PRODUCTIVE USE OF DOMESTIC PIPED WATER FOR SUSTAINING LIVELIHOODS IN POOR HOUSEHOLDS

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EXECUTIVE SUMMARY

Poverty can be defined as "the inability to attain a minimal standard of living, measured in terms of basic consumption needs or the income required to satisfy them" (Republic of South Africa, 1998). This definition includes aspects such as the poor being alienated from the community, experiencing food insecurity, with crowded homes, the usage of unsafe and inefficient forms of energy, the lack of adequately paid, secure jobs, and fragmentation of the family. Is was noted by May (1998) that poverty was not a static condition; individuals, households or communities are vulnerable to falling into poverty as a result of external and internal shocks, crises and long-term trends.

The Integrated Sustainable Rural Development Strategy (ISRDS) (Republic of South Africa, 2000) notes that 85% of the rural population live in the former homelands, with the rest living on commercial farms and small towns. There is a gender bias in poverty levels, with female-headed households being more likely to experience poverty than male-headed households (Republic of South Africa, 1998). Poor households tend have a larger number of income sources that non-poor households, this spreads risk, and improves, to some degree, security of income.

Water has been called the dividing line between poverty and prosperity, and is a cross-cutting tool for the achievement of the Millennium Development Goals (MDG). The primary target group of the MDG is the rural and peri-urban poor in developing countries, whose diversified livelihoods depend strongly on water. Water use at the household level is typically for meeting basic needs (e.g. bathing, drinking and sanitation). However, a vital and growing use of water that is not usually planned for is made up of those activities at the household level that promote economic growth and advance sustainable livelihoods. This is known as the 'productive use of water'.

Since 1994, considerable improvements have been made in water service delivery. Just over 37 million (84.5 %) of South Africans now have access to piped water in their dwellings, on site, or from communal taps (Statistics SA, 2001). However, rural water service delivery is still a major challenge. Rural areas also tend to be more susceptible to drought, making access to natural water supplies even more vulnerable.

The development focus of the South African state demands that efforts be made to improve the condition of the urban and the rural poor. Can water be used at household level to contribute to a solution and encourage the development of sustainable livelihoods within poverty stricken households?

Productive water is defined as the quantity of domestic water at household level, over and above the 'basic needs' quantity, used by small-scale users to generate an income and improve the

quality of their livelihoods. Productive use of water is generally discussed at household level to indicate both the relatively small-scale nature of the activities involved and the primary social unit at which this type of domestic water use takes place.

The potential benefits of productive water use include income generation, enhanced food security, improved health, saved time (reduced amount of time spent collecting water), saved expenditure (reduced expenditure on expensive water supplied by water vendors), and improved education (with more time and improved health, children are able to attend and perform better at school). The majority of rural South Africans depend upon multiple strategies for their livelihoods, with a number of their activities being water dependant.

South Africa is a water scarce country with a large percentage of the population falling below the poverty line. In the past, the aim of South Africa's water sector has been to supply people with a clean, reliable and safe supply of water, with the primary goal of improving their health More recently, however, the potential for water to be managed better to contribute to people's wider well-being and livelihoods has been recognised. There is a socio-economic imperative to alleviate poverty for all residents of the country and this imperative has been taken up by the political leadership of the country. This study specifically focuses on piped water. Thus, when referring to the water used it is in reference to water sourced from piped water. This qualification is important in order to understand the economics of any decision to extend water supplies to households. The cost of such an extension of supply can then be compared to the gains made by the households in improving their livelihoods.

Given this background, the question arose – how can the water sector contribute to poverty alleviation? One potential method of doing this is to provide additional water to poor households in the hope that it would be used to supplement their incomes – the so-called roductive uses of piped water.

Information regarding productive uses of piped water is limited in South Africa. This study was commissioned to provide additional information on the phenomenon and to provide guidance to existing policy. Given the background above, this study was conceived to address aspects of the provision of productive water to poor households. Specifically, this study aimed at:

- *Determining whether the provision of domestic piped water for productive uses is featured in national policies, legislation and strategies.*

This section was investigated to give insight into whether the concept of productive water use exists and is provided for in the national legislative framework. The outputs are important to inform policy and legislation which may have to be developed, as well as determine the responsibility for this provision of water.

- *Reviewing both local and international literature to determine the trends in the provision and use of domestic piped water for productive uses.*

This section aimed at providing an overview of how productive uses of water manifest in local and international practice. The section provides the policy maker with insight into the uses to which productive water is put so as to frame a possible national implementation framework.

- *Through the selection of case studies determine the following:*
  - *Establish whether domestic piped water is being used for productive uses;*
  - *Identify the types of productive uses; and*
  - *Determine the volume of water used for each productive use.*

Based on the above objectives the following are the outcomes and findings from the study. This is presented on three levels: legislative, international best practices and current productive water usage practices, as follows:

South Africa's legislative and policy framework covering the use of water for productive use

The South African legislative framework is strongly supportive of water provision for basic human use. According to the Water Services Act (Act No 108 of 1997) 6000 litres of free basic potable water must be supplied to households each month to support basic human use. It is the responsibility of local government to provide this water. This conforms to the UNESCO minimum requirement for basic human needs (health and hygiene) **and thus does not address productive water use.** Although recognising the ability of water to support social and economic development, **there is less focus on productive water uses** in South Africa's legislation and policy than on the provision of water of basic human needs. The description or interpretation of basic water needs is narrow and limited to drinking water requirements.

The National Water Act (Act No 36 of 1998), in protecting the resource, allows for reasonable domestic use. This includes garden watering and small-scale agricultural production. The Act recognises the ability of water to support social and economic development. The Act encourages efficient, sustainable and beneficial use in the public interest. **These are tasks to which productive water use is suited, yet this is not made explicit. Beneficial water use is not defined.** The National Government is responsible for water allocation. There is, however, **no guidance to local government on methods to be used for the provision of these potentially productive uses.**

The Strategic Framework for Water Services (2003) holds that water programmes should support economic development and sustainable livelihoods. Again, these are tasks to which productive water use is suited, yet this is not made explicit. **According to this framework, it is the role of local government to make provision for this. However, the Municipal Structures Act (Act No. 118 of 1998) does not make provision for this** – only that at least basic services be provided and not necessarily without a cost.

In terms of policy statements, productive water uses are allowed and encouraged, although there are no measures to subsidise this use. The Free Basic Water policy allows 6000 litres of free potable water to each household per month. Current policy states that additional water use above 6000 litres should be paid for. This position finds support in the Strategic Framework for Water Services, with its concept of households moving up the water ladder where households move progressively up the ladder to higher service levels and more sophisticated uses of water, however this has more to do with drinking water supply.

International best practice with regards to productive water use

It has been estimated that in order to ensure our basic needs, every individual needs 20 to 50 litres of water free from harmful contaminants each and every day (UNESCO). At an international symposium held in Johannesburg in 2003 on "Water, Poverty and Productive Uses of Water at the Household Level", it was acknowledged that ***between 50 and 200 litres per capita per day*** **(lpcd)** is a quantity of water sufficient for both domestic and some small-scale multiple uses. With such a supply, a family of five could comfortably irrigate 100 m^2 of garden or water 5 cattle or a mix of the two.

Differentiation is made between water for productive use and water for beneficial use. Productive use of water is defined as the use of water to promote economic growth and improve livelihoods such as watering foodlots and livestock (Desvouges & Kerry Smith, 1983). Beneficial water use on the other hand does not necessarily result in economic growth, however it does add value to people's standard of living such as the use of water for traditional/cultural and/or ritual functions (Desvouges & Kerry Smith, 1983). Both these uses of water are important.

Internationally, there is a move towards water for multiple uses. This takes into account domestic, productive and beneficial water use. The advantage of this approach is that water intended for a particular use (for example domestic water use) is in urban communities *de facto* used for multiple purposes.

Research exists that demonstrates that water is being put to productive use in poor households in many developing areas of the world. This research consistently shows that this productive use contributes to the improvement in the quality of life enjoyed by households.

The review of the literature on productive water use, both in South Africa and internationally, showed that water is being made use of for economic or social purposes beyond that required for domestic purposes. This use is largely made on the initiative of the household and such use can measurably increase a household's economic circumstances. The types of use are biased towards small-scale agricultural production, but where the market and the opportunities exist, other types of commercial ends are achieved through using water productively. This is the experience both internationally and locally. Rural households are much more likely to use water productively. This experience is replicated in South Africa where agricultural uses predominate.

These varying applications of water make the distinction of quantity versus quality of water supply important. Many productive uses require a greater quantity of water (yet not necessarily potable water). Soussan et al., 2002 found productive water use in villages between 23 to 40 $\ell c^{-1}d^{-1}$. Domestic uses require water of a potable standard 21 to 22 $\ell c^{-1}d^{-1}$ was used in villages according to Soussan et al.

The source of non-potable water for productive use can be from rainwater or groundwater where available, and used domestic or treated water as a supplementary source of water. Van Koppen et al., 2006 found that water-related activities are often more sustainable where water is derived from more than one source.

Other important considerations identified when providing water is that ownership is fostered. That is the community needs to be involved in the planning and management of water supply systems. This decreases mismanagement and as a result reduces leaking and illegal connections which ultimately improve maintenance and repair costs. Lastly, the cost recovery strategies need to be investigated as well as the cost of maintenance to ensure sustainability.

Current productive water use by the poor in South Africa

A detailed survey of 270 poor households across South Africa was undertaken where the measuring water use by means of a five litre bucket and residing with the subject of the study for a period of two days was undertaken. In this way a great deal of data on household water use was generated. The 270 surveyed households were selected from eighteen case study areas. The case study areas were selected with reference to: the six rainfall bands in South Africa; with household incomes less than R800 per month; a spread of rural and urban communities; and with differing levels of piped water service (i.e. communal standpipes, yard and household connections).

The study clearly demonstrates that water is being put to productive uses. Of the households surveyed by the study, half engaged in some form of productive use of water. Productive use appears to be heavily weighted towards agricultural uses and a greater number of rural households engage in productive use than urban households. The average water use is **183 litres per day in rural households compared to 119 litres per day in urban households.** This is a result of rural households been larger than urban households and rural households being more prone to using water productively.

Vegetable production is the highest user of additional household water, followed by the production of fruit and livestock watering. The agricultural uses vastly outnumber other uses such as small-scale commercial uses (car washes, hair salons, and water storage and resale), ice making, brick making and beer brewing.

This breakdown of productive uses shows why the rural poor tend to engage on productive water use more than their urban counterpart. The urban poor dweller has less space and possibly less expertise in agricultural production than the rural dweller, the urban dweller also has a greater variety of economic opportunities than the rural dweller, and many of these opportunities would be more economically rewarding than agricultural production.

The data also established the link between water use and rainfall. There was a clear increase in the use of water for productive purposes as the annual rainfall increased. It is submitted that this is due to the conditions for agriculture being improved via better access to water, better soil conditions and a wider variety of crops being possible. Household responses to the qualitative sections of the questionnaire also indicated that households in the higher rainfall areas stated a greater need for additional water for productive purposes. There was also higher domestic used of pipeline water in higher rainfall regions. It seems as though the general higher availability of water resulted in households using it less sparingly. Also, more water is used during summer.

Just less than one quarter of the households surveyed indicated that they derive some benefit from putting water to productive use. These households either benefitted from the support that the extra production added to their food consumption, or who derived an actual profit from selling the products of the productive water use. The average profits derived by those households that yielded a profit were R307 per month. This is a significant fraction of the average household income reported by all 270 households surveyed; that of R835 per month.

Overall, there is **less focus upon productive water uses in South Africa's legislation and policy** than there is on the provision of water for basic human needs. There is no direct reference to the use of water for productive purposes. It is rather alluded to and encouraged though references to the reasonable, beneficial, sustainable and economic development uses of water. There are no recommended measures for this use or authority held responsible for making provision for this use. Similarly the beneficial use of water, which does not necessarily result in economic growth, but does add value to people lives, is not reflected in policy.

Administratively South African water providers should plan for growth in water demand; this allows increases in water use above and beyond basic human needs and into productive water uses. Definitions need to be clear, the authorities responsible for the provision of the productive water need to be held accountable and the amount of water provided for productive use needs to be made explicit. The international trend towards multiple water use (taking into account domestic, productive and beneficial water use) would be an ideal definition to follow. It makes provision for the way in which water is actually being used in rural settings.

A better water supply (greater volume and reliability) would encourage more households, to undertake more varied productive uses, and possibly to intensify their activities. The data demonstrated a small correlation between volumes of water use and the degree of productive water use.

From the literature, it appears that better water supply would reduce some of the uncertainty around the sustainability of household activities. It would also negate the loss of earnings spent on initiatives that would previously have collapsed because of a lack of water.

Ultimately, the results of the literature and policy reviews, stakeholder engagement, and case study analysis have prompted the reassessment of the volume of free basic water. The current allocation is 6000 litres of water per household. This study has found that the average water use for both domestic and productive uses is 8300 ℓ/month in rural areas and 5200 ℓ/month in urban areas (in poor communities), and the average household size is 5.6 in rural areas and 4.7 in urban areas. The methods of accessing this additional water in rural areas and funding its supply are the next level of consideration in the use of productive water in South Africa.

Based on these findings the following is recommended:

1. It is important that the element of productive water use is clear and used consistently throughout legislation and policy (rather than varying definitions) and specified allocations. There is no clarity on the relationship between the Free Basic water, which has a drinking water bias to that of productive use of water. This needs to be cleared as a matter of urgency before it leads to confusion and conflict.
2. Currently, it is not clear who has the mandate and responsibility for the provision of productive water use. Whether it is a component of water services or not needs to be established, since it has implications for water allocations, support and funding.
3. Assistance with water provision for productive uses in terms of funding and support.
4. Consider raising the level of service to a minimum of a yard connection (especially in rural areas where the predominant service level is water stand pipes more than 200 metres away).

5. Consider increasing the free basic allowance to a minimum of 8300 litres/month/household in rural areas as there is greater productive use of water and larger household size than in urban areas.
6. Consider increasing the FBA to 10 000 litres per month in rural areas during the summer months and to 6500 litres per month in urban areas.
7. Provide water storing facilities in low rainfall regions and water harvesting technologies in high rainfall areas

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The major question raised by the research is whether water for productive use should be subsidised. This report has demonstrated that water is being used for productive use and the various uses to which this water is being put. The report also highlights that poor households using water for productive use 122% more than poor households that do not. The levels of water debts are high and that 40% of the households surveyed indicate that they pay for water, when possible, demonstrates both that water affordability can be low amongst the poor and that the provision of more water to households for beneficial use may experience financial sustainability challenges.

This research indicated that the majority of water users surveyed have stated that they would use water if it were available. It is suggested that wanting to use water in such a manner and actually using the water are not the same thing. This research also indicates that households with higher levels of service use more water for productive use than those with lower service level standards.

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ACRONYMS

DWAF	Department of Water Affairs and Forestry
EC	Eastern Cape Province
FBW	Free Basic Water
FBWIS	Free Basic Water Implementation Strategy
FS	Free State Province
GP	Gauteng Province
IDP	Integrated Development Plan
ISRDS	Integrated Sustainable Rural Development Strategy
KZN	KwaZulu-Natal Province
MDG	Millennium Development Goals
MP	Mpumalanga Province
NC	Northern Cape Province
NWRS	National Water Resource Strategy
SA	The Republic of South Africa
SFWS	Strategic Framework for Water Services
USAID	United States Agency for International Development
WC	Western Cape Province
WSP	Water Services Provider
WSA	Water Services Authority

GLOSSARY OF TERMS

Basic water services	A basic water supply and/or sanitation service.
Basic water supply services	The provision of a basic water supply facility, the sustainable operation of the facility (available for at least 350 days per year and not interrupted for more than 48 consecutive hours per incident) and the communication of good water-use, hygiene and related practices.
Community-based water services provider	A not-for-profit organisation situated within a defined community that is mandated by that community to provide a specific municipal service to that community on behalf of the municipality, provided that (1) all members of the governing body of the organisation are nominated members of the community and are permanently resident within the community, (2) all employees of the organisation are members of the community and are permanently resident within the community, and (3) the area constituting the community is defined by the municipality.
Potable water	Water used for drinking or domestic purposes of a quality consistent with SABS 241 (Specifications for Drinking Water) as may be amended from time to time.
Wastewater	Used water resulting from the use of water for domestic or other purposes which include or exclude human excreta.
Water sector	Includes both water resources and water services.
Water services authority	A municipality responsible for ensuring access to water services
Water services provider	An organisation that provides water services to consumers or to another water services institution

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1. INTRODUCTION

South Africa is a water scarce country with a large percentage of the population falling below the poverty line. There is a socio-economic imperative to alleviate poverty for all residents of the country and this imperative has been taken up by the political leadership of the country.

Given this background, the question arose – how can the water sector contribute to poverty alleviation. One potential method of doing this is to provide additional water to poor households, in the hope that it would be used to supplement their incomes – the so called productive uses of piped water.

Information regarding productive uses of piped water is limited in South Africa. This study was commissioned to provide additional information on the phenomenon and to provide guidance on future policy direction.

1.1 Characterisation of Poverty

In income per capita terms, South Africa is categorised as a middle-income country. This categorisation however masks underlying poverty and unequal distributions of wealth in the country. The richest 10% of the economy receive approximately 40% of the total income, whilst the poorest 40% receive approximately 11% of the total income (Republic of South Africa, 1998). This extreme inequality is felt in both urban and rural areas. The poverty burden falls most heavily on rural areas, where it is estimated that 45% of the population live outside a major urban node. This population group contains 72% of the poor (Republic of South Africa, 2000). Thus the phenomenon of the 'rural poor' is one that presents considerable development challenges. Rural poor in this context means those who live outside a major urban node.

Poverty can be defined as "the inability to attain a minimal standard of living, measured in terms of basic consumption needs or the income required to satisfy them" (Republic of South Africa, 1998). This definition includes aspects such as the poor being alienated from the community, experiencing food insecurity, with crowded homes, the usage of unsafe and inefficient forms of energy, the lack of adequately paid, secure jobs, and fragmentation of the family. Is was noted in by May (1998) that poverty was not a static condition; individuals, households or communities are vulnerable to falling into poverty as a result of external and internal shocks, crises and long-term trends.

The Integrated Sustainable Rural Development Strategy (ISRDS) (Republic of South Africa, 2000) notes that 85% of the rural population live in the former homelands, with the remaining living on commercial farms and small towns. There is a gender bias in poverty levels, with female-headed households being more likely to experience poverty than male-headed households (Republic of South Africa, 1998). Poor households tend have a larger number of income sources that non-poor households, this spreads risk, and improves, to some degree, security of income.

Water has been called the dividing line between poverty and prosperity, and is a cross-cutting tool for the achievement of the Millennium Development Goals (MDG) (Wenhold et al., 2007). The primary target group of the MDG is the rural and peri-urban poor in developing countries, whose diversified livelihoods depend strongly on water (Van Koppen et al., 2006). Water use, at the household level, is typically for meeting basic needs (e.g. bathing, drinking and sanitation). However, a vital and growing use of water that is not usually planned for is made up of those activities at the household level that promote economic growth and advance sustainable livelihoods. This is known as the 'productive use of water' (Moriarty & Butterworth, 2003).

Since 1994, considerable improvements have been made in water service delivery (Kelley, 2004). Just over 37 million (84.5 %) of South Africans now have access to piped water in their dwellings, on site, or from communal taps (Statistics SA, 2001). However, rural water service delivery is still a major challenge. Rural areas also tend to be more susceptible to drought, making access to natural water supplies even more vulnerable (Bakker & Hemson, 2000; Kelley, 2004).

The development focus of the South African state demands that efforts be made to improve the condition of the urban and the rural poor.

Can water be used at household level to contribute to a solution and encourage the development of sustainable livelihoods within poverty stricken households?

1.2 Productive Water – a Definition

Productive water is defined as the quantity of domestic water at household level, over and above the 'basic needs' quantity, used by small-scale users (Moriarty et al. 2004) to generate an income and improve the quality of their livelihoods. Productive use of water is generally discussed at household level to indicate both the relatively small-scale nature of the activities involved and the primary social unit at which this type of domestic water use takes place (Moriarty et al., 2004).

This study specifically focuses on piped water. Thus, when referring to the water used it is in reference to water sourced from piped water. This qualification is important in order to understand the economics of any decision to extend water supplies to households. The cost of such an extension of supply can then be compared to the gains made by the households in improving their livelihoods. This report does not seek to explore the essentially costless (to the state) supply of water to households through alternative supplies such as, for example, rainwater harvesting or direct drawing from rivers.

The potential benefits of productive water use include income generation, enhanced food security, improved health, saved time (reduced amount of time spent collecting water), saved expenditure (reduced expenditure on expensive water supplied by water vendors), and improved education (with more time and improved health, children are able to attend and perform better at school) (Moriarty et al., 2004). The majority of rural South Africans depend upon multiple strategies for their livelihoods, with a number of their activities being water dependant (Maluleke et al., 2005).

1.3 Aims and Objectives of the Research

Given the background above, this project was conceived to address aspects of the provision of productive water to poor households.

This study aimed at:

- *Determining whether the provision of domestic piped water for productive uses is featured in national policies, legislation and strategies;*

This section was investigated to give insight into whether the concept of productive water use exists and is provided for in the national legislative framework. The outputs are important to inform policy and legislation which may have to be developed, as well as determine the responsibility for this provision of water.

- *Reviewing both local and international literature to determine the trends in the provision and use of domestic piped water for productive uses*

This section aimed at providing an overview of how productive uses of water manifest in local and international practice. The section provides the policy maker with insight into the uses to which productive water is put so as to frame a possible national implementation framework.

- *Through the selection of case studies determining the following:*
    - *Establish whether domestic piped water is being used for productive uses;*
    - *Identify the types of productive uses; and*
    - *Determine the volume of water used for each productive use.*

This section aimed at (by accomplished primary research using various case-studies selected across South Africa) determining whether water is indeed being put to "productive" use and if so, how much water is being used and what impacts that this has upon the livelihood of the user. This section gives the policy maker insight into the impact of productive water on poor South African households.

- Provide guidance on future research needs

From the findings of this study, provide information for further research required in this subject area.

1.3.1 Assumptions and Limitations

The study made the following assumptions:

- That the relative socio-economic status of the sub-places selected for the case study remained the same in 2007 when the primary research was conducted as was the status in 2001 when Census 2001 was conducted;

The study methodology has following limitations:

- Eighteen case study areas were selected and studied. A single level of service (whether it be standpipe or yard tap) was chosen in each case study area.

- This was the case to achieve greater data integrity and comparability and was largely forced on the study team due to the fact that all four service levels are very rarely found within the same case study area. This has led to the limitation that direct conclusions about whether or not a better level of service will lead to greater volumes of water being used for productive uses could not be drawn. The best the study could achieve was to compare productive use volumes between study areas with differing levels of service. This comparison is unsatisfactory since other variables such as location and rainfall cloud the conclusions.

- The nature of the water uses found during the literature review had a rural bias. Primarily agricultural uses were found to predominate, such as vegetable production or livestock watering. Productive uses found in the literature which could be practiced within the space constraints of the typical urban area include ice and beer making. This has led to a slight rural bias to the results. This should be balanced by the fact that the sampling of households displayed a 50/50 split in the rural/urban balance.

2. REVIEW OF THE SA LEGISLATIVE FRAMEWORK

In the past, the aim of South Africa's water sector has been to supply people with a clean, reliable and safe supply of water, with the primary goal of improving their health (DWAF, 2003). More recently, however, the potential for water to be managed better to contribute to people's wider well-being and livelihoods has been recognised. The most important South African policies, legislation and strategies, relevant to free water supply and the productive uses of domestic water, are highlighted below. A short summary as well as an analysis of each is provided.

2.1 Water Services Act (108), of 1997

One of the main objectives of the act is to provide for the right of access to a basic water supply and basic sanitation. The minimum standard for a basic water supply is stipulated in terms of quantity and associated education:

a) Minimum quantity of potable water of 25 litres per person per day or 6 kilolitres of per household per month. This potable water must be within 200 m of a household; and

b) Provision of appropriate education in respect of effective water use.

The Act acknowledges that proper operation and maintenance of infrastructure, and sound health and hygiene practices would complement the provision of water supply services in improving people's health. Proper operation and maintenance of infrastructure is seldom in place, with many leaks, broken pumps and broken pipes. Another major problem is the storage of water – although water may arrive relatively pure to a storage tank, the tanks are of poor quality and in a state of disrepair, resulting in water being impure by the time it reaches many households. Although education should be provided, there is no information available on whether this is actually being undertaken for each new system installation or upgrade. With the prevalence of leaks and poor illegal connections to water supply systems, education would go a long way to reducing wastage and instilling water conservation attitudes.

The Act states that access to a basic water supply and sanitation is a right, and that water services authorities must provide measures to realise these rights. Several different interpretations can be made of 'reasonable measures', and the Act does not specifically state what types of measures these might be (Kelley, 2004).

