City of Cape Town
Residential Water Consumption Trend Analysis
2014/2015

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Abstract

According to the National Water Act (1998), the monitoring, recording, assessing and dissemination of information on water resources is critically important for achieving the objects of the Act. Predictions and estimations of residential potable water consumptions are often assumed and included in city-wide planning and forecasting documentation. Water and Sanitation initiatives are mostly planned on these estimated consumption figures. To this date, no statistically significant residential water consumption study focusing on the City of Cape Town (CCT) has occurred. Due to this gap in the body of knowledge this research study focused on analysing consumption analysis and variations relating to alternative water usage, water saving fixtures, toilet water usage, residential stand size and property valuation, household demographics and corresponding water usage, amongst others. The residential water consumption analysis during this study was conducted with the assistance of the Expanded Public Works Programme (EPWP) and the SWIFT consumption analysis software programme. A survey was conducted where willing participants provided information on residential household water consumption. The data was combined with demographic and economic factors to provide an assessment of water-use patterns at the local level.

Key Words: Alternative water resources, property valuation, stand size, water conservation, water consumption trends, water demand management, water saving fixtures.

Introduction

The National Water Act (1998) recognises that water is a scarce and unevenly distributed resource which occurs in many different forms which are all part of a unitary, interdependent cycle. It also recognises that the ultimate aim of water resource management is to achieve the sustainable use of water for the benefit of all users. One of the City of Cape Town's Integrated Development Plan's (IDP) 5 year objectives is to "promote a sustainable environment through the efficient utilisation of resources (Objective 1.3) (CCT, 2013).

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In order to manage the City's consumer demand for water effectively a clear understanding of the City's consumer demands and consumption behaviour is essential. Developing sustainable water options for the future requires water usage investigations which focus on the impact of different factors on consumer water usage. By examining the City's water usage per household this study will quantitatively explore the influence of the changing household demand on average daily water consumption trends per established consumption categories. The information obtained from this study will enable an understanding of residential water-usage behaviour patterns and trends and the assessment of the impact of those patterns on water utility operations. It will also provide data that

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can be correlated with future trends for planning purposes.

Research Objectives

The main objective of this study was to establish residential consumer water demand benchmarking guidelines. The key outputs will provide updated data on residential water use in the Cape Town metropolitan area. It will also support demand forecasting for water supply, wastewater services and water efficiency programme design.

Research Need and Knowledge Contribution

According to Willis (2010) there is an increasing need for comprehensive and frequent residential water consumption end-use studies. Studies done by Giurco et al., (2008) and the Water Services Association (WSAA) (2003) recommended further research on water consumption trends. Willis (2010) is strongly suggesting that gaining data on how and where water is used within residential households is critical for water utility planners. According to Inman and Jeffrey (2006)) data with high levels of disaggregation such as water consumption end use data is required to achieve Water Demand Management (WDM) strategic objectives.

Short Literature Review

It is well documented that the monitoring and evaluation of integrated urban water resources management initiatives have been limited without proper knowledge of residential water consumption trends, and a proper analysis of residential consumption trends is therefore essential (White and Turner, 2003). The need to conduct research on location specific water consumptions is strongly encouraged to provide an understanding of local consumption behaviour (Mayer and DeOreo, 1999; White and Fane, 2001; Turner et al., 2005).

Household incomes continue to rise, leading to more luxury water features and less sensitivity to price. These and other factors complicate the identification of underlying causes and their associated effects on residential water usage (Water Research Foundation, 2010). Factors that are influential in residential water demand forecasting are not always considered by water institutions (Water Services Association (WSAA), 2003). Residential consumption trend analysis studies allow for the dissemination of technological and consumer behavioural aspects and provide significant opportunities for water institutions to improve water service delivery and long term planning (Giurco et al. 2008).

Research Methodology

The research methodology included various data collection components to strengthen and add evidence to the study objectives. The main data collection components consisted of a residential water consumption trend survey conducted within fifteen chosen suburbs across the City of Cape Town. The survey questionnaire sheets were designed to collect both qualitative and quantitative data. This enabled a good indication of the water consumption trends as well as the perceptions that consumers have on water demand management. The survey was conducted as a mix of face-to-face surveys, email surveys and telephonic surveys. Research assistants were recruited by means of the City's Mayoral Expanded Public Works Project (EPWP) on contract basis and their duties included in the field data collection as well as survey questionnaire data capturing. Training of the EPWP research assistants were provided and certificates were issued to each assistant which formed part of the capacity building component of the research study.

The questionnaire sheets were developed to enable the comparison of collected data. Separate types of questionnaires were developed to facilitate the collection of category specific data and specific

target respondents. Given the linguistic variation across the study areas, the questionnaires were developed in English with translation being done by research assistants fluent in the main language of the given area.

Survey Sampling Methodology

A stratified random sample of residential suburbs representative of the different income categories was done. This involved dividing the sample population into different non-overlapping groups (i.e., strata) that were of interest or deserved special attention because of the project objectives, and then selecting a simple random sample from each stratum. The stratification method helped to determine any differences among subgroups. The primary objective of the survey was to determine the consumption trends per residential consumer throughout the pre-determined categories.

Sample sizing was assessed in order to incorporate representativeness. This meant that all constituencies in the population had a known chance of being selected in the sample. The sampling procedure ensured that the sample contained the same characteristics as the population. The following formula was used in order to establish the desired sample size per suburb:

$$N_S = \frac{(NP)(P)(1-P)}{(NP-1)\left(\frac{B}{C}\right)2+(P)(1-P)} \quad [1]$$

According to the results obtained from the above formula; if 80% of the population were expected to answer a certain way a sample size of 61 per suburb were needed to be 95% confident that the sample estimate was within $\pm$ 10% of the true population value.

Study Area

Five representative suburbs from three different income group categories were chosen as representative of the income categories and average precipitation zones throughout the City of Cape Town (Table 1).

Table 1: The survey research suburbs chosen to be representative of different income categories and precipitation zones.

Informal Settlements Category	Low Income Category	Middle/High Income Category
Masiphumelele (Sunnydale)	Bonteheuwel	Fish Hoek
Imizamo Yethu (Hout Bay)	Langa	Newlands
Endlovini (Khayelitsha)	Lavender Hill	Melkbosstrand
Malawi Camp (Bishop Lavis)	Lentegeur	Gordon's Bay
Dunoon	Ocean View	Edgemead

The above areas were carefully chosen to represent the income categories across geographical areas with different climatic conditions such as average precipitation and temperature zones. This was done in order to assist with the identification of water demand needs of consumers within the same income categories but with different geographic climatic variances.

Statistical Analysis

The data obtained from the survey was combined, statistically analysed and compared in order to identify and quantify differential water consumption across different residential water usage categories.

Research Results

Informal Settlements Category

Some 20.5% of Cape Town's population currently lives in informal housing (CCT, 2013/2014). This category can be characterised as consisting of very poor water and sanitation infrastructure conditions. Water and sanitation services are commonly supplied by the City at certain points within the settlement areas and is in line with the national guideline levels, which include water provision via one tap per 25 families within a distance of 200 m, and sanitation services comprising a minimum of one toilet per five families.

The residents in this category lives below the poverty line and accommodation consists mainly of self-made dwellings. These dwellings are closely situated and

properties with any additional dwelling/s are non-existent. Water usage occurs mainly from the communal municipal supply points and household water is fetched by the residents in containers and carried some distance to the individual households where it is used for general household washing purposes. Due to water and sanitation services not being reticulated to individual households, residents within the informal category characteristically do not receive any water accounts and water consumption patterns as well as related savings are therefore very difficult to quantify.

Average Household Water Consumption

The research results indicated that the average water collection container size is 20 ℓ across all the informal settlement study suburbs. The average number of trips to collect water at the standpipe were two times per day. With these figures the average daily water consumption per household within informal settlements was estimated to be 41.366 ℓ or 0.041 kl a day (Table 2).

Table 2: The estimated average daily water consumption for the informal settlements category.

Informal Settlements Category
Estimated Average Daily Water Consumption

Average Water Container Capacity (ℓ)	Average Daily Number of Trips to Standpipe	Average Daily Water Consumption (ℓ)
20	2 Trips	41.366

Highest Water Usage Category and Laundry Washing Frequency

Results indicated that laundry washing (hand washing) was the highest water usage category within the informal settlements category, with 55.82% of respondents indicating laundry washing as the highest water usage category (Figure 2).

It was found that 63.88% of the respondents indicated a washing frequency of once per week (Figure 3).

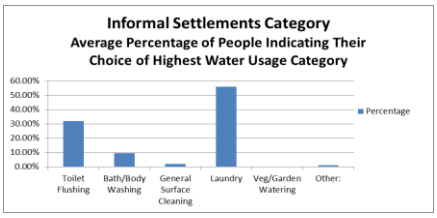

Figure 2: Results indicated that 55.82% of respondents indicated laundry washing as the highest water usage category within the informal settlements category.

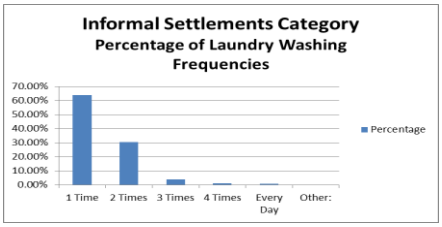

Figure 3: It was found that 63.88% of the respondents indicated a washing frequency of once per week.

Alternative Water Resources

It was found that 33% of residents indicated that they were using some type of alternative water resource (Figure 4).

Results showed that 25% of the alternative water users indicated that they were re-using their greywater (Figure 5).

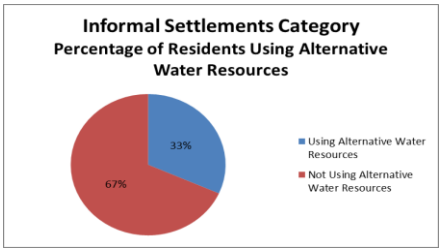

Figure 4: It was found that 33% of residents indicated that they were using some type of alternative water resource.

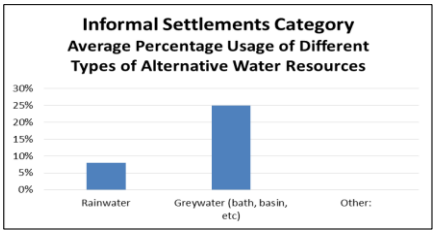

Figure 5: Results showed that 25% of the respondents indicated that they were re-using their greywater.

Low Income Category

Additional Buildings/Dwellings and Household Demographics

The results indicated that properties with main and additional households were using 21% more water than properties with a main household only (Figure 6).

It can be seen in Figure 7 that there was an increase in average daily water consumption per household with an increase in number of household occupants within the low income category.

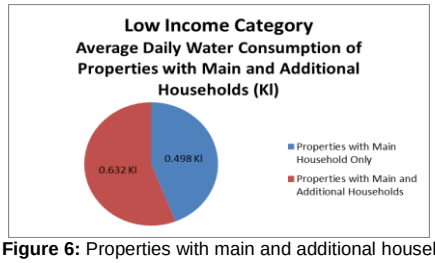

Figure 6: Properties with main and additional households are using 21% more water than properties with a main household only.

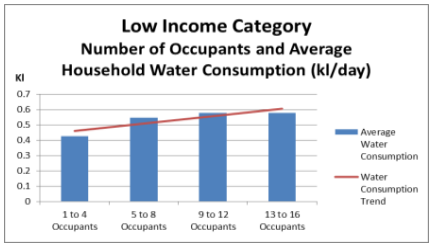

Figure 7: Within the low income category there was an increase in average daily water consumption with an increase in number of household occupants.

Water Saving Fixtures and Highest Water Usage Category

The research results indicated that properties that had some type of water savings fixture/s installed were using on average 5% less water than those that did not (Figure 8).

Laundry washing (hand and/or washing machine) was found to be the highest water usage category within the low income category, with 62.86% of respondents indicating laundry washing as the highest water usage category on their properties (Figure 9).

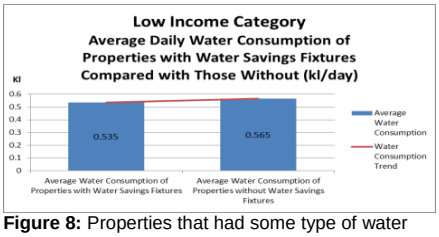

Figure 8: Properties that had some type of water savings fixture/s installed were using on average 5% less water.

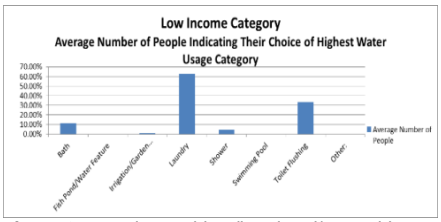

Figure 9: Laundry washing (hand and/or washing machine) was the highest water usage category within the low income category.

Alternative Water Resources and Toilet Water Usage

Results indicated that although less than 1% of respondents were making use of groundwater resources within the low income category, users that did make use of this type of resource were consuming 79% less water than users of other types of alternative water resources (Figure 10).

The average daily water consumption of respondents who flushed their toilets 9 - 11 times per day was approximately 7% higher than that of respondents flushing their toilets less times per day (Figure 11).

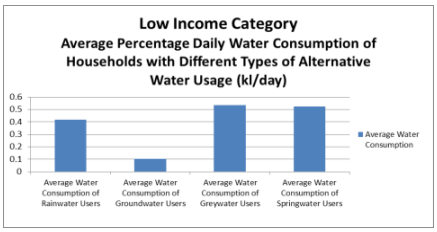

Figure 10: Less than 1% of respondents were making use of groundwater resources.

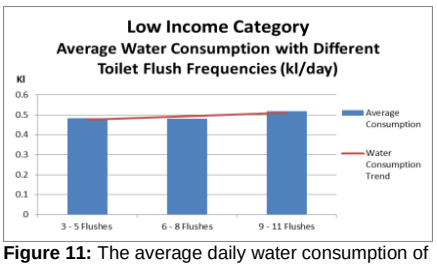

Figure 11: The average daily water consumption of respondents who flushed there toilets 9 - 11 times per day was approximately 7% higher than those with lower flush frequencies.

Stand Size and Property Valuation

Properties with stand sizes falling within the range of 200 - 300m^2 were using 12% more water than those with stands that fell within the size range of 50 - 199m^2 (Figure 12).

The results indicated that there was an average daily water consumption increase of 20% between properties valued <R200 000 and those valued between R200 000 - R800 000 (Figure 13).

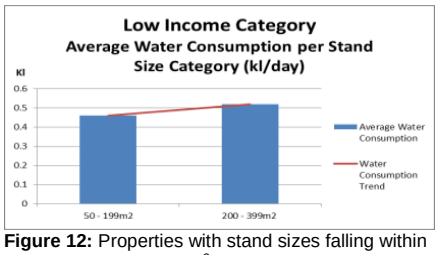

Figure 12: Properties with stand sizes falling within the range of 200 - 300m^2 were using 12% more water than those with stands that fell within the size range of 50 - 199m^2.

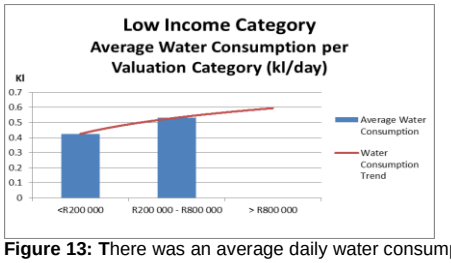

Figure 13: There was an average daily water consumption increase of 20% between properties valued <R200 000 and those valued between R200 000 - R800 000.

Middle/High Income Category

Additional Buildings/Dwellings and Household Demographics

The results indicated that properties with main and additional buildings were using 29% more water than properties that had a main household only (Figure 14).

There was a 28.3% increase in average daily water consumption per household with an increase in number of household occupants within the middle/high income category (Figure 15).

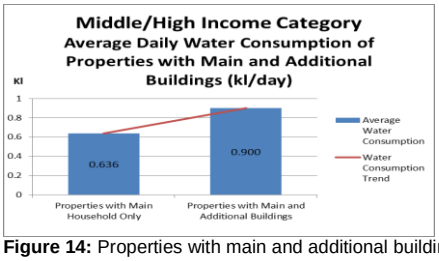

Figure 14: Properties with main and additional buildings were using 29% more water than properties that had main household only.

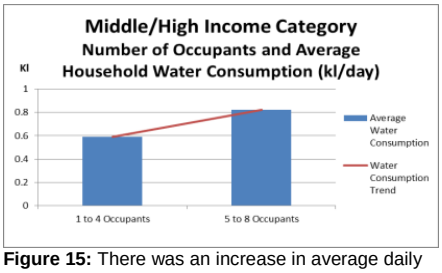

Figure 15: There was an increase in average daily water consumption with an increase in number of household occupants.

Water Saving Fixtures and Highest Water Usage Category

The research results indicated that properties that had some type of water savings fixture/s installed were using an average of 15% more water than those that did not (Figure 16).

Showering was considered to be the highest water usage category within the middle/high income category. Almost half (46.51%) of the respondents indicated showering as the highest water usage category on their properties (Figure 17).

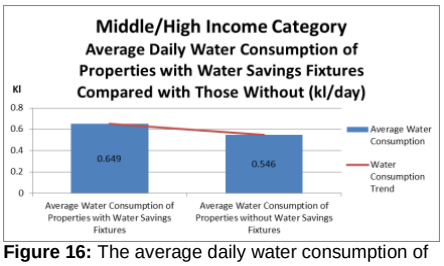

Figure 16: The average daily water consumption of properties where water savings fixtures were installed compared to those without.

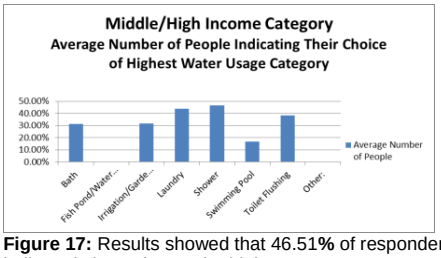

Figure 17: Results showed that 46.51**%** of respondents indicated showering as the highest water usage category within the middle/high income category.

Alternative Water Resources and Toilet Water Usage

Within the middle/high income category the average water consumption of alternative water users were 21% lower than those that did not make use of any alternative water resource/s (Figure 18).

Results also indicated that that the average daily water consumption per property increased with 19% with an increase in toilet flush frequency of 3 - 5 flushes to 6 - 8 flushes per person per day (Figure 19).

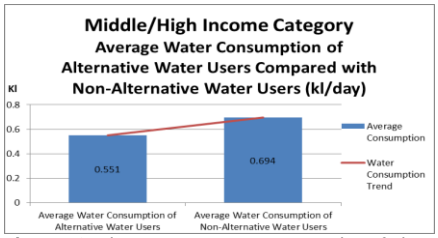

Figure 18: The average water consumption of alternative water users were 21% lower than non-alternative water users.

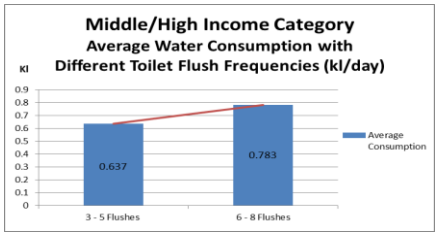

Figure 19: The average daily water consumption increased with 19% with an increase in toilet flushing frequency of 3 - 5 flushes to 6 - 8 flushes per person per day.

Washing Machine Frequency and Swimming Pools

Results indicated a 49% increase in average daily water consumption between properties that had a wash frequency of once per week and those that had a wash frequency of four times per week (Figure 20).

Within the middle/high income category the average water consumption of properties with swimming pools were significantly higher (31%), than those that did not had any swimming pools installed (Figure 21).

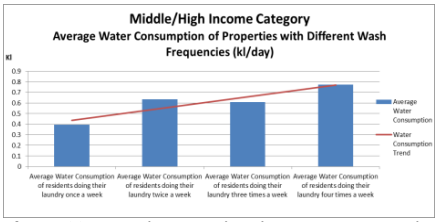

Figure 20: It can be seen that there was a general increase in average water consumption as the laundry washing frequencies is increasing.

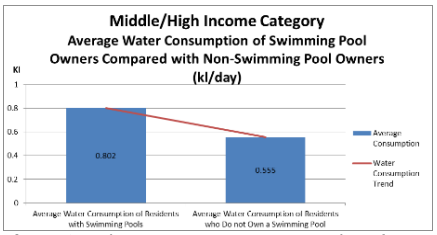

Figure 21: The average water consumption of properties with swimming pools was significantly higher (31%) than those that did not have swimming pools installed.

Stand Size and Property Valuation

It can be seen that properties with stand sizes that fell within the range of 900 - 1 299m^2 were using 58% more water than those that fell within the stand size range of 200 - 399m^2 (Figure 22).

The results also indicated that there was an average daily water consumption of 0.683 kl at properties valued at >R800 000. There was no data available of properties falling within the lower valuation ranges, making water consumption comparison between different valuation categories impossible for the middle/high income category (Figure 23).

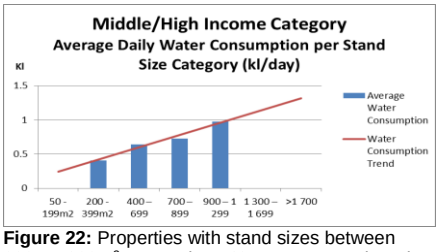

Figure 22: Properties with stand sizes between 900 - 1 299m^2 were using 58% more water than those with stand sizes between 200 - 399m^2.

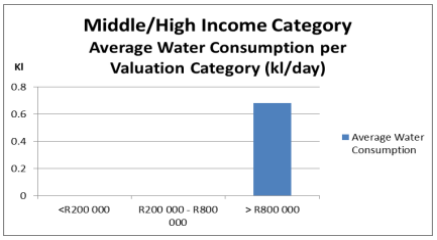

Figure 23: There was an average daily water consumption of 0.683 kl at properties valued at >R800 000.

Precipitation and Geographic Variation

Each of the study suburbs were assigned a number to correspond with geographic precipitation zones, as measured by the Department of Agriculture (Figure 24).

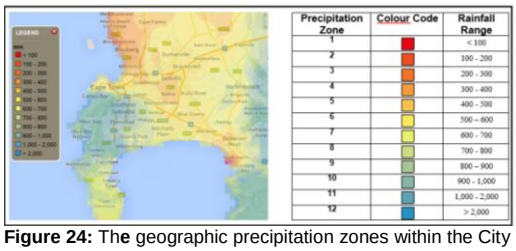

Figure 24: The geographic precipitation zones within the City of Cape Town (Harris Corp Earthstar Geographics, 2015).

According to Table 3, the results for the informal settlement and low income category indicated that there is a correlation between areas with low rainfall but with very high temperatures and high average daily water consumption figures. It can be seen that in the informal settlements areas, Endlovini (Khyalitsha) had the highest mean annual temperature of 16.9 °C and the second lowest rainfall figure of 541.0 mm/annum, with the highest average daily water consumption figure of 0.058 kl/day.

In the low income areas Bonteheuwel also had the highest mean annual temperature of 17.0 °C and the third lowest rainfall figure of 646.0 mm/annum, with the highest average daily consumption of 0.576 kl/day. It therefore seems that high water consumption can be linked to areas with very high mean annual temperatures together with a low (but not necessarily the lowest) rainfall figure.

In the middle/high income areas the above trend was not clear but there seems to be a correlation between lowest rainfall figure and highest average daily water consumption figure. It can be seen that Melkbosstrand had a mean annual rainfall figure of 300.0 mm/annum and a highest average water consumption figure of 0.813 kl/day. There is however not a correlation between highest temperature and high consumption within this category.

Table 3: The study suburbs assigned to different precipitation zones according to geographic variation. Source: SA Atlas of Climatology and Agro-hydrology (Schulze, 2009).

Suburb	*Mean Annual Rainfall (mm/annum)	Precipitation Zone	Map Colour Code	Precipitation Range	**Mean Annual Temperature (°C)	Average Consumption per Property (AADD)
Informal Settlements Category						
Masiphumelele	876.0	9		800 – 900	16.0	0.045 kl
Imizamo Yethu	1119.0	11		1,000 - 2,000	16.2	0.044 kl
Khayelitsha (Endlovini)	541.0	6		500 – 600	16.9	0.058 kl
Malawi Camp	556.0	6		500 – 600	16.7	0.025 kl
Du Noon	524.0	6		500 – 600	16.6	0.035 kl
Low Income Category						
Bonteheuwel	646.0	7		600 - 700	17.0	0.576 kl
Langa	620.0	7		600 - 700	16.6	0.469 kl
Lavender Hill	787.0	8		700 - 800	15.7	0.566 kl
Lentegeur	574.0	6		500 – 600	16.7	0.515 kl
Ocean View	955.0	10		900 - 1,000	16.2	0.514 kl
Middle/High Income Category						
Fish Hoek	873.0	9		800 – 900	16.0	0.559
Newlands	1121.0	11		1,000 - 2,000	16.6	0.715
Melkbosstrand	300.0	4		300 - 400	16.3	0.813 kl
Gordon's Bay	755.0	8		700 - 800	15.9	0.621 kl
Edgemead	444.0	5		400 - 500	17.2	0.617 kl

*Annual average of monthly median rainfall (taken over 50 years).
**Long term mean annual temperature, including minimum and maximum temperatures (taken over 50 years).

The above trends could be an indication of the impact of high temperatures on residents in the informal and low income categories. This can be due to the fact that most of these residents had corrugated iron roofs and structures (informal) and roofs (low income) which can create very high indoor temperatures, with a resultant increase in water use. It can also be assumed that due to the lack of large irrigated gardens in these areas the impact of low rainfall figures would be limited.

The lack of correlation between high temperatures and water consumption in the middle/high income areas could be ascribed to the indoor ventilation and cooling effect of most affluent residential building design. It can be assumed that due to large irrigated gardens, low rainfall figures could have a larger impact on water consumption and could be the cause of increased water usage within the middle/high income areas. Whatever the case might be, the trend seems to be that high temperature can be linked to high water consumption in the informal and low income categories, but low rainfall can be linked to high water consumption in the middle/high income categories. More research is needed to confirm trends as picked up during this study.

Discussion and Conclusions

Due to the challenges and specific conditions within informal settlements as well as the lack of quantifiable consumption data per household, water consumption figures could not be assessed and quantified for this specific category.

Additional Buildings and Dwellings

Within the low income category the most dominant type of additional buildings where water was used were backyard dwellings. The average number of occupants within these additional buildings were 4 (3.6 rounded off) occupants. The results indicated that the average daily water consumption of properties with additional buildings were 21% higher than those that had only a main residence.

Within the middle/high income category the most dominant type of additional buildings where water was used were found to be workshops/garages. Most of these buildings is used for storing vehicles but are also used as workshops for additional purposes. Water consumption within these buildings can include vehicle washing, workshop/garage surface/floor washing as well as water usage relating to additional workshop practices like woodworking, hobby works, etc. The research results indicated that the average daily water consumption of properties with additional buildings where water was used were 29% higher than those that had only a main residence.

Household Demographics

Within the informal settlements the highest number of occupant range indicated by respondents was between 1 - 4 occupants per household. This correlated with the smaller household occupant size which can be expected within informal settlements due to cramped space conditions within these areas.

Within the low income areas the average household occupant numbers were larger than the informal and middle/high income categories, with between 5 - 8 occupants per property. It can be seen that there was an increase in average daily household water consumption of 22.2% between households with 1 - 4 occupants and those with 5 - 8 occupants within the low income category. A further 5.4% increase in consumption was found where households had 9 - 12 occupants, levelling off at this point with a reduction of 0.2% beyond this point.

Although only 12% of households within the middle/high income category had between 5 - 8 occupants, it should be noted that the results had shown a significant increase in water consumption within these households. In the middle/high income category the average daily increase in water consumption was found to be higher, with a 28.3% increase in consumption between the households that had 1 - 4 occupants and those that had 5 - 8 occupants. Within the middle/high income category the number of household occupants seldom exceeded 8 occupants.

Estimated Highest Water Use Category

The highest household water use category as indicated by respondents within the informal settlements were laundry washing, where 55.82% of participants indicated that the most water was used for laundry within their households. The second highest water use category within informal settlements were toilet flushing, where 31.84% of respondents indicated this as the category where the most water was used.

The highest household water use category as indicated by respondents within the low income category was also laundry washing, where 62.87% of participants indicated that the most water was used for laundry within their households. The second highest water use category within the low income category was toilet flushing, where 33.34% of respondents indicated this as the category where the most water was used.

The highest household water use category as indicated by respondents within the middle/high income category was shower water usage, where 46.51% of participants indicated that the most water was used for showering within their households. The second highest water use category within the middle/high income category was laundry washing, where 43.69% of respondents indicated this as the category where the most water was used.

Water Saving Fixtures

The survey indicated that the usage and popularity of water savings fixtures within all categories of Cape Town were very low, with less than 30% of respondents indicating that they had any water saving fixtures installed on their properties. Within low income categories, 73% of respondents indicated that they did not have any water savings fixtures installed on their properties, whilst 72% of respondents within the middle/high income categories did not have any water savings fixtures installed on their properties.

The most popular water saving fixture installed within the low income category was dual flush toilets, where 20% of respondents indicated that they had dual flush toilets installed. The most popular water saving fixture installed within the middle/high income category were low flow showerheads, where 40% of respondents indicated that they had low flow showerheads installed. The results is indicating that within the low income category the properties that had some type of water saving fixture installed were using 5% less water than those that did not have any water saving fixtures installed.

In the medium/high income category however, the results indicated that the properties that did have some type of water saving fixture installed were using 15% more water than those that do not had any water saving fixture installed. It can be debated as to the reason for this; some might argue that it is the higher water consumers that will install water saving fixtures. Future similar trend studies are therefore necessary in order to pick up a continued trend in this regard.

Alternative Water Usage

In the informal settlements category only 33% of respondents indicated that they were using some type of alternative water resource. The main type of alternative water resource used within this category was greywater, with 25% of the alternative water users indicating that they were greywater users.

Within the low income category 40% of respondents indicated the use of some type of alternative water resource. The main type of alternative water resource used in this category was also greywater, where 31% of respondents indicated that they were recycling/re-using their potable water. It is also interesting to note that within the low income category the average water consumption of properties where boreholes/wellpoints were installed was only 0.104 kl/day, which was significantly lower than the average water consumption of properties with other types of alternative water resources installed. This could be an indication of the high water saving potential of groundwater usage. Although groundwater sources within this category indicated a high water usage reduction potential, only 0.1% of respondents within this category were using groundwater, and its impact on the overall difference in water consumption of alternative water users and non-alternative water users were insignificant. For the low income category the average daily water consumption of properties using some type of alternative water resource were actually 14% higher than those properties not using alternative water resources. This could be due to the low rate of alternative water usage; especially groundwater usage.

It is interesting to note that there was a lower alternative water usage frequency within the middle/high income category, with only 30% of respondents indicating some type of alternative water usage. The two main types of alternative water resources used were groundwater

resources (14%) and rainwater harvesting (13%). Due to a very small sample size the water consumption data per resource type were too small to produce significant results. The overall consumption results however indicated that the average water consumption of alternative water users were 21% lower than non-alternative users. It can be assumed that the higher percentage usage of groundwater resources could be attributed to this reduced consumption, but needs to be tested by regular consumption studies in order to show trend and to prove this assumption.

Properties with Swimming Pools

Only 1% of properties within the low income category had swimming pools installed. Due to the low figures of swimming pool ownership the data were insignificant and no comparison between average water consumption figures for properties with swimming pools and those without could be established for the low income category.

The research results indicated that there was a significant increase in average water consumption between properties with swimming pools and those without in the middle/high income category. It can be seen that properties with swimming pools consumed on average of 31% more water than those without swimming pools.

Toilet Usage Frequency

The results showed that there was an increase in average water consumption of 19% between properties where the toilet flush frequency fell within the range of 3 - 5 flushes, and properties where the toilet flush frequency fell within the range of 6 - 8 flushes within the middle/high income category. The daily frequency of toilet flushing per person per day was in the range of 3 - 5 flushes per day for all categories.

Washing Machine Ownership and Wash Frequency

No households within the informal settlements owned a washing machine and 100% of the respondents indicated that they did their laundry by hand.

Within the low income category 77% of respondents indicated that they owned a washing machine. Results showed that there were 16% more water consumption on properties where washing machines were used within the low income category.

All (100%) of the respondents within the middle/high income category indicated that they owned a washing machine.

The laundry washing frequency of respondents within the informal and low income categories were 1 - 2 times a week. The laundry washing frequency of respondents within the middle/high income category were higher with a laundry frequency of 2 - 3 times a week. Results indicated a 49% increase in average daily water consumption between properties with a frequency of once per week and those with a frequency of four times per week within the middle/high income category.

Stand Size and Water Consumption

Within the low income category 50.13% of respondents indicated a property size falling within the range of 200 - 399m^2. The stand sizes within the middle/high income areas were much larger, with 46.87% of respondents indicating a property size that fell within the range of 400 - 699m^2. Properties with stand sizes that fell within the range of 200 - 300m^2 were using 12% more water than those with stands that fell within the size range of 50 - 199m^2. Properties with stand sizes falling within the range of 900 - 1 299m^2 were using 58% more water than those falling within the size range of 200 - 399m^2.

Property Valuation and Water Consumption

Results showed that within the low income category, 78% of respondents indicated a property valuation falling within the range of R200 000 - R800 000 and 22% indicated a property valuation of less than R200 000. Average stand sizes were

much larger within the middle/high income category with 93.33% of respondents indicating a property valuation falling within the range of > R800 000. The results indicated that there was an average daily water consumption increase of 20% between properties valued <R200 000 and those valued between R200 000 - R800 000 within the low income category. Within the middle/high income category there was no data available of properties falling within the lower valuation ranges, making water consumption comparison between different valuation categories impossible for this category.

Recommendations

Access to tagged standpipes for backyard dwellers is recommended in order to provide an additional water supply to properties with additional dwellings. Water management devices should be programmed to also consider the water demands of the backyard dwellers living on a property. The higher water usage linked to properties with high occupant numbers should be the focus of water conservation efforts. Water management devices should also be programmed to consider the higher water demand on these properties.

Within the middle/high income category there should be an increased focus on the monitoring of wastewater flow into the stormwater system from water usage practices within workshops/garages.

Increased emphasis should be placed on information that educates the consumers on water efficient washing machines within the low and middle/high income areas. Awareness should also be provided on the impact of washing frequency on water consumption.

Reduced showering times as well as water saving fixtures such as low flow shower heads should be promoted within the middle/high income areas.

The reason for the low water saving fixture usage levels by City of Cape Town consumers should be investigated; it could be due to consumers still being unaware of the positive impact of these fixtures for themselves and for water conservation in general, or it could be due to the relatively high prices to acquire and install these water saving fixtures. Ownership of water saving fixtures is influenced by consumer perception. Education and awareness around water saving fixtures is therefore highly recommended as it could have a positive impact in reducing household water consumption. Consumer attitudes and positive behaviour towards water saving technology could greatly influence water consumption and education and awareness of water saving technology is therefore necessary.

Due to results indicating showering as the highest water usage category within the middle/high income category, there should be an increased focus on awareness on showering length/periods and the promotion of low flow shower heads within this category.

Alternative water resources are mostly expensive to install and any borehole/wellpoints as well as costly rain- and greywater systems are mostly not present in informal settlements. Cheap and self-made options are however very popular within this category. The practice of greywater re-use is predominant as water collected from communal points are stored within the household in containers such as buckets and plastic basins and are commonly re-used over and over for different household purposes. Self-made catchment containers are also used to harvest rainwater which is then used within the household. These types of alternative water usage within this category are very popular due to the convenience as it saves the residents the effort of fetching and carrying heavy containers and prolongs the need for tedious trips to the communal points. Education and awareness campaigns should focus on these aspects within the informal settlements category.

The significant water savings potential of groundwater usage within the low and

middle/high income areas should be investigated more closely. Research and monitoring of groundwater usage impact should be made high priority. It is recommended that a regular water consumption trend analysis is done in order to obtain significant trend results for alternative water resource usage.

The significant higher levels of water consumption on properties with swimming pools should be investigated. The impact of water conservation practices focusing on swimming pools such as reduced back-flushing frequencies, the use of swimming pool covers and the filling up with alternative water resources should be investigated and promoted.

Properties with large stand sizes within the middle/high income areas should receive increased water conservation education and awareness, especially on irrigation practices, swimming pool practices, and alternative water usage, amongst others. Education and awareness initiatives should also focus on the water demand needs of backyard dwellers, properties with residential workshops/garages where water is used, laundry washing frequency within the informal and low income areas and groundwater usage.

Further Research Recommendations

A regular residential water consumption trend survey is recommended as water consumption trends can only be revealed through regular surveys.
- A more detailed literature review of test procedures and methods is recommended.
- The accuracy of the results could be improved by increasing the sample size and improving of survey instruments and procedures.
- Research and monitoring of groundwater usage impact should be made high priority.
- Further research should be done on water consumption trends within high income areas.
- It is recommended that future research studies include different seasons to provide for the analysis of the relationship between climate and water consumption patterns.
- Future research studies could also focus more on outdoor water usage such as irrigation technology, garden water use and water wise gardening.
- More research is needed on the social impacts of water demand management legislation such as water restrictions on consumer behaviour and residential water use.

References

City of Cape Town (CCT). (2013a) Integrated Development Plan, 2013/2014. CCT: Cape Town.

City of Cape Town (CCT). (2013b) *Integrated Human Settlements Five-Year Strategic Plan:* 1 July 2012 to 30 June 2017. 2013/14 Review. CCT: Cape Town.

Department of Water Affairs (DWA). (1998) *National Water Act, 1998* (Act No. 36 of 1998). DWA: Pretoria.

Giurco, D., Carrard, N., McFallan, S., Nalbantoglu, M., Inman, M., Thornton, N. and White, S. (2008) *Residential End-Use Measurement Guidebook: A Guide to Study Design, Sampling and Technology.* Prepared by Institute for Sustainable Futures, UTS and CSIRO for the Smart Water Fund: Victoria.

Harris Corp Earthstar Geographics. (2015) Western Cape Government, Department of Agriculture: Microsoft Corporation. Available at: www.elsenburg.com/gis/apps/cfm (accessed on 5 May, 2015).

Inman, D. and Jeffrey, P. (2006) A review of Residential Water Conservation Tool Performance and Influences on Implementation Effectiveness. *Urban Water Journal*, 3:3, 127-143.

Mayer, P.W. and DeOreo, W.B. (1999) Residential End Uses of Water. *Water Engineering and Management:* Denver.

Schulze, R.E. (2009) SA Atlas of Climatology and Agrohydrology. Water Research Commission: Pretoria.

Turner, A; White, S.; Beatty, K. and Gregory, A. (2005) Results of the Largest Residential Demand Programme in Australia. *Institute for Sustainable Futures, University of Technology.* Sydney Water Corporation, Sydney: Australia.

Water Research Foundation. (2010) *North America Residential Water Usage Trends Since 1992.* Water Research Foundation: Denver.

Water Services Association (WSAA). (2003) *Urban Demand Forecasting and Demand Management: research needs review and recommendations.* White, S. Robertson, J. Cordell, Jha, M., Milne, G. Institute for Sustainable Futures UTS for Water Services Association: Sydney.

White, S. and Fane, S. (2001) Designing Cost Effective Water Demand Management Programs in Australia. *Water Science and Technology*, 46:6-7, 225-232.

White, S. and Turner, A. (2003) The role of effluent reuse in sustainable urban water systems: untapped opportunities. *National Water recycling in Australia Conference.* September 2003. Brisbane: Australia.

Willis, R.M. (2010) D*omestic End Use Investigation: WDM and Dual Reticulation.* Griffith School of Engineering, Griffith University: Australia.