any administrative or political problems?
Are there any other problems?

What initiatives are being taken to improve water coverage for those not supplied? What are the potentials for improvements?

Water costs
What type of tariff is used by the official water supplier? (For Households/commercial premises/public taps)
What is the connection cost including joining fee, materials and labour costs for (households/business/public taps/standpipes)?
What are the measures taken to ensure that water is affordable to the poor?

Other water providers
Apart from the official water provider which other providers are found in Kisumu/Addis Ababa?
Which areas do they cover?
Where do they get the water from?
How do they provide water service?
How important in your view is the role of such providers/What is the role played by such providers in terms of:
  Population covered/how many households do they serve?
  Approximate number/proportion of people they employ, and
  The volume of their business/investment in water sector/infrastructure?
  Are there any other importance?

How do they finance (source of funds) their investments in the water supply services? Do you think such investments are important for water supply? (Explain)
What do you see as their main advantages/strengths?
What are their disadvantages/weaknesses?
What obstacles do they face in seeking to expand their activities or improve the quality of service?
How can these obstacles be removed and their services be improved (what policies would improve their services and benefit the urban consumers they serve)?

What is the legal status in water supply legislation?

What is the cost of water from these providers in comparison to the water you provide?

How would you describe the cost and quality of water from independent providers?

What kinds of relationships do they have with local authorities and official water providers/how are independent providers treated?

How does the quality controlling system affect the independent water providers?

Is there any room for working in cooperation with independent water providers?

Specifically for water regulator in Kisumu/ Addis Ababa Bureau of Water Resources

What is your role in water service provision?

Which aspects of water service provision do you deal with?

Do you control price/ quality of water provided to ensure that it is meets the required standards? How is this done?

Who else is empowered to control and what aspect of water provision?

What are the measures that are taken to ensure that the water provided is of the right quality?

Have you had any complaints about official and independent (unofficial water providers) water from the consumers, regarding quality and price, for example?

What problems do you encounter in enforcing quality for water provided?

How do the price and water quality controlling system/standards affect the independent water providers?

What are the measures taken to ensure that water is affordable to the poor?

Has there been any previous attempt to work together with the independent water providers?

Have you done any work on or with independent water providers?

How are independent providers treated?

Is there any room for working in cooperation with independent water providers? (Probe further for reasons for or against)

How can their services be incorporated in the formal water supply system to improve water supply?

What should be done to improve the services as well as incorporate the unofficial water supplies into the regular water supply system?
How would their services be regulated in order to improve their services including costs and 
quality for their benefit and those whom they currently serve?
What problems/ constraints have you/would be encountered in working with independent 
water providers including regulating their services?
What initiatives/ potentials for improvements are there for independent water providers?
What threats are there for water provision by independent water?
F. Sanitary Inspection/Survey Forms

1. Sanitary Form for Boreholes

I General Information
1. City/Town: ___________________ Kebelle/Estate: ___________________

2. Code Number: _______________ Borehole depth: ____________________

3. Date of visit: ___________ Time: ___________ Grid reference ___________

4. Is water sample taken? ___________ Sample No ___________ FC/100ml ___________

II Specific Diagnostic Information for Assessment

<table>
<thead>
<tr>
<th></th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are there any open water sources within 20m of the borehole?</td>
<td>Y/N</td>
</tr>
<tr>
<td>2. Are there any uncapped wells within 30m of the borehole?</td>
<td>Y/N</td>
</tr>
<tr>
<td>3. Is the drainage faulty allowing ponding within 2m of the borehole?</td>
<td>Y/N</td>
</tr>
<tr>
<td>4. Is the drainage channel cracked, broken or need cleaning?</td>
<td>Y/N</td>
</tr>
<tr>
<td>5. Is the fence missing or faulty?</td>
<td>Y/N</td>
</tr>
<tr>
<td>6. Is the apron less than 1m in radius around the borehole?</td>
<td>Y/N</td>
</tr>
<tr>
<td>7. Is there spilt water collecting in the apron/concrete floor area?</td>
<td>Y/N</td>
</tr>
<tr>
<td>8. Is the apron/concrete floor cracked or damaged?</td>
<td>Y/N</td>
</tr>
<tr>
<td>9. Is the handpump loose at the attachment to the base?</td>
<td>Y/N</td>
</tr>
<tr>
<td>10. Are there any latrines/manholes within 10m?</td>
<td>Y/N</td>
</tr>
<tr>
<td>11. Are there any other scattered waste, waste dumps, additional latrines, septic tanks within 30m of the well</td>
<td>Y/N</td>
</tr>
<tr>
<td>12. Are there any other additional latrines, septic tanks within 30m of the well?</td>
<td>Y/N</td>
</tr>
</tbody>
</table>

Total Score of Risks ....../10

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

III Results and Recommendations:
The following important points of risk were noted: (list nos. 1-10)
(Indicate at which sample sites the risk was identified)