The Act also states that the responsibility for water supply systems, domestic wastewater and sewage disposal lies with local government. National government should provide support and capacitate the local municipalities. Although, according to the Act, water service providers may not deny people access to basic water services because of non-payment (if they can prove that they are unable to pay for such services), many homes have had their water cut or metres blocked. The problems stem from water supply projects being unable to recover their costs, becoming unsustainable. Subsidy options available to local government are derived the national government's 'equitable share' automatic transfers, cross-subsidies from other users, or local taxes. Although options for cost recovery are included in the Act, McDonald & Pape (2002) argue that models of cost recovery and the provision of free basic services are not necessarily compatible, and that cost recovery is in fact the downfall of most free service supply projects.

There are thus two implications for productive use of water. Firstly, the act provides for basic water supply, thus excluding productive uses. Secondly, the responsibility of providing this basic service lies with local municipality. Thus, water for productive use falls outside of the responsibility of water services.

2.2 National Water Act (36), of 1998

The National Water Act was written for the fundamental reform of the law relating to water resources, and to repeal certain laws. The Act acknowledges that water is scarce and unevenly distributed in South Africa, that it belongs to all in South Africa, and that national government is responsible for the allocation and distribution of water. The ultimate aim of the Act is the protection of water resources for the sustainable use of water by all.

Section 4 of the Act states the categories of water use allowed. Category 1 entitles people to use water for *reasonable* domestic use, including gardening and animal watering. This would cover the allocation of water for productive uses. However, (a) there is little guidance or support to local government on methods to be used for the provision of water for productive uses, and (b) there is no definition or measurement of 'reasonable' water use. Does reasonable use extend to community gardens and livestock watering? At which level of water use does it cease to be reasonable, and become unsustainable?

One of the guiding principles of the Act recognises the need to promote social and economic development through the use of water. The takes into account, amongst other factors, the following aspects, which directly supports the provision of water for small-scale multiple uses:

- Promoting equitable access to water;
- Redressing the results of past racial and gender discrimination;
- Promoting the efficient, sustainable and beneficial use of water in the public interest;
- Facilitating social and economic development and,
- Providing for growing demand for water use.

According to the National Water Act (36), of 1998 the "National Government has overall responsibility for and authority over water resource management, including the equitable allocation and beneficial use of water in the public interest" (Chapter 4, introduction).

However, municipalities are required to take cognisance and provide input on the National Water Resource Strategy which addresses present and future water requirements. On a catchment level, municipalities must ensure that water allocation plans, as part of a CMS, includes water allocation for multiple uses.

The National Water Act (Act 36 of 1998) creates an enabling environment for the implementation of small-scale multiple water use systems. However there is no clarity around what reasonable water use encompasses or who is responsible for funding productive water use.

2.3 Municipal Structures Act (118), of 1998

The Municipal Structures Act defines Water Services Authorities (WSAs) as any municipality that has the executive authority to provide water services within its area of jurisdiction. WSAs may be metropolitan, district or authorised local municipalities, and are primarily responsible for ensuring the provision of water services. WSAs must ensure that all people in their jurisdiction are progressively provided with at least basic water services. It does not, however, insist that these basic water services are provided for without any cost. Where practical and sustainable, WSAs must plan for and provide higher levels of service.

According to the Act, the district authority is responsible for service delivery in areas where the capacity does not exist at the local level – usually in rural areas. Because of the many role players and many responsibilities of each, there is certainly some level of confusion as to who is responsible for water services in the different sectors and communities.

2.4 Municipal Systems Act (32), 2000

The Municipal Systems Act provides an environment for integrated planning, through the establishment of municipal Integrated Development Plans (IDPs), which are integral to the planning, design and implementation of productive use systems. This act is not enabling and implies that the responsibility resides with municipalities.

2.5 Free Basic Water Policy (FBW), 2001

The Department of Water Affairs & Forestry (DWAF) established the Free Basic Water (FBW) policy in 2001 to provide 6000 litres of clean water to each household at no cost. This 6000 litres was seen as a basic water supply, approximately 25 litres per person per day, for a household of eight. No distinction is made between water provision for urban and rural households, or between large and small households. Urban households are typically smaller than rural households, so this policy actually provides more water per person to urban communities than to rural communities. Further to this 'discrimination', is the fact that the policy has been rolled out mostly on-schedule within larger urban areas. Difficulties have occurred in rural areas, because of the large distances to water resources, small volumes needed (cost recovery would be poor) and limited financial resources. Progress varies greatly between municipalities (Balfour et al., 2005).

The FBW policy provides for water allowance through a piped system. This means that only those with current reticulation systems will be afforded the benefit of free water supply. Those without reticulation systems are already disadvantaged because of the lack of existing services, but are further disadvantaged by not being able to receive the free water supply. As such, the problem lies with the provision of infrastructure prior to the provision of water.

2.6 Strategic Framework for Water Services (SFWS), September 2003

The SFWS sets out the national framework for the water services sector (water supply and sanitation). It addresses all the water supply and sanitation services and institutions. South Africa's SFWS acknowledges that water should be made available for economic use. However, South Africa is one of the world's 30 most water-scarce countries, and supplying water of sufficient quantity and quality for productive use is challenging (DWAF, 2003).

The Framework acknowledges that water for small-scale multiple uses is necessary for the reduction of poverty and the improvement of livelihoods (through the creation of jobs, use of local resources, improvement of nutrition and health, development of skills, and provision of sustainable livelihoods for many households), hence water programmes must be designed to support sustainable livelihoods and economic development. The use of community-based WSPs in smaller, localised water supply schemes is encouraged. These smaller supply schemes often provide for productive uses of water in rural areas.

Services and the use of water resources must be sustainable to ensure continued benefit for future generations. Provision of basic water services is the most important and immediate priority. This implies that providing water for communities is more important and should receive preference over providing water for large-scale irrigation and agriculture, which could lead to conflict between users as well as in terms of cost recovery.

The Strategic Framework for Water Services, 2003 (SFWS) acknowledges that water for small-scale multiple uses is necessary for the reduction of poverty and the improvement of livelihoods. To this end the following is stated in the SFWS:

- **Economic development and sustainable livelihoods.** Water and sanitation programmes will be designed to support sustainable livelihoods and local economic development. The provision of water supply and sanitation services has significant potential to alleviate poverty through the creation of jobs, use of local resources, improvement of nutrition and health, development of skills, and provision of a long-term livelihood for many households.
- Water is used effectively, efficiently and sustainably in order to reduce poverty, improve human health and promote economic development. Water and wastewater are managed in an environmentally responsible and sustainable manner.
- **Providing more than just basic services (climbing the ladder).** Water services authorities do not, and should not, only provide water services necessary for basic health and hygiene. It is important that municipalities facilitate the provision of higher levels of services for domestic users where viable, undertake gender-sensitive health communication, and provide services which support sustainable livelihoods and economic development.
- **Higher levels of services (stepping up the ladder).** The provision of basic water services is only the first step up the ladder of service provision as set out by the national government in the Reconstruction and Development Plan in 1994. Whilst this is the most important and immediate priority, water services authorities are expected to provide intermediate and higher levels of services (for example water on-site) wherever it is practical and provided it is financially viable and sustainable to do so. National government will need to increase the amount of resources made available to local government through the municipal infrastructure grant and the local government equitable share over time an in real terms commensurately with economic growth in order assist households to step up the water services ladder. In addition, water services authorities should put in place appropriate financing mechanisms to make this possible.
- The water services authority is ultimately responsible to ensure that the provision of water services is financially sustainable (enabling the ongoing operation of services and adequate maintenance and rehabilitation of assets).
    - ✓ The water services authority can influence the financial viability of water services and water services providers through the following mechanisms:
        - Investment choices;
        - Choices related to the use of the local government equitable share;
        - Tariff policy and the setting of tariffs;
        - Credit control policies and revenue management, and
        - The contract (service delivery agreement) between the water services authority and an external water services provider, specifically the service obligations and the financial conditions of the agreement.
- **The right of access to sufficient water** is dependent on the state taking reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of these rights. It is also subject to specific obligations such as

payments for services (over and above the basic amount) and the limitation and disconnection of the service in certain circumstances.

- Water and sanitation programme should be designed to **support sustainable livelihoods and local economic development.** The provision of water supply and sanitation services has significant potential to alleviate poverty through the creation of jobs, use of local resources, improvement of nutrition and health, development of skills, and provision of a long-term livelihood for many households.

From the above, it is clear that the SFWS indicate that water must be made available for more than just basic needs, that municipalities facilitate the provision of these higher levels of service and that national government increase the resources available to local government. It is however not clear that the economic development to which the SFWS refers equates to productive water use. Also water availability for economic development is not a mandate of the Municipal Structures act.

2.7 National Water Resource Strategy (NWRS) (September 2004)

The NWRS provides information about ways in which water resources should be managed and how institutions will be established. It requires municipalities to provide input that addresses current and future water requirements. On a catchment level, municipalities must ensure that water allocation plans (as part of a Catchment Management Strategy) include water allocation for multiple uses. In reality it may be difficult to link small-scale users of domestic water with the catchment-wide allocation of water. Research must therefore be undertaken to determine each community's water needs and uses.

3. LITERATURE REVIEW

3.1 Introduction

Literature was reviewed to determine types of productive uses undertaken, the water needs of communities versus the provision of water by government, alternate sources of water used for productive uses, community support of water supply projects, and best practices in terms of water provision, management and efficiency of water use. At the end of each section the lessons learnt are highlighted in a text box.

In the literature, productive use of water or water for beneficial use is often mentioned. Productive use of water is defined as the use of water to promote economic growth and improve livelihoods such as watering foodlots and livestock (Desvouges & Kerry Smith, 1983).

Beneficial water use on the other hand does not necessarily result in economic growth, however it does add value to people's standard of living such as the use of water for traditional/cultural and/or ritual functions. Water for both productive and beneficial uses is considered equally important hence for the purposes of this document. Multiple water use includes domestic, productive and beneficial water use. It takes multiple water uses of rural and peri-urban urban communities into account (von Koppen, Smits, Moriarty and Penning de Vries, no date).

3.2 International Productive Uses of Domestic Water

Water is used in many ways that are economically, socially or ecologically beneficial. The figure below, Figure 3-1, shows the various beneficial uses for water (Desvouges & Kerry Smith, 1983). The figure shows that there are three categories of user value that water creates; uses in stream of a river, uses with respect to the withdrawal of water from a source and uses with respect to the proximity of a water body.

It is the withdrawal uses that form the subject of this study. General categories of withdrawal uses are Municipal, Agricultural and Industrial or Commercial. When viewed from the perspective of the rural poor it is the municipal and agricultural uses that would receive the focus in the present study.

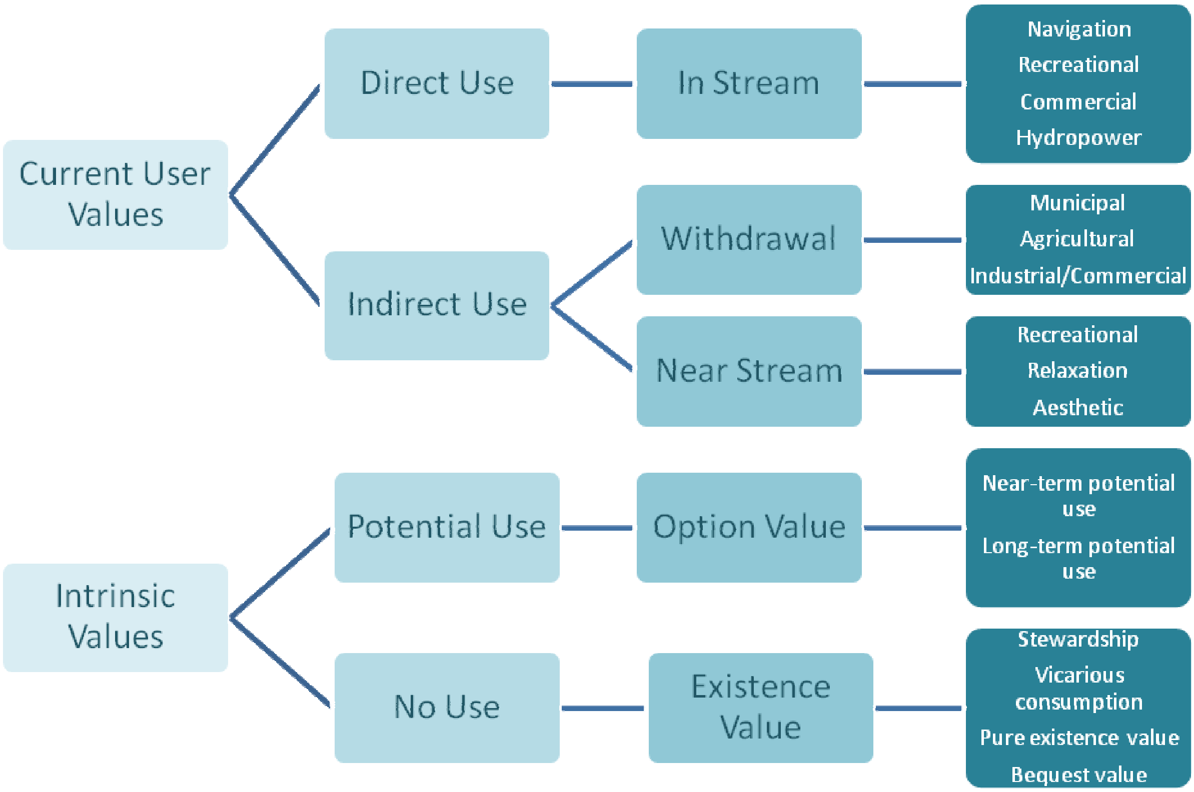

Figure 3-1 Beneficial Water Use Categories (Desvouges & Kerry Smith, 1983)

Lew et al. (2005) published a study that listed the value of water in various categories of beneficial use. This study was a compilation of the results of worldwide studies into the various values of water. The range of the beneficial uses for water was large and the study identified twelve separate categories for which water could find a beneficial use. These categories are listed in Table 3-1 below.

Table 3-1 Beneficial Water Use Categories (Lew et al., 2005)

Agriculture	Navigation
Aquaculture	Power
Commercial Fishing and Shellfish Production	Preservation of Vulnerable Species
Groundwater	Recreation
Habitats and Ecosystems	Water Quality
Municipal	Wetland and Floodplain

Those categories with relevance to this study would be agriculture, aquaculture and municipal uses.

A temporal, longitudinal study, entitled Drawers of Water II, studied household water use patterns in communities in East Africa. In general, the households studied were poor and sixty percent of the total sample was rural (Thompson et al., 2001).

The water use types uncovered in the study fell into four categories; consumption (drinking and cooking), hygiene (bathing and washing), amenities (car washing and other non-essential tasks) and productive uses. The productive uses category is of most interest to the current study and the study provided the following instances of the productive use of water (Thompson et al., 2001):

1. consumption by livestock (e.g. cattle, goats, pigs and sheep);
2. brewing beer;
3. distilling gin;
4. making fruit juice;
5. brick making;
6. the construction of homes; and
7. irrigating tree and horticultural crops.

A further significant conclusion of the study was that rural households with piped water supplies used significant quantities of water for productive uses. This significant usage was not found in urban households with a piped water supply. This finding prompted the researchers to conclude that access to a piped water supply is beneficial to rural households from a productive as well as a health and well-being perspective. It is also significant to note that most of the productive use of water took place away from the household (e.g. in agricultural holdings), and in this regard cannot be considered "domestic" water.

Two studies on beneficial water use in Bolivia were reviewed. The first of the two was most relevant to the current subject and is entitled *Multiple sources for multiple uses: Household case studies of water use around Cochabamba, Bolivi*a (Bustamante et al., 2004). Multiple users take water from multiple sources and use and reuse it for multiple purposes (Van Koppen et al, no date).

The case study found that most of the families used multiple sources of water to satisfy their water requirements. It was found that 44% of the overall water usage was consumed by activities other than basic human needs. These other activities included small-scale farming or vegetable gardens, small livestock raising or micro home enterprises such as beer brewing.

The study served to demonstrate that the expected water demand would increase dramatically if consumers were able to make use of water for productive purposes. The study also demonstrated that if various water sources are available, and for differing costs (cost being measured both in currency value and in labour value), the source that reduces the overall cost would be chosen over the alternatives.

Whether or not the cost to the state of providing the water and supplying the infrastructure is offset by the gain from productive uses, would be determined by individual circumstances. Amongst the factors to consider would be the agricultural potential of the land and the skill of the producer.

Further international studies into the productive uses of water are summarised in the section below. In these studies, types of productive uses are investigated, with an emphasis on the source and management of water. The types of productive uses of water was be influenced by external factors such as availability of a viable source of water, climate, and technology, as well as the needs of the community or end-users, poverty levels, available finances and skills of those undertaking the activities.

1. In Morocco, domestic water is provided, and is generally used for drinking. Water for other domestic and productive purposes is stored in subterranean tanks, or wells, and is either rainwater or ground water. Stored water is also used for the watering of large livestock (Boelee & Laamrani, 2004).
2. In India, productive use of domestic water includes making bricks, pottery, ropes and salt, running dairies and gardens, and running tea stalls (James, 2003). These activities generally make use of untreated water. There is often conflict regarding water sources in India, often due to the caste system, which means that those in higher social castes receive more and better quality water. A nominal fee is paid for treated water, but where households are very poor, this nominal fee becomes unattainable.
3. In Diass, Senegal, many people still collect water from hand dug wells, for drinking, bathing and washing clothes. They walk long distances to collect this water, so its use is prudent. However, there are water vendors that sell water from community boreholes to households and herders. This is in itself a productive use of water (Moriarty & Butterworth, 2003). Recently USAID assisted with water provision and services, and found that the key to improving revenue collection was clarifying roles and building cooperation between the rural council and the state treasury (USAID, no date).
4. In Paris, France, there are two public water supply systems. One contains potable water and the other, non-potable water. Both systems supply water to households. The potable water is expensive and as such is used sparingly. The non-potable network uses water from the Seine River to flush the sewers and clean the streets. Non-potable water is free. Most of Paris's public (display) fountains use water from this non-potable network (Barraqué & Juuti, 2006). It is, however, expensive to install such infrastructure, and is not necessarily applicable to South African cities or

villages since many communities are situated great distances from sufficient water sources.

In most of the above case studies, domestic water is used for drinking, and alternate sources are used for productive or economic activities. In cases where domestic water is used for productive purposes, this water is usually seen as a secondary source of water, used during times of shortage. It also appears that rural households make use of domestic water, where available, for economic activities, because rural areas do not provide options for many income-generating activities.

3.3 South African Productive Uses of Domestic Water

Most people are familiar with using water to irrigate subsistence food plots and for the watering of livestock. This applies to both urban and rural communities. Semi-subsistence urban farming, while appearing to be an environmental or hygiene hazard by urban municipalities, makes an important contribution to livelihoods and reduces the incidence of malnutrition (Gordon et al., 2000).

Bushbuckridge, in the north-eastern region of South Africa, is a very water-scarce region with high population densities. Access to rural water supplies, mainly from piped systems, provides an important opportunity for the community to engage in a wide range of small-scale activities and enterprises. The productive uses identified include livestock watering, aquaculture (Rouhani & Britz, 2004), irrigation of small-scale vegetable gardens and orchards, brick-making, micro home enterprises (e.g. hair salons), beer-brewing, and making ice (Mvula Trust, 2006).

To these conclusions are added the results of a study conducted in 2000 in Kwa-Zulu Natal, entitled "Mkomazi Catchment Rural Water Use Survey: Final Report". This report presents the results of a data survey into the primary water uses in three rural villages of the Mkomazi Catchment. The study used a sample size of 232 households (Clark et al., 2000).

The study (Clark et al., 2000) detailed three productive uses for water; use for livestock watering, use for the cultivation of vegetable gardens and use for building work. The type of livestock watered in the sample households included cattle, sheep and goats. The study found that cattle typically use 30-40 litres of water per head per day.

The cultivation of vegetable gardens differed across the three areas, with one area being heavily involved in a communal vegetable garden project. It was speculated that the difference in use could be ascribed to the relative poverty of this community. The implication of this observation is that these three communities would not cultivate vegetable gardens were they not forced to by economic circumstances.

Building activities were a widely practiced use for water. The homes in the area comprise either adobe (mudblock) or wattle and daub construction with water being required both to fashion the clay building blocks for these structures and for the clay plaster. Water use was both for the maintenance of existing structures and for the construction of new structures (Clark et al., 2000).

> In summary, productive water use includes almost any water-based activity conducted at the household level – that generates food and/or an income for the users. Both urban and rural communities make use of water for subsistence farming. Where water is readily available, and productive uses are encouraged, a wider variety of economic activities using water are initiated. Vegetable gardens, livestock and aquaculture are often preferred productive uses in communities with particularly high levels of poverty.

3.4 Water Needs vs. Water Provision

International recommendations as to the volume of water required for basic human needs and hygiene are compared to the volumes of water currently being provided in South Africa.

Quantity

In 2000, the South African government introduced policy that a minimum of 6000 litres of free potable or drinking water to be supplied per household per month, based on supplying a household of eight with 25 litres of free water per capita per day ($\ell c^{-1}d^{-1}$). The Johannesburg Symposium "Poverty and Water: Productive Uses of Water at the Household Level" was held in January 2003. A major outcome from this symposium was agreement among numerous professionals that the quantity of water sufficient for both domestic and some productive use is typically between 100 and 150 $\ell c^{-1}d^{-1}$ (Butterworth et al., 2004), with approximately 50 $\ell c^{-1}d^{-1}$ being required for domestic purposes alone (Wenhold et al., 2007). This is 2 to 4 times greater than the current allocation of free basic water. However, free basic water in South Africa is generally implied to be used for domestic (health and hygiene) and not productive needs.

Soussan et al. (2002) showed levels of productive water use in villages to range from 23 to 40 $\ell c^{-1}d^{-1}$ above the amount used for basic needs (21 to 22 $\ell c^{-1}d^{-1}$), totalling between 44 and

62 $\ell c^{-1}d^{-1}$ for both domestic and productive uses. From this study it appears that households require a minimum of 44 litres per person per month, which is more than the 6000 litres of free water (for an eight-person household).

In general, more water is used and more income is derived from water-related activities in areas where water supply is better (in terms of volume and reliability) (Soussan et al., 2002).

> While 6000 litres of water is provided freely to households, it is apparent that they require significantly more water for suitable health and hygiene, and for productive purposes. Productive water uses can provide or supplement an income, and this seems relatively more important in rural areas where fewer opportunities exist for generating income. When water is provided and is easily accessed, poor households undertake a variety of subsistence and economic water-related activities.

Quality

According to Van Koppen et al. (2006), water quantity is relatively more important than water quality. However, a certain amount of high quality water is required for drinking purposes, if for nothing else. The relatively small amount of water needed for drinking could be housed in a separate container or tank, and communities provided with the necessary chemicals or tools to ensure that the drinking water is of suitable quality. Quite often in developing countries, water treatment itself may ensure quality, but the subsequent transport and/or storage of water again renders it impure (Scheelbeek, 2006). Point-of-use treatment, such as boiling or filtration, may then be a more effective method to ensure water quality for drinking (Van Koppen et al., 2006).

Early in the development of water supply systems, it was assumed that the provision of high quality water was more important than the provision of an average quality, but greater quantity of water (Van Koppen et al., 2006). This related to high investments in treatment systems, which in turn caused conflict when expensive domestic water was used for gardens or livestock watering (Moriarty & Butterworth, 2003).

Water quantity may be more important than water quality, since only small amounts of high water quality are necessary for drinking (approximately 2 – 4 $\ell c^{-1} d^{-1}$). It seems sensible to provide larger quantities of water, of a lesser quality and hence less expensive, and supplement this with point-of-use purification options.

Sources of water for productive use

Although not essential for the purposes of this project, it is interesting to determine where communities derive their water from for productive purposes. The source of water used may be related to the lack of domestic water, associated costs, or the relative ease of use or collection of alternate sources of water. Water sources also indicate the degree to which projects have been planned, in that many projects plan for contingency sources of water from inception, in the case of unplanned water shortages.

Water for productive uses may be sourced from any body of water that contains sufficient volumes for the required purpose. The type of productive water use employed will be largely determined by the quantity and quality of water available. However, the quality of water sources may not necessarily suit the proposed productive use. For example, harvesting rainwater for beer-making may be unsuitable because of the potential health risks for the consumption of poor quality water. Similarly, one does not have to use domestic or piped water for brick making as this task could be satisfactorily completed using collected rainwater or abstracted ground water. Water sources for productive use are usually from four broad categories (DWAF, 2004), including groundwater (boreholes and wells), rainwater, re-use of wastewater, and domestic or potable water.

Access to multiple sources of water is important for coping with water shortages (seasonal, annual or unforeseen) (Van Koppen et al., 2006). Studies mentioned previously noted that many projects relied primarily on rainwater or groundwater where available, and used domestic or treated water as a supplementary source of water. This significantly reduces the reliance on one system, and if used correctly, could reduce the cost of water where it is being paid for. However, the cost implications of dual systems must be considered if two separate sets of infrastructure are to be constructed. It may not be financially sustainable to provide infrastructure for water provision if the infrastructure is not going to be utilised sufficiently and paid for by the recipients.

Alternate sources of water need to be accompanied by alternate systems. Rainwater harvesting cannot occur without the provision of rainwater harvesting tanks, and boreholes cannot be accessed without drilling. The alternate systems tend to have very high initial costs, but are easily maintained afterwards.

> Water-related activities are often more sustainable where water is derived from more than one source. Domestic water often serves as a supplementary or secondary source of water for productive uses.

Community Support and Acceptance

Community buy-in is invaluable when it comes to the payment for services, avoiding conflicts, and the maintenance and management of water supply systems. Unplanned uses or unaccounted for users often leads to conflict. Therefore it is essential to recognize that communities, especially the rural poor, value the productive uses of water, and will often undertake such activities regardless of sustainability or cost to the system (Moriarty et al., 2004). Community involvement in the planning, implementation and maintenance of productive use water supply systems is essential to ensure the sustainability of such systems.

Subsidised services

In Chile, households are screened to identify income and expenditure, with the aim of allocating subsidies for water and sewer services to the poorest households. This ensures that only those that can't afford to pay for services are provided with 'free' or subsidised services. Columbia distinguishes between socio-economic groups based on the neighbourhoods in which they are located. The lowest groups receive subsidies for water, gas and electricity. The upper groups pay surcharges on their service costs, effectively subsidising those not paying for services (DWAF, 2002). These methods ensure that cost recovery is achieved, while at the same time providing free or subsidised services to the poor. It also ensures that a transparent process has determined the households as being within certain socio-economic groups, and that allocation of subsidies is not biased.

Conflicts

Conflicts generally occur when there are unplanned uses or users, lack of service delivery, and when services are not targeted to specific needs (e.g. high cost services to poor communities that would otherwise be willing to purify their own water). When costs are unaffordable, or services are allocated to specific users and not to all, the reticulation systems may be 'hijacked' in order to illegally gain access to water via the system. This causes leaks, high maintenance costs, and a lack of service to users that are already paying for and expecting water (McKenzie et al., 2003; Schouten & Moriarty, 2003; Moriarty et al., 2004; Maluleke et al., 2005).

The Laka Laka dam in Bolivia was planned to provide water for a large irrigation scheme and to meet the basic domestic needs of the town (Bustamante et al., 2004). However, water from this dam was not to be made available for productive water use in the urban area (Bustamante et al., 2004). When water was supplied for cultivation around urban homesteads, there were violent conflicts with farmers from the irrigation scheme who were determined to protect their water rights (Bustamante et al., 2004). This kind of conflict emphasizes the need to plan for productive uses prior to the installation of supply systems.

Maintenance of supply systems

As much as 21.8% of total water supply in South Africa is stated to be lost or 'unaccounted for' (Sibanda, 2002), due to theft and leaks. Where agreements are in place for water to be used for productive purposes, people may undertake greater conservation of the water, and develop some sort of ownership for the resource. Since leaks and illegal connections are financial losses to the water services provider, the ownership of the resource may reduce theft and leaks, thereby freeing up some of the finances previously lost. This 'recovered' finance could possibly used to subsidise the cost of the water for productive purposes (on top of that already provided for domestic purposes), or could be used to pay for the infrastructure maintenance services of the community.

> For services to be subsidised, qualifying households need to be defined and identified, possibly through a screening process. Transparent processes allow communities to be involved in the planning of water services as well as understanding the process of subsidies.
>
> Conflicts mostly occur over water resources when there are unplanned users or uses. It is essential to plan for the productive uses of the poor, since in some cases it is their only option for subsistence of income generation.
>
> Ownership of water supply systems should be fostered, by involvement of the community in planning and management of water supply systems. This would possibly reduce mismanagement and the occurrence of leaks and illegal connections, which will ultimately reduce maintenance and repair costs.

3.5 Financial implications of productive uses of water

The financial implications of productive uses of water are two-fold: income-generation to poor households, and cost to the water service provider. Ideally one would hope to find a balance between the two, where service providers can recover at least some of the costs, and poor households do not have debt because of their water use for subsistence or income generation.

Perez de Mendiguren Castreana (2004) found that water-related activities represented an increase in total income of households by 17 to 33%. Economic returns for productive water use ranged from 1 cent per litre for vegetable gardens and fruit trees, to R1.60 per litre for beer brewing and ice making (Soussan et al., 2002). This represents a significant income or supplement to income for poor households, especially where water is provided freely. However, that brings up the question of whether those deriving some profit from water use should contribute for their water.

Local conditions, such as the size of the community to be served, and the presence of suitable aquifers, can cause large variations in the unit cost of water supply (Cairncross & Valdamanis, 2006). The smaller size of rural communities means that piped water systems in general will tend to be more expensive per capita there than in urban areas (Cairncross & Valdamanis, 2006). Providing water of sufficient quantity and quality for productive uses can be expensive especially when treatment and infrastructure are required (Moriarty & Butterworth, 2003). It is possible to recover some of the costs associated with providing water for productive uses, e.g. by introducing stepped tariffs (Moriarty et al., 2004). Additional costs that must be considered are those of operation and maintenance. Poor cost recovery from water supply schemes has been cited as a major stumbling block to the long term sustainability of such systems (Hazelton & Kondlo, undated).

However, economic analyses that capture most of the abstract benefits suggest that the extra costs involved in infrastructure improvement are a sound investment (Lovell, 2000; Waughray, Lovell & Mazhangata, 1998). It is impossible to place a value on community or household upliftment and self-sufficiency.

> Although few studies consider the economic costs and benefits of water supply schemes, it is generally accepted that the costs of installing such systems are justified, even if not initially economically sustainable. It is, however, necessary to investigate cost recovery strategies and the cost of maintenance, and to match any water supply schemes with the recipient communities in terms of their requirements and ability to pay for water.

3.6 Best practices

The best practices can be derived from the literature review, as important points to consider when proposing either productive use projects or water supply projects.

International case studies determined that treated water is primarily used for drinking, and that it supplements alternate water sources used for productive purposes. Hence, it is not necessary to consider treated water as the primary source of water for all productive uses.

Dual water systems should also be investigated. They are practical but not necessarily applicable to South Africa. Dual water sources could be a viable option – i.e. have two systems from which to draw water (e.g. rainwater tank or borehole, and the domestic reticulation system).

In South Africa, both rural and urban communities undertake subsistence farming. Communities with higher levels of poverty tend to undertake productive uses such as vegetable gardens, livestock farming and aquaculture, where possible (Thompson et al., 2001). These productive uses must be investigated and possibly recommended to very poor communities.

Quantities of water appear to be more important than quality in some respects. Where treatment, transport and subsequent storage of the treated water is expensive, or requiring extended time to prepare, there are other options available. It may be suitable to supply large quantities of untreated or slightly treated water to rural communities that are long distances from formal reticulation systems. The receiving communities could be supplemented with point-of-use treatments for smaller amounts of drinking water to be siphoned from the untreated water.

Alternate sources, although not investigated in this study, are essential options for dealing with periods of water shortage, whether they are seasonal, annual or unforeseen periods. This is especially important in areas where no one source is sufficient to meet all the water needs of a community, during all seasons. What is important, however, is that the quality of water from the alternate water sources must suit the proposed productive use.

Community support of water supply systems is essential. Subsidies to the poor should be via a transparent process. Productive uses of the poor must be planned for from the inception of the water supply project, and communities must be involved in decision-making, and sometimes in the maintenance and/or management of the systems. It is important to foster ownership of the resource to ensure water use efficiency, reduction in leaks and illegal connections, and payment for services.

While the financial costs of water supply infrastructure and maintenance must be taken into account, most water supply projects can be justified regardless of the cost recovery potential.

However, cost recovery is essential for the long term sustainability of the system, and alternate methods should be investigated such as rising tariffs and cross-subsidies.

Another essential component to any water supply project is education and training. The water sector needs to broaden its infrastructure provision to include an adult education aspect to improve the use and sustainability of water for productive uses (Moriarty & Butterworth, 2003). This is important especially with regards to the finite nature of water, water conservation, sustainable use of water, maintenance of systems, and the possible use of alternate sources. Education of the end-users, in terms of maintenance, will encourage community self-sufficiency, reducing the amount of time that a system is unusable (previously during maintenance by external parties). Education and awareness programmes should not only be extended to any new developments, but to existing developments where there may be long term sustainability problems.

Conducting a throughout financial and socio-economic assessment is critical to ensure that the system design is guided by the needs of the end user. If the needs of the end user are not being met, there will be limited, if any, cost recovery. People are only willing to pay for services that meet their needs – i.e. pricing is equitable and the level of service is adequate (reliable and sufficient).

3.7 Conclusion

Providing water security can play a wider role in poverty reduction and improving livelihoods. Benefits derived from productive uses of water can be direct (enhanced livelihoods, food security, and income generation) and indirect (improved health and nutrition, saved time, and empowerment). Researchers have agreed that people require between 100 and 150 litres of water per person daily to cover their domestic and productive needs. However, the majority of people in developing countries, especially in rural areas, receive far less than that, and their water supply is dependent on the availability and cost of water, as well as the distance to collect water.

Productive uses of water in South Africa are similar to those undertaken internationally. They range from the production of food for consumption or sale (vegetables, livestock and fish), to higher value products (ice and beer). Home enterprises such as hair salons and car washes also classify as productive uses of water.

Providing water for productive uses does not necessarily mean that domestic supply systems need to be upgraded. Alternative sources of water can be used, incorporating alternative technologies such as boreholes, greywater recycling, and rainwater harvesting.

Water supply systems must be financially sustainable. Cost-recovery mechanisms must be in place. Costs increase significantly when additional infrastructure such as treatment, pumping or piping is required. Additional costs can be limited by the use of alternative technologies or sources. Maintenance costs of systems must be taken into account. Despite the high costs of installing and maintaining water supply systems, there is general acceptance that the initial outlay of funds is justified when community and individual livelihoods are considered.

4. CASE STUDY ANALYSIS

4.1 Methodology

The objective was to determine if poor communities are using potable or piped drinking water for productive uses in South Africa. More specifically, it was to determine the types of productive uses, volumes of water used for productive uses. The design of the questionnaire also allowed the consideration of policy related questions, such as whether or not water is a limiting factor in the initiation of productive uses (i.e. would communities undertake more, and intensify, productive uses if free basic water allocation were to be increased).

The aim was to study an average of fifteen households in each of the case study areas. Overall, eighteen study areas were selected, and within them, 270 households were interviewed.

There were a number of selection criteria used for the case study areas. These were applied in the following order in order to arrive at a balance between the factors:

1. Spatial representation within different rainfall regions
2. Definition and identification of 'poor'
3. Community population greater than 150
4. Distinction between urban and non-urban
5. Equal representation of service levels

A decision was made to study one service level in each area, rather than studying all service levels in each area. This decision was made for the following reasons:

1. Better data integrity in that many households were studied within a particular area. This allows data from an area to be aggregated, thus enabling data smoothing to reduce the impact of the outlier values; and
2. In the vast majority of communities in South Africa, the level of service is the same across the community. An initial interrogation of the sub-place data for Census 2001 showed that the chances of finding a community that has households experiencing all of the various service levels was remote.

The disadvantage of this methodology is that the choice of productive use may depend upon factors other than service standard and rainfall conditions, and this diversity will not show up in the captured data.

The study was conducted in October and November 2007. Ward councillors and churches were contacted from wards within each sub-place. They were requested to assist in terms of selecting suitable, educated field workers for employment. Five candidates were selected as field workers per study area (90 in total), with one of them being appointed as team leader. The team leader was trained telephonically, and was responsible for managing information flows, coordinating team meetings, purchasing equipment, and returning completed questionnaires within a given time period. Each questionnaire was completed over a 2-day period. The researchers had to spend two full days with each household, monitoring and measuring their water use by means of a 5 litre bucket. They also had to interview the household and complete a number of questions on the questionnaire (see attached copy of the questionnaire – Appendix A).

Data from returned questionnaires was captured in a database format. Data was then analysed according to three criteria: 1) urbanisation, 2) level of service, and 3) rainfall region. The data was also analysed overall for a representation of poor households.

4.1.1 Case Study Area Selection Criteria

At the start, twenty case study areas were to be selected using the following criteria:

- Poor Communities;
- A spread of urban and rural communities;
- With differing rainfall/climate; and
- With differing service levels, which included:
    - House connections;
    - Yard taps;
    - Standpipes every 200 m; and
    - Standpipes greater than 200 away.

A balance had to be achieved between all of these factors to arrive at a representative sample of communities from which to draw data.

Communities were selected on the basis of the Statistics South Africa Census 2001 data. Sub-places were used as the level at which community selection was used. This choice was made to achieve a relatively small community size, which would in turn increase the chances that the community was homogenous in terms of income levels. Hence household income within that sub-place, and consequently any household selected for the study, could be expected to be representative of the income figures for the entire sub-place.

Poor Community and Size of Community Selection

The first criterion was that the selected communities were to be poor. For the purposes of this study, poor was defined as when more than 50% of the community earn less than R800 per household per month.

Community population had to be greater than 150 people. This was to ensure a population size of at least 75 classified as 'poor' (when considering that at least 50% of the community had to be poor), for relative ease of household selection for the study.

Urban and Non-Urban Communities

Urban and non-urban definitions were derived from Statistics South Africa. Urban areas are defined as being towns or cities as well as vacant areas defined as urban previously, areas with informal dwellings within urban areas, areas with hostels within urban areas, and areas with hospitals or prisons within municipal boundaries. Non-urban areas are those that don't fit the urban criteria (Stats SA, 1996a). These are thus traditional areas and farmlands. There was equal representation between the two groups – with 135 households interviewed per group.

Rainfall Regions

The third criterion was to ensure that the selected case studies represented the various rainfall regions in the country. Rainfall regions were selected as being relatively more important for water services and productive uses than other spatial criteria such as provinces or catchment areas, because of the 'safety net' feature rainfall may offer to areas.

There are two ways in which rainfall regions can be determined; after the DWAF 1986 publication and the Rainfall Bands method.

According to the DWAF 1986 method, there are five rainfall regions in SA:

1. Summer;
2. Late Summer;
3. Very Late Summer;
4. Winter; and
5. Year Round.

If this method was used, selection of case study numbers on the basis of rainfall will be apportioned as follows:

Table 4-1 Theoretical Apportionment of Case Studies to Rainfall

No.	Rainfall Region	No. of Case Study Areas
1	Summer	4
2	Late Summer	4
3	Very Late Summer	4
4	Winter	4
5	Year Round	4
		20

(Areas defined by DWAF, 1986)

The six rainfall regions in South Africa are defined according the amount of rain received annually. Figure 4.1 graphically illustrates the location of the rainfall regions.

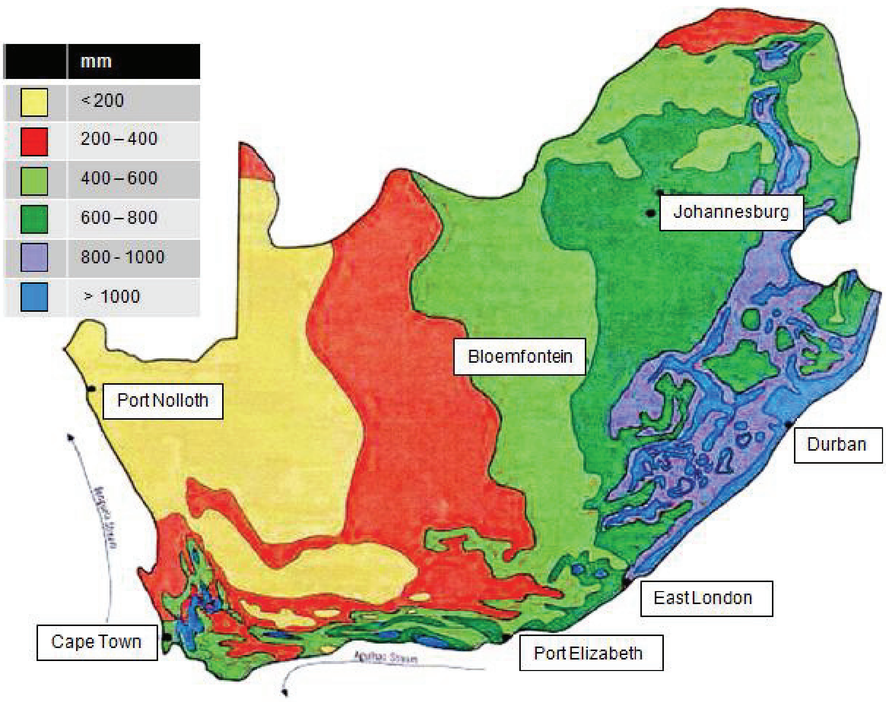

Figure 4-1 Mean annual precipitation regions. Adapted from DWAF, 1986.

According to the Rainfall Bands Method, there are six rainfall regions in SA, [figures are in mm rainfall per calendar year]

1. < 200 mm;
2. 200-400 mm;
3. 400-600 mm;
4. 600-800 mm;
5. 800-1000 mm; and
6. >1000 mm.

Selection of case study area numbers on the basis of rainfall will be apportioned as follows:

Table 4-2 Apportionment of Case Studies to Rainfall

No.	Rainfall Region	No. of Case Studies Areas
1	< 200 mm	3
2	200-400 mm	3
3	400-600 mm	4
4	600-800 mm	4
5	800-1000 mm	3
6	>1000 mm	3
		20

(Areas defined by the Rainfall Bands method)

In the event, the rainfall region receiving more than 1000 mm was omitted because of the relatively small distribution area and the difficulty of identifying sub-place locations that fell within this rainfall band.

<u>Levels of Service</u>

A distinction was made between different levels of water services. A selection was made of households so that overall there was a relatively equal representation of water connections in dwellings, water connections to yard taps, communal standpipes less than 200 m from households, and communal standpipes further than 200 m from households.

As discussed above, one service level per study area was studied, rather than to study all the service levels in each area.

4.1.2 Case Study Area Selection

Case study area selection was an iterative process. The first selection criterion used was the rainfall band. Potential local municipalities were selected based upon which rainfall band they fell. In this way, if communities were selected from the local municipalities, the researchers could be sure that the community would fall within a stated rainfall band. In this way local municipality was made analogous to rainfall band.

Once the local municipalities had been selected, an apportionment of the levels of service between each rainfall band/local municipality was made. This was done so that qualifying sub-places within the local municipality could be selected. Once the sub-places had been selected based upon service level, the selected sub-places were then checked for the final two criteria, poverty and community size. If a sub-place passed each of these hurdle criteria, it was added to the list of potential study areas.

In a few cases no sub-places existed which has the combination of location, service level, poverty and community size required by the study.

Once this process had been completed, eighteen case study areas were selected that met the criteria and ensured that a balance between the criteria had been achieved.

The selection process is described in detail below.

Rainfall

The Rainfall Bands Method was used in the selection of the case studies. This choice was made over the alternative since it relied upon a quantitative measure of the rainfall in a particular region. In addition, this classification was more up to date than the 1986 classification. The following initial case study apportionment was made.

Table 4-3 Identification of Local Municipalities with the Rainfall Bands

No.	Rainfall Region	Broad Case Study Area Location		
		Province	District	Local
1	< 200 mm	Northern Cape	Namakwa	Richtersveld (NC061)
		Northern Cape	Siyanda	Kai !Gharib (NC082)
		Western Cape	Central Karoo (DC05)	Beaufort West (WC053)
2	200-400 mm	Western Cape	West Coast (DC01)	Saldanha Bay (WC014)
		Northern Cape	Kgalagadi (DC45)	Gamagara (NC452)
		Northern Cape	Pixley ka Seme	Umsobomvu (NC072)
3	400-600 mm	Western Cape	Overberg	Cape Agulhas (WC033)
		Northern Cape	Frances Baard	Sol Plaatje (NC091)
		Eastern Cape	Chris Hani	Lukanji (EC134)
		Limpopo	Waterberg	Lephalale (LIM362)
4	600-800 mm	Limpopo	Waterberg	Bela Bela (LIM366)
		Gauteng	City of Johannesburg (JHB)	
		Free State	Thabo Mofutsanyane	Dihlabeng (FS192)
		KwaZulu-Natal	Umkhanyakude	Jozini (KZN272)
5	800-1000 mm	Mpumalanga	Gert Sibande	Msukaligwa (MP302)
		KwaZulu-Natal	Sisonke	Kwa-Sani (KZN432)
		Eastern Cape	OR Tambo	Mbizana (EC151)
6	>1000 mm	KwaZulu-Natal	Ugu DM	Hibiscus Coast (KZ216)
		Mpumalanga	Ehlanzeni	Umjindi (MP323)

Following the location selection, the number of case study areas across the various service levels were apportioned as per the table below.

Table 4-4 Apportionment of Case Studies to Water Service Level

No.	Service Level	Theoretical No. of Case Study Areas	Actual No. of Case Study Areas
1	House Connections	5	5
2	Yard taps	5	6
3	Standpipes every 200 m	5	3
4	Standpipes greater than 200 away	5	4
		20	18

The theoretical case study apportionment column lists what case studies were sought using the available data. Based upon the data and instances where all the criteria for each case study were not met, the actual apportionment column was generated.

Once the number of case studies experiencing a given level of service had been selected, apportionment of the service levels according to the rainfall region was carried out as follows:

Table 4-5 Apportionment of Case Studies to Rainfall Band and Water Service Level

No.	Rainfall Region	Service Level	Theoretical No. of Case Study Areas	Actual No. of Case Study Areas
1	< 200 mm	House Connections	1	1
		Yard taps	1	1
		Standpipes every 200 m	1	1
		Standpipes greater than 200 away	0	0
2	200-400 mm	House Connections	1	2
		Yard Taps	0	1
		Standpipes every 200 m	1	0
		Standpipes greater than 200 away	1	0
3	400-600 mm	House Connections	1	1
		Yard taps	1	1
		Standpipes every 200 m	1	1

No.	Rainfall Region	Service Level	Theoretical No. of Case Study Areas	Actual No. of Case Study Areas
		Standpipes greater than 200 away	1	1
4	600-800 mm	House Connections	1	0
		Yard taps	1	2
		Standpipes every 200 m	1	0
		Standpipes greater than 200 away	1	1
5	800-1000 mm	House Connections	1	1
		Yard taps	1	1
		Standpipes every 200 m	0	1
		Standpipes greater than 200 away	1	2
6	>1000 mm	House Connections	1	0
		Yard taps	0	0
		Standpipes every 200 m	1	0
		Standpipes greater than 200 away	1	0
			20	18

The theoretical case study area apportionment column lists what case studies were sought using the available data. Based upon the data and instances where all the criteria for each case study were not met, the actual apportionment column was generated.

Following from the municipalities/rainfall bands table and the rainfall bands/service level table, the selection of the major places was carried out. This was done using the Census 2001 data. Sub-place data for major places within each municipality were used to test for poverty and service level. In all cases, many sub-places were identified that had high levels of poverty as well as the required service level. In these cases, accessibility to the researchers was used as the final arbiter.

The Census 2001 data sub-sets that were:

1. Sub Place level household income; and
2. Sub Place level household water supply.

Household income of less than R800/month was used. This number was translated into a percentage of the community to arrive at a percentage poor figure. Any figure with greater than 50% of the households in the sub-place having an income less than R800 per month was denoted a poor community.

The household water supply information provides information as to the number of households in each community that has the levels of service required by the research. For any given level of service, a percentage of the population enjoying that level of service was calculated. Any percentage greater than 50% was used as an indicator that the entire community used the specific level of service.

Those sub-places with small community sizes were disregarded for the analysis. Community sizes less than 150 were considered to be too small.

In some cases either the community size or the threshold income restrictions were relaxed if required. The relaxation was never more than fifteen percent. Typical circumstances under which this was done was if the required service type could not be found in a Local Municipality or where there were too few community members, but the service type and the poverty level were what was required. Such adjustments were made on an ad-hoc basis.

It should be noted that the following case study areas could not be found:

1. In the 200 mm to 400 mm rainfall band, there is no example of a poor community with standpipes. The poor communities in the Northern Cape tend to be well provided with water (i.e. a service level of stand taps or higher); and
2. In the 600 mm to 800 mm rainfall band, there are no examples of a poor community that have house connections. It appears as if poor communities in this band have informal housing and as serviced through standpipes. This is also a relatively wealthy area of the country and thus the number of communities meeting the definition of poor are relatively limited.

The results of the case study selection are been detailed as follows:

Table 4-6 Case Study Area Details

No.	Rainfall Area	Study Area Location					Community Information				
		Local	Service Level Criterion	Main Place	Sub-Place	Sub-place Code	% Poor	% with level of service	Community Size	Ward No.	Urban or Rural
1	< 200 mm	Richtersveld (NC061)	Dwelling	Port Nolloth	Sizamile	30106003	76.1	8	240	3	Rural
		Nama Khoi (NO062)	Yard Taps	Concordia	None	30204000	40	41.1	656		Urban
		Kai !Gharib (NC082)	Standpipes every 200 m	Augrabies	Augrabies	31602001	78.9	80.7	214	1	Rural
2	200-400 mm	Saldanha Bay (WC014)	Dwelling	Saldanha	Middelpos	10407003	50	80	3650	5	Urban
		Ga-Segonyana (NC452)	Yard Taps	Batlharo Ba Ga Motlhware	Ncweng	68101014	81.5	2	227	7	Rural
		Umsobomvu (NC072)	Dwelling	Umsombomvu	Noupoort	30806002	44.2	34.3	138		Urban
3	400-600 mm	Cape Agulhas (WC033)	Dwelling	Struisbaai	Struisbaai North	11308002	54.3	100	1575	5	Rural
		Sol Plaatje (NC091)	Yard taps	Galeshewe	China Square	32101003	50.6	53	3906	13	Urban

No.	Rainfall Area	Study Area Location					Community Information				
		Local	Service Level Criterion	Main Place	Sub-Place	Sub-place Code	% Poor	% with level of service	Community Size	Ward No.	Urban or Rural
		Lukanji (EC134)	Standpipes every 200 m	Mlungisi	Mlungisi	22110001	79.9	48.6	6708	25	Urban
		Lephalale (LIM362)	Standpipes greater than 200 away	Seleka	Bossche Diesch	01508001	54.1	52.0	1689	5	Rural
4	600-800 mm	City of Johannesburg (JHB)	Yard taps	Johannesburg	Thembalihle	77409270	59.6	85.7	20687	8	Urban
		Dihlabeng (FS192)	Yard taps	Masjaing	Mashaing	41307001	84.6	8.2	1150	12	Urban
		Jozini (KZN272)	Standpipes greater than 200 away	Nyawo	Othobothini	53310014	72.5	42.9	4992	8	Rural
5	800-1000 mm	Kwa-Sani (KZN432)	Dwelling	Kwa-Sani	Underberg	54804001	70.7	13.9	1479		Rural
		Msukaligwa (MP302)	Yard Taps	Msukaligwa	Ermelo	80209002	54.2		8238		Urban

No.	Rainfall Area	Study Area Location					Community Information				
		Local	Service Level Criterion	Main Place	Sub-Place	Sub-place Code	% Poor	% with level of service	Community Size	Ward No.	Urban or Rural
		Mbizana (EC151)	Standpipes greater than 200 away	Imizizi	Dindini	23009002	79.4	80.5	722	17	Rural
6	>1000 mm	Umjindi (MP323)	Standpipes every 200 m	Verulum	Verulum	81607001	63.1	48.0	1159	1	Urban
		Hibiscus Coast (KZ216)	Standpipes greater than 200 away	Nzimakwe	KwaNzimakwe	50617003	64.2	50.2	5357	10	Rural

Table 4-7 Summary of the Eighteen Case Study Areas

Province	Local municipality	Sub-place	Urban/ non-urban	Level of service	Rainfall region (mm)
NC	Richtersveld	Sizamile	NU	Dwelling	< 200
NC	Kai !Gharib	Augrabies	NU	<200 m	< 200
NC	Nama Khoi	Concordia	U	Yard	< 200
NC	Ga-Segonyana	Ncweng	NU	Yard	200-400
NC	Umsobomvu	Noupoort	U	Dwelling	200-400
WC	Saldanha Bay	Middelpos	U	Dwelling	200-400
WC	Cape Agulhas	Struisbaai North	NU	Dwelling	400-600
EC	Lukanji	Mlungisi	U	<200 m	400-600
LP	Lephalale	Bossche Diesch	NU	>200 m	400-600
NC	Sol Plaatje	China Square	U	Yard	400-600
GP	City of Johannesburg	Thembalihle	U	Yard	600-800
FS	Dihlabeng	Mashaing	U	Yard	600-800
KZN	Jozini	Othobothini	NU	>200 m	600-800
KZN	Kwa-Sani	Underberg	NU	Dwelling	800-1000
EC	Mbizana	Dindini	NU	>200 m	800-1000
MP	Msukaligwa	Ermelo	U	Yard	800-1000
MP	Umjindi	Verulum	U	<200 m	800-1000
KZN	Hibiscus Coast	Kwa-Nzimakwe	NU	>200 m	800-1000

Provinces are abbreviated.NC = Northern Cape, WC = Western Cape, EC = Eastern Cape, LP = Limpopo, GP = Gauteng, FS = Free State, KZN = KwaZulu-Natal, MP = Mpumalanga.

Figure 4-2 below graphically illustrates the location of the eighteen study areas.

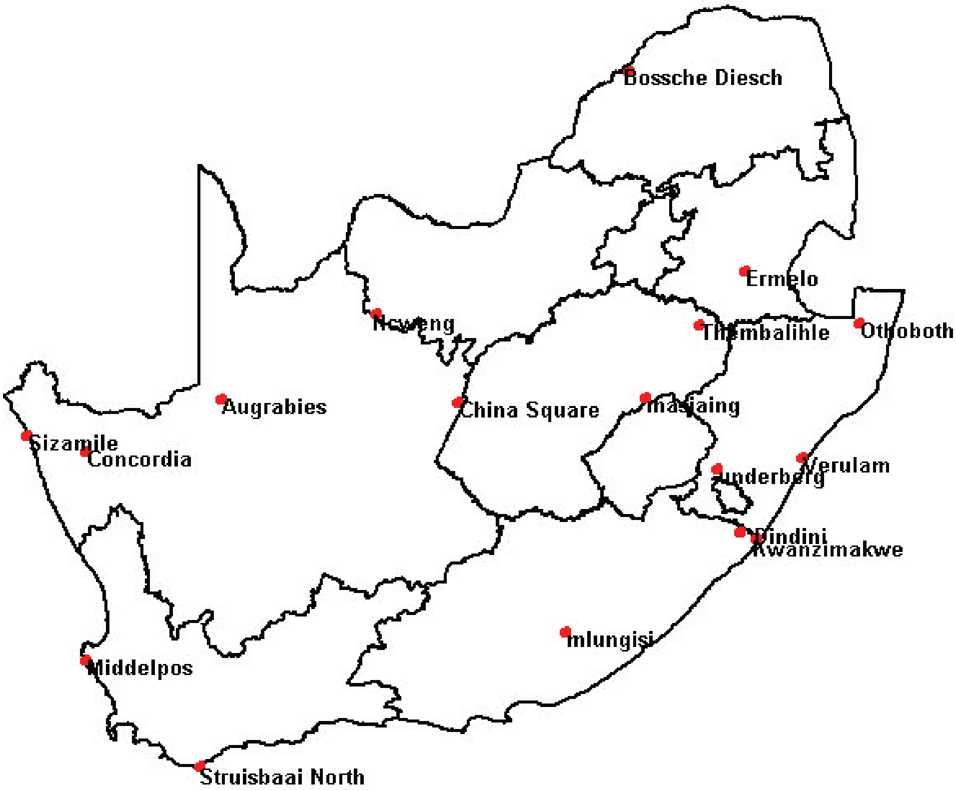

Figure 4-2 Locations of the eighteen study areas (sub-places) for the project

4.1.3 Approach to Data Analysis

The possibility of policy change necessitated the development of specific questions pertaining to the current FBW policy, and its possible change. These were analysed using cross-tabulation and correlation. Pearson correlations (2 tailed) were made of selective findings. This resulted in a detailed analysis of the statistics obtained. The findings of the appropriate tests are summarised and presented below, and discussed in relation to the project. The statistics obtained from the survey were analysed using SPSS version 15.

Cross-tabulation

Cross tabulation is method of presenting data in a more manageable manner. It allows better understanding of the data.

The Pearson Correlation

Correlation is the departure of two variables from independence. Thus, the higher the correlation between two variables, the higher their dependence upon one another. A measure of correlation is Pearson's Correlation Coefficient. The Correlation Coefficient can either be positive (with ranges between 0 and 1) or negative (with ranges between 0 and -1). Positive correlation means that as one variable increases, so does the other, whilst negative correlation means that as one variable increases, the other decreases. It should be noted that correlation does not necessarily imply causality.

Cohen (1988) suggests the following interpretations for correlations in behavioural research, below. These interpretations take into account the lower degrees of certainty that are inherent in social science research and should thus not be regarded as definitive or be observed too strictly.

Table 4-8 Degrees of Correlation

Degree of Correlation	Negative	Positive
Small	-0.3 to -0.1	0.1 to 0.3
Medium	-0.5 to -0.3	0.5 to 0.3
Large	-1.0 to -0.5	1.0 to 0.5

4.2 Data analysis

The following section summarises the data derived from the study. The study results are drawn from 270 households, within the 18 case study area selected for the study.

4.2.1 Descriptive Analysis of the Dataset

The main quantitative variables used for analysis in the project are as follows:

1. Water used for cooking;
2. Water used for cleaning the house;
3. Water used for bathing;
4. Water used for washing clothes;
5. Water used for drinking;
6. Water used for watering the garden;
7. Water used for watering livestock; and
8. Water used for other purposes.

These variables were measures in three periods. The first period was the initial 11 hour stretch from 07h00 to 18h00. The second period was over overnight period between 18h00 and 07h00 the next morning. The final period was between 07h00 and 18h00 the next day. The total number of hours during which water use measurements were made was 36 hours.

The following table provides a summary of the data presented above, arranged along to allow comparisons between the three periods. For a detailed descriptive analysis of the data, see appendix B.

Table 4-9 Types of productive use and amount in litres

		First Period (07h00 – 18h00)	**Second Period** (18h00 – 07h00)	**Third Period** (07h00 – 18h00)
Water used for cooking	Mean H/Hold Consumption	5.7	5.3	5.8
	No. Households	250	229	249
Water used for cleaning the house	Mean H/Hold Consumption	9.2	6.2	8.6
	No. Households	246	134	236
Water used for bathing	Mean H/Hold Consumption	21.2	17.2	21
	No. Households	266	238	266
Water used for washing clothes	Mean H/Hold Consumption	67.1	16.7	43
	No. Households	226	62	144
Water used for drinking	Mean H/Hold Consumption	4.8	3.1	4.4
	No. Households	260	244	255
Water used for watering the garden	Mean H/Hold Consumption	52.4	52	49.6
	No. Households	116	51	102
Water used for watering livestock and	Mean H/Hold Consumption	19.7	15.7	21.3
	No. Households	55	30	50
Water used for other purposes	Mean H/Hold Consumption	20.9	17.3	21.4
	No. Households	56	40	51

The following aspects of the above comparison led further credence to the integrity of the data:

- The mean household consumption of water used for cooking for the three periods is similar, with the overnight period showing the least consumption. This is intuitively expected, given that the daytime periods potentially include three meals, whilst the overnight period can be expected to contain two meals. The number of households who used water for cooking is around 92% of the total sample set during the day and 85% of the total during the overnight period. This indicates that either meals are being taken outside the house, or that meals are being missed. Both are possible outcomes in poor households such as those surveyed;

- Water consumption for household drinking water is higher as a percentage of the total sample, than water used for cooking; at 94-96% for the daytime period and 90% for the overnight period. This is to be expected, given that water intake is more necessary for daily survival than food intake, and that daytime drinking water use should be higher than night-time water use;
- Similarly water used for bathing is being used by 98% of the sample during the daytime and 88% during the night-time. These figures are higher than those for cooking water use. This is intuitively correct since it is less likely that people will bath outside their homes than eat outside their homes;
- A comparison of the mean consumptions for each of the categories of water use, between the first and the third period show good correlation. For all of the categories, barring clothes washing, all of these activities should be the same every day. Clothes washing is a periodic activity, with clothes typically being washed in batches during the week in a typical household;

These observations, added to the results of the descriptive statistics provided above lead the researchers to conclude that the data set provides a valid basis for analysis.

4.2.2 Domestic uses for water

Table 4-10 Water used by house

WATER USED BY HOUSE	
	Total
Sample	270
ALL	264
1 - 3 uses	6

264 of the 270 households interviewed use water in the house for cooking, cleaning, bathing, washing, personal hygiene and drinking (see table 4-10). There were 6 cases where only one to three of the above uses were cited.

4.2.3 Productive uses for water

Table 4-11 Water used for by household

WATER USED FOR BY HOUSEHOLD																
		AREA		RAINFALL					PROVINCE							
	Total	Rural	Urban	<200 mm	200 - 400 mm	400 - 600 mm	600 - 800 mm	800 - 1000 mm	Eastern Cape	Free State	Gauteng	Kwazulu Natal	Limpopo	Mpl	Northern Cape	Western Cape
Sample	270	135	130	30	60	60	45	75	30	15	15	45	15	30	90	30
Veg (% of HHS)	32%	38%	27%	20%	23%	17%	49%	48%	50%	53%	33%	64%	7%	27%	21%	10%
Count	86	51	35	6	14	10	22	36	15	8	5	29	1	8	19	3
Fruit trees	14%	14%	14%	37%	23%	13%	7%	1%	0%	0%	0%	9%	20%	0%	32%	3%
	37	19	18	11	14	8	3	1				4	3		29	1
Livestock	10%	17%	4%	0%	3%	22%	4%	15%	30%	0%	0%	11%	27%	7%	2%	20%
	28	23	5		2	13	2	11	9			5	4	2	2	6
Ice	4%	7%	2%	0%	5%	8%	4%	4%	0%	7%	0%	9%	13%	0%	1%	17%
	12	10	2		3	5	2	3		1		4	2		1	5
Bricks	1%	3%	0%	0%	0%	5%	0%	1%	3%	0%	0%	0%	20%	0%	0%	0%
	4	4				3		1	1				3			
Beer	1%	1%	1%	0%	0%	0%	2%	3%	3%	0%	0%	2%	0%	3%	0%	0%
	3	2	1				1	2	1			1		1		
Flowers	0%	1%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
	1	1				1										1
Other	6%	2%	11%	0%	10%	7%	16%	0%	0%	20%	27%	0%	7%	0%	10%	0%
	17	3	14		6	4	7			3	4		1		9	

The predominant productive uses of water in households (detailed in table 4-11), is watering a vegetable garden (with 32% of households utilising water in this manner), watering fruit trees (14%) and watering livestock (10%).

Watering vegetables has a rural bias (38% of rural households vs. 27% of urban households) bias. It is also an activity mainly falling within the 600-1000 mℓ/annum rainfall regions. In terms of provinces, KwaZulu-Natal, Free State, Eastern Cape and Gauteng respectively have the highest occurrence of vegetable gardens.

Fruit tree watering is equally split between urban and rural groups (with 14% of households utilising water to water fruit trees). There is a higher occurrence within the lower rainfall regions (<200-400 mℓ) of fruit tree watering. The Northern Cape is most productive in this regard, with 32% of households watering fruit trees, followed by Limpopo at 20%.

The watering of livestock is, as can be expected due to spatial constraints, a very rural biased activity (17% of rural households utilising water for this use, as opposed to 2% of urban households). Households predominantly watering livestock are in the 400-600 mℓ/annum rainfall region (225 of households) and in the Eastern Cape (30%), Limpopo (27%) and the Western Cape (20%).

4.2.4 Volumes of piped water used over a 24-hour period

Rural versus urban water usage

Table 4-12 Actual litres of water used/area/day

ACTUAL LITRES WATER USED / AREA / DAY			
	Total	Rural	Urban
Sample	265	135	130
Av/day	151.49	183.03	118.75

An average of 151.49 litres of water is used per household per day. This is approximately 4608 litres/month, 1400 litres below the current free water allowance. Water usage is however higher in rural areas with an average of 183 litres used per day (5566 litres per month), compared to 119 litres per day in urban areas (see table 4-12).

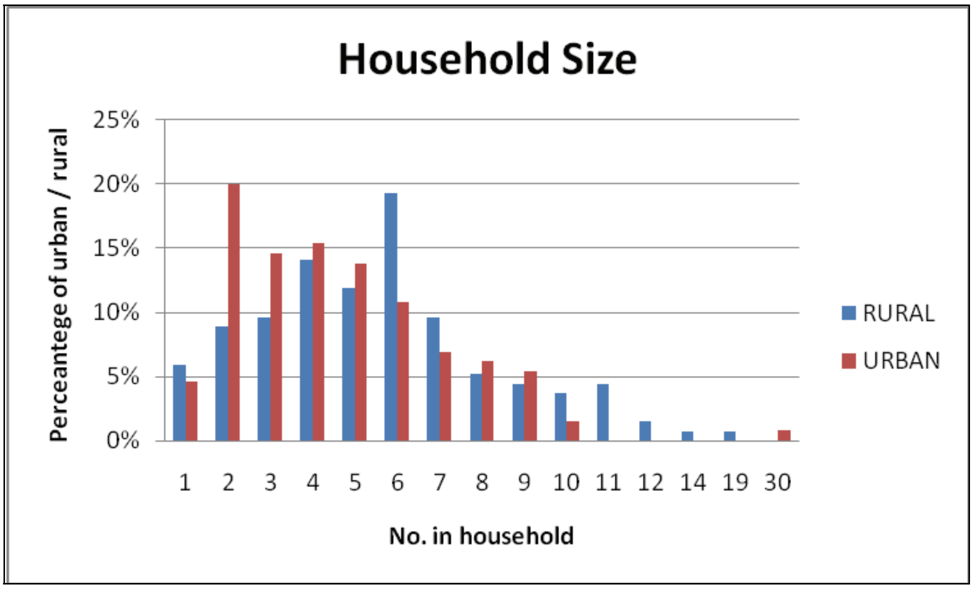

Figure 4-3 Household size/area

Reasons for this are twofold. Firstly, on average rural household are larger than urban households (see figure 4-3). The mean of persons per household in rural areas is 5.6 whilst it is 4.7 in urban areas. With more persons per household, it follows that those households would use more water.

Table 4-13 Average litres of water used/activity/area

AVERAGE LITRES WATER USED / ACTIVITY / DAY		
	Rural	Urban
Sample	135	130
Cooking	11.25	8.27
# of households	132	129
average litres / activity / area	1485.48	1066.63
Cleaning	13.76	8.32
	135	130
	1858.18	1081.43
Bathing	42.74	29.64
	135	130
	5769.43	3853.54
Washing Clothes	46.14	49.25
	129	114
	5951.70	5614.15
Drinking	7.99	6.37
	135	130
	1078.73	827.77
Watering Garden	75.72	42.41
	81	49
	6133.45	2078.13
Watering Livestock	31.01	4.69
	48	8
	1488.25	37.50
Other	32.54	24.39
	29	36
	943.75	878.03
Actual/day	261.15	173.33
Actual /month	**7965.08**	**5286.57**
Average / day	183.03	118.75
Average / month	5567.20	3611.94

Secondly, rural households are more prone to using water productively (see table 4-13).

Please note that in this table, and similar tables hereafter data is investigated in two ways. The amount of litres in the same row as the activity (highlighted in yellow in the below table) refers to the average amount of water used per day by those <u>households</u> using waster for that <u>particular</u> activity. The grey section then takes into account the number of households utilising water in this manner. Thus, the actual/day calculation at the bottom of the table is the higher estimate of the amount used by households utilising water to the greatest extent. The average/day calculation is the more conservative, dividing the actual amount of water used amongst all households (irrespective of whether or not they use water in a particular manner)

60% of rural households use, on average, 75.72 litres of water per day to water the garden, as opposed to 38% of urban households which use 42.41 litres per day on average. 36% of rural households also water livestock and an average of 31.01 litres is used per day to do so.

From this the question emerges whether a focus on rural areas for the implementation of a revised FBW policy might have more immediate benefits than a focus on urban areas. In order to gain clarity on this issue, we subjected the sample to a more complex analysis. Refer to the table below.

Table 4-14 Cross tabulation of Rural/Urban and Use

Variable	Description	Location		Total
		Rural	Urban	
Household Water Usage < 200 ℓ/d	Count	62	58	120
	% of total	33.5%	31.4%	64.9%
Household Water Usage > 200 ℓ/d	Count	48	17	65
	% of total	25.9%	9.2%	35.1%
Total	**Count**	**110**	**75**	**185**
	% within group	**59.5%**	**40.5%**	**100.0%**

The table demonstrates that more households in rural areas use more than the FBW allowance than households who overuse water in urban areas. In general, one third of households use more than the FBW allowance, with those households who use less than the FBW allowance split evenly between rural and urban dwellers.

In order to infer whether the rural or urban location would influence the productive use of water (to control for the possible rural bias in the sample), analysis of the sample was made with rural or urban location included. The results are shown below:

Table 4-15 Correlation of Rural/Urban and Volume

Variable	Description	Volume [litres]	Rural/Urban
Volume [litres]	Pearson Correlation	1	-0.198**
	Sig. (2-tailed)		0.001
	Number of Data Pts	270	265
Rural/Urban	Pearson Correlation	-0.198**	1
	Sig. (2-tailed)	0.001	
	Number of Data Pts	265	265

Correlation is significant at the 0.01 level (2-tailed) – Small Correlation (Cohen, 1988)

A small (20%) correlation was evident from the sample between amount of water used and rural/urban location. This suggests the view that the urban/rural nature of households does not have any influence upon the use of water for productive uses. It shows that merely by being rural, there is a greater chance or opportunity for using water for productive purposes.

Level of Service

Table 4-16 Actual litres of water used/level of service/day

ACTUAL LITRES WATER USED / LEVEL OF SERVICE / DAY					
	Total	>200 m	200 m	Yard	Dwellings
Sample	270	60	45	90	75
Total	150.18	243.70	116.33	143.39	90.36

The lower the level of service, the more water is used (table 4-16); households with standpipes greater than 200 metres away being the highest consumers of water.

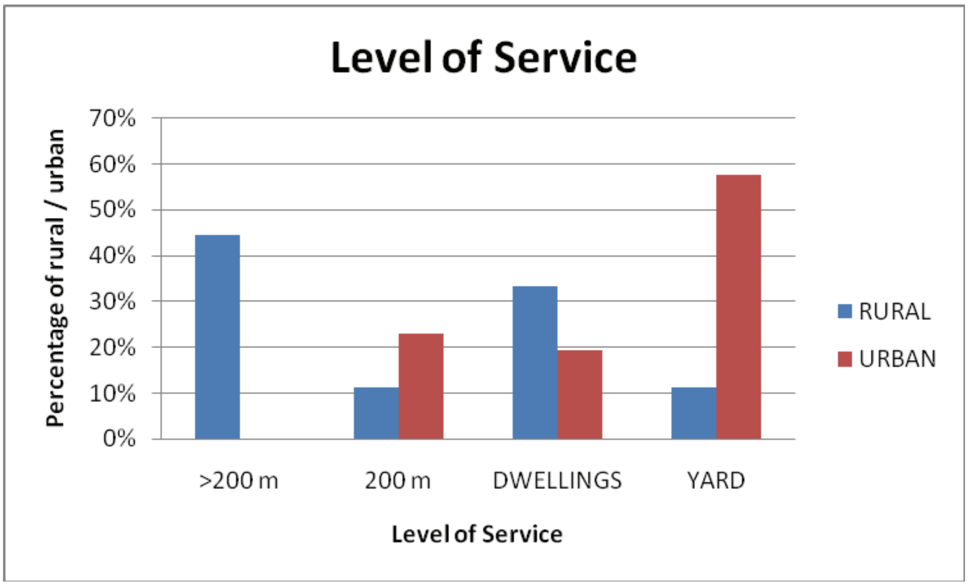

Figure 4-4 Level of Service

The higher usage of water in lower level of service areas is however more likely to be a result of the predominance of standpipes greater than 200 metres in rural areas (see figure 4-4).

Table 4-17 Average litres of water used/level of service/per day

AVERAGE LITRES WATER USED / LEVEL OF SERVICE / DAY				
	>200 m	200 m	Yard	Dwellings
Sample	60	45	90	75
Cooking	16.10	7.71	9.08	7.25
# of households	60	45	88	73
average litres / activity / service	966.20	347.13	799.08	529.20
Cleaning	19.43	6.82	8.86	9.33
	60	43	79	74
	1165.85	293.12	699.96	690.25
Bathing	55.10	29.74	36.76	23.35
	60	45	89	75
	3306.10	1338.10	3271.28	1751.23
Washing Clothes	57.80	39.52	49.03	27.32
	60	44	79	65
	3467.70	1739.03	3873.50	1776.02
Drinking	10.77	5.17	7.90	4.58
	60	45	90	75
	646.25	232.68	710.84	343.70
Watering Garden	97.43	38.42	65.21	24.97
	43	24	37	28
	4189.45	922.15	2412.73	699.25
Watering Livestock	26.65	7.64	48.14	27.37
	30	7	7	13
	799.50	53.50	337.00	355.75
Other	10.09	19.31	30.79	42.10
	8	16	26	15
	80.75	309.00	800.53	631.50
Actual/day	293.37	154.34	255.77	166.27
Actual /month	**8923.47**	**4694.46**	**7779.60**	**5057.42**
Average / day	243.70	116.33	143.39	90.36
Average / month	7412.44	3538.26	4361.38	2748.40

This hypothesis is further backed by the greater incidence of productive use in lower service areas (table 4-17) – the higher productive use of water already established to occur in rural areas.

Province

Table 4-18 Actual litres of water used/province/day

ACTUAL LITRES WATER USED / PROVINCE / DAY									
	Total	Eastern Cape	Free State	Gauteng	KZN	Limpopo	MPL	Northern Cape	Western Cape
Sample	270	30	15	15	45	15	30	90	30
Total	150.18	157.73	106.96	135.65	205.55	291.25	143.20	134.70	71.28

The provinces in which most water is used are Limpopo and KwaZulu-Natal (table 4-18). The households samples in both these areas were completely rural (figure 4-5). The higher water usage appears to be the result of the higher rural dependence on water, rather than a province specific bias.

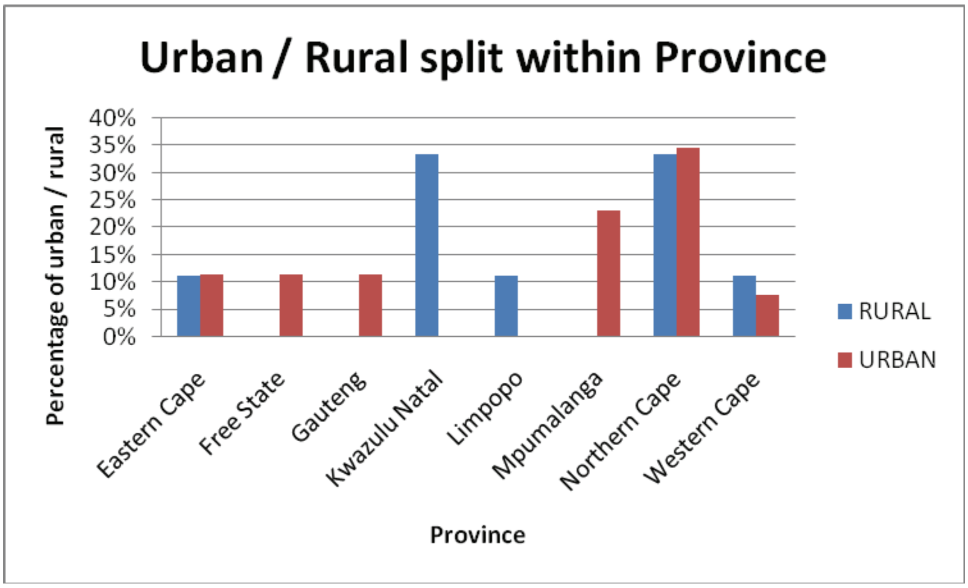

Figure 4-5 Urban/Rural split

Table 4-19 Average litres of water used/province/day

AVERAGE LITRES WATER USED / PROVINCE / DAY								
	Eastern Cape	Free State	Gauteng	KZN	Limpopo	MPL	Northern Cape	Western Cape
Sample	30	15	15	45	15	30	90	30
Cooking	13.04	13.29	12.28	13.63	12.38	8.24	6.78	8.22
# of households	30	14	15	45	15	30	89	28
average litres / activity / area	391.25	186.05	184.25	613.45	185.75	247.05	603.65	230.15
Cleaning	16.70	9.82	13.00	18.77	10.82	11.31	7.97	6.26
	30	14	14	45	15	28	80	30
	501.00	137.50	182.00	844.60	162.25	316.75	637.68	187.83
Bathing	33.23	36.46	41.10	50.47	65.00	39.56	29.83	15.38
	30	14	15	45	15	30	90	30
	997.00	510.50	616.50	2271.10	975.00	1186.75	2685.14	461.48
Washing Clothes	57.83	39.33	40.67	51.06	55.75	65.55	43.04	22.65
	29	12	13	43	15	30	80	26
	1677.00	472.00	528.75	2195.70	836.25	1966.55	3443.10	589.00
Drinking	6.92	6.09	7.08	6.86	19.05	6.94	6.64	4.27
	30	15	15	45	15	30	90	30
	207.50	91.35	106.25	308.75	285.75	208.05	597.87	127.95
Watering Garden	55.67	16.43	58.42	64.01	181.11	18.10	63.15	8.13
	15	7	6	34	9	9	46	6
	835.00	115.00	350.50	2176.45	1630.00	162.90	2904.98	48.75
Watering Livestock	15.41			46.41	30.16	5.70	36.45	4.58
	8			16	8	5	10	10
	123.25	0.00	0.00	742.50	241.25	28.50	364.50	45.75
Other		23.00	13.30	13.89	17.50	14.96	34.10	55.94
		4	5	7	3	12	26	8
	0.00	92.00	66.50	97.25	52.50	179.50	886.53	447.50
Actual/day	198.79	144.43	185.86	265.11	391.77	170.35	227.97	125.42
Actual /month	**6046.60**	**4392.99**	**5653.13**	**8063.65**	**11916.26**	**5181.50**	**6934.05**	**3814.84**
Average / day	157.73	106.96	135.65	205.55	291.25	143.20	134.70	71.28
Average / month	4797.72	3253.37	4126.02	6252.18	8858.85	4355.72	4097.27	2168.10

The productive usage of water in these provinces varies slightly (table 4-19). The majority (76%) of households in KZN use water to water the garden with only a third watering livestock. There is a more even split between these uses in Limpopo. The households that do water the garden in Limpopo however use much more water on average to do so (181 litres per day) than those in KZN (64 litres per day).

Annual Rainfall Region

Table 4-20 Count of other sources of water used/province

COUNT OF OTHER SOURCES OF WATER USED / PROVINCE								
	Eastern Cape	Free State	Gauteng	KZN	Limpopo	MPL	Northern Cape	Western Cape
Sample	30	15	15	45	15	30	90	30
Borehole				3	6		1	1
Rainfall	2		3	28	4	11	36	4
River	5	1		11	4		8	
Vendor	8	3						2
Water vendor		1						
Other		10	5	1	1	4	9	5

The lower usage of piped water in KZN may be a result of their higher dependence on rainfall (table 4-20).

Table 4-21 Actual litres of water used/rainfall region/day

ACTUAL LITRES WATER USED / RAINFALL REGION / DAY						
	Total	<200 mm	200 - 400 mm	400 - 600 mm	600 - 800 mm	800 - 1000 mm
Sample	270	30	60	60	45	75
Av/day	150.18	106.40	114.69	164.49	183.54	164.61

Interesting, it has been found that households in higher rainfall regions, on average use more water (table 4-21).

Table 4-22 Average litres of water used/rainfall region/activity

AVERAGE LITRES WATER USED / RAINFALL REGION / DAY					
	<200 mm	200 - 400 mm	400 - 600 mm	600 - 800 mm	800 - 1000 mm
Sample	30	60	60	45	75
Cooking	4.84	9.52	7.32	15.40	11.10
# of households	30	59	58	44	75
average litres / activity / area	145.18	561.58	424.55	677.50	832.80
Cleaning	6.62	8.54	8.01	16.39	15.80
	29	58	53	43	73
	191.93	495.25	424.58	704.60	1153.25
Bathing	20.81	26.59	35.96	46.29	43.85
	30	60	60	44	75
	624.19	1595.60	2157.83	2036.85	3289.00
Washing Clothes	36.58	28.54	54.67	47.28	59.62
	25	56	54	40	73
	914.60	1598.25	2952.00	1891.20	4352.30
Drinking	3.19	7.04	9.45	6.86	7.19
	30	60	60	45	75
	95.74	422.48	567.10	308.85	539.30
Watering Garden	61.16	56.03	95.86	81.12	33.67
	11	28	26	26	41
	672.73	1568.75	2492.25	2109.20	1380.65
Watering Livestock	2.50	42.00	15.06	37.25	27.46
	1	9	18	10	19
	2.50	378.00	271.00	372.50	521.75
Other	36.34	26.15	48.33	17.61	14.57
	15	10	12	9	19
	545.03	261.50	580.00	158.50	276.75
Actual/day	172.03	204.41	274.66	268.20	213.27
Actual /month	**5232.60**	**6217.43**	**8354.16**	**8157.85**	**6486.88**
Average / day	106.40	114.69	164.49	183.54	164.61
Average / month	3236.21	3488.49	5003.19	5582.61	5006.91

This greater water usage is across all domestic and productive water activities (table 4-22).

Table 4-23 Count of other sources of water used/rainfall region

COUNT OF OTHER SOURCES OF WATER USED / RAINFALL REGION					
	<200 mm	200 - 400 mm	400 - 600 mm	600 - 800 mm	800 - 1000 mm
Sample	30	60	60	45	75
Borehole		1	7	1	2
Rainfall	7	22	15	7	37
River	6	2	4	10	7
Vendor		2		3	8
Water vendor				1	
Other	1	9	5	16	4

Pipeline water does seem to be as precious a resource in higher rainfall regions where these is a greater usage of rainfall water (table 4-23).

Summary of amount of water used

Table 4-24 Number of productive activities done per household

# of productive activities done			
		Rural	Urban
Sample		135	130
	0	19.26%	45.38%
Count		26	59
	1	47.41%	37.69%
		64	49
	2	28.15%	14.62%
		38	19
	3	5.19%	2.31%
		7	3
Any productive activity		80.74%	54.62%
Count		109	71

It thus has become clear that the largest determinant of water use is urban versus rural location with 80% of rural households utilising water for some productive use (in order of incidence, watering a vegetable garden, watering a fruit garden and watering livestock). 54% or urban households utilise water in some productive way (in order of incidence, watering a vegetable garden, watering a fruit garden and other unspecified ways) (table 4.24).

Table 4-25 Average litres of water used – domestic versus productive

AVERAGE LITRES WATER USED DOMESTIV VS PRODUCTIVE		
	Rural	Urban
Sample	135	130
Actual/day	261.15	173.33
Actual /month	**7965.08**	**5286.57**
Average / day	183.03	118.75
Average / month	5567.20	3611.94
Actual / day / domestic	46.67%	58.76%
Actual / day / productive	53.33%	41.24%
Average / day / domestic	65.33%	80.61%
Average / month / productive	34.67%	19.39%
Actual l / month / domestic	3717.38	3106.21
Actual l / month / productive	4247.70	2180.36
Average l / month / domestic	3637.31	2911.49
Average l / month / productive	1929.89	700.45

The data was thus further investigated to determine how much water was needed by those households using water for the greatest variety of tasks, compared to the average use per household. This was then further split between domestic (cooking, cleaning, bathing, washing clothes and drinking) and productive uses (watering garden, watering livestock and other) (table 4-25). About 4000 litres is used per month on domestic uses in rural households as opposed to 3000 litres/month in urban households (this may be attributed to the higher household size of rural households. Of households using water productively, rural households use about 4300 ℓ (this drops to 2000 ℓ when including the 20% of households not using water productively in the average) on productive activities and urban households 2200 litres (this drops to 700 ℓ when including the 45% of households not using water productively in the average). Thus a rounded total of 8300 litres per month are required in rural areas, and 5200 litres in domestic households.

Table 4-26 Average litres of water used – potable versus raw

AVERAGE LITRES WATER USED POTABLE VS RAW		
	Rural	Urban
Sample	135	130
Actual/day	261.15	173.33
Actual /month	**7965.08**	**5286.57**
Average / day	183.03	118.75
Average / month	5567.20	3611.94
Actual / day / potable	46.67%	72.83%
Actual / day / other	53.33%	27.17%
Average / day / potable	65.33%	85.49%
Average / month / raw	34.67%	14.51%
Actual l / month / potable	3717.38	3850.08
Actual l / month / raw	4247.70	1436.48
Average l / month / potable	3637.31	3087.96
Average l / month / raw	1929.89	523.98

The quality of waster needed was then considered (table 4-26). This is more relevant to the rural sample as domestic uses require potable water whist productive uses can be performed using raw water. In urban households by comparison, many productive uses are more likely to require potable water (hairdressing, ice making, car washes etc.). Rural households require about 4000 litres of potable water for domestic purposes. For those utilising water productively, about 4300 litres of raw water are required (this drops to 2000 ℓ when including the 20% of households not using water productively in the average).

Other considerations

<u>Will more FBB result in more productive use of water?</u>

A further question arises: whether those who are productive users of water, use more or less water overall than those who are not productive users. This allows inferences to be made whether the supply of more water than the FBW policy suggests would lead to more productive use. Bear in mind that this complex issue cannot be answered by this question alone, but clear indications of how the amount of water available affects productive use of water is possible.

It was found that those respondents who use water for productive purposes, use less water overall than those who do not use water for productive purposes. This indicates that the amount of water used does not necessarily lead to more productive use. It further indicates that other factors than the amount of water available influences productive use of water.

From the sample, the following figures were obtained: 65.4% of those who use water for productive purposes use less than 200 litres a day, whilst 39.9% use more than 200 litres a day. Refer to the table below.

Table 4-27 Productive Water Users: Volumes of Overall Water Use

No.	Productive Water Users: Volumes of Overall Water Use	No. of Occurrences	Percent of Occurrences	Cumulative Percent
1	Less than 200 ℓ/day	123	65.4	65.4
2	More that 200 ℓ/day	65	34.6	100.0
Total		**188**	**100.0**	

Because it is difficult to come to any firm conclusion based on the analysis above, the sample, was subjected to further analysis, with this issue in mind. A Pearson correlation analysis of the sample was run to infer to what extent the volume of water directly influences productive use of water. The results are shown below:

Table 4-28 Correlation of Volume to Productive Use

Variable	Description	Volume [litres]	Productive User
Volume [litres]	Pearson Correlation	1	0.230**
	Sig. (2-tailed)		0.000
	Number of Data Pts	270	270
Productive User	Pearson Correlation	0.230**	1
	Sig. (2-tailed)	0.000	
	Number of Data Pts	270	270

Correlation is significant at the 0.01 level (2-tailed) – Small Correlation (Cohen, 1988)

A small (23%) correlation exists between the productive use of water and the amount of water used. This could mean that other variables influence water consumption. The amount of water consumed, from the findings contained in this sample, is thus not the most important determinant of the use of water for productive purposes.

Will more FBB be needed due to seasonal factors?

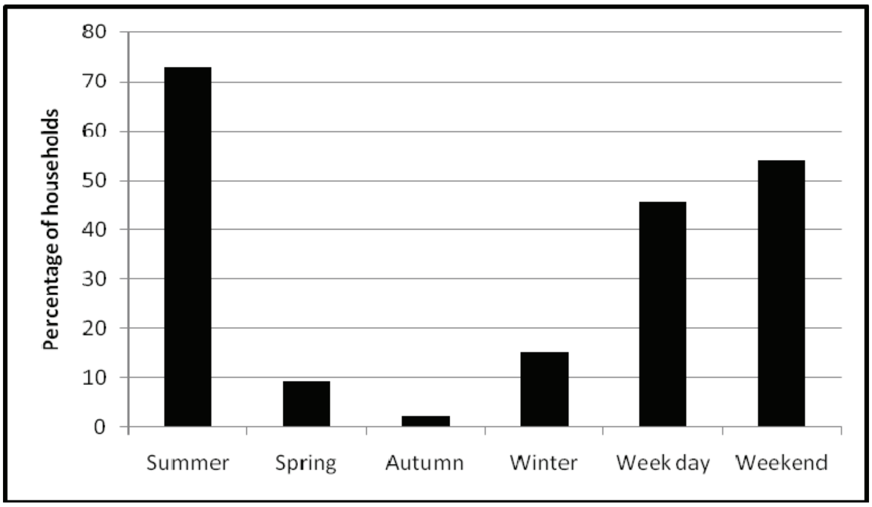

Figure 4-6 Periods of increased water use per household

Most households use more water during summer, and over the weekend (Figure 4-6). This study was conducted early in summer 2007. The water use indicated above is therefore an indication of approximately 80 percent of their highest water use. i.e. the above-mentioned water use does not necessarily indicate the water use for the 'highest use' period. This water use may increase by approximately 20% in mid-summer. To determine maximum water use, we assume that a small amount, roughly estimated at 20%, more water would be used per household during the heat of summer.

4.2.5 Benefits derived from productive water use

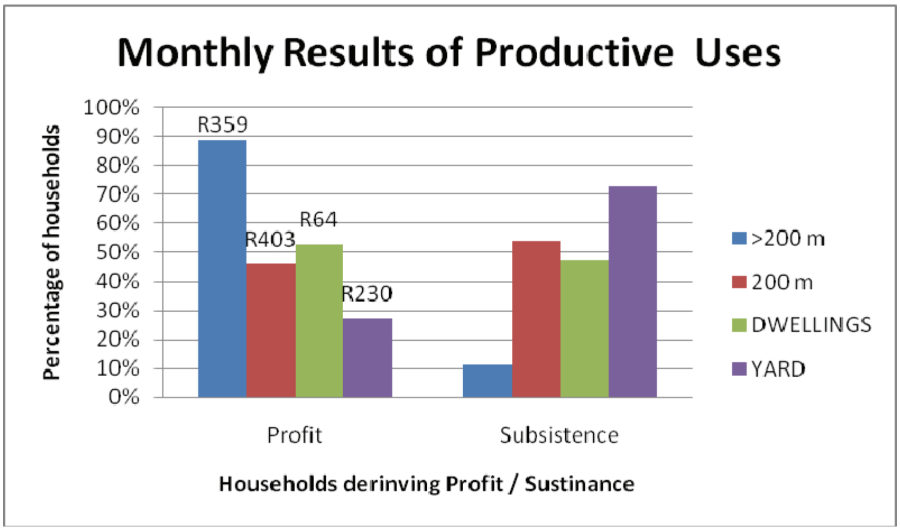

Figure 4-7 Households deriving benefit from productive uses according to level of service

Nine percent of the participating households indicated the subsistence value of their productive uses, while 12.6% indicated the monetary value. Those groups obtaining the most profit from productive uses had water connections to their dwellings or yards (Figure 4-7. The number in the chart refers to the average monthly profit derived from productive uses).

Those earning a profit were earning an average of R307 per month (Figure 4-8 The number in the chart refers to the average monthly profit derived from productive uses).

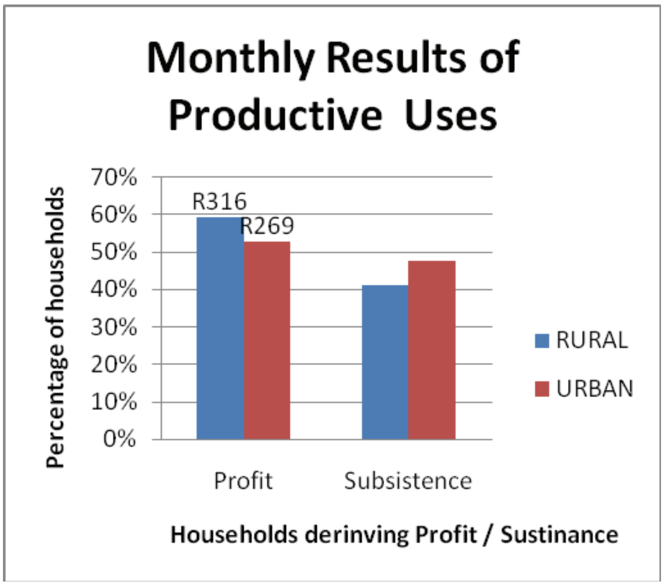

Figure 4-8 Households deriving benefit from productive uses of water

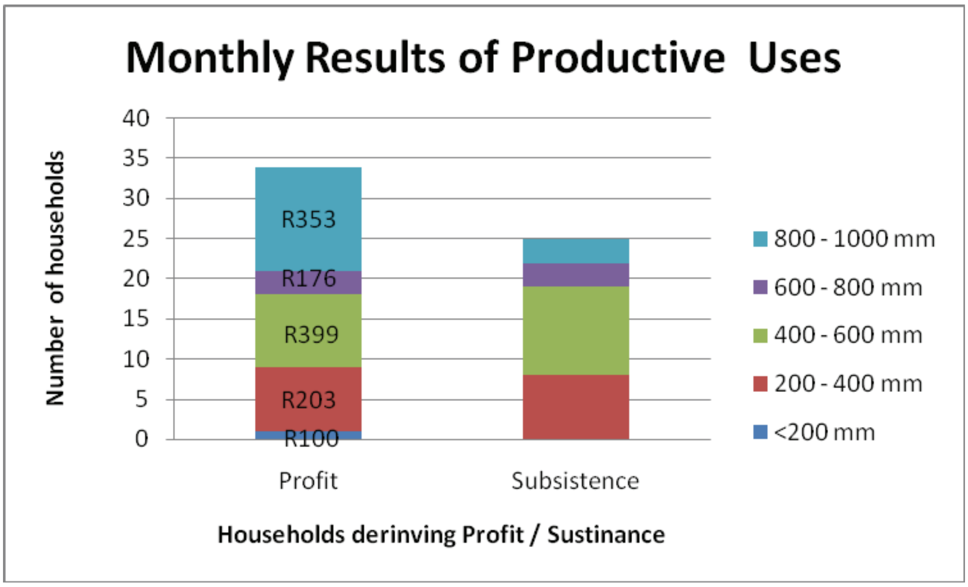

Figure 4-9 Households deriving benefit from productive uses according to rainfall regime

The participating households within the regime receiving least rainfall (<200 mm) had the smallest percentage deriving some profit from their productive uses (Figure 4-17. The number in the chart refers to the average monthly profit derived from productive uses). Their monthly income from productive uses was also the lowest of all the groups. This indicates the 'safety net' or assurance of water supply that encourages households to undertake productive uses for economic benefit. Therefore, households with the assurance of reliable and nearby sources of water are likely to undertake productive uses because of the reduced risk of failure due to water-related problems.

4.2.6 Participation in productive water use

The following section deals with the response to the question "what would the householder do if additional water was provided"

With an increased water supply, a number of different productive uses of water would be encouraged. These include, in order of popularity: providing a washing and cleaning service to others, storing water, cooking for others, hair salons, car washes, and vendors. Two of these activities involve storing water and supplying it at a later stage, possibly making a profit when water supply is low.

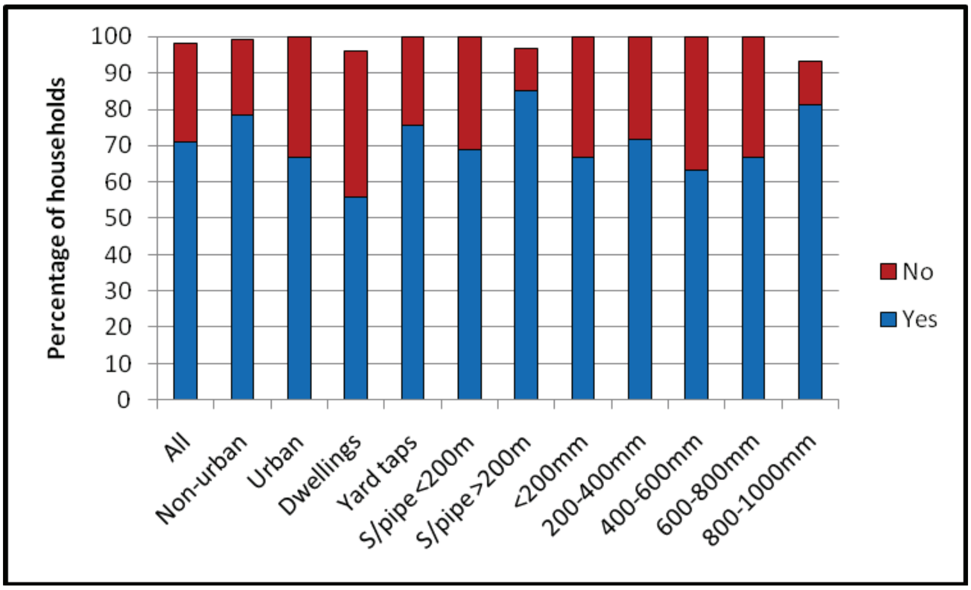

Figure 4-10 The productive uses of water that would be encouraged by a better water supply

On average, 71% of all households indicated that they would be encouraged to participate in productive uses of water if their water supply was better (Fig. 4-10).

The group with the highest percentage (85%) of participants wanting to take part in productive uses, were from areas supplied only by standpipes further than 200 m from their dwellings (i.e. are physically experiencing water shortage). Interestingly, 80% of households in areas receiving 800-1000 mm of rain annually would take part in productive uses of water with a better water supply. One would expect that in areas of high rainfall, rainfall would be harvested and used for just such purposes, without the reliance on domestic water supplies. Perhaps this would merely increase the intensity of productive uses. Another reason could be that these households might not have the infrastructure to harvest rainwater, and yet they realise the benefits of water for productive purposes.

Around 25% of participants indicated that they would not participate in productive uses even if their water supply was improved. Most of those not keen on productive uses were from urban areas, or having water supplied to their dwellings. They may therefore have other opportunities for income-generation, or may have different constraints to productive uses, such as a lack of available space.

4.2.7 Poverty alleviation and productive water use

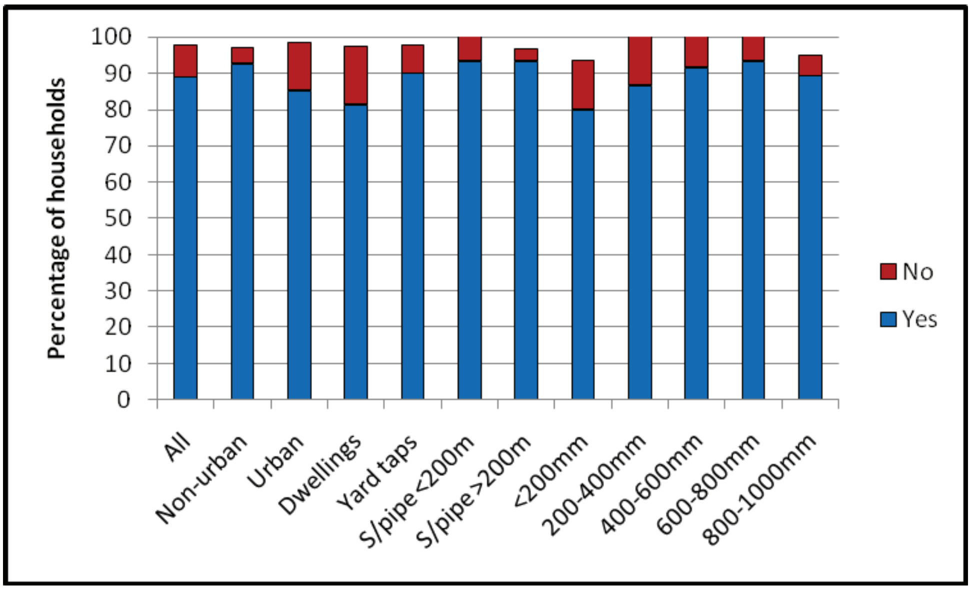

Figure 4-11 Household response to whether productive uses of water assist in alleviating poverty

Almost 90% of the households indicated that productive uses would assist in the alleviation of poverty (Figure 4-11). This indicates an awareness and appreciation for the benefits that water can provide, in terms of domestic use, subsistence and income. However, a small percentage of households responded that productive uses did not assist in alleviating poverty.

5. SUMMARY OF KEY RESULTS

Water use is slightly higher during the day (07h00-18h00) than at night (18h00-07h00). Activities utilising the most water are washing clothes (57 ℓ during the day and 16 ℓ at night), watering the garden (similar levels of around 52 ℓ during both time periods) and livestock watering (20 ℓ during the day and 16 at night).

Watering the garden comprises of watering a vegetable garden (with 32% of households utilising water in this manner) and watering fruit trees (14%). Watering vegetables has a rural bias and falls mainly within the 600-1000 mℓ /annum rainfall regions. Fruit tree watering occurs within the lower rainfall regions (<200-400 mℓ) and is most prevalent in the Northern Cape.

The watering of livestock is a very rural biased activity with 17% of rural households utilising water in this way.

Water usage is higher in rural areas with an average of 183 ℓ used per day, compared to 119 ℓ per day in urban areas. This is because rural households are larger on average than urban households and more likely to using water productively.

Households utilising a lower level of service (standpipes greater than 200 metres away) also use more water. Yet, these are solely rural households so may be more a result of being rural than service level. This additional water is used for watering the garden and watering livestock (again a rural biased activity).

Similarly households in Limpopo and KZN use more water, but again, the sample in these areas was solely rural.

About 4000 litres is used per month on domestic uses in rural households as opposed to 3000 litres/month in urban households. Of households using water productively, rural households use about 4300 ℓ on productive activities and urban households 2200 litres.

Consistent with rural households using more water and in more productive ways, rural households are more likely to make a profit from the productive use of water, and a greater profit (R316 as opposed to R269 in urban areas). Households within higher rainfall regions are also make more of a profit from using water in a productive manner. There is also a rural bias in households that indicated that they would be encouraged to participate in productive uses of water if their water supply was better.

Households in higher rainfall regions, on average use more water where pipeline water does seem to be as precious a resource where these is a greater usage of rainfall water. Also, most households use more water during summer. This study was conducted early in summer and thus there may be an additional 20% used in mid-summer.

6. FINDINGS

Drawing from the survey of the literature, the review of the legislative framework for productive water usage and the case study analysis, the following conclusions can be drawn. These conclusions are drawn with reference to the aims of the study.

6.1 South Africa's legislative and policy framework covering the use of water for productive use

The South African legislative framework is strongly supportive of water provision for basic human use. According to the Water Services Act (Act No 108 of 1997) 6000 litres of free basic potable water must be supplied to households each month to support basic human use. It is the responsibility of local government to provide this water. This conforms to the UNESCO minimum requirement for basic human needs (health and hygiene) and thus does not address productive water use.

The National Water Act (Act No 36 of 1998), in protecting the resource, allows for reasonable domestic use. This includes garden watering and small-scale agricultural production. The act recognises the ability of water to support social and economic development. The act encourages efficient, sustainable and beneficial use in the public interest. These are tasks to which productive water use is suited, yet this is not made explicit. Beneficial water use is not defined. The National Government is responsible for water allocation. There is however no guidance to local government on methods to be used for the provision of these potentially productive uses.

The Strategic Framework for Water Services (2003) holds that water programmes should support economic development and sustainable livelihoods. Again, these are tasks to which productive water use is suited, yet this is not made explicit. According to this framework it is the role of local government to make provision for this. However, the Municipal Structures Act (Act No. 118, of 1998) does not make provision for this – only that at least basic services be provided and not necessarily without a cost.

In terms of policy statements, productive water uses are allowed and encouraged, although there are no measures to subsidise this use. The Free Basic Water policy allows 6000 litres of free potable water to each household per month. Current policy states that additional water use above 6000 litres should be paid for. This position finds support in the Strategic Framework for Water Services, with its concept of households moving up the water ladder.

6.2 International best practice with regards to productive water use

It has been estimated that in order to ensure our basic needs, every individual needs 20 to 50 litres of water free from harmful contaminants each and every day (UNESCO). Between 50 and 200 litres per capita per day is a quantity of water sufficient for both domestic and some small-scale multiple uses (Butterworth et al., 2004). Differentiation is made between water for productive use and water for beneficial use. Productive use of water is defined as the use of water to promote economic growth and improve livelihoods such as watering foodlots and livestock (Desvouges & Kerry Smith, 1983). Beneficial water use on the other hand does not necessarily result in economic growth, however it does add value to people's standard of living such as the use of water for traditional/cultural and/or ritual functions (Desvouges & Kerry Smith, 1983). Both these uses of water are important.

Research exists that demonstrates that water is being put to productive use in poor households in many developing areas of the world. This research consistently shows that this productive use contributes to the improvement in the quality of life enjoyed by households.

It is found that rural households with piped water use significantly more water on productive uses than to their urban counterparts (Thompson et al., 2001). The research also demonstrates that the most common productive use is agriculture related. This experience is replicated in South Africa where agricultural uses predominate.

These varying applications of water make the distinction of quantity versus quality of water supply important. Many productive uses require a greater quantity of water (yet not necessarily potable water). Soussan et al. (2002) found productive water use in villages between 23 to 40 $\ell c^{-1} d^{-1}$. Domestic uses require water of a potable standard (21 to 22 $\ell c^{-1} d^{-1}$ was used in villages according to the Soussan et al. (2002) study).

The source of non-potable water for productive use can be from rainwater or groundwater where available, and used domestic or treated water as a supplementary source of water. Van Koppen et al. (2006) found that water-related activities are often more sustainable where water is derived from more than one source.

Other important considerations identified when providing water is that ownership is fostered. That is the community needs to be involved in the planning and management of water supply systems. This decreases mismanagement and as a result reduces leaking and illegal connections which ultimately improve maintenance and repair costs. Lastly, the cost recovery strategies need to be investigated as well as the cost of maintenance to ensure sustainability.

6.3 Current productive water use by the poor in South Africa

The study clearly demonstrates that water is being put to productive uses. Of the households surveyed by the study, half engaged in some form of productive use of water. Productive use appears to be heavily weighted towards agricultural uses and a greater number of rural households engage in productive use than urban households. The average water use is 183 litres per day in rural households compared to 119 litres per day in urban households.

Vegetable production is the highest user of additional household water, followed by the production of fruit and livestock watering. The agricultural uses vastly outnumber other uses such as small-scale commercial uses (car washes, hair salons, and water storage and resale), ice making, brick making and beer brewing.

This breakdown of productive uses shows why the rural poor tend to engage on productive water use more than their urban counterpart. The urban poor dweller has less space and possibly less expertise in agricultural production than the rural dweller, the urban dweller also has a greater variety of economic opportunities than the rural dweller, and many of these opportunities would be more economically rewarding than agricultural production.

The data also established the link between water use and rainfall. There was a clear increase in the use of water for productive purposes as the annual rainfall increased. It is submitted that this is due to the conditions for agriculture being improved via better access to water, better soil conditions and a wider variety of crops being possible. Household responses to the qualitative sections of the questionnaire also indicated that households in the higher rainfall areas stated a greater need for additional water for productive purposes. There was also higher domestic used of pipeline water in higher rainfall regions. It seems as though the general higher availability of water resulted in households using it less sparingly.

Just less than one quarter of the households surveyed indicated that they derive some benefit from putting water to productive use. These households either benefitted from the support that the extra production added to their food consumption, or who derived an actual profit from selling the products of the productive water use. The average profits derived by those households that yielded a profit were R307 per month. This is a significant fraction of the average household income reported by all 270 households surveyed; that of R835 per month.

7. DISCUSSION OF FINDINGS

Overall, there is less focus upon productive water uses in South Africa's legislation and policy than there is on the provision of water for basic human needs. There is no direct reference to the use of water for productive purposes. It is rather alluded to and encouraged though references to the reasonable, beneficial, sustainable and economic development uses of water. There are no recommended measures for this use or authority held responsible for making provision for this use. Similarly the beneficial use of water, which does not necessarily result in economic growth, but does add value to people lives, is not reflected in policy.

Administratively South African water providers should plan for growth in water demand; this allows increases in water use above and beyond basic human needs and into productive water uses. Definitions need to be clear, the authorities responsible for the provision of the productive water need to be held accountable and the amount of water provided for productive use needs to be made explicit. The international trend towards multiple water use (taking into account domestic, productive and beneficial water use) would be an ideal definition to follow. It makes provision for the way in which water is actually being used in rural settings.

A better water supply (greater volume and reliability) would encourage more households, to undertake more varied productive uses, and possibly to intensify their activities. The data demonstrated a small correlation between volumes of water use and the degree of productive water use.

From the literature, it appears that better water supply would reduce some of the uncertainty around the sustainability of household activities. It would also negate the loss of earnings spent on initiatives that would previously have collapsed because of a lack of water.

Ultimately, the results of the literature and policy reviews, stakeholder engagement, and case study analysis have prompted the reassessment of the volume of free basic water. The current allocation is 6000 litres of water per household. This study has found that the average water use for both domestic and productive uses is 8300 ℓ/month in rural areas and 5200 ℓ/month in urban areas (in poor communities), and the average household size is 5.6 in rural areas and 4.7 in urban areas. The methods of accessing this additional water in rural areas and funding its supply are the next level of consideration in the use of productive water in South Africa.

7.1 Future Research Questions

The major question raised by the research is whether water for productive use should be subsidised. This research report has demonstrated that water is being used for productive use and the various uses to which this water is being put. The research report also highlights that poor households using water for productive use, use 122% more than poor households that do not. The levels of water debts are high and that 40% of the households surveyed indicate that they pay for water, when possible, demonstrates both that water affordability can be low amongst the poor and that the provision of more water to households for beneficial use may experience financial sustainability challenges. Given this background and the fact that South Africa is a water scarce country, is the productive use of water the best use to which water can be put?

Alternative uses for water would be providing the minimum requirement to more of the population, rather than improving the supply to those who have their basic needs satisfied. Any additional water could also be used to satisfy future demand brought about by economic growth. Increasing water allocations could be made to industry and intensive agriculture.

These questions should be debated in future research.

The impact upon productive water use on catchment level water use should be determined. The volumes and quality of the return water that has been used for productive use and the impact on catchment management plans has not been determined.

This research indicated that the majority of water users surveyed have stated that they would use water if it were available. It is suggested that wanting to use water in such a manner and actually using the water are not the same thing. This research also indicates that households with higher levels of service use more water for productive use than those with lower service level standards. Thus it would be insightful if a within-area study was conducted into water use to isolate the desire to use water productively from actual uses. This study would ensure that factors such as location, climate and market conditions do not influence the decision whether or not to engage in productive water use.

8. RECOMMENDATIONS

The types of productive uses undertaken by the poor are influenced by the availability of water, climate, technology, the needs of the community and individual, finances, and skills. An important, but not necessarily decisive, consideration is the availability of water. Although some economic activities might not be water-dependent, the availability of water plays a large role in the ability of the household to undertake productive uses for either subsistence or income. If no direct benefits can be derived from the water supply (income or subsistence) then there are indirect benefits. Having a reliable water supply nearby will free up the time spent by households collecting water; reduce expenditure on water; improve health and nutrition, especially for women and children; reduce time spent away from school; and will reduce medical costs that may be incurred from malnutrition or disease.

Future studies will need to examine the cost of design and installation of suitable water supply systems (including both traditional reticulation systems and subsidising alternate technologies), as well as the economic return, in order to accurately gauge the sustainability of such projects. Studies will also have to take into account methods of cost-recovery, especially where extra 'free' water is supplied to encourage productive use. A number of difficult questions need to be answered when determining the viability of improving infrastructure or providing greater amounts of free water. Should those that derive some income from water use be expected to pay for this extra water? Should there be a stepped tariff dependent on the income derived? Is it fair to make more water available in areas where the end products (such as beer or ice) are more valuable than other products (such as vegetables)?

In summary the following is recommended:

1. Provision for multiple water use consistently throughout legislation and policy (rather than varying definitions) and specified allocations.

2. Responsibility for the provision of multiple water use.

3. Assistance for water provision in terms of funding and support.

4. Increase the level of service (especially in rural areas where the predominant service level is water stand pipes more than 200 metres away).

5. Increase the free basic allowance to 8300 litres per month in rural areas.

6. Ensure that 4000 litres a month of this is potable water – the remaining 4300 could be raw water. (Urban areas are more reliant on potable water so the whole of their FBA should be potable).

7. Provide water storing facilities in higher rainfall regions.

8. Consider increasing the FBA to 10 000 litres per month in rural areas during the summer months and to 6500 litres per month in urban areas.

Increasing the free basic water allowance has some associated issues that need to be fully investigated:

1. Cost recovery needs to be taken into account – a further 3000 litres of water could be provided on a stepped tariff where communities are able to contribute. For example, where water use is greater than 6000 litres and less than 9000 litres, the rate would be slightly more than nominal. Water use above 9000 litres per month would incur greater tariffs. These economic considerations should be thoroughly studied in order to encourage efficient use and identify any possible un-intended consequences;

2. The further 3000 litres could be provided freely to the poorest or most vulnerable communities, after a screening or application process is undertaken;

3. There could be contracts in place ensuring that those communities receiving this extra 'free' water will maintain and repair the systems. This again implies the provision of education and training in conjunction with the installation of such a system;

4. Another option is to provide the quantity of water from alternate sources. This would then entail the provision of suitable treatment for drinking water. Of this 8300 litres of water per household per month in rural areas, approximately 4000 litres of this water would need to be high quality water for domestic purposes. Options include the provision of 8300 litres of untreated or semi-treated water, with the associated storage infrastructure, as well as sufficient chemicals or infrastructure to treat 4000 litres of water for drinking purposes.

Water availability has an impact on the ability of households to be self-sufficient. Most of the households are prepared to independently attempt to alleviate their poverty, relying less on government grants. With the provision of extra free water, or an improved reliability of supply, many households would then be able to undertake productive uses, providing produce for subsistence, and/or selling excess produce for income, or initiating new enterprises that involve the use of water. Providing communities with the options of becoming self-sufficient and economically productive, and reducing their poverty, will improve overall community pride.

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10. APPENDICES

A Questionnaire

EMPLOYEE REQUIREMENTS

1. Complete each question. Use the section at the end to note any information relating to the household's water use that may be interesting or of value to the study.
2. Spend two days with each household. This is from 7am to 6pm.
3. Use the bucket to accurately measure how much water is used for each purpose. Leave the bucket overnight with the household and ask them to estimate how much water they use between 6pm to 7am.

A. HOUSEHOLD INFORMATION – SEE EG OF QUESTIONNAIRE

1. Main member of household:	
2. Phone number of main member:	
3. Address of household:	
4. How many members are there in the household?	
5. What is their monthly income?	
6. Who is the main income provider?	
7. Do they have alternate sources of income?	
8. Does anyone in the household receive any government grants (e.g. disability, pension, child care)?	
9. Where does the household's water come from?	

B. WATER USE INFORMATION

1. WATER USE

1.1 What is water used for in the house?	Cooking	Cleaning (house)	Bathing	Washing (clothes)
	Personal hygiene	Drinking	Other	
Make an X over the relevant answers				

1.2 What is water used for by the household?	Vegetable garden	Fruit trees	Livestock
	Making bricks	Making ice	Making beer
Make an X over the relevant answers			

1.3 If water is not used for any of the above (in1.2), what is the reason?	

2. AMOUNT OF WATER USED

2. Use the 5 litre buckets provided, to measure the amount of water used by the household for the various uses. On the lines provided below, make a note of the volume of water used each time it is used. At the end of the line, add up the volume used. If a bucket is not filled, estimate how much of the bucket is used for a particular purpose.

For example, Sally uses half a bucket in the morning to cook porridge for the household. Half a bucket = 2.5 litres. Later in the day, she uses 2 buckets of water to wash her clothes and another 2 buckets of water to rinse the clothes. 4 buckets = 20 litres of water. Therefore, Sally uses 2.5 litres for cooking, and 20 litres for washing clothes.

2.1 On **DAY 1**, how much water is used for:	
a) Cooking	
b) Cleaning the house	
c) Bathing	
d) Washing clothes	
e) Drinking	
f) Watering the garden	
g) Watering the livestock	
h) Other	
Specify the volume for each use in litres. Use the buckets to measure.	

2.2 How much water is used overnight?	
a) Cooking	
b) Cleaning the house	
c) Bathing	
d) Washing clothes	
e) Drinking	
f) Watering the garden	
g) Watering the livestock	
h) Other	
Specify the volume for each use in litres. Use the buckets to measure.	

2.3 On **DAY 2**, how much water is used for:	
a) Cooking	
b) Cleaning the house	
c) Bathing	
d) Washing clothes	
e) Drinking	
f) Watering the garden	
g) Watering the livestock	
h) Other	
Specify the volume for each use in litres. Use the buckets to measure.	

2.4 Is more water used at other times?	Spring	Summer	Autumn	Winter
(Make an X over the relevant answer.				
What is the reason?				
How much water is used for that purpose?				

2.5 Is more water used at other times?	Week day	Weekend
(Make an X over the correct answer. Specify the amount below the X)		
What is the reason?		
How much water is used for that purpose?		

3. SOURCE OF WATER

3.1 How is water collected?	Buckets	Hosepipe	Bottles	Drums
	Vehicle	Other		
Make an X over the relevant answer				

3.2 Who collects the water	Husband	Wife	Children	
	Other			
Make an X over the relevant answer				

3.3 Do they make use of other sources of water?	Rainfall	Borehole
	River	Water vendor
	Other	
Make an X over the relevant answer		

3.4 When do they make use of other sources of water?

3.5 How much water do they use from alternate sources such as rainfall and river water?	

4. PAYMENT FOR WATER

4.1 How much water do they use every month?		
4.2 Are their connections metered?		
4.3 Do they pay for water?	YES	NO
4.4 If YES, how much do they pay for their water?		
4.5 If NO, why don't they pay for their water?		
4.6 What is their current water bill?		
4.7 What happens if they can't pay for water one month?		
4.8 Do they know how much free basic water they are allowed to use?		

5. VALUE DERIVED FROM WATER USE

5.1 Where water is used for purposes other than domestic (cooking, cleaning, etc), how much profit is made?	

For example. Tom grows tomatoes in his back yard. He collects water from the yard tap in a bucket. Every weekend he sells tomatoes to his neighbours. He makes between R20 and R50 on a good weekend. Tom manages to sell tomatoes twice a month. Therefore, Tom makes between R40 and R100 per month, by selling his tomatoes.

5.2 Does the household derive any cultural or other benefit (other than economic) from using water, for purposes other than domestic? E.g. baptisms	

6. PROBLEMS AND CONSTRAINTS

6.1 Are there any problems with the water used?	YES	NO
6.2 If YES, what are the problems?		
6.3 Is water always available?	YES	NO
6.4 If NO, when is water not available?		
6.5 If there is no water in the taps, what do they do?		
6.6 Is the water of suitable quality for their needs?	YES	NO
6.7 If YES, what are their needs		
6.8 If NO, what quality water is necessary?		
6.9 Would they do something else if more water was available?		
6.10 What would they do if provided with more water?		
6.11 What quality of water would they need for this purpose?		
6.12 Do they believe/think that productive uses of water (uses other than domestic) would assist in alleviating poverty?	YES	NO
6.13 If YES, why or how?		
6.14 If NO, why not?		

B Descriptive Analysis

Descriptive statistics for the variables in each of the measurements periods are presented in the sections below. The purpose of these sections to provide insight into the data gathered and its integrity.

First Period – 07h00 to 18h00

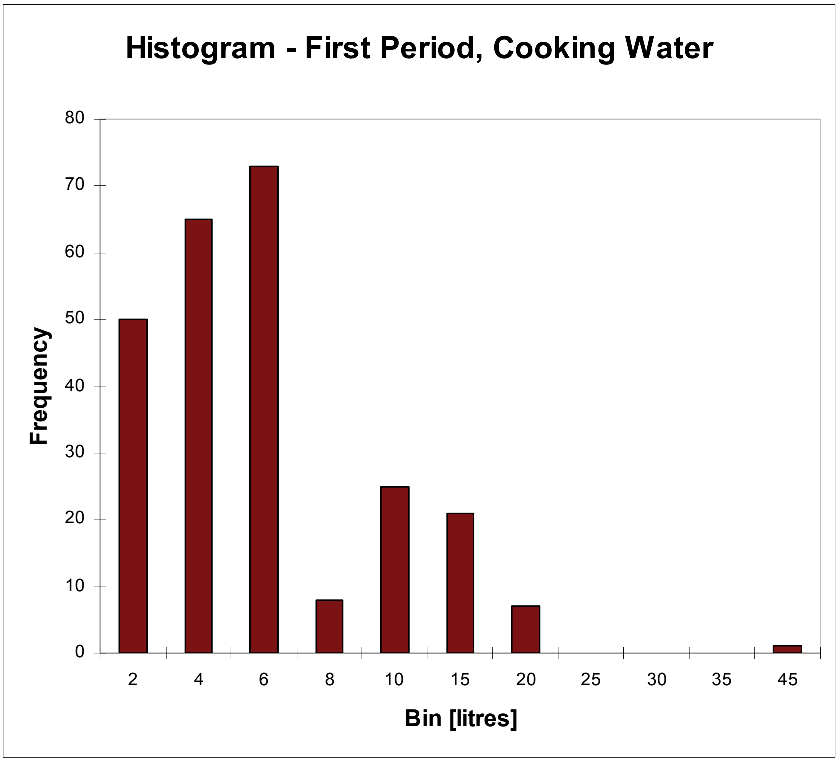
Water used for cooking

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 250 households used water for this purpose.

Table 10-1 Descriptive Statistics – First Period, Cooking

Mean [l]	5.7
Standard Error	0.3
Median [l]	5.0
Mode [l]	5.0
Standard Deviation [l]	4.8
Sample Variance	22.8
Kurtosis	10.9
Skewness	2.5
Range [l]	40.0
Minimum [l]	0.1
Maximum [l]	40.0
Sum [l]	1,422.1
Count [No.]	250.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

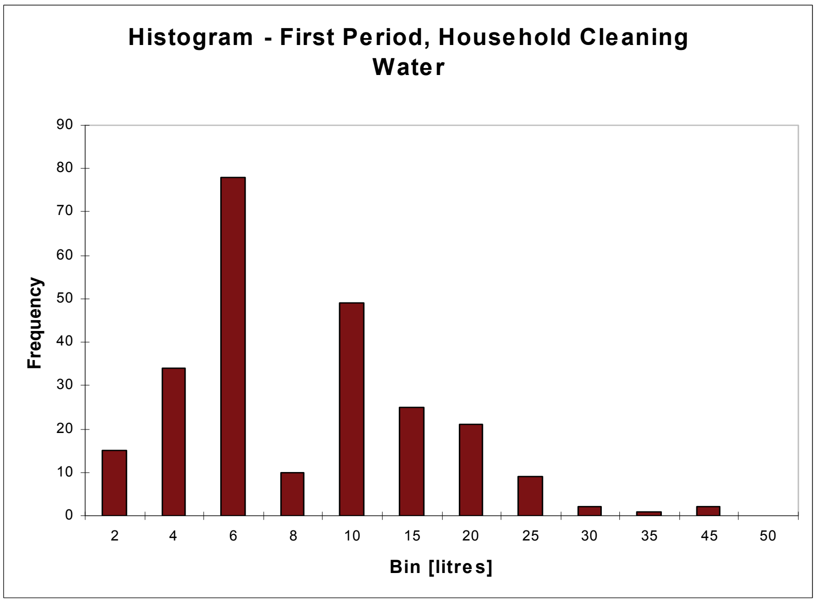
<u>Water used for cleaning the house</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 246 households used water for this purpose.

Table 10-2 Descriptive Statistics – First Period, Household Cleaning

Mean [l]	9.2
Standard Error	0.4
Median [l]	6.0
Mode [l]	5.0
Standard Deviation [l]	7.0
Sample Variance	49.6
Kurtosis	3.0
Skewness	1.6
Range [l]	39.0
Minimum [l]	1.0
Maximum [l]	40.0
Sum [l]	2,258.8
Count [No.]	246.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

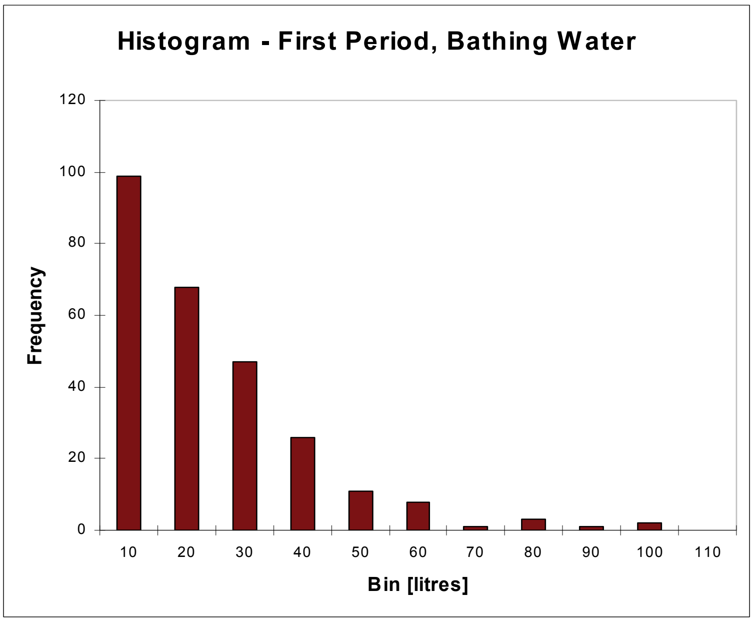
<u>Water used for bathing</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 266 households used water for this purpose.

Table 10-3 Descriptive Statistics – First Period, Bathing

Mean [l]	21.2
Standard Error	1.1
Median [l]	20.0
Mode [l]	20.0
Standard Deviation [l]	17.2
Sample Variance	296.4
Kurtosis	3.4
Skewness	1.6
Range [l]	99.0
Minimum [l]	1.0
Maximum [l]	100.0
Sum [l]	5,637.0
Count [No.]	266.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

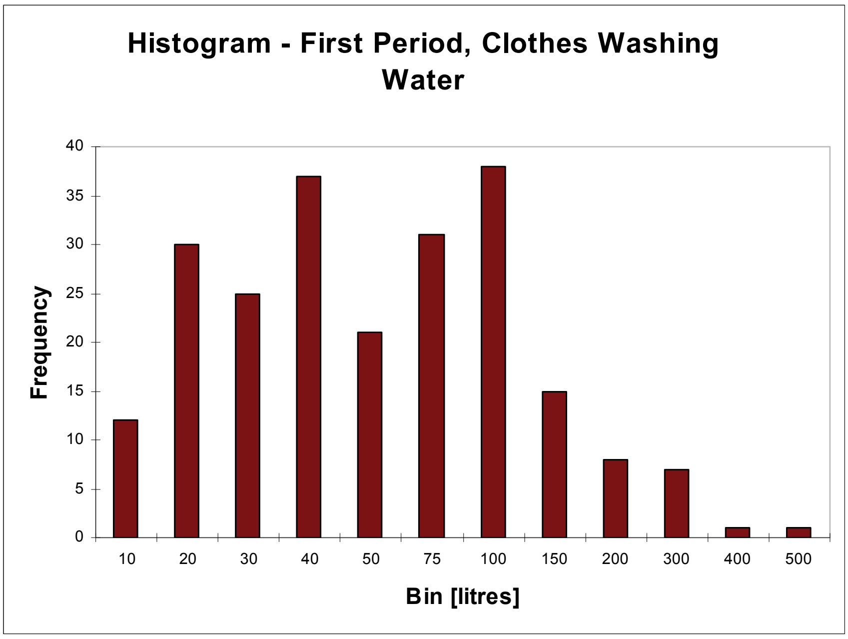
Water used for washing clothes

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 226 households used water for this purpose.

Table 10-4 Descriptive Statistics – First Period, Clothes Washing

Mean [l]	67.1
Standard Error	4.2
Median [l]	50.0
Mode [l]	40.0
Standard Deviation [l]	63.3
Sample Variance	4,007.6
Kurtosis	13.7
Skewness	3.0
Range [l]	496.0
Minimum [l]	4.0
Maximum [l]	500.0
Sum [l]	15,155.0
Count [No.]	226.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

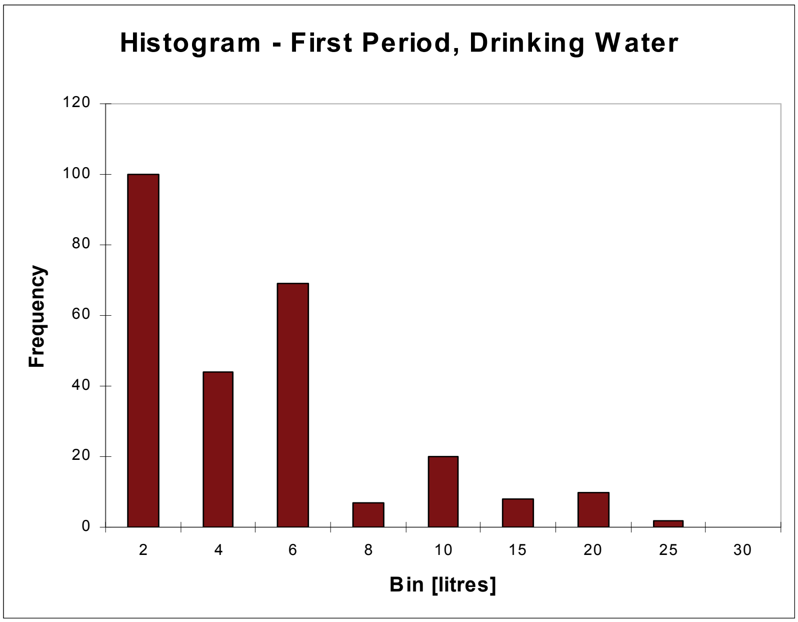
Water used for drinking

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 260 households used water for this purpose.

Table 10-5 Descriptive Statistics – First Period, Drinking Water

Mean [l]	4.8
Standard Error	0.3
Median [l]	3.8
Mode [l]	5.0
Standard Deviation [l]	4.7
Sample Variance	21.9
Kurtosis	4.7
Skewness	2.1
Range [l]	24.7
Minimum [l]	0.3
Maximum [l]	25.0
Sum [l]	1,239.8
Count [No.]	260.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

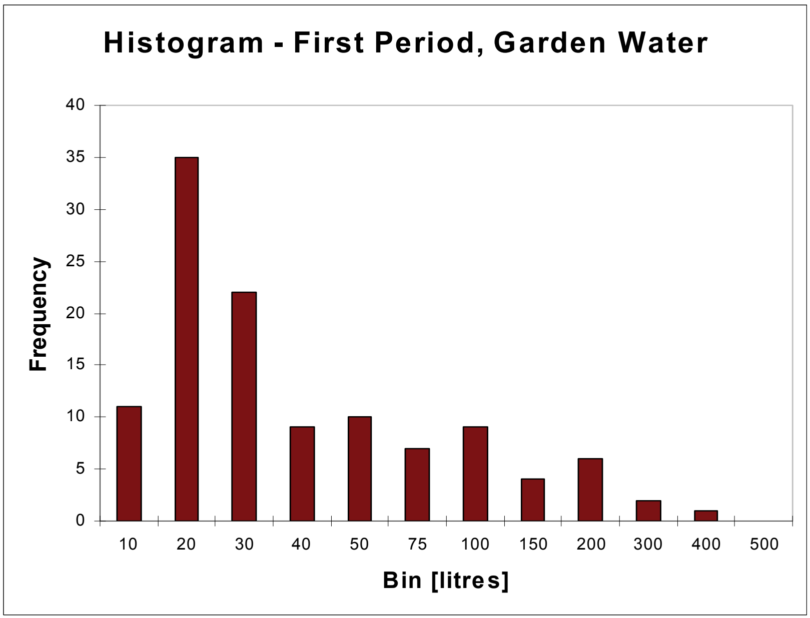
<u>Water used for watering the garden</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 116 households used water for this purpose.

Table 10-6 Descriptive Statistics – First Period, Garden Water

Mean [l]	52.4
Standard Error	6.0
Median [l]	27.5
Mode [l]	20.0
Standard Deviation [l]	64.4
Sample Variance	4,148.0
Kurtosis	10.2
Skewness	2.9
Range [l]	398.0
Minimum [l]	2.0
Maximum [l]	400.0
Sum [l]	6,075.5
Count [No.]	116.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

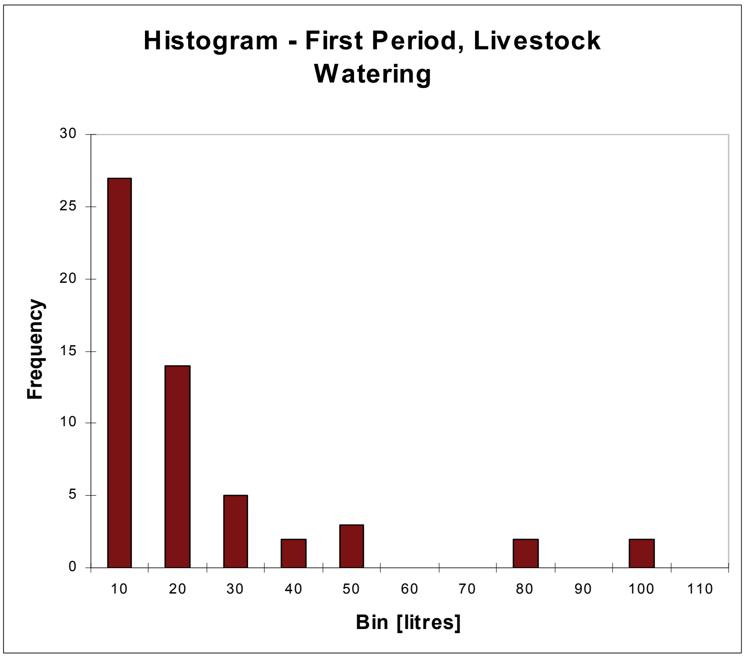
<u>Water used for watering livestock</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 55 households used water for this purpose.

Table 10-7 Descriptive Statistics – First Period, Livestock Watering

Mean [l]	19.7
Standard Error	3.1
Median [l]	15.0
Mode [l]	20.0
Standard Deviation [l]	23.2
Sample Variance	538.6
Kurtosis	4.4
Skewness	2.1
Range [l]	99.5
Minimum [l]	0.5
Maximum [l]	100.0
Sum [l]	1,086.0
Count [No.]	55.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

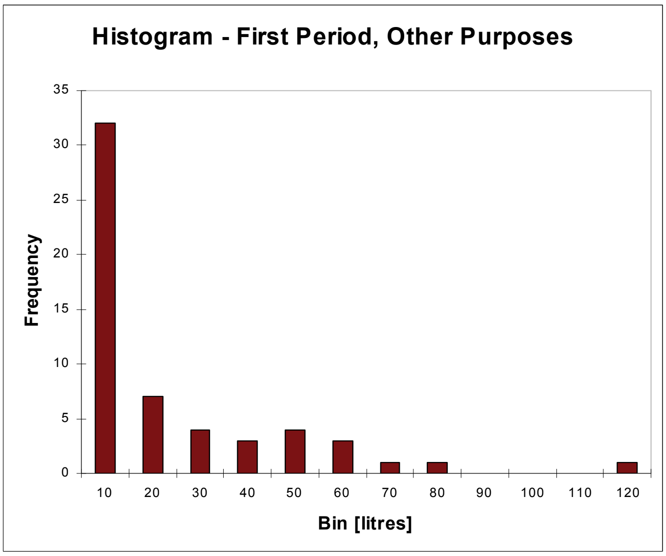
<u>Water used for other purposes</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 56 households used water for a variety of other purposes.

Table 10-8 Descriptive Statistics – First Period, Other Purposes

Mean [l]	20.9
Standard Error	3.1
Median [l]	10.0
Mode [l]	10.0
Standard Deviation [l]	23.3
Sample Variance	544.5
Kurtosis	4.9
Skewness	2.0
Range [l]	119.0
Minimum [l]	1.0
Maximum [l]	120.0
Sum [l]	1,168.6
Count [No.]	56.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

Second Period – 18h00 to 07h00 (Overnight)

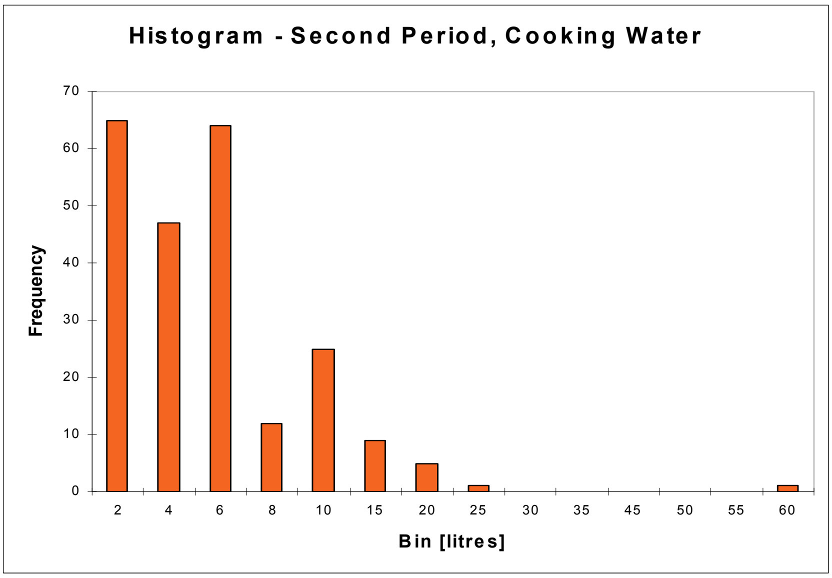
Water used for cooking

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 229 households used water for this purpose.

Table 10-9 Descriptive Statistics – Second Period, Cooking

Mean [l]	5.3
Standard Error	0.4
Median [l]	5.0
Mode [l]	5.0
Standard Deviation [l]	5.5
Sample Variance	30.6
Kurtosis	42.2
Skewness	5.0
Range [l]	60.0
Minimum [l]	0.1
Maximum [l]	60.0
Sum [l]	1,213.8
Count [No.]	229.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

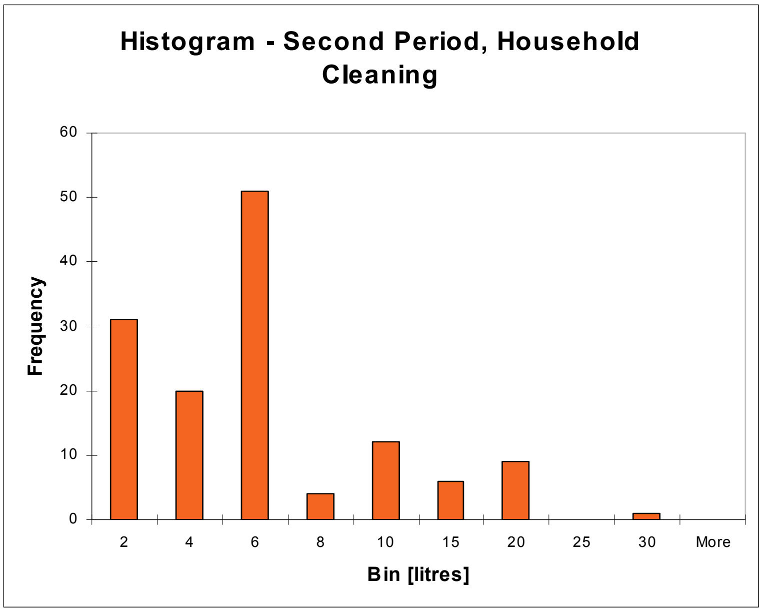
Water used for cleaning the house

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 134 households used water for this purpose.

Table 10-10 Descriptive Statistics – Second Period, Household Cleaning

Mean [l]	6.2
Standard Error	0.5
Median [l]	5.0
Mode [l]	5.0
Standard Deviation [l]	5.3
Sample Variance	28.6
Kurtosis	3.7
Skewness	1.9
Range [l]	29.5
Minimum [l]	0.5
Maximum [l]	30.0
Sum [l]	827.0
Count [No.]	134.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

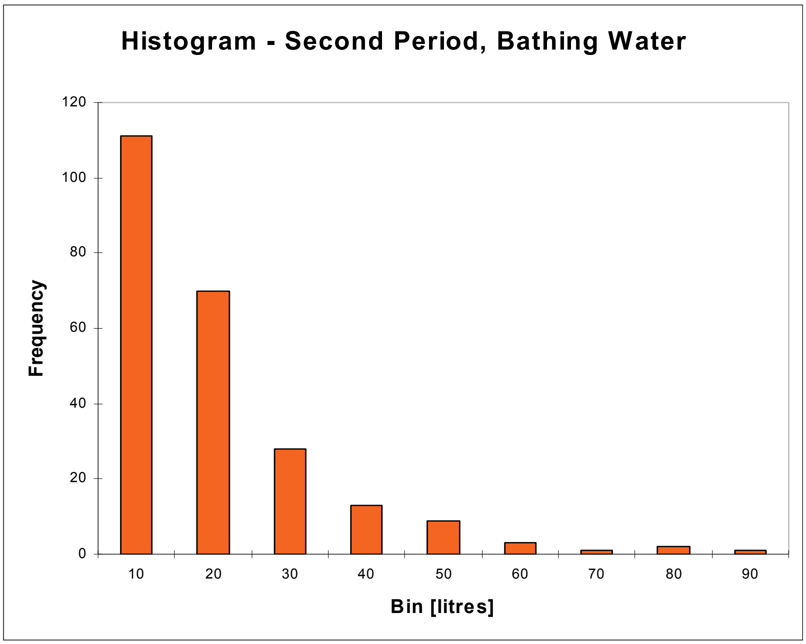
Water used for bathing

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 238 households used water for this purpose.

Table 10-11 Descriptive Statistics – Second Period, Bathing

Mean [l]	17.2
Standard Error	1.0
Median [l]	15.0
Mode [l]	10.0
Standard Deviation [l]	14.8
Sample Variance	219.4
Kurtosis	4.2
Skewness	1.8
Range [l]	89.0
Minimum [l]	1.0
Maximum [l]	90.0
Sum [l]	4,093.0
Count [No.]	238.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

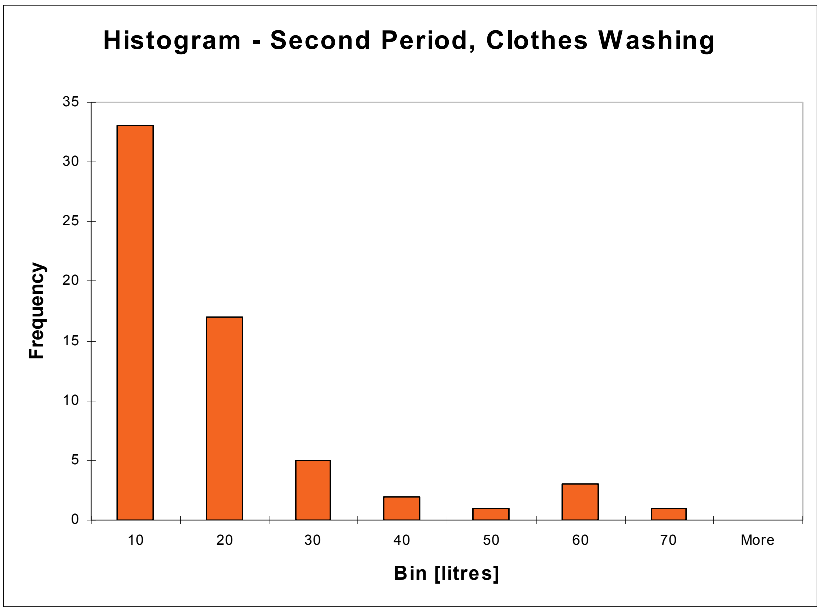
Water used for washing clothes

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 62 households used water for this purpose.

Table 10-12 Descriptive Statistics – Second Period, Clothes Washing

Mean [l]	16.7
Standard Error	2.0
Median [l]	10.0
Mode [l]	10.0
Standard Deviation [l]	15.7
Sample Variance	245.2
Kurtosis	3.1
Skewness	1.8
Range [l]	68.0
Minimum [l]	2.0
Maximum [l]	70.0
Sum [l]	1,036.8
Count [No.]	62.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

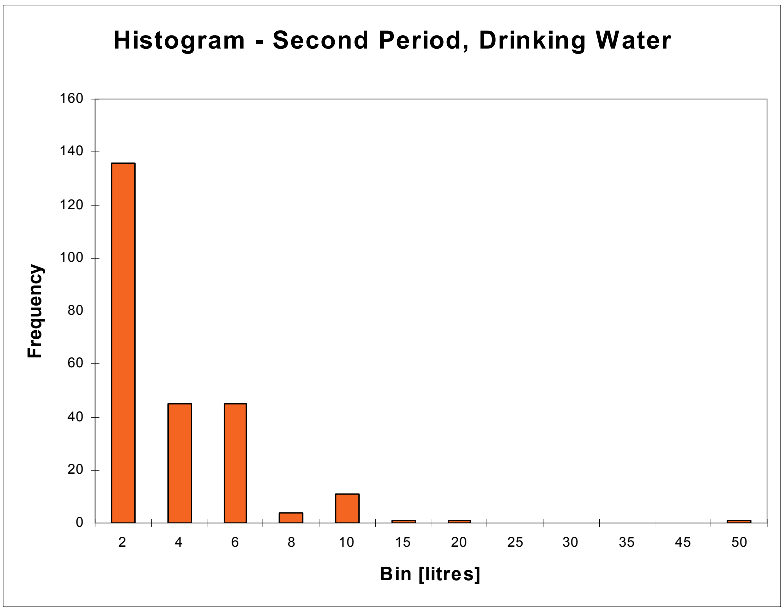
<u>Water used for drinking</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 244 households used water for this purpose.

Table 10-13 Descriptive Statistics – Second Period, Drinking Water

Mean [l]	3.1
Standard Error	0.3
Median [l]	2.0
Mode [l]	1.0
Standard Deviation [l]	4.0
Sample Variance	15.9
Kurtosis	79.7
Skewness	7.4
Range [l]	49.8
Minimum [l]	0.3
Maximum [l]	50.0
Sum [l]	755.2
Count [No.]	244.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

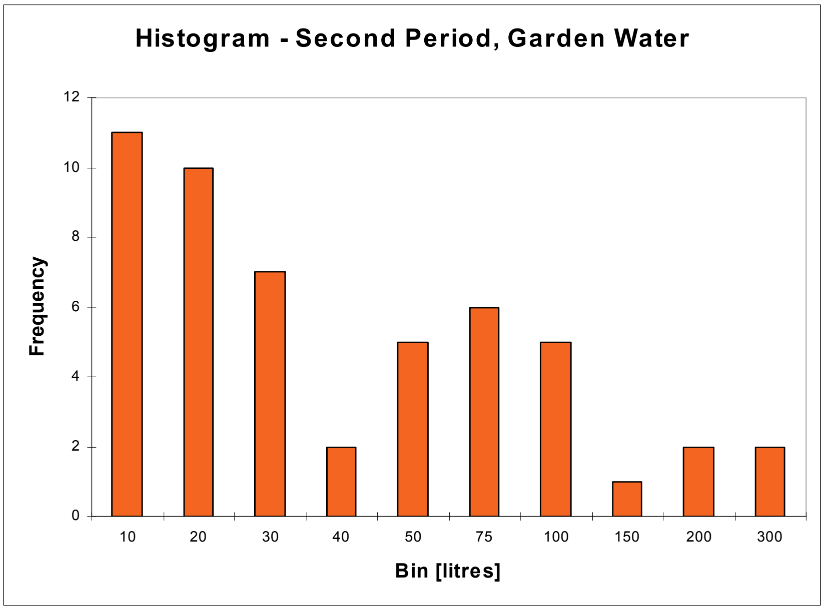
<u>Water used for watering the garden</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 51 households used water for this purpose.

Table 10-14 Descriptive Statistics – Second Period, Garden Water

Mean [l]	52.0
Standard Error	8.5
Median [l]	30.0
Mode [l]	10.0
Standard Deviation [l]	60.7
Sample Variance	3,680.0
Kurtosis	6.8
Skewness	2.5
Range [l]	299.0
Minimum [l]	1.0
Maximum [l]	300.0
Sum [l]	2,653.9
Count [No.]	51.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

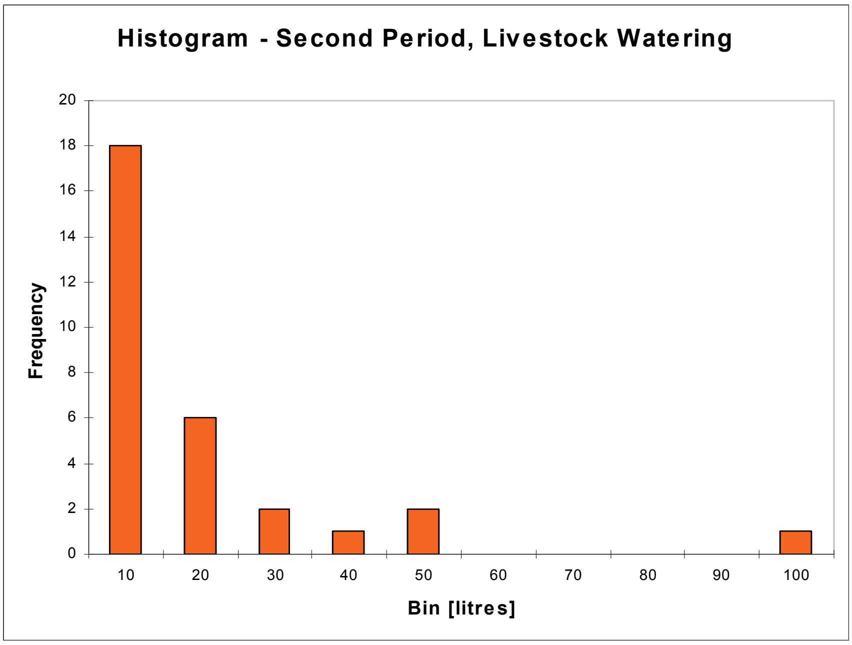
<u>Water used for watering livestock</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 30 households used water for this purpose.

Table 10-15 Descriptive Statistics – Second Period, Livestock Watering

Mean [l]	15.7
Standard Error	3.6
Median [l]	10.0
Mode [l]	10.0
Standard Deviation [l]	19.7
Sample Variance	389.9
Kurtosis	8.4
Skewness	2.6
Range [l]	94.8
Minimum [l]	0.3
Maximum [l]	95.0
Sum [l]	471.3
Count [No.]	30.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

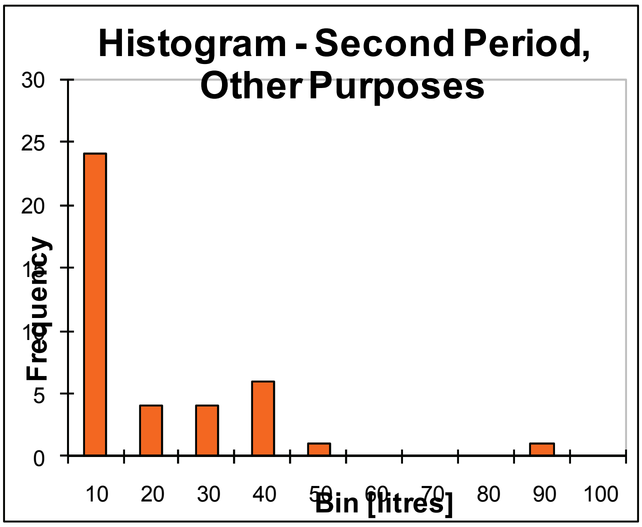
Water used for other purposes

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 40 households used water for a variety of other purposes.

Table 10-16 Descriptive Statistics – Second Period, Garden Water

Mean [l]	17.3
Standard Error	2.8
Median [l]	10.0
Mode [l]	10.0
Standard Deviation [l]	17.5
Sample Variance	307.4
Kurtosis	4.2
Skewness	1.8
Range [l]	83.0
Minimum [l]	2.0
Maximum [l]	85.0
Sum [l]	693.0
Count [No.]	40.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

Third Period – 07h00 to 18h00

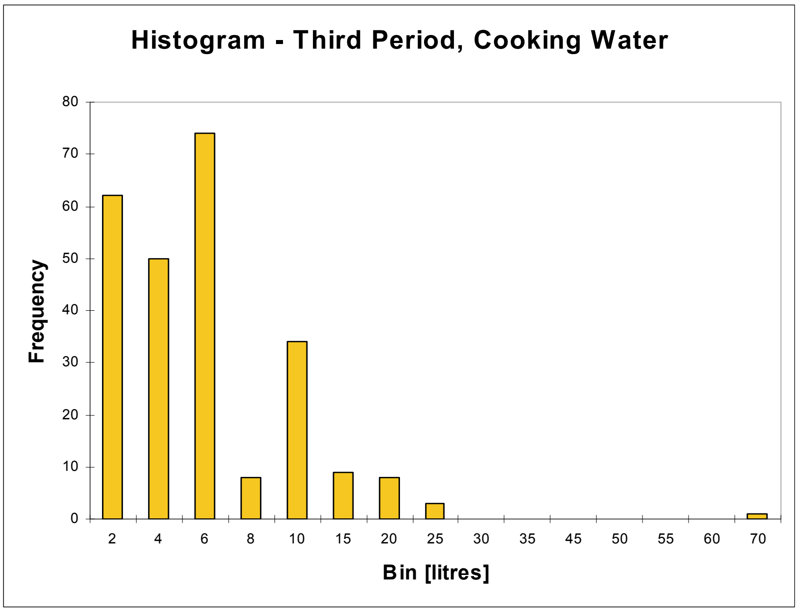
Water used for cooking

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 249 households used water for this purpose.

Table 10-17 Descriptive Statistics – Third Period, Cooking

Mean [l]	5.8
Standard Error	0.4
Median [l]	5.0
Mode [l]	5.0
Standard Deviation [l]	5.8
Sample Variance	34.0
Kurtosis	36.0
Skewness	4.5
Range [l]	62.3
Minimum [l]	0.1
Maximum [l]	62.3
Sum [l]	1,433.5
Count [No.]	249.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

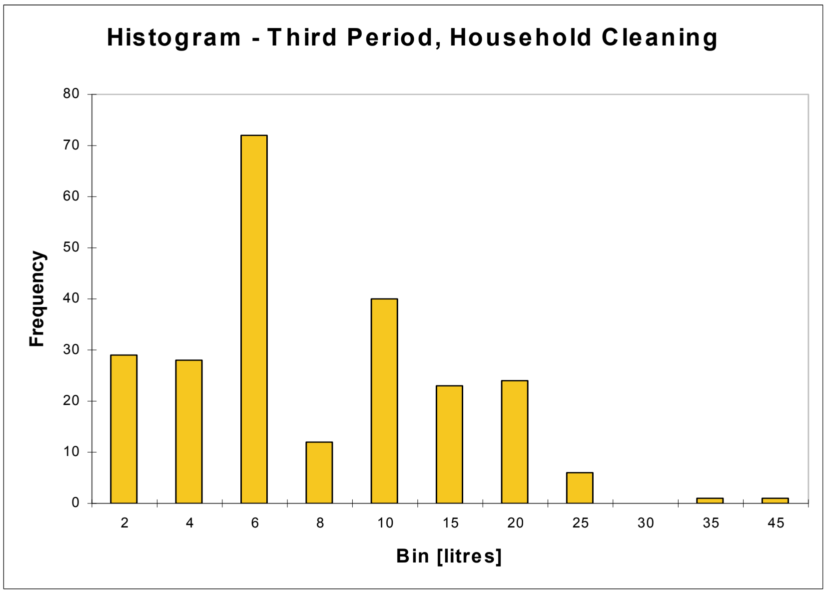
<u>Water used for cleaning the house</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 236 households used water for this purpose.

Table 10-18 Descriptive Statistics – Third Period, Household Cleaning

Mean [l]	8.6
Standard Error	0.4
Median [l]	5.0
Mode [l]	5.0
Standard Deviation [l]	6.7
Sample Variance	45.2
Kurtosis	3.8
Skewness	1.6
Range [l]	44.8
Minimum [l]	0.2
Maximum [l]	45.0
Sum [l]	2,026.4
Count [No.]	236.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

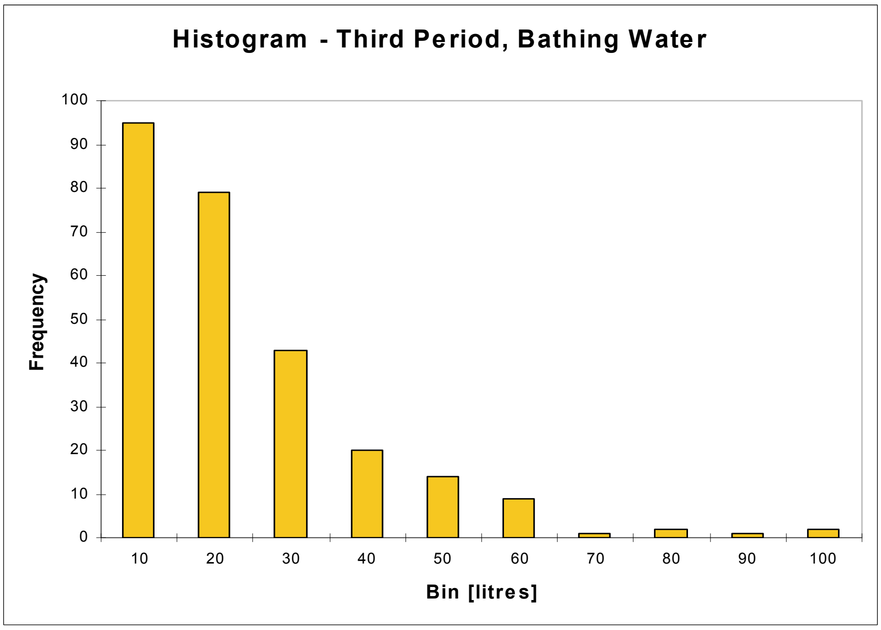
<u>Water used for bathing</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 266 households used water for this purpose.

Table 10-19 Descriptive Statistics – Third Period, Bathing

Mean [l]	21.0
Standard Error	1.1
Median [l]	17.3
Mode [l]	20.0
Standard Deviation [l]	17.2
Sample Variance	294.8
Kurtosis	3.8
Skewness	1.7
Range [l]	99.0
Minimum [l]	1.0
Maximum [l]	100.0
Sum [l]	5,584.0
Count [No.]	266.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

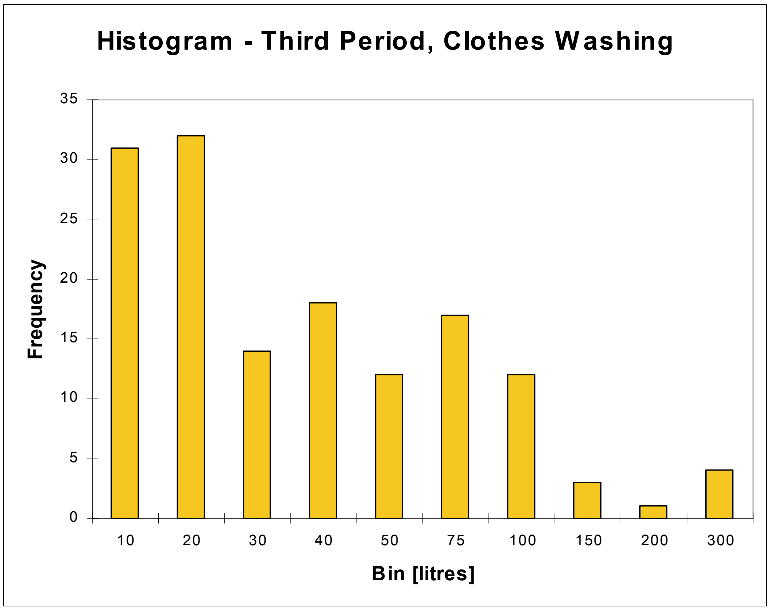
Water used for washing clothes

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 144 households used water for this purpose.

Table 10-20 Descriptive Statistics – Third Period, Clothes Washing

Mean [l]	43.0
Standard Error	4.1
Median [l]	27.8
Mode [l]	20.0
Standard Deviation [l]	49.2
Sample Variance	2,416.1
Kurtosis	12.2
Skewness	3.1
Range [l]	299.0
Minimum [l]	1.0
Maximum [l]	300.0
Sum [l]	6,188.1
Count [No.]	144.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

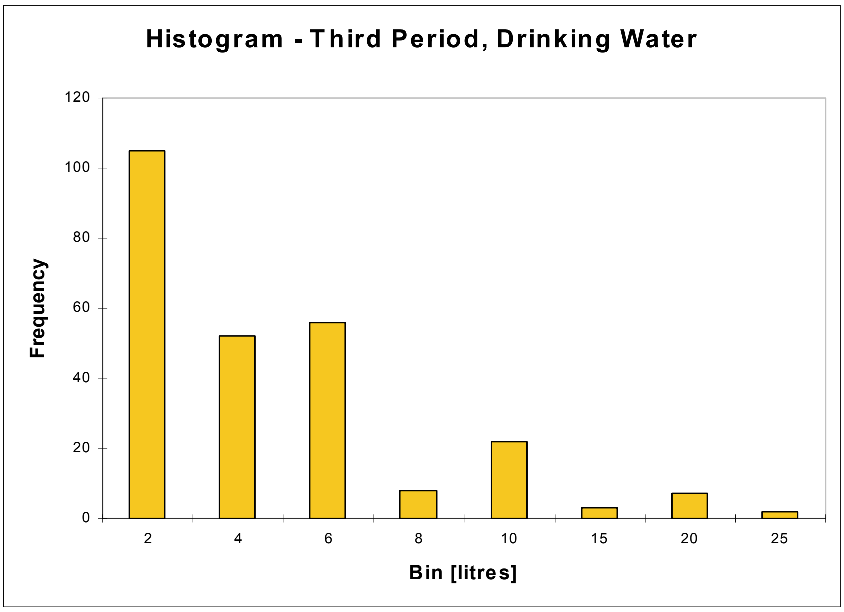
Water used for drinking

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 255 households used water for this purpose.

Table 10-21 Descriptive Statistics – Third Period, Drinking Water

Mean [l]	4.4
Standard Error	0.3
Median [l]	3.0
Mode [l]	5.0
Standard Deviation [l]	4.3
Sample Variance	18.5
Kurtosis	6.8
Skewness	2.4
Range [l]	24.8
Minimum [l]	0.2
Maximum [l]	25.0
Sum [l]	1,116.7
Count [No.]	255.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

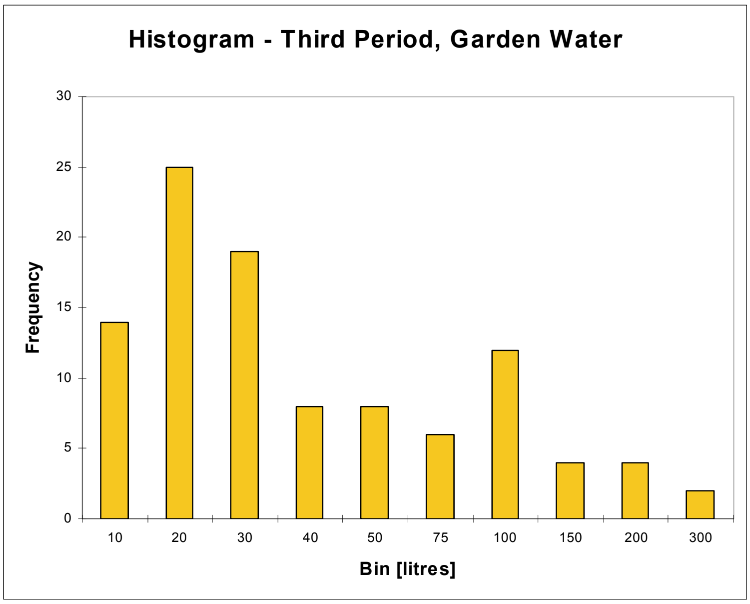
Water used for watering the garden

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 102 households used water for this purpose.

Table 10-22 Descriptive Statistics – Third Period, Garden Water

Mean [l]	49.6
Standard Error	5.3
Median [l]	25.0
Mode [l]	20.0
Standard Deviation [l]	53.5
Sample Variance	2,857.5
Kurtosis	5.0
Skewness	2.2
Range [l]	273.5
Minimum [l]	1.5
Maximum [l]	275.0
Sum [l]	5,063.9
Count [No.]	102.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

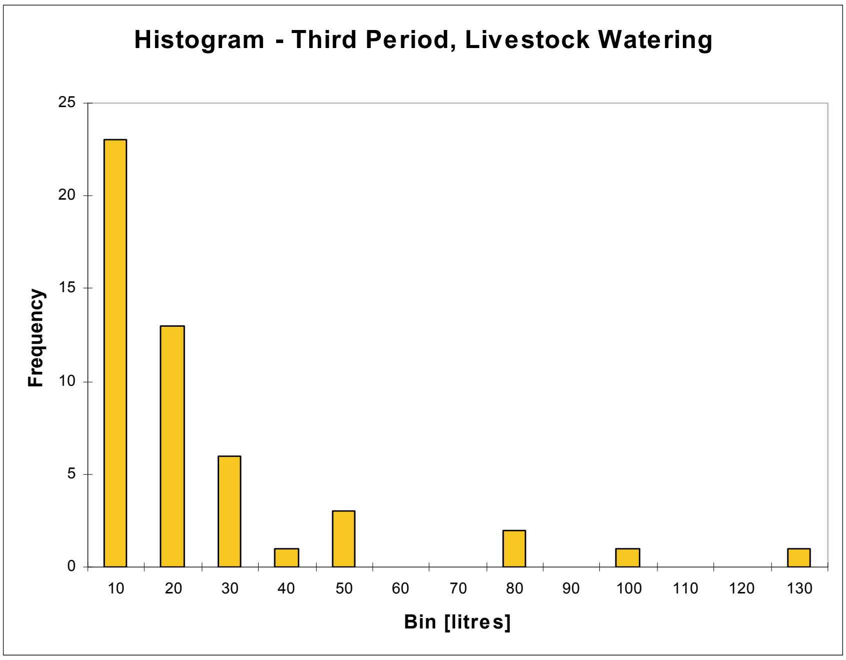
Water used for watering livestock

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 50 households used water for this purpose.

Table 10-23 Descriptive Statistics – Third Period, Livestock Watering

Mean [l]	21.3
Standard Error	3.6
Median [l]	17.5
Mode [l]	20.0
Standard Deviation [l]	25.7
Sample Variance	661.5
Kurtosis	6.0
Skewness	2.3
Range [l]	124.5
Minimum [l]	0.5
Maximum [l]	125.0
Sum [l]	1,063.0
Count [No.]	50.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above.



The data exhibits the right tail skew expected for a variable of this nature. The variable does not contain any large, and possibly erroneous, outliers.

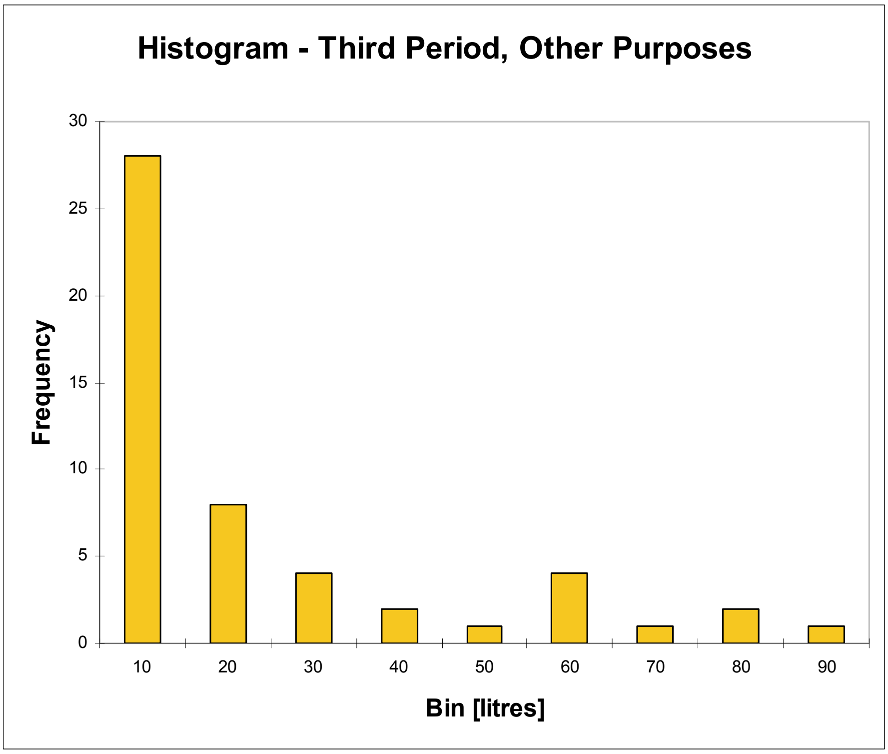
<u>Water used for other purposes</u>

The table below details the descriptive statistics for the data gathered in this period. Of the 270 households surveyed, 51 households used water for a variety of other purposes.

Table 10-24 Descriptive Statistics – Third Period, Garden Water

Mean [l]	21.4
Standard Error	3.3
Median [l]	10.0
Mode [l]	10.0
Standard Deviation [l]	23.4
Sample Variance	549.5
Kurtosis	1.0
Skewness	1.5
Range [l]	83.3
Minimum [l]	2.0
Maximum [l]	85.3
Sum [l]	1,089.0
Count [No.]	51.0

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above.



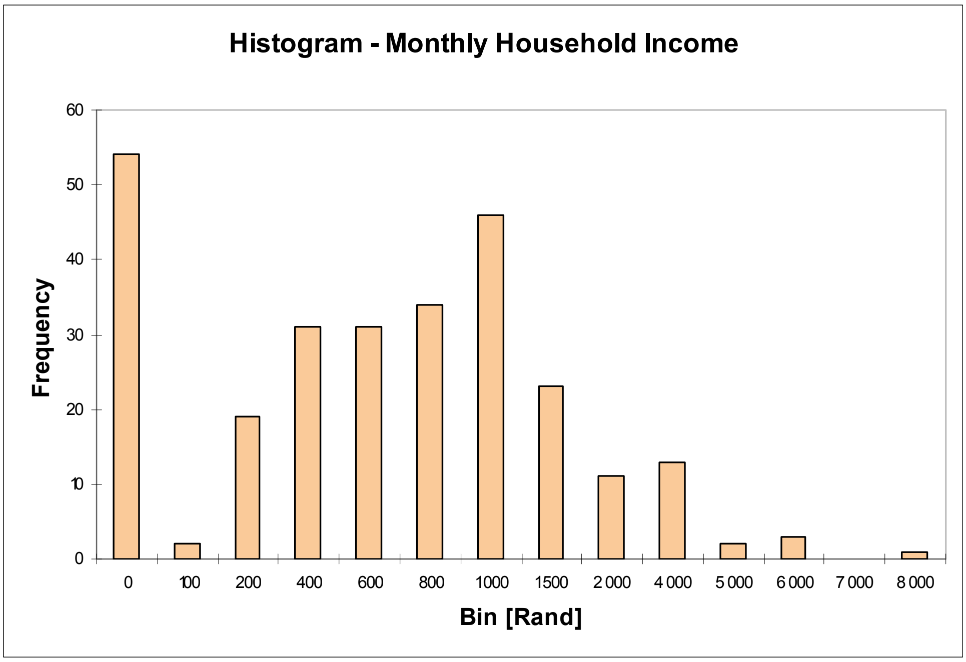
Household Income

The table below details the descriptive statistics for the data gathered with regards household income. All 270 households surveyed provided data for this variable.

Table 10-25 Descriptive Statistics – Household Income

Mean [R]	834
Standard Error	64
Median [R]	600
Standard Deviation [R]	1058
Kurtosis	14.44
Skewness	3.30
Range [R]	8 000
Minimum [R]	0
Maximum [R]	8 000
Sum [R]	225 382
Count [No.]	270

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.



Household Size

The table below details the descriptive statistics for the data gathered with regards household size. Of a sample size of 270 households, 269 households provided data for this variable.

Table 10-26 Descriptive Statistics – Household Size

Mean [No.]	5.2
Standard Error	0.2
Median [No.]	5
Mode [No.]	6
Standard Deviation [No.]	3.1
Sample Variance	9.7
Kurtosis	15.2
Skewness	2.5
Range [No.]	29
Minimum [No.]	1
Maximum [No.]	30
Sum [No.]	1 390
Count [No.]	269

A histogram of the data is presented below. This is a graphical representation of the some of the key descriptive statistics shown in the table above. Note that the bin ranges are not equal in this graph, thus care should be exercised during interpretation.