Surveyor: Additional Comments:
2. Sanitary Form for Covered Dug well

I General information

1. City/Town: ______________________  Kebelle/Estate name: ______________________

2. Code Number: ______________________  Date of visit: ______________________

3. Grid Ref ______________________  Depth of well: ______________________

4. Is water sample taken? Sample No: _______ FC/100ml

II Specific Diagnostic Information for Assessment

<table>
<thead>
<tr>
<th>Risk</th>
<th>Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is the drainage channel cracked, broken or need cleaning</td>
<td>Y/N</td>
</tr>
<tr>
<td>2. Is the drainage faulty allowing ponding within 2m of the borehole?</td>
<td>Y/N</td>
</tr>
<tr>
<td>3. Is the fence missing or faulty?</td>
<td>Y/N</td>
</tr>
<tr>
<td>4. Is the cement floor less than 1m radius all around the handpump?</td>
<td>Y/N</td>
</tr>
<tr>
<td>5. Is there any ponding on the cement floor around the handpump?</td>
<td>Y/N</td>
</tr>
<tr>
<td>6. Are there any cracks on the cement floor around the handpump?</td>
<td>Y/N</td>
</tr>
<tr>
<td>7. Is the handpump loose at the point of attachment to the base?</td>
<td>Y/N</td>
</tr>
<tr>
<td>8. Is the cover of the well unsanitary?</td>
<td>Y/N</td>
</tr>
<tr>
<td>9. Are there any latrines within 10m of the well? How many? ..........</td>
<td>Y/N</td>
</tr>
<tr>
<td>10. Are there septic tanks, additional latrines, sewers, cess pool within 30m of the well?</td>
<td>Y/N</td>
</tr>
<tr>
<td>11. Are there any open water sources, uncapped wells within 20m of the well?</td>
<td>Y/N</td>
</tr>
<tr>
<td>12. Are there any scattered waste or waste dumps within 30m of the well?</td>
<td>Y/N</td>
</tr>
</tbody>
</table>

Total Score of Risks /10
Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

III Results and Recommendations:

The following important points of risk were noted: (list nos.1-10)
(Indicate at which sample sites the risk was identified)

Surveyor:  Comments:
3. Sanitary Form for Piped Water

I. General Information
1. Town/City: ___________________ Estate/ Kebelle: ___________________
2. Code No. ___________________ Grid reference: ___________________
3. Date of Visit _______________ Time ____________________________
4. Water samples taken? ________ Sample No. __________ FC/100ml____

II Specific Diagnostic Information for Assessment
1. Does any tap/standpipe leak? Y/N ........
2. Does surface water collect around any tap/standpipe? Y/N ........
3. Is the area uphill of any tap/standpipe eroded? Y/N ........
4. Are pipes exposed close to any tap/standpipe? Y/N ........
5. Is human excreta on the ground within 10m of any tap/standpipe? Y/N ....
6. Is there a sewer within 30m of any tap/standpipe? Y/N ....
7. Has there been discontinuity in the last 10 days at any tap/standpipe? Y/N ....
8. Are there signs of leaks in the mains pipes in the Kebelle/Estate Y/N ....
9. Do the community report any pipe breaks in the last week? Y/N ....
10. Is the main pipe exposed anywhere in the Estate/Kebelle? Y/N ....

Total Score of Risks ... /10

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

III Results and Recommendations:
The following important points of risk were noted: (list nos. 1-10)
(Indicate at which sample sites the risk was identified)
Surveyor: Additional Comments:
4. Sanitary Form for Handcarts

I General information
City/town.......................................................... Estate/Kebele .............................................
Date................................................................. Grid reference.....................................................
Carter No.......................................................... No. of persons served by the carter.....................
Code of Well & Tap used..................................... Depth of well water level............................
Water samples taken?.......................................... Sample No.....................................................
Conditions of the containers............................... FC/100ml...................................................

II Specific Diagnostic Information for Assessment

1. Does the vendor get water from more than one source with any unprotected? Y/N
2. Is the filling point insanitary? Y/N
3. Is the pipe/hose from source used to fill the container (discharge hose) unclean or kept in a dirty place while not in use? Y/N
4. Can the discharge hose/pipe touch the ground? Y/N
5. Is the inside of the container dirty/Does the vendor report no frequent disinfection washing of the containers/tanker? Y/N
6. Is the water transported in some containers without proper lids/caps? Y/N
7. Does any of the containers leak or have cracks? Y/N
8. Does leaking water collect in the cart as water is transported? Y/N
9. Does the vendor report not cleaning the container when changing from one source to another or storing water in own container before delivering? Y/N
10. Does the vendor show insensitivity to general hygiene practices or report not having attended any training/workshop/seminar on general water handling and hygiene practices? Y/N

Total Score of Risks ........................................../10

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

III Results and Recommendations:
The following important points of risk were noted: (list nos. 1-10)
(Indicate at which sample sites the risk was identified)

Surveyor:
Additional Comments: