UNIVERSITY OF THE WESTERN CAPE

Determining the Socio-economic Value of Groundwater:

Franschhoek Case Study

By

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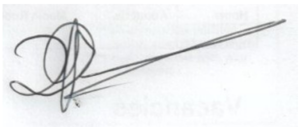
Mr Rob Armstrong	Franschhoek Sustainability Committee / Resident

ii. Declaration

Declaration

I declare that the academic document "Determining the Socio-economic Value of Groundwater: Franschhoek Case Study" is my own work, that it has not been submitted before for any degree or examination in any other university and that all the sources I have used or quoted have been indicated and acknowledged by my references.

Darian Pearce



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iii. Executive Summary

Introduction

The Western Cape, a province of South Africa is facing increased pressure to develop new supplies of fresh water to cater for the regions rapidly growing demand. Groundwater is being explored as a possible contributor to the freshwater supply. Development of the resource has been slow despite the existence of significant potential groundwater resources in the form of several shallow primary aquifer systems and an extensive secondary aquifer formation known as the Table Mountain Group (TMG) Aquifer. This slow development may be attributed primarily to a lack of awareness amongst key stakeholders and general ignorance in the water market with regards to the potential of this resource.

Problem Statement

In the past decision making systems have focused on the value of groundwater as a resource in its own right. This has led to a significant spectrum of water values being excluded from the decision making process. Groundwater contributes to society in various ways both directly and indirectly, yet the indirect benefits are often overlooked. In addition, the fact that this subterranean resource is “out of sight” has contributed to a general lack of awareness amongst stakeholders with regards to the prevalence, function and general knowledge of the resource.

This has resulted in less than adequate level of investment in groundwater resource development which in turn has contributed to an underestimation of the resources potential. The purpose of this study is to develop and apply a valuation model that can estimate the value of this resource from a demand sided approach so that the socio-economic factors that drive its value can be identified. It is also necessary to assess the levels of awareness and knowledge that exist with regard to groundwater resources. In addition it is necessary to measure the extent to which groundwater contributes to total societal consumption.

Design and Methods

The study utilized 3 primary sources of data. These are as follows:

- Municipal Water Billing Data: Used to track consumption in the research area
- Agricultural Hydro Census Data: Used to assess water use within the agricultural sector
- Contingent Valuation Survey Data: Used to assess the non-market values of groundwater and to collect demographic data from households in the research area

Secondary supporting data was collected through in-depth interview with industry experts as well as through the available literature. The interviews were used as an investigative tool to identify possible sources of key information and to guide the hands on practical components of the project.

A framework for the total economic value of groundwater was utilized; it included direct use value, indirect use value, existence value and bequest value. These were divided up into market and non-market values with direct use being the only readily identifiable market value. The remainder was all classified as non-market values. A direct valuation approach using the municipal water billing data was used to quantify the market values of groundwater. Contingent valuation was used to quantify the non-market values of groundwater.

The household survey covered the three clusters of Franschhoek Town, Groendal and La Motte. The sample was stratified based on geographic location, an approach that proved effective given that the research area is highly segregated and income levels and race area highly correlated with geographic location. Basic descriptive statistics were used to analyze the household data collected in the survey. The contingent valuation data that was collected was analyzed using double bonded logit model. The hypothetical scenario for the contingent valuation assessment was built with the assistance of a panel of hydrogeologists and focus group style think tanks were utilized to filter and structure the information that they had to offer. The survey team was trained in survey technique and etiquette and the questionnaire was pretested in order to ensure the efficacy of the instrument. The survey was conducted in three languages; English, Afrikaans and Xhosa face to face interviews were utilized to overcome respondent illiteracy. A pre-survey awareness campaign was conducted by contacting and informing community groups of the impending survey and by placing an article in the local newspaper. The survey yielded a sample of 277 questionnaires which passed the screening process.

The water billing data obtained from the municipality was analyzed using Visual Basic for Applications in the Microsoft Excel Package which allowed for effective and efficient processing of the large data sets. This allowed us to account anomalies in the data including inactive accounts, clusters (multiple units registered under a single account) and incidences of municipal estimation of billing amounts. The data obtained from the municipality covers the period from March 2005 up until February 2011. The data was used to identify the water use patterns and trends including long run growth rates, seasonal fluctuations, water price trends and cluster expansion.

The water use census covered a total of 97 farms in the research area and managed to account for more than 99% of the irrigation/agricultural water usage within that area. The water use census team was trained in census technique and etiquette as well as being involved in the development of the census instrument. A pre-census awareness campaign was conducted by distributing letters of intent through and with the assistance of the Franschhoek Farmer Association and the Berg River Irrigation Board. In addition an article informing residents of the impending census was placed in the local newspaper. Data collected in the census includes crop size and type, irrigation regimes, water sources and some ancillary farm details.

Findings

The household survey data revealed a highly segregated community with high levels of income disparity. Economic growth rates within the area were exceptionally high and this was particularly evident in the large number of housing developments taking place and in the exceedingly rapid expansion of the informal settlement that lies adjacent to the Groendal Cluster. The fluctuating economic trends are thus affecting all levels of the social structure.

The rapid expansion and economic growth taking place within the communities in the research area is driving an ever increasing demand for potable water with demand increasing at an average of 9.75% per annum over the last 6 years. Demand for water supplied by the municipality is currently around 1129432m^3 per year.

Of the municipal water that is consumed in the research area approximately 33.98% is supplied from groundwater fed stream located in the Mont Rochelle Nature Reserve with the remainder being supplied from Wemmershoek Dam. The agricultural sector accounts for approximately 66.02% of the total water consumption in the Franschhoek Valley

In the agricultural sector the demand for water has also seen significant expansion with this being most evident in the increase in the number of boreholes from 32 to 90. The approximate amount of water used each year from irrigation and agricultural purposes is 4224216m^3. Approximately 24.41% of the water used for irrigation and agriculture is sourced from private boreholes and a small number of springs. The remaining 75.59% is supplied from surface water sources such as streams, rivers and dams.

The real (adjusted for inflation and economic growth) price of water in Franschhoek Town, Groendal and La Motte has been increasing year on year at an average of 6.55%, 2.88% and 1.55% respectively. However despite these price increases there has been no decrease in per household consumption in any of the clusters. This is due to the low price of water and the plausible notion that the economic growth is pushing up household income levels and average household size.

Due to the fact that there is no inverse relationship between price and consumption it is not possible to derive a demand curve for municipal water in Franschhoek and therefore it is not possible to calculate consumer surplus generated through the consumption of this resource. The demand curve for water is thus indeterminate and following from this it is not possible to calculate the market value of groundwater

The contingent valuation approach used to quantify the non-market values of groundwater yielded some results. The willingness to pay (WTP) for the non-market value of groundwater in the less affluent segment of the Franschhoek community was estimated to be R119.77 per household per month, which represents 1.8% percent of a mean household income. Several factors that influence willingness to pay within the less affluent community were identified. These were household income, respondent age, satisfaction with municipal services and the type of dwelling in which the respondent resides.

The willingness to pay for the non-market values of groundwater in the more affluent segments of the Franschhoek was estimated at R456.84 per household per months. Several factors that influence willingness to pay within the more affluent community were identified. These were household income, satisfaction with municipal water services and household education levels.

Conclusions

Water consumption is increasing on the whole across all strata of the Franschhoek Valley with the side the effects of economic development, expansion and urbanization, being the primary drivers behind that growth in demand.

As things currently stand, groundwater is decreasing as a percentage of municipal water supply. The opposite is true in the agricultural sector where groundwater is making up an ever increasing proportion of the water being used for irrigation and agricultural purposes.

There is uncertainty regarding water security in this area, as the contract that the Stellenbosch Municipality had with the City of Cape Town to obtain water from Wemmershoek Dam has expired, which introduces an element of uncertainty with regards to Franschhoek water security.

The market value of groundwater is indeterminate because the consumption is non-responsive to changes in price. This is because the price of water is too low and as a result consumers don't factor it into their consumptive considerations.

The willingness to pay estimates of R119 and R457 for the less affluent and more affluent segments of the Franschhoek community are strong evidence of society's willingness to protect the environment. There are several factors that influence the willingness to pay for the non-market values of groundwater, though most of them relate back to household income levels and perceptions of the municipality/state.

Recommendations

Franschhoek would benefit from further investment into the development of its groundwater resources, particularly for the purposes of domestic and commercial consumption. The area currently lacks a single user or groundwater user organization (in essence a water user association) of sufficient size to assume responsibility for the monitoring of the resource.

The drilling of boreholes for private consumption is already proliferating in the agricultural sector. As this consumption is not being tracked there is uncertainty with regards to how the current abstraction rates are affecting the state of groundwater resources in the area. It would be beneficial if the there was active involvement on behalf by the state or water user association monitor the resource and ensure its integrity.

This would have the direct benefit of increasing water security in the Franschhoek Valley and would also promote the wider usage, protection and monitoring of groundwater resources, which would in turn promote involvement of the local community towards understanding the local groundwater resources, which would have a positive effect on consumer awareness and knowledge of said groundwater resources.

The price of water provided by the municipality should be increased beyond the current rates being applied. The demand for water at the current pricing levels is highly inelastic and this could generate significant quantities of additional revenue for the municipality, which in turn could be reinvested in resource and infrastructure development or used to make up for budget deficits.

The positive estimates of willingness to pay for the non-market values of groundwater indicates that there is a willingness amongst the Franschhoek Community to absorb additional costs, so long as it results in tangible benefits to the local environment.

Since the evidence indicates that consumer satisfaction with regards to municipal services is an influential factor in the socio-economic value of groundwater, there needs to be a concerted effort on behalf of the state to deliver on promises and promote customer satisfaction. All aspects of society have a role to play in the sustainable development, preservation and protection of groundwater resources and a functional relationship between the state and its constituents is a prerequisite for this.

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vii. Acronyms

BRIB	Berg River Irrigation Board
CMA	Catchment Management Agency
CS	Consumer Surplus
CV	Contingent Valuation
CVM	Contingent Valuation Method
CVS	Contingent Valuation Survey
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EC	Environment Canada
ES	Ecosystem Services
ESA	Ecosystem Services Approach
FISBA	Franschhoek Informal Small Business Association
FFA	Franschhoek Farmers Association
GDP	Gross Domestic Product
GV	Gross Value
Ha	Hectare
IWRM	Integrated Water Resource Management
Km	Kilometer
LSM	Lifestyle Standard Measure
m	Meter
MA	Millennium Ecosystem Assessment
MCA	Multi Criteria Analysis
NPV	Net Present Value
NRC	National Research Council (United States of America)
NWA	National Water Act
NWRS	National Water Resource Strategy
pa	Per Annum
QC	Quaternary Catchment
R	Rand
RSA	Republic of South Africa
SADC	Southern African Development Community
StatsSA	Statistics South Africa
TCM	Travel Cost Method

TCTA	**Trans Caledon Tunnel Authority**
TE	**Total Expenditure**
TEV	**Total Economic Value**
TMG	**Table Mountain Group**
UNECA	**United Nations Economic Commission for Africa**
UNEP	**United Nations Environment Program**
WHO	**World Health Organization**
WRC	**Water Research Commission**
WTA	**Willingness to Accept**
WTP	**Willingness to Pay**
WUA	**Water User Association**

Introduction

1. Introduction

1.1 Background to the Project

Freshwater is an essential component to all aspects of human life. The rapid development of human society in the 20th Century is putting an immense amount of pressure on the planet's available freshwater resources. South Africa is a semi arid country with a mean annual rainfall of around 500mm/a compared to the global mean of 860mm/a (Woodford and Rosewarne. 2006). As such the availability of freshwater (or lack thereof) is of key concern to this country.

The Western Cape and the Cape Metropolitan Area (CMA) in particular are working towards securing a greater supply of freshwater in order to provide for the regions predicted growth in demand. One option that has been explored is the abstraction of groundwater from the TMG Aquifer (Table Mountain Group Aquifer), a semi-confined fractured rock aquifer underlying most of the Western and Eastern Cape. (TMG Aquifer Alliance. 2004)

Research has and is still being undertaken, has produced very useful data regarding the potential yield and possible environmental impact of utilizing this resource. However, despite this growing body of knowledge, there has been an insufficient financial commitment on behalf of government and associated stakeholders to adequately develop this resource.

There is still very little knowledge amongst policy and decision makers regarding the true value of groundwater (Lopi. 2009). This is due in part to the fact that subterranean water sources are "out of sight", which has resulted in the resource being relatively unnoticed and less understood (Braune and Xu. 2008). As such, the role of groundwater has as yet not been adequately incorporated into the institutional development which in turn has been reflected in inadequate funding commitments (Braune and Xu. 2008).

The purpose of this study is to develop and apply a valuation model that will allow us to paint a comprehensive picture for stakeholders outlining the total socio economic value of groundwater within the TMG Aquifer.

1.2 Research Area

Franschhoek is a small peri-urban community located in the South West of South Africa in the province of the Western Cape. It is one of six wine regions that comprise the Cape Winelands District, the largest wine growing region in South Africa. Franschhoek consists of several clusters of residential development nestled amongst farmland. The greater area, surrounded on three sides by mountainous terrain is known as the Berg River Valley.

1.2.1 Socio-Economic Structure and Layout

The area is located in the upper reaches of the Berg River Catchment Area, illustrated in figure 9 below. Specifically, Franschhoek is located in quaternary catchment G10A.

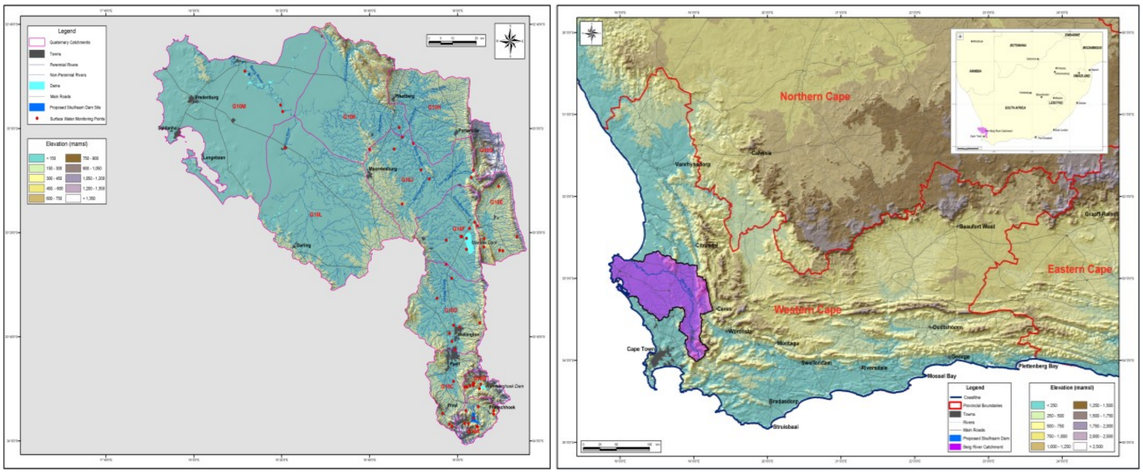


Figure 1: Map of the Berg River Catchment (DWAF. 2007)

The area was chosen and is suitable for this study for a number of specific reasons. Despite being located near to several dams including the Skuifraam Dam, Theewaterskloof Dam and Wemmershoek Dam, Franschhoek is facing imminent water shortages. The water contained within these dams is proposed for the City of Cape Town (CoCT), which is facing its own looming water shortages. Franschhoek obtain approximately 66% of its water from Wemmershoek Dam (Stellenbosch. 2011a). This water was purchased from the CoCT under contract in 2001, but this has since expired and its renewal is not a certain issue.

In addition there is significant contrast between the income levels of the wealthy and the poor and the areas playing host to the various income levels are geographically separate from one another, such that the lower income, lower middle income, upper middle income and upper income areas are distinct. The three main clusters of development being considered are Franschhoek Town, Groendal and La Motte, Groendal itself consists of a formal and informal housing component. The informal housing section of Groendal is known as Langerug.

Franschhoek Town, Groendal and La Motte collectively represent the entire the entire socio-economic spectrum. Franschhoek Town is comprised almost entirely of upper income and upper middle income households. Groendal residents cover the entire range of income levels; however lower income and lower middle income households make up the majority of households in this area. La Motte is comparable to Groendal in this regard but does not have any informal housing. La Motte is also a relatively new settlement having been established lees than 10 years ago.

The primary economic activities in the area are tourism/hospitality and agriculture. The Franschhoek Valley is knows in colloquial terms as the "Food and Wine Capital" of South Africa and is recognized as one of the nation's premier tourist destinations.

1.2.2 Recent Socio-Economic Developments

The Beauty of the immediate surroundings in the area and its proximity to the Cape Town (Approximately 80km from Franschhoek to the Cape Town CBD) combined with the "wine culture" of the region have it an incredibly popular tourist destination in the last decade.

The area has just come out of a immense property market boom which has been playing of the incredibly high rates of return in the South African Property market between 2004 and 2008. Between the three residential clusters under consideration the number of active formal stands has increase from 2154 to 2575 over the period March 2005 until February 2011. This development has mostly been of premium luxury housing and some commercial properties in Franschhoek Town.

The informal housing sector of Groendal expanded from less than 500 informal dwellings in 2007 up to approximately 1700 in 2011 with large number of low income families being attracted into the area due to increased employment opportunities and access to basic services and education.

The farmland amongst which the residential areas may be found has also played host to significant development with further proliferation of hotels and restaurants. A fair number of the smaller wine farms have been purchased by foreign developers and have been developed into exclusive holiday establishments. Wine production on these farms continues but is not run for the sake of profitability but more for the lifestyle that it portrays.

1.2.3 Skuifraam Dam

The Skuifraam Dam, also known as the Berg River Dam, is the Western Cape's most recently completed dam, having been commissioned in 2009. The dam, built in the La Motte state forest, 5km west of Franschhoek Town is in the immediate proximity of the Franschhoek residents and has become a prominent landmark.

The Skuifraam Dam was built to augment the City of Cape Town's water supply. It holds 81 million m^3 and cost in the region of R780 million . The project was managed and implemented by the Trans-Caledon Tunnel Authority (TCTA), a state owned entity. Construction began in 2004 and the dam became operational in 2008 (World Bank. 2010). The La Motte residential cluster was constructed to provide accommodation to those working on the dam's construction.

1.2.4 History of Water Use

The water source coming out of the Mont Rochelle Nature Reserve dates back to the late 1800's, some years before 1885, when one of the local Franschhoek Farmer's, Mr Daniel Hugo, commissioned a regiment of British Soldiers to survey a route to allow water that would originally have flowed into the Teewaterskloof area to flow in to the Franschhoek Valley.

At the time the primary sources of water were the local streams and springs, however the growing economic activity, including the need for more water to power a local mill, prompted the action. The primary occupation of the farms at this time was cattle farming, as the farms in the area were purposed to supply beef to the Cape Castle. The new water source, which traveled via an open furrow, was diverted into a local stream named the Oakleaf stream. A portion of this water was diverted to the local church to allow for the maintenance of the church gardens. In 1930, due to increases in cattle farming and local water use, the furrow was upgraded to a steel pipe. This water supply, including the diversion for the local Dutch Reform Church still exists today.

1.3 Research Problem

In the past decision making systems have focused on the value of groundwater as a resource in its own right. This has led to a significant spectrum of water values being excluded from the decision making process.

Examples of values that have been excluded (Moss et al. 1997):

- reduced incidence of infectious disease
- lost economic opportunities
- environmental quality

This has contributed to a vicious cycle of low funding:

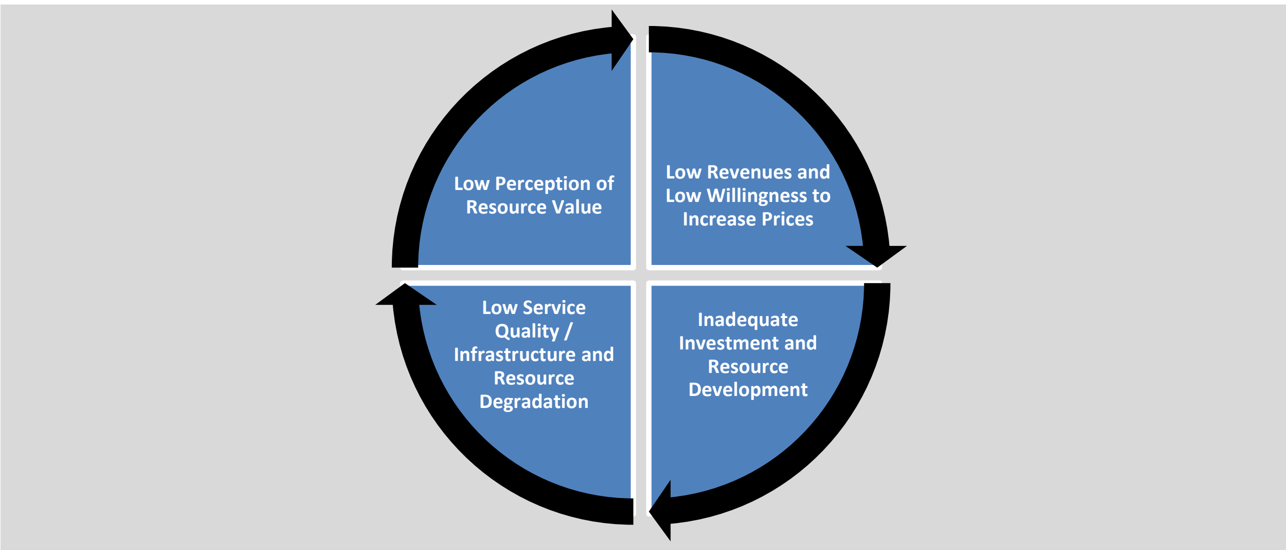


Figure 2: Cycle of Low Funding in Water Markets

This study seeks to address this issue through the development and application of a holistic valuation model that incorporates all the significant use and non-use values of groundwater.

The project will take a demand side approach focusing on the factors that drive demand for both the direct and indirect benefits for groundwater resources. The project will attempt to disaggregate the forces at play and indentify key factors that currently distinguish the groundwater market in the research area.

1.4 Research Objectives

Primary

1. Develop and apply a valuation model in order to determine the total socio economic value of groundwater within specific sampling areas
2. Identify the underlying socio-economic factors that influence that the value of groundwater

Secondary

1. Understand the nature of conjunctive use within the research area
2. Build a demographic profile of the research area
3. Identify the key economic contributors of the research area.
4. Identify the key trends in water/groundwater usage
5. Define the contribution that groundwater resources make to the research area
6. Measure the local perceptions, awareness and knowledge of groundwater resources
7. Observe the affect of pricing on water consumption
8. Assess the suitability of the area for the development of groundwater resources

1.5 Preliminary Hypotheses

Primary

- The hypothesized value of groundwater in the TMG Aquifer is (Kulshreshta. 1994):

Where:

= Net present value of the non-market values of the aquifer.

= Net present non-market value in the i^{th} usage. (i=1…s)

= Total non-market value in the ith use for year t (t=1…L)

Discount rate for time value of money

- The key socio economic factors that underlie the value of groundwater are income, with government satisfaction, knowledge of the resource, economic activity, well-being and population size.

Secondary

- Both groundwater and surface water resources are used in the research area. Private groundwater abstract is mostly confined to the agricultural sector whilst in the domestic sector groundwater is mainly accessed by the state
- Groundwater usage is rapidly expanding in the agricultural sector but is slow to develop for domestic supply as this is governed by the state
- The study area is a highly segregated peri-urban settlement with high levels of income inequality.
- There primary economic activities in the research area are agriculture and hospitality
- Knowledge and understanding of groundwater resources is very low across all societal levels in the research area
- Water consumption is irresponsive to changes in price as the price of water is too low
- The research area is highly suitable for the development of groundwater resources and this is evident in the agricultural sector where abstraction has proliferated

1.6 Structure and Layout

The layout of this document proceeds as follow:

1. **Preliminary Chapters**
2. **Introduction:** This brings to the fore the background to the project, problem statement and some contextual considerations that pertain to the study
3. **Literature Study:** A review of the necessary literature to build a theoretical framework for the project
4. **Design and Methods:** Detailed descriptions of the techniques and methods applied in this project.
5. **Findings**
6. **Discussion** of the findings and the conclusions of the study

NOTE: Due to the large number of detailed graphs that are contained within this document it was decided that it would be preferable to confine most of the graphs and table to the appendices.

1.7 Scope and Limitations

This project was designated as a pilot study designed to explore the avenues toward valuating groundwater resources. With a limited budget available, the research and survey activities needed to be confined to easily achievable goals.

The scope of the contingent survey was to include only the residential sector and would not include the commercial or agricultural sector. The goal would be to cover 250 to 300 household, and the research would be confined to the communities of Franschhoek Town, Groendal and La Motte.

The water use census would cover the entire Franschhoek Valley down as far as the intersection of the R45 and the Klapmuts Road. Data gathering would be limited to what is accessible through an interview and would not involve physical measurements.

Literature Review Part one: Theory of Valuing Groundwater

2. Groundwater Valuation: Key Economic Concepts

The valuation of a natural resource such as groundwater requires an understanding of a range of economic concepts that are somewhat broad in nature. For the sake of practicality it is necessary that we explicitly define these concepts in the contexts in which they will be applied. By doing so, this chapter aims to establish a clear integrative framework that will serve as the foundation for our valuation efforts.

2.1 Value Defined.

Human Beings express their perception of value through their preferences for certain goods or services. In the simplest sense, this perceived value can be measured by determining the maximum quantity of one good an individual would be willing to trade for a certain quantity of another (Field and Field.2002). Thus, as a simplification of this fundamental concept, translated into modern day economic terms, value may be expressed as the maximum amount an individual would be willing to pay for a specific quantity of a certain good or service.

It is important to note that willingness to pay (WTP) is distinct from price in that willingness to pay represents the maximum amount that a consumer is willing to pay for a particular good or service whereas the price of a good represents the marginal value at which the next exchange occurs (Moss et al.2003). If the WTP of a particular consumer is greater than or equal to the price of a particular good then they will purchase the good. If the price of the good is greater than the consumer's WTP then they won't purchase the good.

If we aggregate the WTP of all the individual consumers who proceed with the exchange we arrive at a figure that is recognized as the Gross Value for that particular good or service. The difference between the gross market value and the amount actually paid for a certain quantity of goods/services represents the benefit to society from the consumption of that good. This benefit is known as consumer surplus and it will be further elaborated upon in the proceeding section.

2.2 Consumer Surplus

In very simple terms, consumer surplus is defined as the difference between the benefit derived from the consumption of a certain quantity of goods and the amount paid for that quantity of goods. It is the measure of the benefits to society from the consumption of a certain good (Kulshreshta. 1994).

We have already established in the previous chapter that the total benefit derived from the consumption of a specific quantity of a certain good is recognized as its gross value, which is the summation of the WTP's of all the individuals who consume the good.

In order to determine the total amount that was paid for the specific quantity of the good in question, we simply need to multiply the quantity of the good that has been consumed by its price. This will give us **Total Expenditure** as illustrated in figure 2 below:

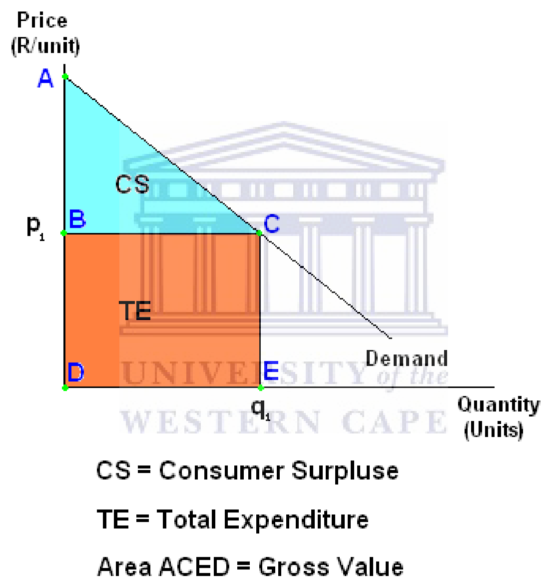


Figure 3: Functional Dissection of the Demand Curve (Griffiths and Wall. 2000)

Area ACED represents the gross value, which is the maximum amount that consumers would be willing to pay rather than go without that quantity of the good in question. Area BCED represents total expenditure which is the total amount paid for the good. Area ABC, is the difference between the gross value and the total expenditure and represents consumer surplus which is the net benefit to society from the consumption of this good.

2.3 Taxonomy of Groundwater Values

An important precursor to the valuation of groundwater is the identification of all of the significant values that require estimation.

Several differeing comprehensive frameworks for the taxonomy of groundwater values can be found in the available literature. This is due primarily to the interdisciplinary nature of groundwater valuation with different valuation frameworks being proposed by each of the academic perspectives; economists, hydrologists, ecologists, etc.

"The inherent interdisciplinary nature of the groundwater valuation problem becomes obvious in the confusion about terminology used to describe it. There is no commonly used groundwater valuation terminology and no one set that is obviously superior." (NRC.1997).

Hardisty and Ozdemiroglu (2008) assert that a particular set of terminology has gained popularity amongst economists, and, even though it may not be technically superior to its counterparts, it has been designed with a " resource economists" perspective, and as such, in the context of this study, is far more practical in its application.

The set of terminology proposed consists of two major divisions of **Total Economic Value (TEV)** into **Use** and **Non-use** values. Illustrated below as:

Total Economic Value = Use Value + Non Use Value

Each of these divisions is then subdivided into 2 subcategories such that:

Use Value = Direct Use Value + Indirect Use Value

Non-Use Value = Existence Value + Bequest Value

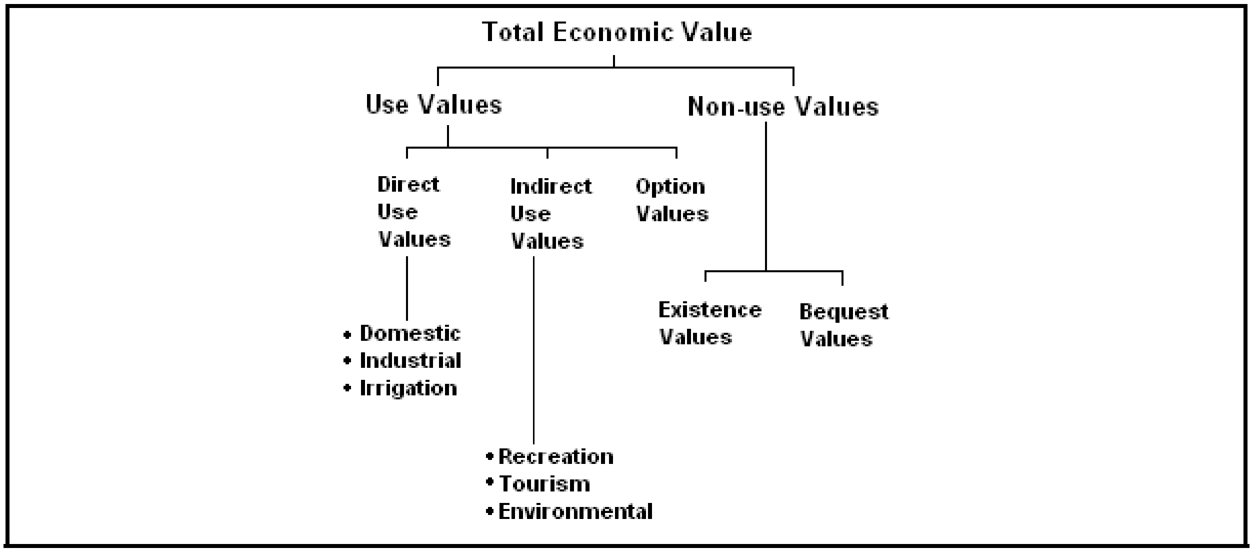


Figure 4: Disaggregation of Total Economic Value (Kulshreshta.1994)

Each of the five categories is defined as follows:

Direct Use: Value of water derived from the direct use of groundwater resources which includes domestic, industrial, commercial and irrigation.

Indirect Use: Value contributed through the indirect use of groundwater resources such as tourism or recreation. This also includes contributions to the hydrological cycle such as discharge to streams or the sustenance of wetlands.

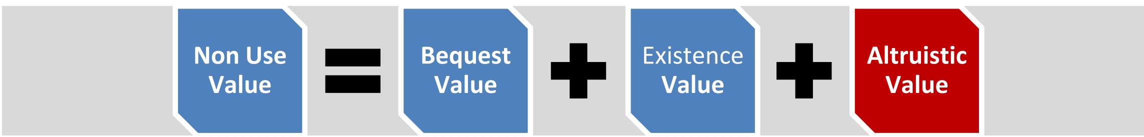
Option Value: This is the premium that certain users are willing to pay to guarantee access to a groundwater resource at a specified point in the future.

Existence Value: The value derived from the knowledge that the resource exists, unharmed, in its natural form.

Bequest Value: This is the value obtained from the desire of individuals to preserve and pass on the resource to future generations.

2.3.1 Exclusion of Altruistic Value

Hardisty and Ozdemiroglu (2008) have included a third category in the "Non-use Value" component of their valuation terminology framework called **Altruistic Value**. Altruistic Value is defined as the value derived from the desire to preserve the groundwater resource for the use of others such that:



However, most of the supporting literature argues against its inclusion stating that it has overlapping similarities with bequest value and that it adds no real significance to groundwater valuations. As such several studies including Kulshreshta (1994), UNECA (2006) and others have excluded it.

In concordance with these findings "Altruistic Value" will be excluded from the taxonomy of values in this study as well.

2.3.2 Exclusion of Option Value

The option value of groundwater according to its theoretical definition is the premium that is paid above the market price of a resource in order to guarantee access to it at some point in the future, where supposedly its value will have increased.

Legislation in South Africa makes no allowance for the existence of a market where option values for water resources can be traded, at least not in any scale that be considered to be bulk water consumption. For this reason, "option value" will not be included in the valuation of groundwater that takes place in this study.

2.4 Market Values vs. Non-market Values

In an economic sense there are two levels of value attributable to environmental factors; they are market values and non-market values. Market values are the values of environmental goods and services that are revealed through exchanges on the market whilst non-market values are the untraded values associated with an environmental resource.

In the case of groundwater an example of an associated market value may include the value of drinking water or water used for irrigation. In both of these examples the associated value is easily identifiable through market exchanges.

In contrast, an example of a non-market value associated with an environmental factor is "environmental quality". As stated by Field and Field (2002), "Environmental quality, on the other hand, is generally and non-market type of outcome, in the sense that elements of environmental quality do not trade directly on markets where prices could be evaluated.".

Economists often use the analogy of an iceberg to describe the relationship between market and non-market values. The submerged section of the ice represents the depth of consumer preferences and tastes and acts as the determinant and support for the visible tip of the iceberg representing the market values. The underestimation of these "submerged" non-market market values is the source of much of the frustration surrounding the value of water resources, due to the fact that they are often far greater than anticipated and are regarded very dearly by those who experience them. This can be attributed to significant intrinsic, cultural, historical or religious factors. (UNECA.2006). The boundary between market and non-market goods is not stationary but rather, in our modern day economy, it is incredibly dynamic as more goods or services are either added to or removed from the actively traded market (Moss et al.2003)

There are increasing amounts of evidence detailing the willingness of people to pay for environmental attributes that are traditional non-market factors. An excellent example of such an occurrence would be the charitable donations that people make to preserve environmental resources that they, in all probability, will never set eyes on; for instance African Wildlife or an endangered species of whales. (Field and Field.2002)

This also reflected in the following statement: "There is a growing body of evidence of the consumers' willingness to pay for ecological benefits. Trends such as growing demand for ecologically certified wood products, organic foods, shade grown coffee, non-toxic cleansers and other goods and services." (Environment Canada.2001).

Since the value of non-market goods is not readily revealed, the application of alternative methods of resource valuation is necessary. These non-market valuations use several indirect and direct approaches to estimate the values. The indirect approaches rely on observed behavior and proximal markets to infer benefits for non-market environmental benefits. An example of such an indirect valuation technique would be the “Travel Cost Method”, whereby the amount consumers pay to travel to particular environmental resource (e.g. Lake, beach or Wildlife Park) is used to infer a value for the resource itself.

The direct methods for non-market valuation consist of survey based techniques that are used to elicit preferences for environmental resources (NRC.1997). This survey method is known as the hypothetical market technique or the contingent valuation method (CVM).

3. Groundwater Valuation: Key Hydrological Concepts

Undertaking the valuation of subterranean water sources requires an understanding of a range of principles that are central to the study of hydro-geology. For the economist undertaking such a study, in depth knowledge of this field of science is not mandatory; however, a thorough layman's understanding of certain concepts is essential. The following chapter serves to outline, in more accessible terms, the nature of certain hydro-geological phenomena.

3.1 Important terms

3.1.1 Aquifer

An aquifer is a subsurface zone that contains/yields appreciable amounts of water. The structure of an aquifer may be comprised of porous rock, unconsolidated grave, fractured rock, cavernous limestone or a combination thereof.

An aquifer may be confined or unconfined. Confined aquifers are overlain by a layer of impermeable rock whereas an unconfined aquifer has no impermeable layer between itself and the surface. More than 90% of the worlds unfrozen freshwater is stored in aquifers.

3.1.2 Hydrological Cycle

In a global sense, water can be transferred from one location to another and it can be transformed through each of its three phases; solid, liquid and gas, but the total amount of water available on the planet remains constant (NRC.1997).

The global hydrological cycle is made up of a myriad of basins each with its own hydrological intricacies. The major difference here is that individual basins can gain or lose quantities of water as the water is transferred from one basin to another within the global system.

Water enters a basin via precipitation (rainfall) and generally exits via evaporation, transpiration and stream flows (NRC.1997).

3.1.3 Groundwater Balance

The amount of water stored within an aquifer over time is a function of the inflows and outflows and can be expressed by the following equation:

$$\text{Quantity}_{P+1} = \text{Quantity}_{P} + \text{Inflows}_{p} - \text{Outflows}_{p}$$

Where:

P = the current period

P+1 = the proceeding period (The period that proceeds period p)

Recharge may occur in one of two ways; either by surface water that infiltrates through the soil down to the water table or by lateral flows below the surface. Rates of recharge can differ greatly between aquifers. Water within an aquifer that experiences zero recharge is considered non-renewable and is known as fossil water.

The discharge of groundwater may occur through a number of avenues including seeps and springs, direct uptake from plants and from extraction.

3.1.4 Groundwater Dependant Ecosystem

Groundwater dependant ecosystems are ecosystems that rely partially or completely or groundwater resources to function effectively. Groundwater dependent ecosystems may be rather distinct from ecosystems dependent on surface water resources, in a manner that is comparable to how surface water resources differ from groundwater resources.

Examples of such ecosystems may include springs and wetland ecosystems. In addition to providing water, groundwater resources may also provide nutrients and heat, thereby helping to sustain a unique and rich range of plant and animal life.

3.1.5 Ecological Services

Ecological Services may be defined as the aspects of ecosystems that are used or consumed by member of society to derive benefit. Such benefits may be derived from the processes within the ecosystem or from the products (outflows) of the ecosystem (Turner, Georgian and Fisher.2008).

Examples of such ecological services may include soil retention in wetlands, water filtration/purification in groundwater aquifers or the creation and sustenance of habitats for plants and animals.

3.1.6 Hydro-Geological Uncertainty

The very nature of groundwater lends itself towards uncertainty. Groundwater is very much unlike other subterranean resources such as oil and minerals. The extraction of resources such as coal and minerals involves, in most cases, the destruction and removal of large sections of the geological structures wherein the resources may be found. However, with groundwater abstraction, maintaining the surrounding geological structures is important in ensuring the integrity, and hence functionality, of the aquifer.

This lack of access limits the extent to which data may be obtained to effectively model these natural systems, resulting in uncertainty regarding the quality and quantity of groundwater systems (NRC.1997). Mathematical models have been under development for many years; however data are rarely adequate enough to allow accurate prediction. Factoring the elements of uncertainty into decision making is an important concept when dealing with potential groundwater resources.

3.2 Ecosystem Structure and Function

The effective description of aquatic ecosystems relies on the analysis and understanding of three essential elements namely: geomorphology, hydrology and biology (NRC. 2004). This is the most logical starting point and since each of these factors, within the context of a specific ecosystem, relies on the others; it makes sense that each needs to be studied in the context of these relationships.

That being said, the infinite amount variability that can exist between aquatic ecosystems imposes its own limitations on the extent to which they can be studied and fully understood. This is further compounded by the fact that natural systems are dynamic and tend to exhibit non-linear behavior over time (NRC.2004).

Ecosystem functions, although numerous and inexhaustible, can be grouped into four primary categories (NRC.2004):

1. Habitat
2. Regulation

3. Production
4. Information

3.3 Ecosystem Goods and Services

Understanding the economically relevant goods and services provided by aquatic ecosystems is of particular importance and is an essential component of the decision making process. As a growing human population puts pressure on limited natural resources we are increasingly being faced with the trade-off between short term human benefit and environmental preservation.

Turner, Georgian and Fisher (2008) provide the following definition of ecosystem goods and services:

"Ecosystem services are the aspects of ecosystems consumed and/or utilized to produce wellbeing. This includes ecosystem organization, operation (process) and outflow. "

The NRC (2004) of the United States defines ecosystem services in a comparable but altogether unique manner. The state that:

"Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill life."

Most of the goods and services provided by aquatic ecosystems are obvious and require little more than some common sense to take note of them. An extensive list of ecosystem services may be found in *Appendix H*.

3.4 Mapping Ecosystem Services

For the purpose of valuing natural resources it is useful to have a structured and systemized approach to mapping out the goods and services provided by the resource in question. Turner, Georgian and Fisher (2008) recommend making use of the Ecosystems Services Approach (ESA)

The ESA consists of four sequential steps:

Step 1: Identification and Scaling: This step in the process is about defining the scope and limitations of the project about to be undertaken. This phase takes stock of critical factors such the specifics of the resource being valued (geographical boundaries, functions, environmental context), available expertise, budget, timeframe and the specifics aims of the project.

Step 2: Models and Mapping: Step two looks at the various functions of the aquatic ecosystem and the goods and services provided by those functions. Once a comprehensive list of the functions is identified they need to be pieced together and mapped according to their relationships and stage of the hydrological cycle.

Step 3: Environmental Change Scenario Analysis: At this point in the process the collective knowledge of the specific aquatic ecosystem in question is analyzed and extrapolated to produce scenarios that outline the most likely outcome of specific human interventions in regular ecosystem function.

Step 4: Ecosystems Services Benefits Capture: The fourth and final phase involves deploying the chosen valuation technique/s to capture and aggregate the value of the resource being analyzed.

[The four phases of the ESA are fundamentally related to the four generic steps of the CVM process as outlined in *chapter 4.4*]

3.5 Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MA) is a comprehensive and widely accepted methodology for assessing the relationships between ecosystem functionality and human benefits. According to the MA there are four categories of ecosystem services which need to be accounted for. These four categories, listed in figure 4 below, are “Supporting”, “Regulating”, “Provisioning” and “Cultural”.

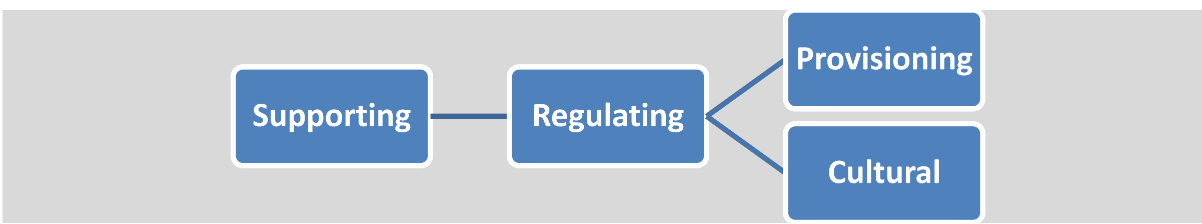


Figure 5: Millennium Ecosystem Assessment Value Categories

Supporting Services: This refers to the fundamental/foundational functions of a given ecosystem from which all other functions/services are birthed.

Regulating Services: Regulating services are the direct effect of the supporting services provided by an ecosystem. These include, water regulation, erosion regulation, water purification and waste treatment, etc.

Provisioning Services: These are the ecosystem products that are, for the most part, directly consumed by society. This includes food, raw materials, naturally occurring compounds, etc.

Cultural Services: These are the passively enjoyed less definable cultural, religious and aesthetic benefits that ecosystems afford us (Ginsburg et al. 2010).

In addition to the value categories that are prescribed, the MA also details direct and indirect feedback loops to distinguish the effect that certain human actions have upon the state of a resource and the consequential basket of benefits that we derive therefrom.

The framework emphasizes the “connected” nature of the four value categories with “supporting” and “regulating” being termed intermediary services whilst “cultural” and “provisioning” are termed final services (Ginsburg et al. 2010).

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4. Approaches to Groundwater Valuation

A considerable body of knowledge exists in the field of environmental economics, and for good reason. The world's economy, as we are oft to forget, is still very much dependent on the extraction, processing and consumption of natural resources. Groundwater is just such a resource and in labeling it as such we recognize, as with other valuable natural resources, that it is scarce and needs to be managed effectively and in a sustainable fashion.

4.1 Overview

The economic valuation of groundwater has evolved considerably over the last few decades. Earlier valuations were primarily focused on the value of groundwater as a resource in its own right (Hardisty and Ozdemiroglu.2008) and as a result attempts made to estimate its economic value considered only it's direct use market based values. However, as our understanding of groundwater has evolved, so has our perception of the benefits that we obtain from it.

It is now recognized that groundwater provides benefits to society in three major ways (Hardisty and Ozdemiroglu.2008):

- As an input to economic productivity through domestic, agricultural, industrial and commercial use.
- As a contributor to surface water resources which are used to generate economic value.
- As an essential component of the hydrological cycle, contributing to the existence of ecosystems and natural beauty.

These benefits are accounted for in the valuation framework proposed in chapter 2.3.

4.2 Comparison of Alternative Techniques

Several techniques exist for the valuation of natural resources. The suitability of each of the techniques differs according to certain determinant factors such as the inherent nature of the resource, the value being estimated and the availability of data for the valuation.

Abdalla (1994) writes that in the past, some groundwater value categories have received considerably more attention than others, with many researchers specializing in a particular valuation method or a specific benefit category and he further suggests that future efforts should be directed towards the inclusion of gap areas using complementary techniques so that a more integrated, far more accessible sets of results can be produced.

In this study we are seeking to estimate the *Total* Economic Value of a groundwater resource, specifically the Table Mountain Group Aquifer, and, as stated by Freeman (1993. Quoted by NRC. 1997), the place to start any valuation effort is to look for situations where prices for natural / environmental resources already exist as a result of competitive market or simulated exchange arrangements.

However, as discussed in chapter 2.4, markets simply do not exist for many of the indirect use values, and none of the option, bequest or existence values. Therefore we must conclude that, in addition to the observation of existing market values, the use of one or more complementary valuation methods will be necessary.

4.2.1 The economic valuation techniques are as follows:

Derived Demand / Production Estimation Technique

- In situation where a firm's cost structure is known, it would be possible to derive the value of water for that firm based on the contributions that water makes to the firms profitability.

Averting Costs Method

- The method is used mostly to determine the value of avoiding specific negative environmental scenarios by measuring the consumption of goods and services that substitute for change in environmental quality.

Hedonic Price Method

- This method ascertains the value of an environmental attribute by measuring the appreciation or depreciation effect that it has on assets within it's sphere of influence.

Travel Cost Method

- This method calculates the values of an environmental resource by determining the amount of money that people are willing to pay to go and see or experience it.

Contingent Valuation Method

- The contingent valuation method utilizes structured questionnaire to elicit a value from respondents regarding hypothetical market scenarios.

4.3 Comparison of Valuation Methodologies

In this chapter I will briefly compare the advantages and disadvantages of the various valuation methods in order to ascertain which will be the most suitable for the study at hand. The criteria by which I will evaluate the most suitable method/s are that it:

- Needs to be able to estimate all facets of Total Economic Value (TEV) including direct use value, indirect use value, option value, existence value and bequest value
- Needs to be practical in terms of the scope and limitations of a master level dissertation.
- Considerations should be made for the cost of the methodology relative to amount of funding available
- Considerations should be made for the amount of data required in comparison to the amount of data that is available
- Where possible, simplicity should be favored over more complex techniques.
- The technique should be easily replicable and suitable for use in multiple potential case study areas

4.3.1 Derived Demand / Production Estimation Technique

This technique has the advantage of being firmly grounded in microeconomic theory, producing reliable results. It is however very limited in its application since it requires observable data, and as such is not suitable for measuring non-market values.

4.3.2 Averting Costs Methodology

This method has its usefulness in that it can estimate certain indirect use values, based on observable behavior. This does however also severely limit its use to specific situations where this behavior is easily observable, and as such is not very suitable for broad based valuation studies.

4.3.3 Hedonic Price Method

Very useful in estimating indirect use values but just like the averting cost method, it is mostly suited to the valuation of specific cases and has no use in the estimation of non-use values.

4.3.4 Travel Cost Method

This relatively inexpensive method has its uses but is limited to situations that include a significant element of travel.

4.3.5 Contingent Valuation Method

The contingent valuation method can be used to measure any kind of data without the need for observable data. It is also the only method capable of measuring existence and bequest value and is not particularly difficult to understand. The disadvantages of the method include errors due to survey/respondent biases and the need for thorough survey development and pretesting to minimize these errors (NRC.1997).

The Hedonic Price, Averting Costs and Travel costs methodologies are all far too specific in purpose to be practical for this study, given that we are attempting to estimate the total spectrum of economic values for a groundwater resource. In addition, we will not be able to ascertain whether these methods will be applicable until the sample sites have been chosen and evaluated.

The contingent valuation method is the only technique that can estimate existence and bequest value, thus its utilization in this study is inevitable. If we then consider that it is also capable of measuring indirect use value and option value, the logic follows that CVM should be used to estimate these values as well.

This is advantageous because in a best case scenario, the estimation of all of the values (except the use values) could be integrated into one CVM survey. The use of just this one method will also assist in reducing the complexity of the study and aid in producing a more integrated study of the value of groundwater which, according to Abdalla (1994) would be highly advantageous.

Lastly, it is also worth mentioning that the inherent flexibility of this technique, would allow us to adapt the study for additional sample sites without too much difficulty.

In conclusion, it is worth stating that the final applied methodology should consist of the observation of existing markets for use values complemented by a comprehensive CVM Survey to estimate the Indirect-use, Option, Existence and Bequest values.

Table 1: Summary of Value Categories and Corresponding Valuation Approaches

Groundwater Value	Estimation Method
Direct Use Value	Market Data
Indirect Use Value	CVM
Option Value	CVM
Existence Value	CVM
Bequest Value	CVM

4.4 Dissecting CVM

The flexibility of the contingent valuation method has seen it grow in popularity in recent years. It goes by several other names as well namely, hypothetical market technique, due to the supposition of hypothetical market exchanges as well as the stated preference technique because it gives respondents the opportunity to state their preferences for environmental goods..

This technique can be applied in a wide range of contexts and can be used to estimate the value of all environmental factors. An additional bonus in the application of this technique is that it can be used to determine the psychological motivations that underlie an individual's willingness to pay (Hardisty and Ozdemiroglu.2008). This is easily achieved by including respondent motivation queries in the CVM survey. In fact, it is very possible to combine the contingent valuation method with all manner of survey based research practices.

From initiation to conclusion the Contingent Valuation Method goes through four generic phases (Field and Field.2002):

Phase One

- The first phase is focused on the identification and description of the environmental attribute that the study seeks to value. These environmental attributes may be presented individually or as bundles consisting of several values.

Phase two

- This phase is concerned with the identification of survey respondents and the selection of the sampling procedure. Efforts need to be taken to ensure that the sample is chosen randomly and that the sampling procedure is practical in the context where the study will be carried out.

Phase Three

- The third phase is the design and application phase. The questionnaire is designed according to the objectives of the study and then it is applied to the sample group through the sampling procedure decided upon in phase two.

Phase Four

- The final phase consists of the analysis of the data collected in order to ascertain the values for the environmental attributes in question.

4.5 The Questionnaire

The design of the contingent valuation questionnaire is central to the efficacy of this valuation method. A good questionnaire will go a long way towards reducing sampling errors and obtaining reliable figures. As such it is important that a great deal of effort be put into its formulation, including a solid foundation based on thorough qualitative research and one or more pretesting phases to root out any potential problems.

The basic CVM questionnaire has three core components (Field and Field.2002):

1. A set of questions that will be able to provide the researcher with personal information that is relevant to the study, for example, age, gender, no of dependents, occupation, etc.
2. A clear, comprehensible description of the environmental attribute/s that the respondents are being asked to evaluate.
3. A set of questions designed to elicit WTP responses from the respondent whilst minimizing negative factors such as response bias.

There are three question formats that are most commonly used. These are as follows (Field and Field.2002):

1. Open ended question. - Respondents are asked straight forward open ended questions about what they believe are the values of certain environmental attributes.
2. Bidding questions – The interviewer start off with a low value for an environmental attribute and then gradually makes it higher and higher until the respondents WTP threshold is reached.

3. Printed Card Approach – Respondents are given a printed card with a certain range of value responses. Respondents are then asked to mark the maximum WTP in response to the valuation questions.

4.6 Advantages and Disadvantages of the CV Method

Contingent Valuation possesses certain key attributes that will ensure its use and development will continue well into the future. The most obvious advantage to using this method is its inherent flexibility. In fact, Field and Field (2002) state that "virtually anything that can be made comprehensible to respondents can be studied with this technique."

The method has been widely applied in studies done throughout Africa. The technique has really proven its worth and, with good survey design, has been shown to produce reasonable and consistent result even in poor and illiterate communities. It has proven an invaluable means to include the impoverished and destitute in the decision making process (UNECA.2006).

On the other hand, the very nature of the CV method provides grounds for criticism and there are many who question the efficacy of this approach. Hypothetical situations contain an inherent bias and since a fictional situation will always differ from reality and there is no means by which to ensure that the respondent in a CV survey possesses the identical perception of the hypothetical scenario as that being conveyed by the survey instrument.

In the end however, there are a certain number of values that can only be measured using this method. In addition, contingent valuation has, over time, been refined to such a point that it is able to provide reliable results in various types of studies.

Part Two: Socio-Economic Considerations

5. Groundwater: As it pertains to Economic Development

Freshwater is an essential and valuable resource that needs to be utilized efficiently and effectively in order to maximize the benefits derived therefrom and to ensure its sustainable use in the long term. It is a finite but renewable resource and the available supply is being put under ever increasing pressure by growing populations and accelerating global economic development (Barbier. 2005)

5.1 Overview

It is often easy to forget that in addition to sustaining life on the most basic level, freshwater is also an essential input at all levels of economic activity. Empirical evidence indicates that moderate or extreme water scarcity can adversely affect economic growth. However, studies also indicate that many of the water resource problems within developing countries and trans-boundary watersheds has to do with specific cases of upstream downstream water misallocation (Barbier. 2003). This suggests that although significant problems already exist there is much room for solution through better management, allocation and foresight in infrastructural development.

5.2 Groundwater: Efficient Use

Groundwater is used most efficiently when it is extracted at rates that maximize the net benefits of its use over time (NRC. 1997). This then implies that in order to determine the most efficient rate of water extraction the benefits derived from a groundwater resource would need to be accurately quantified.

Attempting to derive these benefits can be difficult due to the large number of influential factors that need to be taken into account. This is further complicated by the fact that water use permeates every facet of human society and trying to account for 100 % of the direct and indirect benefits derived from its use would require a considerable effort.

The subterranean nature of groundwater poses its own challenges that influence the amount of water that can be extracted, including the structure and makeup of the aquifer, the rate of recharge, quantity of rainfall in the basin area and so on and so forth. Some of the more critical factors will be further discussed in the remainder of the chapter.

The availability of groundwater is therefore determined by the interaction of geological, hydrological and economic factors (NRC. 1997).

5.3 Market Failure

The failure of markets to reflect the true value of groundwater can result in market failure. It is often not possible for individual owners to receive direct monetary benefits since the services provided by the ecosystem are free. It is usually only when these services are lost that monetary costs are incurred (Environment Canada. 2001).

Some of the factors that contribute to the failure of markets concerned with ecological systems include:

5.3.1 The tragedy of the commons

For resources that are shared between large numbers of people there is very little incentive for an individual to reduce his use of the resource for the benefit of someone else. With each of the consumers trying to maximize his/her utility without consideration for the overall effect on the resources, depletion is inevitable. For this situation, a regulatory framework is necessary to ensure that the resource is not over utilized.

5.3.2 Missing Costs

The market price for a specific good may not reflect all of the costs to society for the production of that good. The prices of such goods often reflect the direct cost of the production of that good, but do not reflect the indirect costs such as resource depletion, environmental degradation and the cost of restoration once the extraction process has been completed.

5.3.3 Limited Understanding of Science

The ability to measure the value of a groundwater aquifer is limited by our knowledge of these subterranean ecological systems. We have yet to fully understand the full measure of the benefits that are conferred to us by these natural resources and this gap in our knowledge has led to these benefits being undervalued.

5.4 Renewable vs. Non-Renewable Groundwater

A fundamental distinction that needs to be made in natural resource economics is that between renewable and non-renewable resources (Field and Field. 2002), the same distinction needs to be made when considering groundwater resources.

There exists a strong inter-temporal dimension when evaluating the use of groundwater. This is because timescales of groundwater flow are long relative to atmospheric moisture, soil moisture, swamp water, stream water and lake water. The following table indicates, in a very generic sense, the average length of time it takes for the above mentioned freshwater sources to completely renew their water.

Table 2: Length of Water Renewal Cycles (UNEP. 1996)

Atmospheric Moisture	8 Days
Stream Water	16 Days
Soil Moisture	1 Year
Swamp Water	5 Years
Lake Water	17 Years
Groundwater	1400 Years

On occasion geological processes may occur that over time can completely cut off a portion of an aquifer from its supply of water and its outlets. Climate change may also starve a subterranean water source of its ability to recharge. Groundwater resources that do not recharge are known as fossil water. Fossil Water can be abstracted but the water that is removed may never be replaced (UNEP. 1996).

Biological processes create correlation between the rates of resource use and the quality and quantity of that resource available in the future (Field and Field. 2002). Given this strong inter-temporal dimension of groundwater flows that need to be taken into account, decision makers need to take a long term view when considering the valuation and use of groundwater resources. This is necessary to ensure sustainable long term use.

5.5 Economic Growth and Development

We must be mindful of the fact that a large portion of the modern global economy is still reliant on the extraction and utilization of natural resources (Field and Field. 2002). Freshwater is just such a resource, though its value goes far beyond simple extraction and utilization as it is an essential component, directly or indirectly, to all levels of societal development.

As such we can expect that constraints on the supply of freshwater, depending on the severity of the shortage, will eventually begin to impede economic development.

Freshwater, from an economic or social perspective, may be directed towards any number of different uses including drinking water, irrigation, industrial use or recreational use. However, a lack of available freshwater will be more problematic for certain sectors of the economy, particularly agriculture, which is responsible for the greatest proportion of our consumption of freshwater (Barbier. 2005).

Development in low and middle income economies is associated with increased land conversion and degradation as well as stress on available freshwater resources. In these countries relatively large portions of the population tend to be located in rural areas and are dependent on agriculture and other renewable resources to sustain their way of life (Barbier. 2008). From this we may deduce that semi arid to arid developing nations that are highly dependent on water intense sectors like agriculture for their productivity would be particularly susceptible to economic retardation caused by water scarcity.

Studies indicate that freshwater scarcity may become a key factor behind global food insecurity, reduced production growth and rising international cereal prices (Barbier. 2005).

In South Africa there are currently a number of factors that threaten to reduce the quantity of available fresh water and reduce water security in the country. These include acid mine drainage, climate change, depreciating infrastructure and a skills shortage in the sector

Water scarcity is already a reality around the country's major urban centers, which are also the economic drivers of the country Rapid urbanization and industrial expansion are adding further strain to these localized shortages. With this in mind, and fundamentally connected to the rate of unemployment are the concerns around rural water supply. As the inability to subsist of the land is a major contributing factor to the rate of urbanization and joblessness.

6. The Role of Groundwater in Poverty Alleviation

Reliable access to freshwater and sanitation, or the lack thereof, remains a key factor in the global fight against poverty. Poverty levels in the SADC region have been rising and are expected to keep doing so until the year 2025 (SADC.2002). Current estimates show that more than 60% of the regions 200 million people live in absolute poverty.

6.1 Overview

The presence of these impoverished communities, who are largely dependent on agriculture and other renewable resources, poses a significant threat to the existing water resources. This is because these resources are often exploited in an unsustainable fashion, resulting in environmental degradation (Barbier.2005). The unfortunate truth is that poor people behave in a manner that harms the environment not because they choose to, but rather because it is the only means by which they can survive (SADC.2002). The environmental cost in these cases is unfortunate, but unavoidable given the current circumstances.

6.2 The Burden of Debt

A major contributor to the Southern African Development Community's (SADC) inability to effectively manage its water resource base is its foreign debt burden (SADC.2002). The resulting economic instability has hampered access to financial resources that would allow nations to develop the necessary infrastructure to manage their water resources. Of course the debt burden, more than a simple financial obstacle, represents a bottomless pit for many developing countries, putting immense pressure on already stretched economic resources.

The need to finance this debt coupled with an expanding population is driving the need to increase economic output. This represents a major problem for SADC countries, as most are highly dependent on basic resource extraction and agriculture. This implies that most of the economic pressure will be directly translated into additional stress on available land and water resources (Barbier.2005).

It seems unlikely that most of the nations in the SADC will be able to develop and maintain the necessary human resources and capital necessary to effectively and sustainably manage their water resources until the debt burden is relieved (SADC.2002).

6.3 The Role of Women

All around the world, particularly in developing regions, women play a central role in the collection and protection of water for domestic and agricultural purposes. In many cases this responsibility represents a significant burden as women often have to walk great distances to collect water. In rural areas women spend up to 6 hours per day collecting water for the household. This time spent collecting water represents a significant loss of productivity that could be better spent in a wide range of more productive efforts. Not only do these women lose productive time, but it also reduces the time that they have available to participate in social activities and invest in the wellbeing of their families (Moss et al.2003).

The burden of these women is often passed on to their families as well. In rural Africa, only about 10% of school age children attend their classes (Moss et al.2003) Many children work with their families on water collection duties, which would include the watering livestock. Only about 15% of the children that manage to attend school are girls.

Whilst the role of women is recognized, it is also true that societal structure often excludes women from the management and decision making process associated with water resources. The exclusion of women is to the detriment of the process as they often possess unique insights into the problems associated with accessing and maintaining water supplies. The role of women is critical to the evolution of water management, and as such there is a great need to be more inclusive of women at all levels of the water management process.

6.4 Meeting the Millennium Development Goals

The inescapable irony is that Africa is a continent well enough endowed with water resources for those who inhabit the region. The tragedy is that climatic, geographic, political and economic issues have left millions without access to safe drinking water and sanitation facilities. The total quantity of water withdrawn for human consumption and use is still small relative to the size of the renewable resource (UNECA 20006b)

One of the millennium development goals, set up by the United Nations, is to halve the number of people who don't have sufficient access to drinking water and sanitation facilities by the year 2015. With just years left to go, the deadline looms ever closer.

This is not the first time that we have attempted to remedy the water and sanitation situation in Africa. During the International Water Supply and Sanitation Decade, 1981 – 1990, great progress was made. By 1988 more than 40 million people in urban areas in Africa were supplied with safe drinking water and another 52 million were provided access to sanitation facilities. In the rural areas 87 million people were provided access to drinking water and 1 million were provided with access to sanitation facilities (UNECA.2006b)

The efforts to provide access to safe drinking water and sanitation facilities continued through the nineties; however the rate of development in this sector was outpaced by the population growth rate, resulting in a decline in the proportion of people with access (UNECA.2006b).

In 2001 the World Health Organization and UNICEF (UNECA.2006b) estimated that in consideration of the population growth rate in Africa, in order to meet the MDG for 2015, the number of people that will have to be provided with drinking water and sanitation facilities will be 210 million and 211 million respectively.

7. Psychological Value of Water

7.1 Overview

There is more than one side to the coin when considering the value of water. Studies attempting to ascertain the value of a water resource tend to focus almost exclusively on the econometric methods that are applied. Whilst many methods exist for the valuation of environmental resources, each has its own advantages and shortcomings, producing unavoidable variations in their estimations of environmental values (Hardisty and Ozdemiroglu.2005).

Given that a certain level of variability between interpretations and expressions of economic value is inevitable, understanding the context within which the measurements are made become extremely important.

Perceptions of value are shaped by a myriad of extrinsic and intrinsic factors. To the uninitiated, the intricacies of such complex and dynamic systems may be overwhelming. However, there exist some rather simple yet effective tools to help us understand the relationship between perceptions and the phenomena that shape them. Understanding the context within which natural resources are being used adds an exponential amount of value to the economic measurements that are made of these resources.

7.2 Determining the source of the Value

Each and every individual in the market has a perception of the value of water, in its various forms. The perceptions that each of us possess regarding the value of water are shaped over the course of our lives and are the end results of the interactions between a multitude of extrinsic and intrinsic factors.

Determinism is the word we ascribe to these factors that form us, that "determine" who we are, and our perceptions of the world that surrounds us. The three main components of "determinism" theory are biological determinism, psychic determinism and environmental determinism (Covey.1989).

7.2.1 Genetic Determinism

The rationale behind biological determinism is that we are born with certain unchangeable genetic traits that influence / determine our particular perspective towards the world and everything in it. Genetic determinism is longstanding and unchangeable. Biologically, we require water to survive, this is a genetic trait. Our bodies are made up of around 70% water and without a regular daily supply we risk dehydration, physical impairment and eventually death. This represents the primary and most fundamental value of water, it's ability to sustain life.

7.2.2 Psychic Determinism

The portion of our psychological make-up that developed through our formative years (childhood) is attributable to determinism. Neural development that takes place during specific phases of human development (early childhood to late teens) combined with susceptibility to new concepts, makes humans highly impressionable (BBC.2005). Psychological traits developed during this phase are long lasting and resistant to change but not unchangeable. With respect to our perspectives on the value on water, what we are taught and the things we experience in our formative years leave us with a long lasting impression of this essential resource. These influences may be attributable to our education, the teachings of our parents and a whole host of other factors that we are exposed to while growing up.

7.2.3 Environmental Determinism

Environmental determinism is the attribute that accounts for the immediate present tense factors influencing our perspectives. These influences are the most short term of the three branches of determinism. They are mostly concerned with day to impressions though under certain circumstances they may develop into more long term factors, such as when there is a consistent long term stimulus that ingrains a certain perspective. Every day we engage in activities and are exposed to stimuli that shape our view of the world and this is also true for our view of water (Covey.1989).

The essence of deterministic theory suggests that any given perspective held by an individual or group of individuals may be attributed to one or a combination of these three factors. As I hope is clear, the three branches of this theory vary in their time frame and degree of flexibility. Genetic determinism is arguably unchangeable (given the limitations of current medical technology) with a time frame that stretches back millennia whilst psychic determinism is more active the further you go back in an individual's lifetime. It is considered to be ingrained but there are techniques for altering or modifying its effects. Environmental determinism is concerned primarily with the present and considers effects that, except for certain cases, are quite transitory.

Covey (1989) considers that human beings posses a unique attribute termed “free will”, that allows us to choose our perception of the world and everything in it. He argues that the above mentioned precepts may be tinkered with to the extent that we are able to choose our path of development. The conclusion we may draw from this is that perceptions, be they about water or anything else, are changeable and susceptible to reeducation. It is therefore possible to change society’s perception of the value of water for the better for the better or the worse.

The theory of determinism could be very helpful in considering the psychological value of water. Using it we may be able to identify and hopefully isolate the factors that influence our perception of the value of water. It is stated by Moss et al. (2003) that there exists a very deep level of value between human populations and their water resources. He postulates that these deep preferences and values stem from factors like culture, history and a sense of ownership of the land and he goes on to account for the fact that these preferences exist on both the conscious and the unconscious level.

In the world of resource valuation, there exists no absolute measure of value, and different studies and different methodologies are always going to vary in their precise estimations of a given resource, producing what is, in simplest term, a relative expression of value. However, if we can understand the psychological precepts that underlie our perspectives of the value of water, then we will be able to put our valuations in the context of what is happening inside the minds and hearts of those who experience nature’s value.

7.3 The Cultural Significance of Water

Water plays a significant role in human culture and cultural celebrations. Our cultures have evolved over thousands of years and have been dependent on water resources for our livelihoods for the entire length of that period. This has fostered an appreciation for water that is reflected in our cultural practices.

Water celebrations are often enacted where communities, dependent on the resource, live. The Ganges River in India and Bangladesh is the site for countless cultural celebration and rituals. The same can be said for the Amazon and Mississippi rivers.

For regions where there is a monsoon season, celebrations are often held to mark the coming of the rain. The Songkran festival in Thailand is just such an example, where people celebrate the coming of the wet season. In Thai culture, this also marks the start of the New Year, and symbolizes the beginning of a new cycle of life.

7.4 The Religious Significance of Water

South Africa is a nation deeply rooted in religious beliefs with 85% of people claiming some sort of religious affiliation (CIA.2009). Christianity is the predominant faith whilst the religious minorities consist of Muslim, Hindu, Jewish and a scattering of smaller religious groups.

The teachings of religious groups are significant in their ability to influence perceptions of water and its value. References to water, its value and symbolic associations are plentiful in the religious texts of the world.

> "Although humans are the most favored of God's creations, we also are responsible for ensuring that God's gifts are available to all living things."(Faruqui et al.2001:3)

The teachings of Islam state that human beings are stewards of the planet on which we live and of all of God's creations with which we cohabitate. In the Quran it says that "the believers should not make mischief on earth.". (Faruqui.2001) states that the Islamic way of life entails living in peace and harmony at ecological as well as individual and social levels. The Quran speaks of the scarcity of water and the importance of its sustainable usage. It states "we send down water in fixed measure." and also "O children of Adam!...Eat and drink but waste not by excess, for God loveth not the wasters." (Faruqui.2001)

Similarly there is a great wealth of references to the importance of water in the Christian and Judaic texts. In the book of Exodus, a text common to both the Christian and Judaic texts, a prophet named Moses struck his staff against a rock which caused water to burst forth, allowing the Israelites to quench their thirst. This is one of the earliest known references to hydrogeology.

The Christian ritual of Baptism is a rite whereby followers of the Messiah, Jesus Christ, are immersed in water. The symbolism of being immersed in the water represents the cleansing / forgiveness of their sins and start of a new life. The baptism ritual is one of the central rites of Christianity and thus water is of great significance to this faith.

7.5 The Historical Significance of Water

Water in all its forms and uses has for the length of our existence formed a fundamentally importance aspect of our societal practices. Throughout the ages, cultures possessing the skills to manage water effectively have had a significant advantage, allowing their empires to grow larger and expand further.

For example, the Ancients Roman Empire was famous for its use of aqueducts to supply their cities with water. The ancient city of Rome was served by no less than eleven aqueducts with a total length of between 420 and 500 kilometers. This supply of fresh water was an integral component of Roman civilization and as such is just one demonstration of how important fresh water is for a society to progress.

Anthropologists state that there are several significant benefits that water resources confer to all human settlements. These are:

- Drinking water: Allowing population groups to stay hydrated.
- Sanitation: Water resources aided in maintaining cleanliness and the removal of human waste.
- Food sources: Water resources often connected with supplies of food including marine plant and animal life.
- Irrigation: Water resources are central to the production of food crops.

As such, human populations have spread and expanded along the banks of rivers and oceans and have therefore shaped the course of human history.

8. Water: Legislation and Policy

8.1 Overview

An effective legal framework is a necessary addition to any country's water resource management efforts as it serves as the foundation upon which all other ventures are built (SADC.2005). The "proof" however lies in the implementation of such legislation. This brings into question the role of these directives in the context of our ability to follow them through and reminds us to be mindful of the difference between the reality of *where we are* and the ideal of *where we want to be*.

The trans-boundary nature of many water resources often necessitates coordination between several legislative bodies. This introduces yet another level of complexity into the legal management of water resources. As such it is pertinent that an effective discussion of this subject matter include the broad universal concepts in addition to the specific relevant pieces of legislation, policy and the contexts in which they are enacted.

8.2 Water Management

The nature of water of water is such that it requires an integrated, coordinated approach to manage effectively and it is out of this need that the multidisciplinary field of Integrated Water Resource Management took root in the 90's, addressing the need to manage water along hydrological and political boundaries and to manage it holistically.

It is in particular the increasing scarcity of high quality freshwater that is driving the need for more effective management. Although global water management policies are evolving to account for changes in the market for freshwater, there is still much that needs to be done to optimize this process.

8.3 Local vs Regional Management

The necessity for the effective regional management of water is a given. In South Africa, the body charged with the responsibility of managing water resources and services is the Department of Water Affairs. This Department is under the executive authority of the Minister of Water Affairs and is responsible for water resource management at the national and provincial level.

At the regional to local level, the responsibility of water management falls to the Catchment Management Agencies (CMA).

Water management becomes increasingly complex the closer you get to the end use requiring something a more practical hands on rather than the top down governmental approach. Community input is essential at the lower levels. Communities often have better understanding of the problems they are facing and thus they are in a better position to evaluate the pros and cons of the options available to them (SADC.2005). In fact, the Constitution of South Africa requires that stakeholder be consulted in a manner that is inclusive of all industries and people groups.

In addition, the National Water Act (1998) allows for the establishment of Water User Associations (WUA's) who's purpose it is to undertake water related activities at a local level. WUAs enable water users to group together and use their collective resources to engage specific issues such as groundwater management, poverty eradication and so on and so forth. The WUAs fall under the jurisdiction of the CMAs and are an essential extension to the CMA networks.

A significant portion of the South African rural community lack sufficient access to water and sanitation services. For these communities a big barrier to service provision is the cost of transporting water. The dispersed nature of such rural communities makes surface water schemes prohibitively expensive (SADC.2005). Groundwater resources present an ideal solution to assist these communities with their water requirements. However, there has as yet only been a limited roll out of groundwater abstraction schemes and there remains a huge potential for development in this area.

8.4 Legal and Institutional Framework

Due to the threat of increasing water pressure, the SADC nations have begun a process of policy and legislative reform that tackles the challenges faced by the region. At the Africa Water Resource Management Policy Conference in Nairobi in 1999, a critical review of the regions resource situation revealed the following issues that need to be addressed. They are (SADC.2002):

- Over allocation of flows
- Watershed degradation
- Pollution Control
- Community participation
- Human resource capacity development

In the ten years since, a number of positive policy trends have emerged focusing on the adoption of IWRM approaches that are increasingly utilizing economic instruments to track and evaluate the use of water resources. Three key facets that have been identified as critical to water resource utilization are sustainability, equity and efficiency.

The definitions according to Griffiths and Wall (2000) are as follows:

Sustainability

- To utilize the resource in a manner that does not compromise its long term viability.

Equity

- Ensuring that all demographic segments have access to the resource.

Efficiency

- According to the economic definition for pareto-efficiency, this efficient allocation of resources between firms, efficient allocation of goods between consumers, and an efficient combination of products in the economy as a whole.

In South Africa, The National Water Act (1998) is founded upon these three principles. This piece of legislation has made a significant contribution to water resource management in South Africa. Two stipulations within the act are of particular importance, that being, the basic Human Needs Reserve and the Ecological Reserve.

The basic Human Needs Reserve states that all people in South Africa are entitled to a minimum of 25 liters of water per day within a distance of 200 meters of their home; this corresponds to the "Basic Water Requirements for Human Activities" as set out by the World Health Organization (1996).The Ecological Reserve on the other hand recognizes that the environment also has a right to water, though the quantity is not strictly defined as with the human needs reserve.

For the purposes of this study it is worth noting that the key issues addressed by the NWA of 1998 are as follows (SADC.2002):

- Strict Monitoring of Environmental Flows
- Categorizing of water systems from cleanest to most polluted
- Monitoring of pollution
- Pricing structure to regulate use of water and discharge of wastewater
- Inclusion of all levels of society in the decision making process
- Recognition that water cannot be privately owned
- Formation of CMA's and WUA's to regulate and monitor the market

Design and Methodology

9. Research Design

The research design may be described as having three primary sources of data:

- **Municipal Water Billing Data: Used to track consumption in the research area**
- **Agricultural Hydro Census Data: Used to assess water use within the agricultural sector**
- **Contingent Valuation Survey Data: Used to assess the non-market values of groundwater and to collect demographic data from households in the research area**

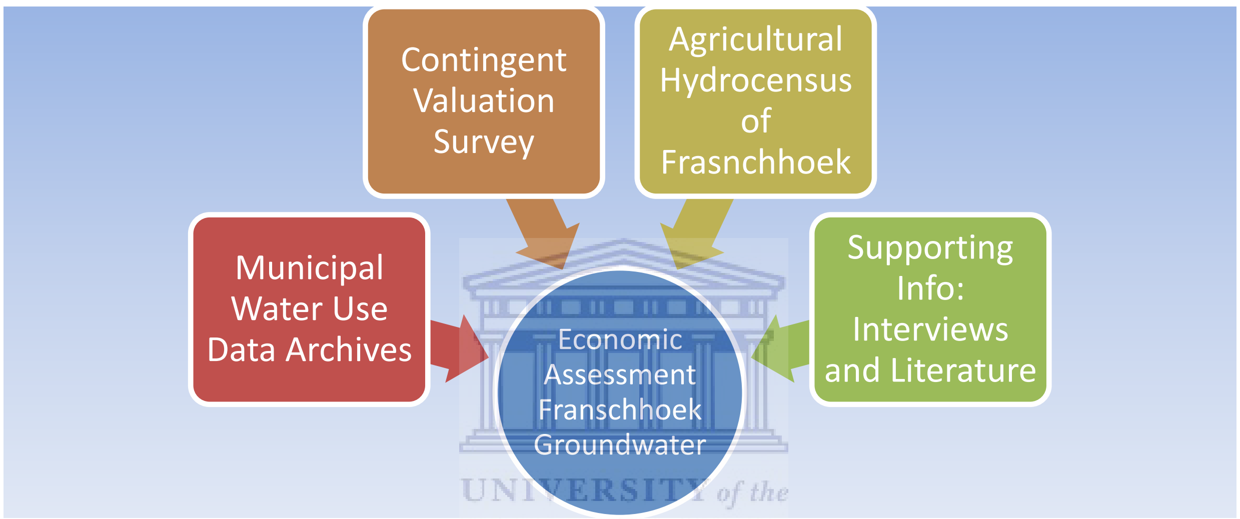

Figure 6: Research Design Fundamental Components

Secondary supporting data was collected through in-depth interview with industry experts as well as through the available literature. The interviews were used as an investigative tool to identify possible sources of key information and to guide the hands on practical components of the project.

9.1 Methods of Data Collection

Several Methods of data collection were employed during the course of the study including a literature review, in-depth interviews, focus groups, data mining and a household survey.

9.1.1 Literature review

A review was conducted of the various literature sources deemed relevant to the study. Various academic texts and journals were utilized to explore and further understand the pertinent issues relating to the valuation of groundwater resources.

9.1.2 In-Depth Interviews

Several in-depth interviews were conducted over the course of the study. The interviews were semi-structured and most had duration of between one and two hours. The interviews were recorded on a dictaphone and subsequently transcribed to ensure easy access to the information at a later stage.

Interviewees were selected based on their specific areas of expertise. Interviews were conducted at the convenience of the interviewee in a location of his/her choosing. A copy of the generic interview guide may be found in Appendix F.

9.1.3 Focus Groups

Two focus groups were conducted prior to the survey phase of the project. The focus group participants were selected based on their hydrological and geo-hydrological expertise. Priority was given to individuals with site specific knowledge of the Berg River Valley. Identifying and recruiting such individuals was a relatively easy task since the University of the Western Cape's Natural Sciences Department had been conducting ongoing research in the Berg River Valley for at least seven years prior to the initiation of this study. The purpose of the focus group was to extract specific information that would contribute towards the groundwater valuation process.

The intricacies of the focus group are expanded upon in much greater detail in chapter 12. A copy of the Focus Group Agenda can be found in Appendix L.

9.1.4 Data Mining

The municipalities are required to keep archives of all financial billing data for services rendered to their customers for a minimum of five years. This data is stored in on databases maintained the municipalities. Using specifically designed data mining software, the Stellenbosch Municipality Revenue Department was able to extract and provide six years worth of water billing data for our designated research area.

9.1.5 Household Survey

In order to collect specific consumer data for the study it was necessary to conduct a survey of the households within the research area. A questionnaire was designed and a survey team was recruited and trained to conduct the interview. Given that the questionnaire was relatively complex it was decided that face-to-face administration of the questionnaire would best option so as to ensure the validity of the data. This would also remove the problem of response bias caused by high levels of illiteracy in the poor segments of the community. In addition, the questionnaire was translated into three languages namely; English, Afrikaans and Xhosa.

The household survey was an immensely complex phase of the project which is exhaustively detailed in chapter 10. A copy of the survey questionnaire may be viewed in Appendix D.

9.1.6 Agricultural Water Use Census

In order to develop a comprehensive conjunctive water use map factoring all avenues of water use in the research area it was necessary to conduct a water use census in the agricultural sector of Franschhoek.

The water use census was conducted by a team of five enumerators and the necessary information was gathered by conducting face-to-face interviews with farm owners and farm mangers. The goal of the water use census was to collect information detailing irrigation regimes, crop size and type, water sources and water usage rates.

10. Survey Design

10.1 Survey Overview

In order to gain insight into the minds and behavioral patterns of our research population it was necessary to conduct a thorough survey of the households within the research area. The specific aims of the household survey include:

- Collecting demographic information
- Determining household composition (family size, age, etc.)
- Measuring household income and distribution
- Measuring levels of awareness and knowledge relating to water and groundwater systems
- Determining the attitudes and perceptions of individuals within the research population
- Measuring the willingness to pay (WTP) of households within the research population for the protection of groundwater

A questionnaire was developed to fulfill the goals of this survey. An example of this questionnaire may be found in Appendix D. The particular details of the questionnaire are far too lengthy to be discussed here under a minor subheading. As such the development and composition of the questionnaire has been discussed in chapter 10.8.

10.2 Facilitation of the Survey

As mentioned in chapter 9.1.5 it was decided very early on in the survey development process that face-to-face interviews would be the most appropriate means by which to administer the survey. The primary motivation for this decision was the concern about illiteracy in the lower income segments of the research population.

A secondary, yet substantially important motive for this decision was given by the Survey Guidelines in the Literature Review. A major component of the questionnaire is comprised of a contingent valuation section that is particularly complex and lengthy. The survey guidelines state that the most appropriate means for conducting a contingent valuation survey is through face-to-face interview, since this is the only way to avoid several major sources of response bias brought about by the complexity of contingent valuation.

10.3 Survey Team Development

A survey team consisting of Masters, Honors and third year students from UWC was recruited and trained. The positions on the survey team were advertised via departmental notice boards and direct announcements during lectures.

A set of evaluation criteria was developed in order to choose the most suitable candidates from all the applicants. Potential team members were evaluated primarily on language ability as they had to have a firm grasp of a combination of either English and Afrikaans or English and Xhosa. The students who demonstrated the greatest aptitude for these languages, along with a confident and sociable nature were given first priority.

Compensation was offered to the enumerators conducting the survey. The amount paid was R450 per day, which consisted of a R150 subsistence allowance and R300 wages. For the pre-survey training and pre-testing activities, the students were given a R150 subsistence allowance, but no wages.

Twenty two students applied for the positions of which seven were selected and trained. Five of the recruits spoke a combination of English and Afrikaans and the other two spoke English and Xhosa. This reflects the predominant language usage in the research area. The recruits partook in a rigorous training program consisting of:

- Questionnaire Development
- Survey Technique and Ethics
- Avoiding Response Bias
- Questionnaire Pre-testing
- Emergency Procedure

10.4 Sample Population

The population from which the sample for this survey was drawn can be defined as all household that reside within the 3 peri-urban clusters of Franschhoek Town, Groendal and La Motte. The community of Franschhoek is made up of approximately 710 household. The Groendal community comprises approximately 1248 household and 750 informal dwellings. The La Motte Cluster is made up of 210 households..

10.5 Sampling Plan

Due to considerable variation between sub-populations within the research population, it was necessary to devise a stratified sample plan. A sampling plan was constructed based on data we obtained from the Statistics South Africa and the Stellenbosch Municipality.

The research population was stratified according to geographic location of households within the research area. The due to the segregated nature of the area geographic location of household is highly correlated with the race and household income. Thus by building the sampling frame around geographic location, and by selecting proportional samples from each of the residential clusters, we were assured a proportional representation of all the households.

10.6 Sampling Frame

According to Keller and Warrack (2000), a sampling frame may be defined as a source that includes every member of the population from which a sample is to be taken and within that sampling frame each of the units should have an equal probability of being sampled.

In this study the lack of accurate records for residents of the informal settlement meant that an itemized address list would not have been suitable. As such we designed the frame based residential maps of the research area and partitioned the maps into enumeration areas. Households were then sampled from within enumeration areas that were randomly selected. Figure 6 on 74 presents a residential map of a portion of the research area that has been partitioned into enumeration areas.

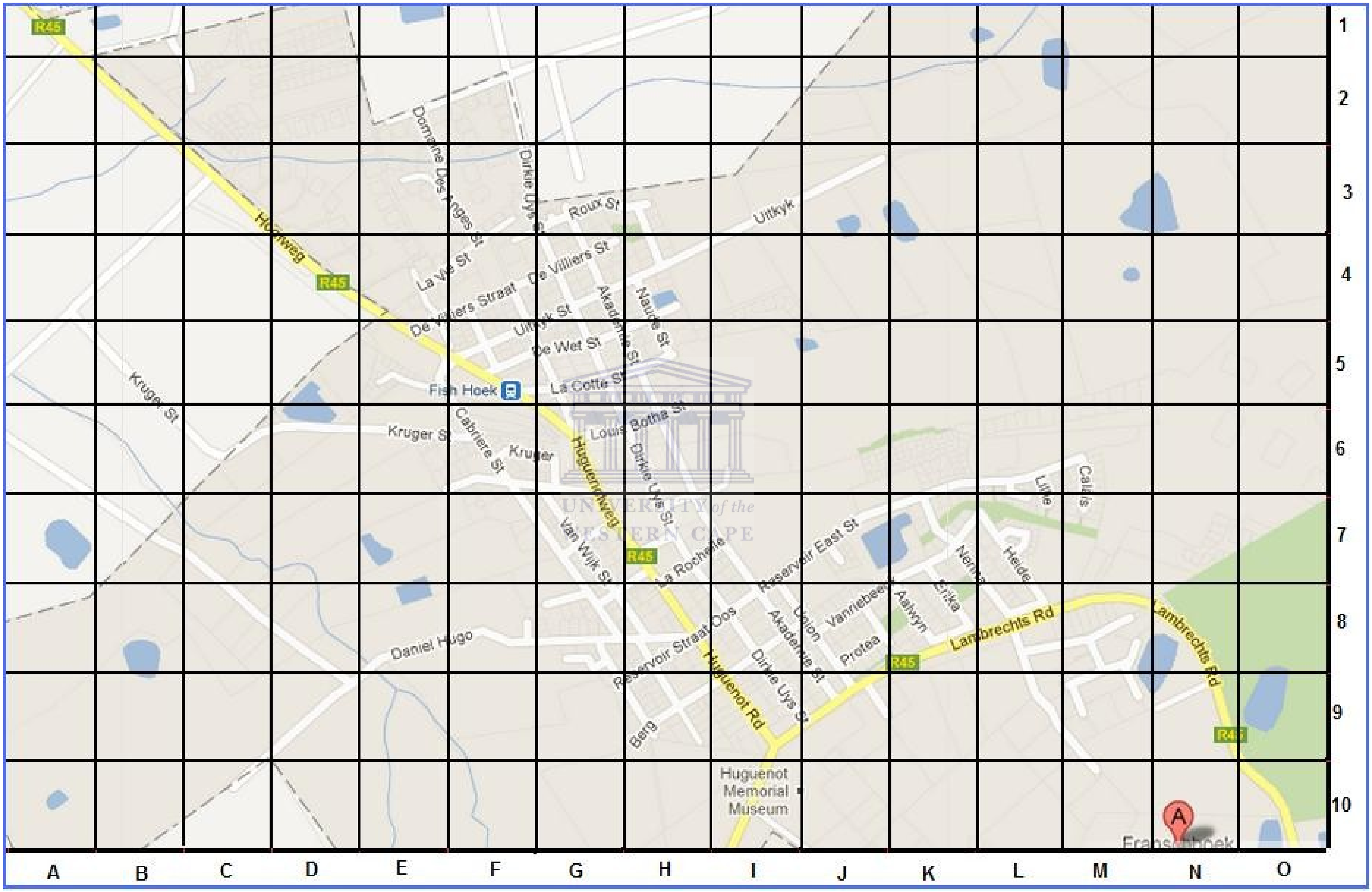

Figure 7: Partitioned Residential Map

Local Newspaper: A local newspaper, "The Franschhoek Tatler" was contacted and members of the research team met with the chief editor to discuss the possibility of placing an article in the paper. An article was subsequently submitted to the paper and published during the month of October when the survey was conducted. A scanned copy of the article may be found in Appendix D.2.

Community Groups: Several fairly influential community groups exist within the research area. Community groups that were contacted include the Local Ratepayers Associations, the Franschhoek Farmers Association, FISBA, The Franschhoek Trust and the Franschhoek Sustainability Committee.

10.7 Questionnaire Design

A highly technical survey instrument was developed in order to elicit information from members of the communities of Franschhoek. The questionnaire, approximately 2400 words in length, was translated into three languages namely English, Afrikaans and Xhosa. An example of the English questionnaire may be found in Appendix D.

10.7.1 Questionnaire Structure

The questionnaire used in the field work is a highly technical contingent valuation survey instrument. Most of the exploratory and qualitative research efforts that preceded the survey were aimed at designing the questionnaire.

The questionnaire consists of six key components:

1. Demographics and Basic Household Details
2. Awareness, Attitudes, Preferences and Perceptions
3. Environmentally Oriented Behaviour
4. Lifestyle Standard Measurement System
5. Household Income
6. Contingent Valuation

10.7.2 Translation of the Questionnaire

The primary languages in the sample area are English, Afrikaans and Xhosa. As such it was necessary to translate the questionnaires into each of these languages. Translation was done by the Lilwimi Language Centre based at the University of the Western Cape. The translated questionnaire underwent several phases of retranslation and pre-testing to ensure the practicality of the translations and the validity of the acquired data.

10.7.3 Pretesting the Questionnaire

A pre-test was conducted on the 30th of September in the Research Area. All member of the survey team participated in the pre-test and all three questionnaire languages were tested. A few minor adjustments were incorporated into the instrument after the pre-test. The instrument performed well throughout the survey.

11. Contingent Valuation Design

11.1 Overview

The contingent valuation component of this study accounted for those groundwater values that could not be determined through observation of the market. It is an inherently flexible technique which can be applied in many different situations. This inherent flexibility also presupposes that a great deal more preparation is necessary to successfully carry out a contingent valuation survey due to the fact that it needs to be specifically tailored to its context.

This chapter outlines the measures that were taken to ensure that the contingent valuation survey produced the most reliable data possible, given the limitations of the study. It also identifies the key decisions that were taken during the development of this contingent valuation component as well as the motivations that underlie those decisions.

11.2 Groundwater Values

The total economic value framework outlined in chapter 2.3 (Literature Review) disaggregates the total economic value of a natural resource into 4 fundamental components, namely:

- 3 Use Values
    - Direct Use Value
    - Indirect Use Value
- 2 Non-Use Values
    - Existence Value
    - Bequest Value

The “quintessential” version of this framework proposed by academic texts has 6 fundamental components although most studies tend to use a slightly modified version of this framework excluding one or more of the components. The modified version of this framework used in this study, seen above, is still lauded as total economic value and suitable arguments are provided to account for the excluded components.

In this case we have made the decision to exclude two components; Altruistic Value and Option Value. The motivation for the exclusion of these components is provided in chapter 2.3 of this report.

11.3 Valuation Context

The context in which a contingent valuation survey takes place has a great influence on the design of the survey. Context by definition refers to the circumstances that surround and influence a particular event and help to determine its meaning. More specifically, it is the manner in which the context interacts with the content of the contingent valuation survey that is of particular concern. The use of hypothetical scenarios in a survey is always controversial. The argument against the use of hypothetical scenarios is that since the respondent has never actually experienced the scenario in question, he may not be considering all of the factors that would influence his decision making process, and introduce an element of bias that can skew the response. The context should thus be compensated for so as to assure, to the greatest degree possible, that it does not bias the outcomes of the survey.

There were several social factors that needed to be accounted for when designing this contingent valuation survey for the residents of the Berg River Valley:

Variance in Levels of Education: There is a large difference in the levels of education between the various communities in the research area. Because it was necessary to use the same survey instrument across the entire research area, an instrument was developed that was equally accessible and relevant to community segments that were fundamentally different from one another in their ability to grasp and comprehend intellectual material.

There were two scenarios that we wanted to avoid. We did not want to reduce the content of the survey to the lowest common denominator and risk sacrificing depth of comprehension within more educated community segments. On the other hand we did not want to raise the technical element of the content so much as to lose effective levels of understanding with community segments that had lower levels of education.

The solution to this problem was to introduce a level of redundancy in the portrayal of our hypothetical scenario. Elements of the scenario that are stated in technical/higher language form are quickly followed by a short layperson-type explanation.

For example:

Box 1: Extract from Survey Questionnaire. "Groundwater Resource Threats"

Domestic Pollution:	Many forms of pollution come from homes. These include cleaning agents, oil, chemicals (Eg. Batteries) and human or animal waste. These wash into the local water systems when it rains and contaminates the streams and local groundwater.

The format is not strictly "technical term" followed by "laymen explanation", for certain sections of the form this was not entirely necessary, but rather care was taken to blend the two into an elegant phrase.

For example:

Box 2: Extract from Survey Questionnaire. "Effects on Groundwater Resources"

Reduced amounts of groundwater (Alien plants species use a lot more water than native species)

Specialized Technical Nature of the Material: Certain areas of technical information are so specialized that they are unlikely to be understood without significant amounts of explanation. Participation a survey of this nature is a relatively brief experience for the respondent and there is a limited amount of time in which to interact with the respondent. If interaction with the respondent extends beyond a certain time period they are likely to become restless, and may even resort to providing quick unconsidered responses in order to end the survey.

Comprehension of the material is, in these cases, not dependent on an individual's capacity to comprehend, but rather on previously acquired knowledge of the content in question. Not to say that CVS's should be devoid of instructive information, for CVS's by their very nature should contain "new" information for the respondent. Rather, a distinction should be made and "new" information should only be included if it adds value and it is practical within the scope of the survey.

The full details of the valuation context may be viewed in the questionnaire in Appendix D.1.

11.4 Hypothetical Scenario

The Groundwater Research Group based at the University of the Western Cape has been conducting research in the Berg River Valley for seven years prior to the initiation of this study. A number of research reports have been produced; some have been considered in this document and included in the bibliography. However in order to filter and structure the large amount of environmental and hydrogeological information in those documents several focus groups were conducted to transform the content and expertise produced in those projects into an accessible and usable format for this project.

The focus group process is discussed at length in chapter 12 of this report. This chapter will deal primarily with the content that was produced, not the process by which it was compiled.

The content of the CVS had to fulfill a number of very specific objectives. These objectives were to:

11.4.1 Inform the respondent about groundwater

There are extremely low levels of awareness about groundwater in the general population of South Africa (Braune and Xu. 2010). We assumed that this would also be the case within the research area and so a short information packet that was thus included with the survey instrument. The information would be read to the respondent during while the survey was being conducted and would serve to educate the respondent about groundwater.

Box 3: Extract from Survey Questionnaire "Fact Sheet about Groundwater Resources"

Some Information about groundwater:
Groundwater is water that is found underground. When it rains water soaks into the ground and is stored in tiny spaces in the sand or in the cracks of rocks. The underground areas of rock and sand that store this water are called aquifers. Sometimes the water can be found just below or very near to the surface, but sometimes the water can be found very deep in the ground, more than 1km.

In Franschhoek, the mountains catch the rainfall and force the water to collect into rivers and streams. A lot of this water also soaks into the ground and becomes groundwater. You can sometimes see this groundwater when it comes out of the cracks in the side of the mountain. This water is flowing through the cracks in the mountain rocks and is eventually forced out. This water that comes out of the ground by itself is called a groundwater spring. There are several groundwater springs like this in the Franschhoek Valley.

It is also possible to pump this water out from underground. A place where we pump groundwater out is called a borehole. Many farmers use boreholes to pump out groundwater for use on their farms.

11.4.2 Itemize the ways in which groundwater benefits the community

Groundwater is widely utilized by the populace of the Berg River Valley for drinking purposes. Some drink the bottled "mineral" water that has been extracted in the area whilst there is a portion of the population that collects groundwater directly from the springs that occur in the area. The other benefits of groundwater are less well known and some are not known at all.

It was thus necessary to comprehensively inform the survey participants about the significant ways in which groundwater benefits their community. The list that was produced appeared as follows:

Box 4: Extract from Survey Questionnaire. "Groundwater Benefits in Franschhoek"

Water Supply:	About one quarter of the water supply of Franschhoek comes from groundwater from the Mont Rochelle Nature Reserve.
Irrigation:	Many of the farmers in the area pump out groundwater and use it to irrigate their crops.
Rivers and Streams:	Some of the streams in the valley, including the La Cotte stream and the Varkblaardrift stream get their water from groundwater springs in the mountains.
Wetlands:	There are wetlands in the lower part of the valley that are completely dependent on groundwater for their water supply.
Plants and Animals:	Groundwater helps to feed the plants during the dry season, once all the surface water has dried up. These plants are also important for animals, birds and insects that rely on the plants for food and shelter.

11.4.3 Itemize societal activities that threaten to harm or degrade groundwater resources.

The focus group (As discussed in chapter 12) identified several potential threats to groundwater resources in the research area. The threats that were the most consistently present and generalized throughout the research area were selected whilst low risk/low frequency threats were filtered out. This was done so as to assure a high degree of certainty with regards to description of the local groundwater context. The threats are listed in table 6 below.

Box 5: Extract from Survey Questionnaire "Threats to Groundwater Resources"

Wastewater:	During the busy tourist/summer season, the Franschhoek sewerage system is unable to process all of the wastewater from the town. This wastewater spills into the local rivers and contaminates the groundwater in the immediate area.
Domestic Pollution:	Many forms of pollution come from homes. These include cleaning agents, oil, chemicals (e.g. Batteries) and human or animal waste. These wash into the local water systems when it rains and contaminates the streams and local groundwater.
Agricultural Runoff:	Fertilizers and pesticides from the farms are washed into the local water systems and contaminate the groundwater.
Salination:	Agricultural activity in the area may be releasing natural salts that were previously trapped in the soil into the groundwater.

11.4.4 Itemize the effects that harmful societal activities will have on the local groundwater resources.

Following on from the description of the threats to groundwater resources, the likely effects of those threats were listed. They are presented in here in table 7.

Box 6: Extract from Survey Questionnaire "Impact of Polluted Groundwater"

People who come into contact with or consume contaminated groundwater/water can get sick.
Reduced Bird Populations
Reduced populations of native animal species.
Increased populations of invasive animal species and pests
Increased numbers of invasive plant species and pests.
Reduced amounts of groundwater (Alien plant species tend to use a lot more water than native species.
Groundwater might become less suitable for agriculture due to high salt content.

11.4.5 Discuss and detail a hypothetical scenario that will "protect" groundwater

In line with this contingent valuation process a hypothetical scenario was proposed to offset the degradation of local groundwater resources and to promote the ongoing viability of these resources. The proposed hypothetical scenario was centered on a state run "Groundwater Management Program" (GMP) that would provide certain services to the community. The GMP would be organized and managed by the local municipality. The services provided by the municipality are listed in table 8 shown here.

Box 7: Extract from survey questionnaire "Services of the Groundwater Management Program"

Monitor and document the quality of groundwater in the area.
Monitor and document the local groundwater levels. (Water Table)
Identifying and documenting sources of groundwater contamination.
Informing community (residents, farmers, etc.) of contaminated groundwater/water sources and of the risks associated with the type of contamination.
Organize and manage efforts to reduce/prevent groundwater contamination.
Organise and manage legal actions where deemed necessary.
Promote the sustainable use of groundwater resources.
Work towards the preservation of groundwater resources for the benefit of future generations.
Educate and inform members of the community about local groundwater resources.

In essence the GMP was thus designed to be a proxy for a full range of non-market values of groundwater, including indirect use value, existence value and bequest value. This was done such that

that willingness to pay for the GMP would constitute willingness to pay for the non-market values of groundwater.

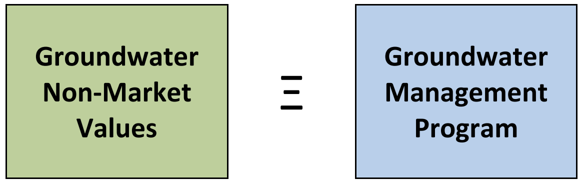

Figure 8: GMP proxy for Non-Market Values

The Groundwater Management Program was described as being a 5 year program with a total projected cost of R7 million rand and it would be funded by means of a levy that would be charged to residents of the research area. The levy would be included in the monthly water bill, and would be sustained for the five year period of the GMP. Once the program has been concluded, its renewal would be put up for consideration. The budget for the GMP is shown here in Table 9. Annual increases and the discounting rate are both set to 5%.

Table 3: Budgetary Breakdown for Groundwater Management Program

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Startup Cost	R 1,750,000.00				
Staffing Cost	R 650,000.00	R 682,500.00	R 716,625.00	R 752,456.25	R 790,079.06
Running Exp.	R 150,000.00	R 157,500.00	R 165,375.00	R 173,643.75	R 182,325.94
Equipment	R 100,000.00	R 105,000.00	R 110,250.00	R 115,762.50	R 121,550.63
Maintenance	R 50,000.00	R 52,500.00	R 55,125.00	R 57,881.25	R 60,775.31
Rent	R 100,000.00	R 105,000.00	R 110,250.00	R 115,762.50	R 121,550.63
Sub-Total	R 2,800,000.00	R 1,102,500.00	R 1,157,625.00	R 1,215,506.25	R 1,276,281.56
Discounted Sub-Total	R 3,000,000.00	R 1,050,000.00	R 1,050,000.00	R 1,050,000.00	R 1,050,000.00
Total (NPV)	R 7,000,000.00				

In line with other municipal pricing schemes, the GMP would use a stepped tariff charging a slightly different levy depending on the income level of the household. The contingent valuation utilized 2 different bidding amounts to simulate this stepped tariff. The initial bid proposed to upper income and upper middle income household was R80, whilst those in the middle income, lower middle income and low income categories were presented with an initial bid of R40. These amounts, given the size of the communities, along with a small state contribution would be sufficient to provide the R7 million needed to fund the 5 year GMP.

11.5 Estimating Willingness to Pay

11.5.1 Eliciting WTP

In figure 8 below the questions for the elicitation of WTP are displayed. Question 42 checks the respondents understanding whilst question 43 filters protest bias by removing those who chose not to vote for the scenario before the bid is posed.

42. Do you understand the situation thus far? **Yes** | **No**
(If the respondent says "No", explain the hypothetical scenario again.)

43. Would you vote "Yes" or "No" for the groundwater management program? **Yes** | **No**
If the respondent says "Yes", go to Q.44, otherwise skip to Q.45)

44. Would you be willing to pay an amount of R_______. **Yes** | **No**
(If "Yes" iterate upwards until response is "No")
(If "No" iterate downwards until response is "Yes")

First Bid ________ **Final Bid** ________

45. If you voted "No", for the program, what are your reasons for doing so?

This is government's responsibility; I should not have to pay extra for this.	
I don't trust government to run a program like this.	
I can't afford to pay for this program.	
Other	

Other ________________________________
(Specify)

Figure 9: Extract from Survey Questionnaire "Eliciting WTP" (Makaudze et al. 2011)

Question 44 elicits WTP and last but not least question 45 elicits the "reason" should the respondent chooses not to vote for the hypothetical scenario.

11.5.2 Binary Logistic Analysis

The probability that a respondent will answer yes or no to a given bid is analyzed using binary logistic regression. It is a regression technique that has a dependent variable that is discreet in nature and not continuous. The dependent variable is binary in nature, allowing for only two options. Various dummy and continuous variables are analyzed to determine if they have a significant influence on the dependent variable.

11.5.3 Recovering the Parameters and Estimating WTP

Binary logistic analysis was performed upon the data to identify significant covariates that might influence the probability that a respondent will respond either positively or negatively to a certain bid price. The respondent's response to the bid price (Yes/No) was used as the dependent variable. As different bidding prices were used for each of the segments, the data was analyzed separately.

The model is constructed as the concatenation of a composite income term (CompositeIncome) and a covariate matrix z, consisting of dummy variables. The composite income term and covariates presented below were constructed according to the instructions of Haab and McConnel (2003) where:

The composite income term is thus the log of the ratio of the residual income (Household Income minus the Bid Price) to the bid price proposed in the hypothetical scenario.

We estimate willingness to pay using a bound logit model where:

can be calculated using the coefficients in the covariate matrix which are estimates of γ/σ, the coefficient of the composite income term which is an estimate of 1/σ and the mean values of the covariates which are the values for z such that:

= +

12. Focus Group Design

12.1 Overview

In order to undertake a proper contextual evaluation of the local socio-economic circumstances and their relationship the surrounding surface water and groundwater systems, it is first necessary to develop a thorough understanding of those local surface water and groundwater systems.

The seven years of surface water and groundwater research that preceded this project was originally intended to provide that understanding. However, it was still necessary was to find an efficient means of pooling that knowledge in a manner relevant to this socio-economic study.

In order to achieve this aim we had to overcome three problems:

1. How would socio-economic researchers manage to navigate their way through a pool of information that is not their area of expertise and produce a valid opinion?
2. How would we filter the relatively small component of essential information from the vast pool that had been produced in years prior?
3. How do we facilitate this process in the minimum amount of time whilst still allowing for debate, discussion and conclusion between the various scientific viewpoints encountered in the research?

The solution to all three of these problems was to conduct a focus group designed to facilitate all three of these three processes simultaneously. Such a focus group is essentially a think tank where the participants, who are experts in their fields, can propose and discuss the research. One individual would act as a moderator, guiding the focus group towards its desired objective.

12.2 Focus Group Participants

A number of key individuals were identified within the UWC Earth and Water Science Research Group. The intended participants consisted mostly of masters and doctoral students, most of whom had their research based in the Berg River Valley, the intended area for this study.

The prospective participants were invited to attend the focus groups via letter and e-mail. Those who accepted the invitation were issued with a guide highlighting the key points of interest that would be covered during the focus group.

12.3 Focus Group Guide

A focus group guide was developed to ensure the proper and efficient administration of the focus group process. The guide was intended to move the group through several pre-determined phases and to manage the amount of time allocated to each phase.

A copy of the "Focus Group Guide" is contained in Appendix L.

The focus group guide contains 6 distinct phases:

Phase 1: Introduction and greetings:

Phase 2: Identifying the keys issues relating to the study.

Phase 3: Discussion of the roles that groundwater plays in supporting environmental and social systems in the designated research area.

Phase 4: Discussion of the potential threats to groundwater resources in the designated research area.

Phase 5: Contingency analysis, discussing the potential effect of certain hypothetical scenarios on the groundwater systems within the research area.

Phase 6: Concluding and revising the key findings.

13. Water Use Census Design

A census is a highly intricate and interactive process. It differs from a "survey" in the very specific sense that you are measuring an entire population and are not simply taking a sample. The comprehensive nature of a census means that it needs to be approached somewhat differently from a survey and on the whole requires a stricter and more considered approach. The approach utilized in this project is expounded upon here.

13.1 Census Instrument Development

Development of the instrument was not an entirely straight forward process. A good number of considerations needed to be taken into account on order for the tool to be effective. The two most important considerations in this situation are listed as follows:

- **Availability of Information:** Although it may be expected that farm owners and managers should be in possession of certain types of information relating to their farms, this is not always guaranteed. Elements of redundancy need to be worked into the census questionnaire so that if one source of information is not available there is the option of an alternate source from which the necessary information may be inferred.
- **Simplicity:** Farmers are incredibly busy people and the researcher needs to be able to get the information that is required in as little time as possible. Having a questionnaire that can be conducted via telephone is also a bonus as it provides an alternate avenue by which data can be collected. However, in order to build a better relationship, it was considered best to initiate the contact face to face, since personal information is often required.

The census instrument was developed by the project team with the assistance of the enumerators. It was important to have the input of the individuals who would be carrying out the census, as they could provide the best feedback on the practicality of the instrument.

The following key categories of information were included in the census instrument:

- Size of cultivated land
- Crop type
- Irrigation schedules and water application amounts
- Water Sources
- Number of permanent residents

- Number of seasonal residents
- Sources of drinking water
- Presence of ancillary business e.g. restaurants, accommodation. Etc.

The full Water Use Census Questionnaire may be viewed in Appendix J.

13.2 Census Team Training and Development

The training of the census team began with the sources of suitable individuals to undertake the process. Compared to the household survey team, census team member needed to be relatively more professional and informed so as to be able to communicate with the professionals they would be in contact with. For this reason only post-graduate students were selected for the census team as they were deemed to be sufficiently mature. Other considerations that were taken into account included:

- Bilingual Ability: Team member had to be competent in both English and Afrikaans.
- Drivers License: Since team members would be driving from farm to farm this was essential.
- Qualification: Team member were recruited from within the earth and water science research group at UWC, ensuring that they had previous knowledge/experience in the water use census process.

The water use census team was intimately involved with the development of the census instrument whilst simultaneously undergoing training to equip them for the necessary work. They attended several workshops where the following subjects were addressed:

- General Census Technique and Etiquette
- Client Relationship Management
- Census Ethics and Client Confidentiality
- Information/Data Availability
- Emergency Procedure

13.3 Equipment and Census Strategy

The basic census strategy was centered on “redundancy” and “excess capacity”.

Redundancy: This is basically the inclusion of contingency strategies for the primary approach to the census. Census teams have two members each, so that if one person gets sick, the other can continue.

Access to extra transport should one of the vehicles fail. The census interview could be effectively conducted in person or via telephone.

Excess Capacity: Related to redundancy, but not quite the same, having excess capacity just means having more than enough resources to get the jobs done. We planned the census for 8 days, but had two extra days to do follow up work. Having five people on the team meant that if one person got sick someone else could fill in. Access to at least one 4x4 vehicle for access to hard to reach locations.

The census was conducted by five individuals. Two people on each of the enumerator teams and one person back in the "Headquarters" managing the telephonic contact and general admin of the process. The inclusion of the fifth individual is essential for handling the large amounts of data generated on a day to day basis by a census. It is also extremely useful for the coordination of the teams.

Each of the teams was equipped as follows:

- Vehicle
- ID Badge, Visibility Jacket, UWC Cap, Shoulder Bag, Rain Gear
- Pepper Spray, Whistle
- Cell phones + Emergency Contact Numbers
- File, Writing Pad, Pens

The "Headquarters" was equipped with the following equipment:

- Mobile computer platform with printer
- Internet access and cellular phone
- Questionnaire Repository and Filing Space

13.4 Pre-Census Awareness Campaign

An awareness campaign was conducted prior to the water use census in order to inform the local farm owners and farm managers of the impending study.

The Franschhoek Tatler, a local newspaper published a short article updating residents on the progress of the project and providing notice of the upcoming water use census. A short letter was also distributed to the local farmers. This was done with the assistance of the Berg River Irrigation Board, a Water User Association affiliated with the Breede Overberg Catchment Management Agency, and the Franschhoek Farmers Association.

Findings

14. Demographics

14.1 Population Statistics

The statistics presented in this chapter are based on the findings the survey conducted in the research area where a sample of 277 households was surveyed. The sample, collected according to a stratified random sampling plan was selected from the +/- 3200 households that comprise the Franschhoek Community.

In order to facilitate comparison of the various strata of the Franschhoek Community, households have been divided into segments according to certain criteria. These segmentation criteria are as follows:

- "Less Affluent Segment" and "More Affluent Segment", a segmentation criterion based on geographic location within the research area. Essentially, the "More Affluent Segment" represents the wealthier neighborhoods whilst the "Less Affluent Segment" represents the poorer portions of the community.
- Racial Segments; "Black". "White" and "Colored". The historical segregation of these three racial groups in pre-1994 South Africa necessitates that this criterion be utilized as a means of comparison. The ongoing separation between these communities warrants some consideration.
- Residential Clusters; "Franschhoek Town", "Groendal" and "La Motte". These three residential clusters collectively make up the population from which the sample has been drawn. However in most cases where comparisons are drawn between these clusters, "Groendal" and "La Motte" are treated as a collective unit. This is done because the similarity between, and the geographical proximity of these communities to one another negates any value that may be found in their comparison.

Further information regarding the segmentation criteria, the sample population and the sampling plan may be found in chapter 10.

14.1.1 Racial Statistics

The overall racial breakdown of the sample was 52.7% colored, 27.4% black and 18.8% white.

The distribution of the racial segments within the research area is as follows: 98% of white households are all confined to Franschhoek Town. Most of the colored and black households in Franschhoek town take the form of farm labor housing with privately owned black and colored households making up less than 15% of the Franschhoek Town segment

The informal sector that makes up a portion of Groendal is estimated to be 100% black. The majority of the formal housing sector of Groendal and La Motte is made majority colored households with some black households making up the difference.

If we compare the more affluent segment to the less affluent segment; the racial breakdown for the former is 9.3% black, 59.3%white and 31.3% colored whilst the latter is 35.6% black, 0.5% white and 62.3% colored.

See Appendix A.2.4

14.1.2 Household Size and Age Profiles

Mean household size for the sample is 4.22 individuals per household. Households in the more affluent segment average 3.38 individuals per household whilst the mean for the less affluent segment is somewhat higher at 4.59.

Household size as segmented by race reveals a somewhat greater difference as black and colored households average 4.14 and 4.78 individuals per household respectively whilst white households average 2.69.

A look at the household age profiles further elaborates upon this difference. Children younger than 10 years are far more prevalent in colored and black households, and the same can be said for children from the ages of 10 to 17.

There is far greater prevalence of individuals older than 55 years of age in white households.

See Appendix A.2.2 and A.2.3

14.1.3 Education Levels

Household education levels correlate predictably with income levels. 67.9% of household have at least one individual who has at least a matric level of education.

65,2% of households in the more affluent segment have post-secondary qualifications, contrasted with 15.7% in the less affluent segment.

See Appendix A.2.7

14.2 Income and Lifestyle Standards

14.2.1 Income

Income varies significantly over the sample, which is to be expected in a region with a high Gini-Coefficient. The income range for the sample was R200,000 with R200,000 being the maximum and zero income being the minimum. Mean income for the sample is R11808.43.

The more affluent segment has a mean household income of R24,974.21 while the less affluent segment has a mean income of R5,940.31.

Comparison of incomes across racial profiles reveals a mean income of R5,339.86 for black households, R9819.88 for colored households and R28806.08 for white households. The percentage of households with and income above R15,000 is 4.9% for black households, 14.7% for colored households and 71.4% for white households.

See Appendix A.3.1

14.2.2 Lifestyle Standard Measure

Lifestyle Standard Measures or LSM's are a means for measuring household purchasing power based on the contents/attributes of a household and does not rely on household income. LSM's are more accurate than household income at determining purchasing power as they account for a number of factors that may be inaccurately represented when measuring household income including household capitalization.

Households are rated on a scale from 1 to 10 with two being the poorest and 10 being the wealthiest. The category is dependent on a set of variables, which may be seen in Appendix D.1, on the 6th page of the survey instrument.

Households in the sample ranged from LSM 4 to LSM 10 with LSM 6 being the most common. LSM 9 and above accounted for 34.2% of the sample whilst LSM 6 and below made up 36.5% of the sample.

See Appendix A.3.2

14.3 Social Awareness and Perceptions

14.3.1 Perceptions of the Municipality

Survey respondents were asked to rate the level of satisfaction with regards to the municipal water service provision in the municipality as either “Satisfied”, “Somewhat Satisfied”, Unsatisfied” or “Very Unsatisfied”. Respondents who responded with “Dissatisfied” or “Very Dissatisfied” were asked to state a reason for their response. (Appendix D.1, Question 16 and 17)

For the entire sample 17.3% of respondents stated that they were either “Dissatisfied” or “Very Dissatisfied” with water service provision. Twelve point eight percent of households in the more affluent segment expressed dissatisfaction, whilst 19.4% of households in the less affluent segment were dissatisfied.

The highest concentration of complaints was with informal households where over 35% of responses were negative. Ironically, an additional portion of the informal households expressed the concern for their access to water, despite their apparent “satisfaction”. In total more than 50% of informal dwellings surveyed expressed dismay at the lack of water access. Their reasons provided focused primarily on the insufficient number of taps, the distance from their households to their taps and a lack of prior notice when the water is cut off. A comprehensive list of complaints from the informal housing sector has been included in Appendix A.5.5.

See Appendix A.5.4 and A.5.5

14.3.2 Water Source Knowledge

Franschhoek has two sources of potable water, Wemmershoek Dam and the Mont Rochelle Nature Reserve. Respondents were asked a series of two questions, the first asking whether they knew the source of their “tap water” and the second asking them to name the two sources.

55.2% of the respondents stated that they did in fact know the source of their “tap water”. Only 7.6% of these respondents were able to correctly name both sources, 35.7% were able to name at least one source.

See Appendix A.4.1

14.3.3 Groundwater Knowledge

A series of questions were posed in the survey to test respondent knowledge and awareness of groundwater resources (Appendix D.2, Questions 19-25). The first question simply enquired as to whether or not the respondent knew what "groundwater" was. Fifty point five percent of the respondents replied that they knew what groundwater was, 72.1% in the more affluent segment and 40.8% in the less affluent segment. The respondent then had to answer 6 questions, of varying difficulty, to test his/her knowledge of groundwater resources. Scores for the 6 question test were very low across the sample. A lowly 1.1% of respondents were able to correctly answer more than two questions correctly, with the highest score 4 correct answers. 94.2% of respondents were unable to answer any of the questions.

See Appendix A.4.1 and A.4.2

14.3.4 Environmental Protection VS Job Creation

Respondents were asked to state whether they thought it was more important to protect the environment or to create jobs. A third option was provided to state that both were equally important. The question was preceded by two priming questions and proceeded by a question asking them to state the reason for their response (See Appendix D.1, Questions 12-15). For the entire sample, 51.6% said that both were equally important, 39.4% said that creating jobs was more important and 8.7% stated that protecting the environment was more important. The substantiating statements provided by the respondents varied predictably with their choices and further discussion here is not warranted. These open ended responses may be viewed in the appendices.

What is of particular interest is the comparison between the more affluent and less affluent segments. Significantly more people opted for the "Creating Jobs" option in the less affluent segment, notably 45% versus the 26.7% in the more affluent segment. The balance was taken up by the "Both are Equally Important" option, which had a response rate of 60.5% in the more affluent segment and 47.6% in the less affluent segment.

See Appendix A.5.1, A.5.2 and A.5.3 (Descriptive Stats)

See Appendix A.5.5 (Open Ended Responses to Survey Questions 15)

15. Water Consumption Trends

The findings presented in this chapter have been grouped according to the three residential clusters, Franschhoek Town, Groendal and La Motte. This has been done to allow for better congruency with Appendix B, in which the data/information for each of clusters is presented in a similar fashion.

15.1 Franschhoek Town

See Appendix B.1

15.1.1 Total Water Consumption

Overall consumption for Franschhoek Town has been increasing over the six year period ending February 2011. The long run average growth rate for consumption stands at approximately 8.79% per annum.

The seasonal fluctuation in water consumption is rather exaggerated as the seasonal peak is approximately 188% larger that the seasonal low. February is month of peak consumption with a seasonal index of 1.608 whilst September is the month of lowest consumption with a seasonal index of .0558.

15.1.2 Average Consumption per Stand

Average consumption per stand increased over the 6 year period from 20.44m^3 per month in year 1 to 23.53m^3 per month in year 6. The data shows a fairly consistent year by year increase in per stand consumption, although it is worth noting that the figure for year 5, at 36.84m^3 per month, is slightly higher than year 6 which tallies at 36.31m^3 per month.

The number of active stands in Franschhoek Town has increase from 791 in year 1 to 1099 in year 6. Thus 72.36% of the increase in total water consumption of the six year period may attributed the increase the number of stands whilst 27.64% of the increase may be attributed to the increase in per stand consumption.

15.1.3 Average Price of Water

The average price of water in Franschhoek Town has increased over the six year period ending February 2011 from R3.75 per m^3 in year 1 up to R6.30 per m^3 in year 6. The data shows a fairly consistent growth in the price of approximately 10.93% per annum. Adjusting for economic growth rates and inflation reveals a more modest real growth rate of 6.55% per annum.

15.2 Groendal

See Appendix B.2

15.2.1 Total Water Consumption

Overall consumption for Groendal Town has been increasing over the six year period ending February 2011. The long run average growth rate for consumption stands at approximately 6.45% per annum.

The seasonal fluctuation in water consumption is moderate as the seasonal peak is approximately 59% larger that the seasonal low. February is month of peak consumption with a seasonal index of 1.322 whilst August is the month of lowest consumption with a seasonal index of 0.831

15.2.2 Average Consumption per Stand

Average consumption per stand increased over the 6 year period from 13.13m^3 per month in year 1 to 17.36m^3 per month in year 6. The data shows a fairly steady year by year increase in per stand consumption, at about 5.74% per annum.

The number of active stands in Groendal has increase from 1208 in year 1 to 1249 in year 6. Thus 9.25% of the increase in total water consumption of the six year period may attributed the increase the number of stands whilst 90.75% of the increase may be attributed to the increase in per stand consumption.

15.2.3 Average Price of Water

The average price of water in the Groendal cluster has increased over the six year period ending February 2011 from R3.28 per m^3 in year 1 up to R4.63 per m^3 in year 6. The data shows a fairly consistent rate of approximately 7.14% per annum. Adjusting for economic growth rates and inflation reveals a more modest real growth rate of 2.88% per annum.

15.3 La Motte

See Appendix B.3

15.3.1 Total Water Consumption

Overall consumption for the La Motte Cluster has been increasing over the six year period ending February 2011. The long run average growth rate for consumption stands at approximately 3.95% per annum.

The seasonal fluctuation in water consumption is moderate as the seasonal peak is approximately 96% larger that the seasonal low. February is month of peak consumption with a seasonal index of 1.434 whilst September is the month of lowest consumption with a seasonal index of 0.763.

15.3.2 Average Consumption per Stand

Average consumption per stand increased over the 6 year period from 20.44m^3 per month in year 1 to 23.53m^3 per month in year 6. The data shows a rather inconsistent trend in the increase as year 4 at 24.86m^3 per month and year 5 at 26.07m^3 per month are higher than year 6 which is 23.53m^3 per month.

The number of active stands in the La Motte Residential Cluster has increase very slightly from 199 in year 1 to 210 in year 6. Thus 25.73% of the increase in total water consumption of the six year period may attributed the increase the number of stands whilst 74.27% of the increase may be attributed to the increase in per stand consumption.

15.3.3 Average Price of Water

The average price of water in the La Motte residential cluster has increased over the six year period ending February 2011 from R3.37 per m3 in year 1 up to R4.38 per m^3 in year 6. The growth in the average price of water shows an increase on the whole but there is a slight decrease from R4.47 per m^3 in year 5 down to R4.38 per m^3 in year 6. The average growth rate however, for the six year period, is approximately 5.38% per annum. Adjusting for economic growth rates and inflation reveals a more modest real growth rate of 1.55% per annum.

15.4 Determinants of Water Consumption Trends

Community size and seasonal fluctuation are the biggest determinants of water consumption within a given cluster. Linear regression analysis with aggregate consumption as the dependent variable reveals that these two variable account for between 74% and 88% of the variation within consumption trends. The specific R-Square readings for the three clusters were 0.88, 0.74 and 0.795 for Franschhoek Town, Groendal and La Motte respectively.

Rainfall data taken from the Robertsvlei rainfall monitoring station was factored into the models to determine whether rainfall was an influential factor in water consumption. The regression model was reconstructed to include the original two variables, "community size" and the "seasonal index", along with the rainfall data. The findings were that rainfall was insignificant factor.

It was however possible that the seasonal index already accounted for the influence of rainfall. So a third model was constructed for each of the cluster that included only monthly rainfall and community size. The third model showed rainfall to be a significantly influential factor at the 1% level indicating that the seasonal index for the consumption patterns was accounting for the variation brought about by rainfall. The third model however had R-square readings of 0.255, 0.355 and 0.274 for Franschhoek Town, Groendal and La Motte respectively. Thus whilst it is clear that the seasonal index accounts for the rainfall in the region, it also accounts for a number of other seasonal factors. These most likely include property size and tourism (population flux).

See Appendix B.1.9, B.2.9 and B.3.9

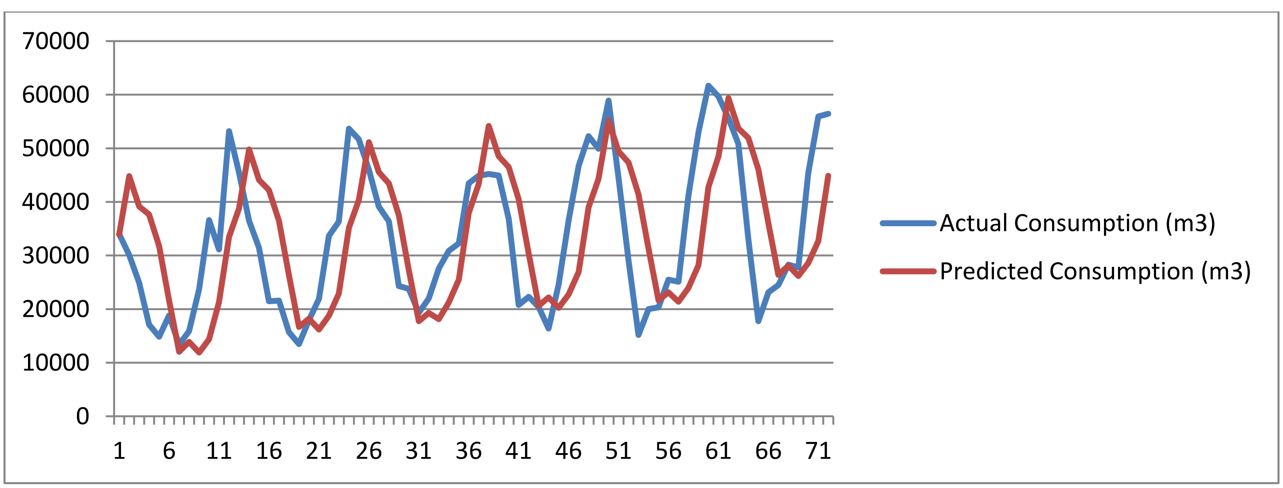

Figure 10: Franschhoek Town. Comparison of Actual Consumption vs Predicted Consumption

16. Water Supply

16.1 Bulk Water Sources

The Franschhoek area obtains its raw water from two primary sources namely Wemmershoek dam and the Mont Rochelle Nature Reserve.

Water is abstracted from several points within the Mont Rochelle Nature Reserve. Water is abstracted from the Du Toits River at two points; a pump station and a weir, whilst perennial spring water fed streams provide water as well. These sources are primarily fed by interflow from subterranean water sources and as such, are categorized as groundwater for the purposes of this study. Water from these

Water from the Wemmershoek Dam was being provided under contract from the City of Cape Town. The contract expired several years back and is yet to be renewed. This supply continues, but without any formal agreement. The amount being supplied from this source also currently exceeds the original contracted amount of 0.6 m^3/a.

In 2010 a total 1.124 million m^3 of municipal water was consumed by users in the Franschhoek Valley.

The Mont Rochelle source supplied 0.509 m^3 of this water. Municipal estimates put non revenue water at approximate 25% of supply. Using this figure we estimated that Wemmershoek supplied around 0.989$m^3$of raw water.

Assuming that rates of non-revenue water are equivalent throughout the research area we can calculate the amount of lost revenue as follows:

Where: = Average Price of Water in the i^{th} cluster

= Amount of Non-Revenue Water in the i^{th} Cluster

Given this equation we can calculate the amount of lost revenue to be **R 1 854 405.00**

See Appendix E

16.2 Private Groundwater Supply

A small percentage of households, less than 1%, have boreholes to abstract groundwater for their own private domestic purposes.

16.3 Agricultural Supply

The Franschhoek Farm utilizes a range of groundwater surface water resource including river and streams [private sources based on leading water rights as well as state allocations], private dams, reservoirs [storing diverted surface and groundwater], springs and spring fed streams, and last but not least, groundwater abstracted via boreholes.

All in all the agricultural sectors utilizes about 4.224 million m^3 per annum for irrigation and agricultural purposes with 75.59% of the water being supplied by surface water sources and the remaining 24.41% being derived from groundwater sources.

See Appendix C.2

16.4 Water Supply for the Region

In total in the research area, including all sectors, approximately 5.447 million m^3 of water are consumed per annum. Groundwater accounts for about 28.33% of water consumed whilst surface accounts for the remaining 71.67%.

See Appendix B.5

17. Value of Groundwater

17.1 Market Value

In order to use consumer surplus as a means to measure the market value of water it is first necessary to estimate the demand curve for those market values. This chapter investigated the possibility of using municipal consumption/price data to derive a demand curve.

17.1.1 Franschhoek Town.

It has thus far been established that the water consumption in the Franschhoek Town cluster has been increasing on the whole and in terms of per stand consumption. Most of this growth is attributed to increased number of active stands in the town.

The data indicates that over this period the price of water has increased from R3.75 per m^3 in year one up to R6.30 per m^3 in year 6. This equates to an average growth rate of 10.93% per annum.

These figures, adjusted for inflation and economic growth give the real price of water. The data indicates that the real price of water has increased every year at an average rate of 6.55% per annum, from R3.75 per m^3 in year 1 up to R5.15 per m^3 in year 6.

Thus in this case there is no discernable inverse relationship between the price of water and the quantity consumed. A viable demand curve for this good can thus not be derived, and in turn, consumer surplus cannot be calculated.

See Appendix B.1.8

17.1.2 Groendal

Water consumption in the Groendal cluster has been increasing. More than 90% of this growth may attributed to increases in the per stand rate of consumption

The data indicates that over this period the price of water has increased from R3.28 per m^3 in year one up to R4.63 per m^3 in year 6. This equates to an average growth rate of 7.14% per annum.

These figures, adjusted for inflation and economic growth give the real price of water. The data indicates that the real price of water has increased every year at an average rate of 2.88% per annum, from R3.28 per m^3 in year 1 up to R3.78 per m^3 in year 6.

In this case there is no discernable inverse relationship between the price of water and the quantity consumed. A viable demand curve for this good can thus not be derived, and in turn, consumer surplus cannot be calculated.

See Appendix B.2.8

17.1.3 La Motte

Water Consumption in the La Motte cluster has been increasing with more than 74% of this expansion being attributable to increases in per stand consumption. Over this period the price of water has increased from R3.37 per m^3 in year one up to R4.38 per m^3 in year 6 which equates to an average growth rate of 5.38% per annum. These figures, adjusted for inflation and economic growth give the real price of water. The data indicates that the real price of water has increased every year at an average rate of 1.22% per annum, from R3.37 per m^3 in year 1 up to R3.58 per m^3 in year 6.

Thus in this case there is no discernable inverse relationship between the price of water and the quantity consumed. A viable demand curve for this good can thus not be derived, and in turn, consumer surplus cannot be calculated.

See Appendix B.3.8

17.2 Non-Market Value

17.2.1 Filtering Response Bias

The samples collected were analyzed to determine if there was significant response bias. Of the 191 interviews that were collected from the less affluent segment of the community, 44 responded that they would not vote for the hypothetical scenario. Of the 86 interviews that were collected from the more affluent segment, 30 stated that they would not vote for the hypothetical scenario. The number of respondents that responded positively to the hypothetical scenario totaled 203, with 147 and 56 positive responses from the less affluent and more affluent market segments respectively. The cumulative "No" response rate was 27% which represents a weak but tolerable level of response bias within the sample. The nature of the response bias was somewhat different for each of the segments. In the less affluent segment, 40.9% of those who voted “No” for the hypothetical scenario stated that they would not be able to afford it. These responses were most common amongst those living in informal dwellings. In the more affluent segment, the stated reasons for voting “No” did not tend towards any specific issue.

17.2.2 Estimation of Model Parameters

Binary logistic analysis was performed on the data to identify significant covariates that might influence the probability that a respondent will respond either positively or negatively to a certain bid price. The respondent’s response to the bid price (Yes/No) was used as the dependent variable. As different bidding prices were used for each of the segments, the data was analyzed separately.

The binary logistic model for the more affluent segment is presented below in table 10. The model is constructed as the concatenation of a composite income term (CompositeIncome) and a covariate matrix z, consisting of 4 dummy variables. The composite income term and covariates presented in table 10 were constructed according to the instructions of Haab and McConnel (2003) where:

The composite income term is thus the log of the ratio of the residual income (Household Income minus the Bid Price) to the bid price proposed in the hypothetical scenario.

Table 4: Binary Logistic Model for the More Affluent Market Segment

	B	S.E.	Wald	df	Sig.	Exp(B)
CompositeIncome	1.093	.484	5.095	1	.024	2.983
Satisfaction_Dummy	-2.447	1.730	2.000	1	.157	.087
Edu_Dummy	-1.612	1.001	2.592	1	.107	.199
Race_Dummy	.864	.830	1.084	1	.298	2.373
RentOwn_Dummy	-.872	.776	1.265	1	.261	.418
Constant	-1.892	2.162	.765	1	.382	.151

CompositeIncome is also the only variable in the model that is significant at the 5% level. The dummy variable Satisfaction_Dummy and Edu_Dummy with Wald scores of 2.000 and 2.592 are slightly significant. The coding for the 4 dummy variables Satisfaction_Dummy, Edu_Dummy, Race_Dummy and RentOwn_Dummy is illustrated below in table 11.

Table 5: Dummy Variable Coding for More Affluent Market Segment

Variable	0	1
Satisfaction_Dummy	Satisfied with municipal water services	Unsatisfied with municipal water services
Edu_Dummy	Up to diploma	Degree and higher
Race_Dummy	Non-white	White
RentOwn_Dummy	Owns the dwelling/property	Renting the dwelling/property

The positive beta of 1.093 for *CompositeIncome* indicates that the probability of a positive response to a certain bid price is directly correlated to the income level of the household. A negative beta for the dummy variable Satisfaction_Dummy indicates that people are less like to respond positively to a given bid if they are dissatisfied with municipal water services. A somewhat surprising finding is the negative beta for Edu_Dummy which indicates that respondents with degree level qualification or higher are actually less likely to respond positively to a given bid.

The mean values for the variables in the model are shown in table 14 and 15 further on.

The model for the less affluent segment was a fair bit more stable, most likely due to the larger sample of 147 interviews. The binary logistic model for the less affluent segment is presented in table 12.

Table 6: Binary Logistic Model for the Less Affluent Market Segment

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	CompositeIncome	.817	.347	5.533	1	.019	2.263
	LOGage	-2.568	.909	7.975	1	.005	.077
	Senior_Dummy	-1.517	.599	6.420	1	.011	.219
	Satisfaction_Dummy	-1.163	.577	4.069	1	.044	.313
	Dwelling_Dummy	1.494	.612	5.951	1	.015	4.454
	OwnRent_Dummy	-.753	.745	1.021	1	.312	.471
	Marital_Dummy	.564	.486	1.344	1	.246	1.757
	Constant	6.783	3.441	3.887	1	.049	883.148

The term *CompositeIncome* is constructed according to the same criteria set out in the model for the more affluent segment. *LOGage* May be quite simply defined as the log of the age of the respondent. The two continuous variable *CompositeIncome* and *LOGage* are significant at the 5% and the 1% levels respectively. Three of the five dummy variables, *Senior_Dummy, Satisfaction_Dummy and Dwelling_Dummy* are significant at the 5% level. The coding for all five of the dummy variables is presented in table 13 shown below.

Table 7: Dummy Variable Coding for Less Affluent Segment

Variable	0	1
Senior_Dummy	No one older than 55 yrs	Has at least 1 person older than 55 yrs
Satisfaction_Dummy	Satisfied with municipal water services	Unsatisfied with municipal water services
Dwelling_Dummy	Informal Housing	Formal Housing
OwnRent_Dummy	Renting the property/dwelling	Owns the property/dwelling
Marital_Dummy	Not married	Married

The positive beta for *CompositeIncome* indicates a positive correlation between the income level of a given household and the likelihood that they will respond positively to a given bid price. The negative beta for *LOGage* tells of a negative correlation between respondent age and the likelihood that he/she might respond positively a given bid price. The dummy variable *Senior_Dummy* supports this finding as its negative beta indicates that households with at least one member over the age of 55 years are less likely to respond positively to a given bid price.

Satisfaction_ Dummy's negative beta indicates that respondents who are not satisfied with municipal services are less likely to respond positively to a given bid price whilst the positive beta for *Dwelling_Dummy indicates* that those living in informal housing are less likely to respond positively.

17.2.3 Estimating WTP

We estimate willingness to pay using a bound logit model where:

Haab and McConnel (2003)

can be calculated using the coefficients in the covariate matrix which are estimates of y/0, the coefficient of the composite income term which is an estimate of 1/0 and the mean values of the covariates which are the values for z such that:

= +

The various parameter estimates for the more affluent segment are presented here in table 14.

Table 8: Parameter Estimates for More Affluent Segment

More Affluent Segment	**(n=56)**			
			Parameter	**Mean**
Household Income			y	27424.3
Bid Term			t	80
	Parameter	**Value**		
CompositeIncome	1/σ	1.093		
Constant	/σ	-1.892		
Satisfaction_Dummy	/σ	-2.447		0.84
Edu_Dummy	/σ	-1.612		0.47
Race_Dummy	/σ	0.864		0.63
RentOwn_Dummy	/σ	-0.872		0.34

The parameter estimates for the less affluent segment are presented below in table 15.

Table 9: Parameter Estimates for Less Affluent Segment

Less Affluent Segment	**(n=147)**			
			Parameter	**Mean**
Household Income			y	6643.53
Bid Term			t	40
	Parameter	**Value**		
CompositeIncome	1/σ	0.817		
Constant	/ σ	6.783		
LOGage	/ σ	-2.568		3.6791
Senior_Dummy	/ σ	-1.517		0.24
Satisfaction_Dummy	/ σ	-1.163		0.81
Dwelling_Dummy	/ σ	1.494		0.7
OwnRent_Dummy	/ σ	-0.753		0.81
Marital_Dummy	/ σ	0.564		0.48

The estimate of median WTP for the more affluent segment, based on the figures presented in table 7 is R456.84 per household where σ = 0.9149 and = -4.07797. These results are summarized in table 16 below:

Table 10: WTP Estimate for More Affluent Segment

WTP Estimate for the More Affluent Segment

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WTP = R456.84

The estimate of median WTP for the less affluent segment, based on the figures presented in table 8 is R119.77 per household where $\sigma = 1.22399$ and = -3.9976. The results shown in more detail in table 17 below:

Table 11: WTP for the Less Affluent Segment

WTP Estimate for the Less Affluent Segment

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(0.81)(-0.74655)+(0.48)(0.331359)

–

WTP = R119.77

Concluding Chapters

18. Conclusion and Discussion

18.1 Conclusions Relating to Water/Groundwater Consumption

18.1.1 Total municipal water consumption is increasing in the research area.

There is a clear and overwhelming trend that municipal water consumption is increasing in the research area. Of the four sectors in which municipal water consumption was analyzed, specifically Franschhoek Town, Groendal, La Motte and the surrounding farmland, all of the long term trends showed a clear increase in the consumption of water supplied by the municipality over the period March 2005 until February 2006.

Total water consumption by an average of 9.75% per annum from 643437m^3 in the March 2005-February 2006 period up to 1129432m^3 in the March 2010-February 2011 period.

18.1.2 Total Water consumption for irrigation and agriculture is increasing.

Despite a lack of time series data that would allow us to view the long term trends of agricultural water consumption in the research area there is strong evidence to indicate that water consumption for irrigation and agricultural purposes is increasing.

Surface Water and spring water supplies have long since been fully allocated in the Franschhoek Valley and there has been significant increase in the number of farmers accessing local groundwater supplies by pumping their own boreholes. A DWA hydrocensus conducted in the area in 2007 revealed approximately 32 boreholes whilst the water use census conducted as a part of this project in May 2011 tallied 90 boreholes in use. The increase in the number of these boreholes supports the hypothesis that water consumption for irrigation and agriculture is increasing.

18.1.3 Groundwater, as a percentage of municipal water in the study area, is decreasing in the short to medium term.

The Mont Rochelle water source, which is classified as “groundwater” for the purposes of this study has been making up a smaller proportion of the Franschhoek water supply year on year. Water supplied from the Mont Rochelle source has remained more or less constant from 2005 until 2011, due to the fact that there are restrictions on how much water the municipality may abstract from those sources. Because of this Franschhoek has been augmenting its water supply by sourcing an ever greater amount from Wemmershoek Dam. Groundwater resources have thus been decreasing as a percentage of the overall municipal water supply. This however may only be concluded for the short to medium term as in the long term it is entirely possible that Franschhoek could develop groundwater resources to to meet its water demand.

18.1.4 Groundwater, as a percentage of irrigation water in the study area, is increasing on the whole.

Surface water resources have long since been fully allocated in the Franschhoek Valley and with the current proliferation of borehole construction in the area it is very logical to conclude that farmers are augmenting their water supplies from groundwater sources and therefore groundwater, as a percentage of the water supply for irrigation and agriculture, is on the rise. A hydrocensus conducted by DWA in 2007 indicated approximately 32 boreholes in the area, but the water use census conducted in the course of this project indicates that there are currently around 90 boreholes that are being used to source water for agriculture and irrigation.

18.2 Conclusions Relating to the Market Value of Groundwater

18.2.1 Consumption of municipal water is irresponsive to the increases in the price.

Per household consumption of municipal water has been increasing over the period March 2005 to February 2011 despite a consistently increasing price of water over this period. In Franschhoek Town with more than 75% of the increase in consumption being due to the increase in the number of household, it is clear that the price of water and the annual increases have simply been too low to induce any reduction in per household consumption.

The situation is a little less clear in La Motte and Groendal where the increases in total consumption are primarily attributable to increases in per household consumption. For these areas it is likely that the socio economic characteristics of the household have been shifting with possible increases in average household size and household income. There is evidence to support this notion; specifically there has been significant economic expansion which would draw in additional labor, there has been growth in the number of backyard dwellings with residents renting out the extra space on their properties and lastly the rapid expansion of the informal settlement in Groendal is evidence of the attraction that the area has for migrating peoples. Thus it may be slightly incorrect to conclude that the increases in the price of water have been too low to induce a decrease in per household consumption as it could posited that the aforementioned economic pressures that are driving an increase in per household consumption could be masking this effect. However, despite the underlying factors, it is still correct to conclude that consumption of municipal water by these household is irresponsive to increases in the price of that water.

18.2.2 The market value of groundwater and water is indeterminate in the research area.

Using consumer surplus as a measure of economic value requires the derivation of a demand curve for the resource in question, and as explained by Griffiths and Wall (2000) in chapter 2 of the literature review a demand should, ceteris paribus, almost always show an inverse relationship between the price of a given resource and the consumption of the resource.

However in this case study the data indicates that per household water consumption has been increasing despite the annual increases in the price of water, which renders any attempt to derive a demand curve for this area ineffectual. This phenomenon is stated by Fraiture and Perry (2007) as being not too uncommon and they postulate that the primary reason for this phenomenon taking place is that population groups are irresponsive to changes in the price of water below a certain threshold price. Only once the price of water increases above that "threshold" price will populations groups become responsive to changes in the price of water.

18.2.3 At the poorest end of the economic spectrum, urbanization is driving the increase in the demand for potable water.

Rapid urbanization is driving the increase in the demand for potable water at the poorest end of the population. The expansion of the Langerug informal settlement is evidence of the increase in the number of individuals migrating into the area. The increase in the presence of backyard dwellings in the Groendal area provides additional evidence towards this conclusion.

The increasing number of employment opportunities and relatively better access to government services are the primary motivators for people moving into the area. It is however unlikely that this expansion will continue unabated as the area is close to its maximum carrying capacity. This should ease the increase in demand for potable water.

18.2.4 In the central portion of the economic spectrum, population pressure is driving the increase in the demand for potable water.

In the communities of La Motte and Groendal (informal sector excluded) there has been growth in demand for potable water which may be primarily attributable to the increases in per household consumption. The available evidence would suggest that these households are experiencing population pressure and most probably an increasing average household size.

The informal settlement adjacent to Groendal has increased at an incredible rate over the last few years and it is logical that the factors that are motivating people to migrate into the area will have a comparable effect on the formal housing sector. The increased prevalence of backyard dwelling [Informal structure constructed on formal properties] provides additional evidence towards this conclusion.

18.2.5 At the wealthiest end of the economic spectrum, property development is the primary driver behind the increase in demand for potable water.

The extensive development of premium level high income housing that has taken place in Franschhoek Town is the primary driver behind the increase in the demand for potable water at the wealthiest end of the economic spectrum. It is also the single biggest contributor to the region's growth in demand.

The developments have by and large been above average size households with large properties and extensive gardens. These housing developments are the result of the areas popularity with both local and foreign investors as well as the exceedingly high rates of return present in the South African property market between 2004 and 2007. In 2007 the South African property market had an average rate of return of 25% which was the highest in the world for that year. The developments were of both a residential and commercial nature with the local hospitality industry experiencing significant growth as well. However limited space within the valley will most likely severely curtail any further expansion within the area.

18.3 Conclusions Relating to the Non-Market Value of Groundwater

18.3.1 In the less affluent segment of Franschhoek, the willingness to pay for the non-market value of groundwater is R119.32 per household.

The contingent valuation survey in the less affluent segment of the Franschhoek yielded 191 sample questionnaires of which 147 remained after filtering for response bias. Based on this sample WTP for the “Groundwater Management Program” proposed in the hypothetical scenario was estimated to be R119.32 per household per month.

As the Groundwater Management program is purposed to be the proxy for the non-market values of groundwater it can be concluded that the WTP for the non-market values in this segment is R119.32 per household per month.

As the mean monthly income for this segment of the population stands at R6643.53, WTP for the non-market values of groundwater is 1.8% of mean household income.

18.3.2 In the more affluent segment of Franschhoek, the willingness to pay for the non-market value of groundwater is R432.34 per household.

The contingent valuation survey in the more affluent segment of the Franschhoek yielded 86 sample questionnaires of which 56 remained after filtering for response bias. Based on this sample WTP for the “Groundwater Management Program” proposed in the hypothetical scenario was estimated to be R432.34 per household per month

As the Groundwater Management program is purposed to be the proxy for the non-market values of groundwater it can be concluded that the WTP for the non-market values in this segment is R119.32.

As the mean monthly income for this segment of the population stands at R27424.30, WTP for the non-market values of groundwater stands at 1.67% of mean household income.

18.3.3 Income, satisfaction with municipal water services and education are influential factors in the demand for the non-market values of groundwater in the more affluent segment of Franschhoek.

For the more affluent segment of the Franschhoek population only Income was a significantly influential factor at the 5% level. However Wald distribution scores above 2.0 for “municipal satisfaction” and “education levels” indicated that they were influential as well, but weakly so.

Household income and “municipal satisfaction” were positively correlated with the demand for the non-market values of groundwater. However, education levels were negatively correlated with the demand for non-market groundwater values as those with a degree level of education or higher tended to have a lower WTP.

There might be several explanations for why education was negatively correlated with demand. It is possible that highly educated respondents are more discerning/informed consumers and that they would approach state run environmental interventions with a higher level of skepticism. It is also possible that more highly educated respondents are more informed with regards to the increasing rates and taxes that they are having to shoulder, which in turn would make them less likely to want to take on additional financial responsibility.

18.3.4 Income, age, satisfaction with municipal water services and the type of respondent dwelling are influential factors in the demand for the non-market values of groundwater in the less affluent segment of Franschhoek.

The binary logistic model for the less affluent segment yielded several significant covariates that influence demand for the non-market values of groundwater. Income and satisfaction with municipal water services were positively correlated with demand.

Age of respondents was, quite surprisingly, negatively correlated with demand for the non-market values of groundwater. The same was true for households that had at least one occupant older than the age of 55 years. It is possible that these respondents have less time left to live and thus would place less value in a program for the protection of the environment. It may also be possible that older respondents are retired or near to retirement and thus would be more protective of their income.

18.4 Conclusions Relating to the State of Water/Groundwater Resource in the Research Area

18.4.1 Franschhoek is facing increased water insecurity

The water that Franschhoek is currently receiving from Wemmershoek Dam is being obtained under a contract with the City of Cape Town that expired several years ago. The agreement has proceeded on an informal basis but currently Franschhoek lacks a solid legal claim to the Wemmershoek water should the city of Cape Town decide to cut off the supply. This fact alone introduces a great deal of insecurity into the Franschhoek situation and even though it is very unlikely that the CoCT would cut off the water they would have the means to put the town under pressure to develop their own sources.

With the demand for water in the City of Cape Town projected to reach and breach the currently available supply within the next 10 years a water crisis in the Franschhoek area is an inevitability unless the local authorities develop new sources of fresh water or a suitable arrangement is made with the CoCT to obtain water from one of the dams.

18.4.2 Franschhoek would benefit greatly from the coordinated development and monitoring of its groundwater resources.

A coordinated approach to the development of groundwater resources in the Franschhoek Valley would be beneficial to the utility of those who consumer the resources as well as to the long term viability of the resource.

Extensive development of groundwater resources is already taking place in the area; however the lack of coordination between users has created an environment conducive to market failure, since no individual user has any incentive to conserve the resource for the good of any of the other users. The eventual overuse of the resource is a thus a concern.

In addition, with the very real possibility of the bulk abstraction of groundwater from the TMG Aquifer for the City of Cape Town in the not too distant future, it would be prudent for the Franschhoek groundwater users to monitor the state of their local resources, should the possible future abstraction have any effect on the local groundwater availability or quality.

19. Recommendations

19.1 Franschhoek groundwater resources would benefit from further development

Franschhoek would benefit greatly from further investment into the development of its groundwater resources. Abstraction of this resource in bulk quantities will lead to greater understanding of how it can be utilized/manages for bulk consumption purposes. The area would make a suitable pilot study for such a development.

The drilling of boreholes for private consumption is already proliferating in the agricultural sector. As this consumption is not being tracked there is uncertainty with regards to how the current abstraction rates are affecting the state of groundwater resources in the area. There needs to be an active committed involvement on behalf of the state in order to ensure the integrity of the resource as only then will groundwater abstraction/quality be sufficiently monitored.

19.2 Franschhoek should invest in infrastructure to reduce non-revenue water losses.

The areas of Franschhoek investigated in the course of this project are currently losing about 25% of their water before it even reaches the point of consumption. This amounts a loss in revenue to a value of approximately R1.8 million per year.

Assuming a constant rate of water loss and a constant price of water, projected over ten years with a discount rate of 3%, the net present value of the lost revenue will be just over R15 million. Thus it is in fact possible to invest in infrastructure in the present and recover the expense over time with the increased efficiency of the reticulation system.

19.3 There should be a long term view with regards to water security in Franschhoek.

The Franschhoek Valley has been through a period of exceedingly rapid development and the projections as to how it will continue are uncertain at best. One fact that is certain is that population and economic expansion of the City of Cape Town and the communities of the Cape Peninsula are going to place an ever increasing burden on the water demand.

The extraction of bulk quantities of groundwater for mass consumption is a real possibility for the region, and it will be best to prepare timeously for intended and unintended results as bulk groundwater is extracted.

19.4 Groundwater resources should be monitored, protected and sustainably utilized

. For similar reasons to the recommendation 20.3, there is a real need to proactively monitor the state of groundwater resources in the research area. As the abstraction of groundwater continues to grow, having a readily accessible database detailing the state of the resource will be essential.

19.5 Further research should be conducted in the socio-economic role that groundwater plays.

Groundwater is set to play an increasingly important role in South Africa, particularly with regards to the augmentation of bulk water supply for expanding urban zones and for rural water supply for support of rural development.

However, there is still a limited body of knowledge detailing the socio-economic impacts of these groundwater resources and thus our ability to make effective decisions regarding the development of the groundwater economy is stunted. There is thus a need to grow our understanding of local groundwater resources and their current and future potential impacts on South African society.

19.6 Consumers should be informed / educated about their water resources, including groundwater resources.

There is a significant need to inform stakeholders and the public in general about their water resources and the state thereof. Having an informed constituency is an essential component to generating political will, and is thereof necessary component of the motivation for the protection, monitoring and sustainable use of surface water and groundwater resources.

19.7 Water pricing needs upwards revision.

There is clear evidence to show that the price of water within the research area is too low. Whilst raising the price of water requires careful consideration, there is clearly room for raised tariffs within the context of the stepped tariff system. In addition, this low price of water contributes to an undervaluation of water resources.

20. Final Project Considerations

20.1 Ideas for Future Research

20.1 Tracking Population Movement/Migration

The exceedingly rapid expansion of the Franschhoek informal settlement that was witnessed over the course of the project brings into stark reality the rate of urbanization that is currently taking place in certain areas. Current methods of monitoring settlement expansion involve the use of aerial counting techniques. It may be possible to improve the estimates of population migration using GIS and satellite observation. This avenue may be worth exploring.

20.2 Centralized, Automated, Comprehensive, Water Consumption Monitoring

A great deal of time, money and effort is invested into the compilation of reconciliations to account for the production and consumption of potable water. These efforts often rely or data collection networks that are not maintained or insufficient. There is room in this field research into the development of less human resource intensive monitoring and reconciliation systems, and the evaluation of the costs and benefits thereof.

20.2 Lessons Learned

20.2.1 Practical Limitations of the Contingent Valuation Method

Although incredibly useful and flexible in its application there are certain limitations to the usefulness of the contingent valuation method. It can be very time consuming, each of the 277 survey interviews conducted in this project lasted between 15 and 45 minutes. This limits the sample size and data collection.

Secondly, it can is costly to conduct CV studies. They have to be conducted via face to face interviews in order to ensure a satisfactory response rate and reliable data.

Thirdly, while these studies can produce very useful insights, they are not accepted as legal evidence in certain countries. Thus, while the method has great value, it also has key limitations.

20.2.2 Early Involvement of All Stakeholders

In depth socio-economic studies such as this one require a great deal of stakeholder involvement and a good relationship with the governing authorities and community groups.

Early involvement with stakeholders is important because it allows the research team to identify possible complications and to compensate for them in the research plan. Planning research of this kind cannot begin in earnest without the buy in of all the key players.

20.2.3 Good Data is Hard to Find

The proposal for this research was written up under the assumption that certain sources of data would be readily available. Whilst contingency plans were obviously a factor of the planning, it was still surprising to the research team that more often than not they had to revert to plan B, and go back to the source of the raw data.

The field of water economics, especially in the case of detailed economic studies is new in South Africa and with the lack of capacity that is a reality in water management sectors new research is certainly necessary.

20.3 Assumptions of the study

20.3.1 Identical markets for surface and groundwater resources in the context of municipal water use:

This study aimed at estimating the use value of groundwater by observing the current water markets that are supplied by both surface water and groundwater sources. We have taken the view that a water resource, whether it originates from above or below ground, does not represent an end product in itself. Rather, we propose that surface water and groundwater are inputs into a process that produces an end product, specifically, water suitable for consumption, whether it be in domestic, commercial or agricultural use.

20.3.2 Stepped Tariff Considered but not Analyzed

The Stellenbosch Municipality utilizes a sliding tariff to charge for water consumption. Although this tariff is mentioned in this study, it has not been considered in detail. Instead, actual prices charged were obtained from the revenue database. Although adequate for the purposes of this study, this data requires further consideration.

20.4 Possible Sources of Error

20.4.1 Expansion of the Informal Settlement

The informal settlement adjacent to the Groendal cluster expanded at a considerable pace during the course of the project. When the initial estimation was made of the size of the informal settlement in November 2009 the most recent estimate of the informal settlement stated that there were approximately 750 informal dwellings. The municipality conducted aerial estimations of the size of the settlement in March 2010 and April 2011. They counted 1200 dwellings in the former estimation and 1700 dwelling in the latter estimation.

20.4.2 Non-payment of water utilities not considered

The project looked closely at the amount that the municipality charged to consumer for their water. This study did not consider the extent to which the municipality recovered the revenue that it charged the consumers for. The information was available in the datasets provided by the municipality but it was decided that the analysis of that data fell outside the scope of this project. This is a possible influential factor, and needs to be investigated further.

20.4.3 Differing Bid Prices in hypothetical scenario introduce statistical bias

The hypothetical scenario utilized different staring bids for the more and less affluent segments of the contingent valuation survey. Whilst this may help to mimic a “real life” scenario, it also introduces an element of bias between the two WTP estimates, which means they cannot be directly compared, in a statistically significant manner with one another.

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Appendices

Appendix A: Demographics

Appendix A.1: Respondent Stats

A.1.1 Respondent Age

Table 12: Respondent Age

Age of the respondent.			
	Entire Sample	More Affluent	Less Affluent
N	267	84	183
Min	16	16	19
Max	88	88	82
Mean	44.5	49.37	42.27
Std Dev	15.056	16.937	13.584

A.1.2 Respondent Gender

Table 13: Respondent Gender

Gender of the respondent						
	Entire Sample		More Affluent		Less Affluent	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Male	127	45.8	50	58.1	77	40.3
Female	146	52.7	36	41.9	110	57.6
Missing	4	1.4	0	0	4	2.1
Total	277	100	86	100	191	100

A.13 Marital Status

Table 14: Marital Status of the Respondent

Marital Status of Respondent.								
	Entire Sample			More Affluent			Less Affluent	
	Freq.	Perc.		Freq.	Perc.		Freq.	Perc.
Single	96	34.7		20	23.3		76	39.8
Married	149	53.8		58	67.4		91	47.6
Divorced	6	2.2		1	1.2		5	2.6
Widowed	22	7.9		6	7		16	8.4
Other	4	1.4		1	1.2		3	1.6
Total	277	100		86	100		191	100

Appendix A.2: Household Composition

A.2.1 Type of Dwelling

Table 15: Types of Dwellings

Dwelling Profile								
	Entire Sample			More Affluent			Less Affluent	
	Freq.	Perc.		Freq.	Perc.		Freq.	Perc.
House	187	67.5		65	75.6		122	63.9
Informal Dwelling	66	23.8		0	0		66	34.6
Town House / Flat	15	5.4		13	15.1		2	1
Small Holding	3	1.1		3	3.5		0	0
Other	5	5.4		4	4.7		1	0.5
Missing	1	0.4		1	1.2		0	0
Total	277	97.1		86	100		191	100

A.2.2 Household Size

Table 16: Number of People per Household

Number of People per Household			
	Entire Sample	More Affluent	Less Affluent
N	275	84	191
Min	1	1	1
Max	14	12	14
Mean	4.22	3.38	4.59
Std Dev	2.15	2.082	2.08

A.2.3 Household Age profiles

Table 17: Household Age Profile

Household Age Profile						
	All		More Affluent		Less Affluent	
	Mean	Perc.	Freq.	Perc.	Freq.	Perc.
Total Size	4.19	100.00	3.38	100.00	4.59	100.00
< 10	0.84	20.05	0.38	11.24	1.05	22.88
10 to 17	0.69	16.47	0.41	12.13	0.81	17.65
18 to 35	1.11	26.49	0.92	27.22	1.20	26.14
36 to 55	1.10	26.25	0.97	28.70	1.16	25.27
> 55	0.48	11.46	0.71	21.01	0.37	8.06
Total	277	100	86	100	191	100

Table 18: Household Age Profile [According to Racial Segment]

Household Age Profile								
	Black			White			Colored	
	Mean	Perc.		Freq.	Perc.		Freq.	Perc.
Total Size	4.14	100.00		2.69	100.00		4.78	100.00
< 10	0.88	21.26		0.28	10.41		1.01	21.13
10 to 17	0.78	18.84		0.24	8.92		0.77	16.11
18 to 35	1.28	30.92		0.58	21.56		1.22	25.52
36 to 55	1.00	24.15		0.80	29.74		1.26	26.36
> 55	0.20	4.78		0.78	29.00		0.53	11.09
Total	277	100		86	100		191	100

A.2.4 Household Race Profile

Table 19: Racial Profiles

Racial Profile										
Entire Sample				More Affluent				Less Affluent		
	Freq.	Perc.			Freq.	Perc.			Freq.	Perc.
Black	76	27.4		Black	8	9.3		Black	68	35.6
White	52	18.8		White	51	59.3		White	1	0.5
Colored	146	52.7		Colored	27	31.4		Colored	119	62.3
Other	1	0.4		Other	0	0		Other	1	0.5
Missing	2	0.7		Missing	0	0		Missing	2	1
Total	277	100		Total	86	100		Total	191	100

A.2.5 Property Ownership

Table 20: Is the property owned or rented?

Do you own this property or are you renting it?						
	Entire Sample		More Affluent		Less Affluent	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Own	199	71.8	55	64	144	75.4
Rent	52	18.8	23	26.7	29	15.2
Other	12	4.3	4	4.7	9	4.9
Missing	13	4.7	4	4.7	8	4.2
Total	277	100	86	100	191	100

A.2.6 Borehole on Property

Table 21: Is there a borehole on the property?

Do you have a Borehole on your property?						
	Entire Sample		More Affluent		Less Affluent	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Yes	9	3.3	5	5.8	4	2.1
No	264	95.3	79	91.9	185	96.9
Missing	4	1.4	2	2.3	2	1
Total	277	100	86	100	191	100

A.2.7 Education Levels

Table 22: Highest Qualification per Household

What is the highest education level held by a member of this household?						
	Entire Sample		More Affluent		Less Affluent	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Primary School	23	8.3	3	3.5	20	10.5
Some High School	66	23.8	6	7	60	31.4
Matric	94	33.9	16	18.6	78	40.8
Diploma	43	15.5	19	22.1	24	12.6
Degree	30	10.8	25	29.1	5	2.6
Post-Grad Degree	16	4.7	12	14	1	0.5
Missing	8	2.9	5	5.8	3	1.6
Total	277	100	86	100	191	100

Appendix A.3: Income and Lifestyle Standard Measure

A.3.1: Income

Table 23: Household Income

Household Income			
	Entire Sample	More Affluent	Less Affluent
N	276	85	191
Min	0	0	0
Max	200000	200000	35000
Mean	11808.43	24974.21	5949.31
Std. Dev	19411.95	30291.84	5260.51

Table 24: Household Income [According to Racial Segments]

.Household Income			
	Black	White	Colored
N	81	52	143
Min	0	0	0
Max	45000	200000	192000
Mean	5339.86	28806.08	9818.88
Std. Dev	6154.35	29428.67	16928.67

A.3.2: LSM

Table 25: Lifestyle Standard Measure [LSM]

LSM (Lifestyle Standard Measures)						
	Entire Sample		More Affluent		Less Affluent	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
LSM 10 High	27	9.7	27	31.4	0	0
LSM 10 Low	13	4.7	13	15.1	0	0
LSM 9 High	25	9	16	18.6	9	4.7
LSM 9 Low	30	10.8	16	18.6	14	7.3
LSM 8 High	16	5.8	4	4.7	12	6.3
LSM 8 Low	17	6.1	2	2.3	15	7.9
LSM 7 High	17	9.4	4	4.7	22	11.5
LSM 7 Low	20	7.2	1	1.2	19	19.9
LSM 6	62	22.4	2	2.3	60	31.4
LSM 5	28	10.1	0	0	28	14.7
LSM 4	11	4	0	0	11	5.8
Missing	2	0.7	1	1.2	1	0.5
Total	277	100	86	100	191	100

Appendix A.4: Awareness, Perceptions, Behavior

A.4.1: Tap Water Source Awareness and Knowledge

Table 26: Water Source Awareness Levels

Do you know the source of the water that comes out of your taps?						
	Entire Sample		**More Affluent**		**Less Affluent**	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Yes	153	55.2	57	66.3	96	50.3
No	114	41.2	29	33.7	85	44.5
Missing	10	3.6	0	0	10	5.2
Total	277	100	86	100	191	100

Table 27: Water Source Knowledge

Can you name the sources? (2 possible answers)						
	Entire Sample		**More Affluent**		**Less Affluent**	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
2 Correct	21	7.6	20	23.3	9	4.7
1 Correct	99	35.7	39	45.3	60	34.1
0 Correct / Missing	157	56.7	35	40.7	122	63.9
Total	277	100	86	100	191	100

A.4.2: What is Groundwater?

Table 28: Groundwater Awareness

Do you know what groundwater is?								
	Entire Sample			More Affluent			Less Affluent	
	Freq.	Perc.		Freq.	Perc.		Freq.	Perc.
Yes	140	50.5		62	72.1		78	40.8
No	132	47.7		23	26.7		109	57.1
Missing	5	1.8		1	1.2		4	2.1
Total	277	100		86	100		191	100

A.4.3: Groundwater Knowledge

Table 29: Groundwater Knowledge

How many of the following 6 questions can the respondent correctly answer?								
	Entire Sample			More Affluent			Less Affluent	
	Freq.	Perc.		Freq.	Perc.		Freq.	Perc.
Six Correct	0	0		0	0		0	0
Five Correct	0	0		0	0		0	0
Four Correct	2	0.7		2	2.3		0	0
Three Correct	1	0.4		1	1.2		0	0
Two Correct	5	1.8		3	3.4		2	1.05
One Correct	8	2.9		6	7		2	1.05
Missing / Zero	261	94.2		74	86		187	97.9
Total	277	100		86	100		191	100

A.4.4: Environmentally Oriented Habits

Table 30: Environmentally Oriented Habits

Environmentally Orientated Habits			
	Entire Sample	**More Affluent**	**Less Affluent**
N	277	86	191
Min	0	0	0
Max	29	26	29
Mean	9.57	12.15	8.4
Std Dev.	5.94	6.27	5.42

Appendix A.5: Consumer Perception

A.5.1: Perception of Franschhoek's Beauty

Table 31: Perceptions of Franschhoek's Beauty

Franschhoek is a beautiful Place. Agree or Disagree?						
	Entire Sample		**More Affluent**		**Less Affluent**	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Agree	260	93.9	82	95.3	178	93.2
Disagree	14	5.1	4	4.7	10	5.2
I Don't Know	2	0.7	0	0	2	1
Missing	1	0.4	0	0	1	0.5
Total	277	100	86	100	191	100

A.5.2: Importance of Job Creation

Table 32: Perceptions about Job Creation

Creating Jobs in RSA is important. Agree or Disagree?								
	Entire Sample			More Affluent			Less Affluent	
	Freq.	Perc.		Freq.	Perc.		Freq.	Perc.
Agree	267	96.4		82	95.3		185	96.9
Disagree	6	2.2		4	4.7		2	1
I Don't Know	3	1.1		0	0		3	1.6
Missing	1	0.4		0	0		1	0.5
Total	277	100		86	100		191	100

A.5.3: Environmental Protection vs Job Creation

Table 33: Environmental Protection VS Job Creation

Which do you feel is more important, protecting the environment or creating jobs?								
	Entire Sample			More Affluent			Less Affluent	
	Freq.	Perc.		Freq.	Perc.		Freq.	Perc.
Protect Env.	24	8.7		11	12.8		13	6.8
Create Jobs	109	39.4		23	26.7		86	45
Both Equal	143	51.6		52	60.5		91	47.6
Missing	1	0.4		0	0		1	0.5
Total	277	100		86	100		191	100

A.5.4: Municipal Satisfaction

Table 34: Municipal Satisfaction

Please rate your level of satisfaction with the municipality.						
	Entire Sample		More Affluent		Less Affluent	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Satisfied	99	35.7	45	52.3	54	28.3
Somewhat Satisfied	119	43	29	33.7	90	47.1
Unsatisfied	30	10.8	10	11.6	20	10.5
Very Unsatisfied	18	6.5	1	1.2	17	8.9
Missing	11	4	1	1.2	10	5.2
Total	277	100	86	100	191	100

A.5.4 Reason for Municipal Dissatisfaction (Open Ended Responses/Informal Dwelling Only)

1 Water is cut off without any prior notice.
2 We get water from the community tap and it is dirty
3 They have to fetch water from far.
4 Doesn't have a yard.
5 No tap inside house.
6 Dirty water is near my house. It smells bad.
7 I must walk far to get water.
8 Sometimes water is cut off without notice.
9 Not much running water
10 We don't have taps in the house.
11 There's a tap next to the road.
12 We don't have our own taps, we use public taps.
13 We don't have taps and hot water.
14 Long distance to the tap.
15 Over crowded
16 Don't let us know when the water is going to be cut off.
17 Taps not inside the house.
18 Stays next to the tap
19 Shut down sometimes.
20 Never cut down
21 Cutoff water
22 They stop water without notification.
23 stop water sometimes

24 taps are far
25 I need taps in my house
26 because I don't pay for water
27 taps are far
28 we don't have water
29 we more taps
30 I need my own ta
31 I don't have to pay, I get water
32 I need my own ta
33 I don't have a tap in my house
34 cut off the tap wit prior notification
35 taps are far

A.5.5 Open Ended Responses to Survey Question 15

Question 15: "Which do you feel is more important, protective the environment or creating jobs?"

Protecting the Environment (Open Ended Responses)

1 Can't work anymore, unemployed too old
2 If no environment, no reason to exist.
3 The "needlessly" destroy the environment for development.
4 Lots of negative things happen.
5 People get up to mischief when unemployed, nature doesn't provide employment.
6 From protecting nature employment can be created.
7 We have to protect the environment to live.
8 If we don't protect the environment, everything else is a waste of time.
9 A lot of unemployment.
10 Both should be prioritised. We should have to choose.
11 We rely on environment for livelihood
12 We are surrounded by poverty, but the environment was here before the people.
13 If people can work, they'll have more self-respect and respect the environment.
14 Crime rate is high.
15 people don't appriciate jobs
16 no environment implies no life
17 if the environment is here, work can be found
18 there is a need for a clean environment because we live in a dirty area
19 because that will create more jobs
20 I have love for nature
21 environment is important to me
22 for our children
23 if people are employed then we can concentrate on protecting our environment

24 God put us in charge of the earth, we must protect it.

Creating Jobs (Open Ended Responses)

1 Lots of people need work
2 Many poor people live in the area
3 The environment creates work
4 Many people are unemployed, which causes other problems like crime.
5 I need a job.
6 Too many unemployed.
7 Too many unemployed.
8 Too many unemployed.
9 We need jobs.
10 There are many young people without work, including the respondents' daughter.
11 If there are more work opportunities the economy will grow.
12 I am desperate to make some money.
13 Loads of unemployed people, especially matriculants.
14 Too many young people are unemployed.
15 Too many people with Grade 12 but no jobs.
16 Too much crime, no employment.
17 Lots of children don't go to school, they have to work.
18 People are struggling to work
19 Too much unemployment
20 Too many people unemployed
21 Lots of unemployment.
22 Lots of people without work.
23 We are desperate for work.
24 My brother is sick, we need money.
25 Nature can't look out for us, in terms of money.
26 People are suffering.
27 People and nature are both living, so if there's no work, crime increases.
28 People are starving.
29 People are suffering and nothing is being done about it.
30 People will care more for the environment is they have work.
31 To survive, buy clothes
32 People get up to mischief when unemployed
33 We are many here, and there is not enough money to feed us all.
34 From nature we get jobs
35 Food to take care of children.
36 We need food.
37 Me and my husband are not working
38 We cannot do anything without money.

39 No money no food

40 We need food.

41 Protecting nature doesn't help when you hungry.

42 Money is more important because when you don't have money you can't clean up the environment.

43 So that people don't suffer.

44 We don't have money.

45 I don't work.

46 Money means everything.

47 Lots of jobless people

48 Because we starving.

49 Because I'm not working I'm selling meat to survive.

50 We all busy looking for jobs

51 People need work.

52 It's our duty to protect our surroundings.

53 The one calling in life is to maintain the environment.

54 The environment will always be there if we protect it.

55 We need to find a balance between the two.

56 Not enough water in area for all people.

57 Preserving the environment is important and right thing to do.

58 currently unemployed

59 respondent is currently unemployed

60 because so many people need work

61 many people with no work, its an immediate problem. Farmers have aa the land. What can I protect? corrupt, they don't care here

62 many hungry people, we don't have enough money

63 creating employment is important for the poor

64 baie mense makeer werk. Kinders op die straat

65 we need to live

66 I am poor

67 no work no food

68 rich people take all the good land anyway

69 if peole have jobs they will be in a better position not to destry the environment

70 too many people walking the streets jobless

71 more jobs equals better infrustructure

72 respondent struggled to find a job even though he studied

73 poor people cant live

74 cant live without money

75 need an income to survive

76 too many people without work

77 als is duur as jy nie werk nie kan mense niks kry nie

78 baie manse lui honger en min mense kry werk

79 werk is skaar

80 only way to stop crime is to give people work
81 the most job creation the more we become concerned about the environment
82 we depend on money
83 when there is no job people don’t care about the environment
84 baie werkloosheid
85 we need money
86 no money no survival
87 because we food to by
88 people need jobs in the area
89 Too many people without jobs.
90 no money cant eat
91 franschoek is a tourist town and jobs should be provided for locals and not outsiders
92 moet n inkomste om dorleef
93 only my husband is working right now, its difficult without money. How can we protect the environment without money
94 we don’t work
95 baie manse is werkloos
96 werk is skaars
97 we need money
98 we need money to buy food
99 I need money, i cant worry about other things.
100 People are not going to respect the environment if they cant feed themselves.

Both are Equally Important (Open Ended Responses)

1 People have to rely on Environment for work
2 Young people need to know the importance of their environment. Through looking after the environment you create work.
3 Without nature, there will be no work.
4 Many poor people, but they rely on nature for work.
5 Pointless working and not looking after the environment
6 Protecting the environment creates jobs.
7 Protecting equals job creation.
8 Can’t only just look after the environment while there are people going hungry.
9 We provide jobs with our business, people need work. Bur I want my children to live in a beautiful country
10 Work is necessary but it is important to keep your living area clean. It is good for life.
11 Can’t create jobs without protecting the environment.
12 No job no food environment determines us.
13 Need to protect the environment for the kids
14 They both sustain life.
15 It’s Gods nature.

16 Health wise and money wise.
17 Jobs will lead to taking care of the environment.
18 We need money to eat.
19 We must look at the environment for the future and jobs for the future.
20 If you can’t create jobs people won’t appreciate the environment.
21 The environment is who we are and we need to create jobs for the poor.
22 Protecting the environment is important for tourism and creating jobs.
23 By protecting the environment you can create more jobs.
24 Too much unemployment.
25 Both need to survive.
26 The environment is here forever.
27 I don’t think there is an owner if you have work, you’ll prefer environment.
28 People can’t survive without the environment.
29 Create jobs by preserving the environment.
30 By preserving the environment you can create jobs.
31 Creating jobs in turn provides conservation.
32 Have to create jobs you can’t let people starve.
33 If you neglect one the other will also be neglected.
34 Because the environment looks after you.
35 We must be in balance with the environment.
36 If the environment is taken care of there will be no work.
37 Creating more jobs is not important to Franschoek, however it is important for rural area of Cape Town.

38 baie mense is sonder werk en hulle makeer werk
39 our livelihood will always be connected to how we treat earth/nature
40 we can create jobs by careing for the environment
41 however feels that creating jobs is important because of the high unemployment
42 win-win situation
43 environment is just as important
44 working is of vital importance, as ons nie omgewing beskerm nie gaan als veriore
45 if the environment is destroyed you cant creat jobs. People living in poverty are major contributors to destroying the environment
46 preserve the environment by creating jobs
47 altwee moet vessorg hord
48 jobs would provide people with education and they would thus sustain the environment
49 without the one you don’t get the other, you have to work in conjunction
50 the need to protect the environment is important as it is our duty, too much poverty in our land
51 because they are both important
52 without environment no jobs are created
53 in order to preserve the environment need to creat jobs
54 without environment no jobs

55 without work we cannot protect the environment
56 high crime as a result of no work
57 both are equally important
58 baie manse wat behoeftig is
59 werk is belangrik want mens moet inkomste kry
60 w…verskaffing is meer belangrik
61 as door nie werk is nie sal notuur agteruit
62 baie werlose mense te min werk
63 the environment is the root of my work
64 I work in the environment
65 the environment is like a pension fund
66 if the environment is not condusive it will hamper with development
67 there is very little here, but we rely on water here
68 people need to work otherwise the would distroy the environment
69 a lot of people need work but the environment needs protection as well
70 the groendal/fhoek nature is very important for business
71 almal het werk nodig dis belangrik dat ons na die angening kyk
72 no jobs leads to destruction of environmentt forestation and fishing
73 healthwise
74 andazi
75 health
76 they both bring cood health
77 we all depend on the environment, no money no food
78 both serve health
79 environment for health, money for food
80 people need jobs to survive and we need plants for environmental services and goods
81 people need work to survive and we need the environment for and plants for oxygen, etc
82 there is a lot of poor people and the environment must be protected
83 matriculants need work and the environment needs protection
84 working in the environment is possible, perhaps by removing alien plants
85 we need jobs to survive but protecting the environment is also necessary
86 we should do both
87 we need work but also water
88 we need nature for our work
89 everyone is looking for work in franschoek but the environment needs protection
90 people are jobless in the area and the environment needs tobe protected
91 most people only work in resturants and shops and its mostly for females, but he feels the environment must also be protected
92 healthwise and to take ourselves
93 people are having difficulty
94 environment creats jobs

Appendix B: Municipal Water Use Trends

Appendix B.1: Franschhoek Town Water Use Trends [Graphs and Data]

B.1.1: Water Consumption Graph (March 2005 – February 2011)

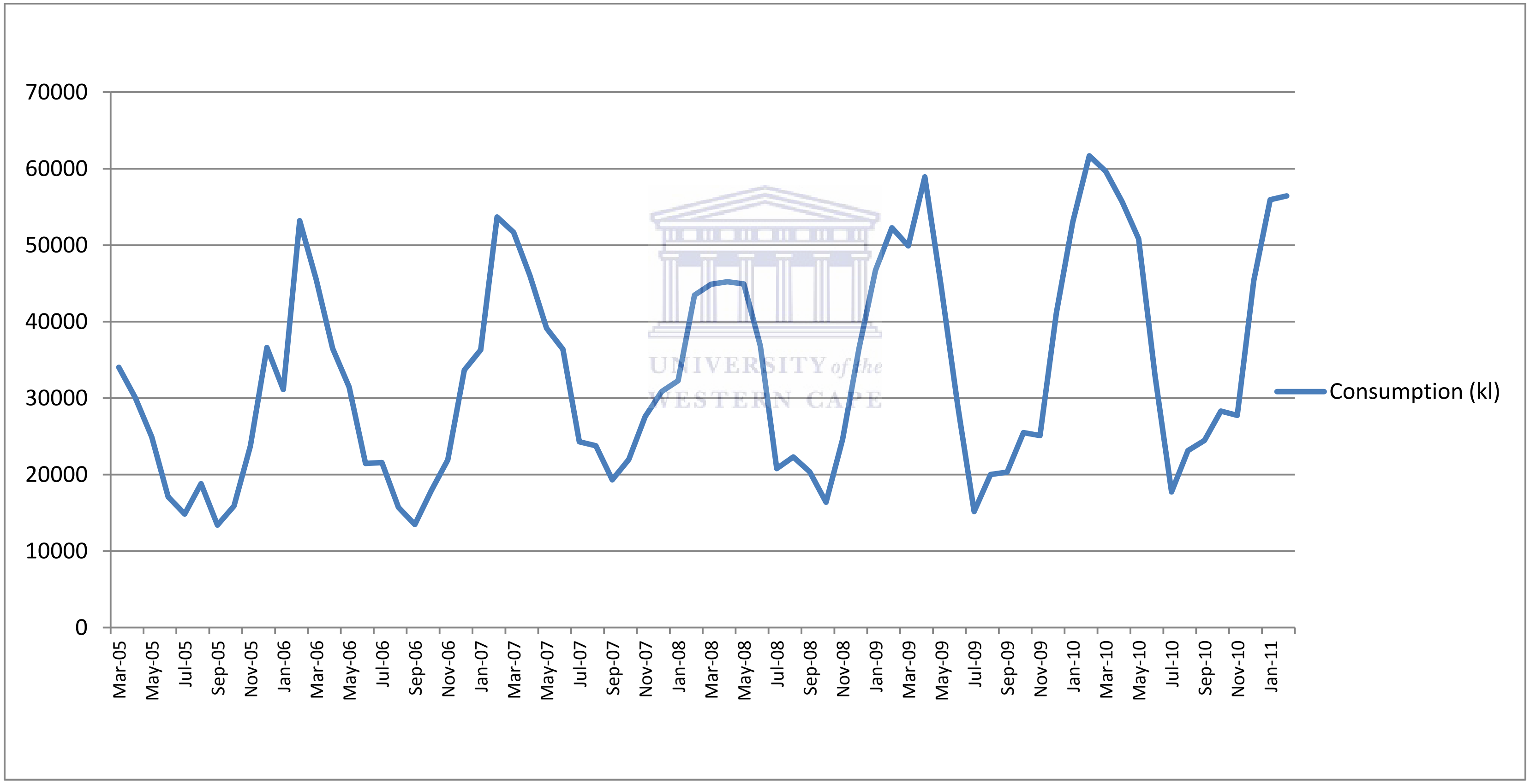

Figure 11: Franschhoek Town Water Consumption. March 2005 to February 2011

[Franschhoek Consumption: Smoothed]

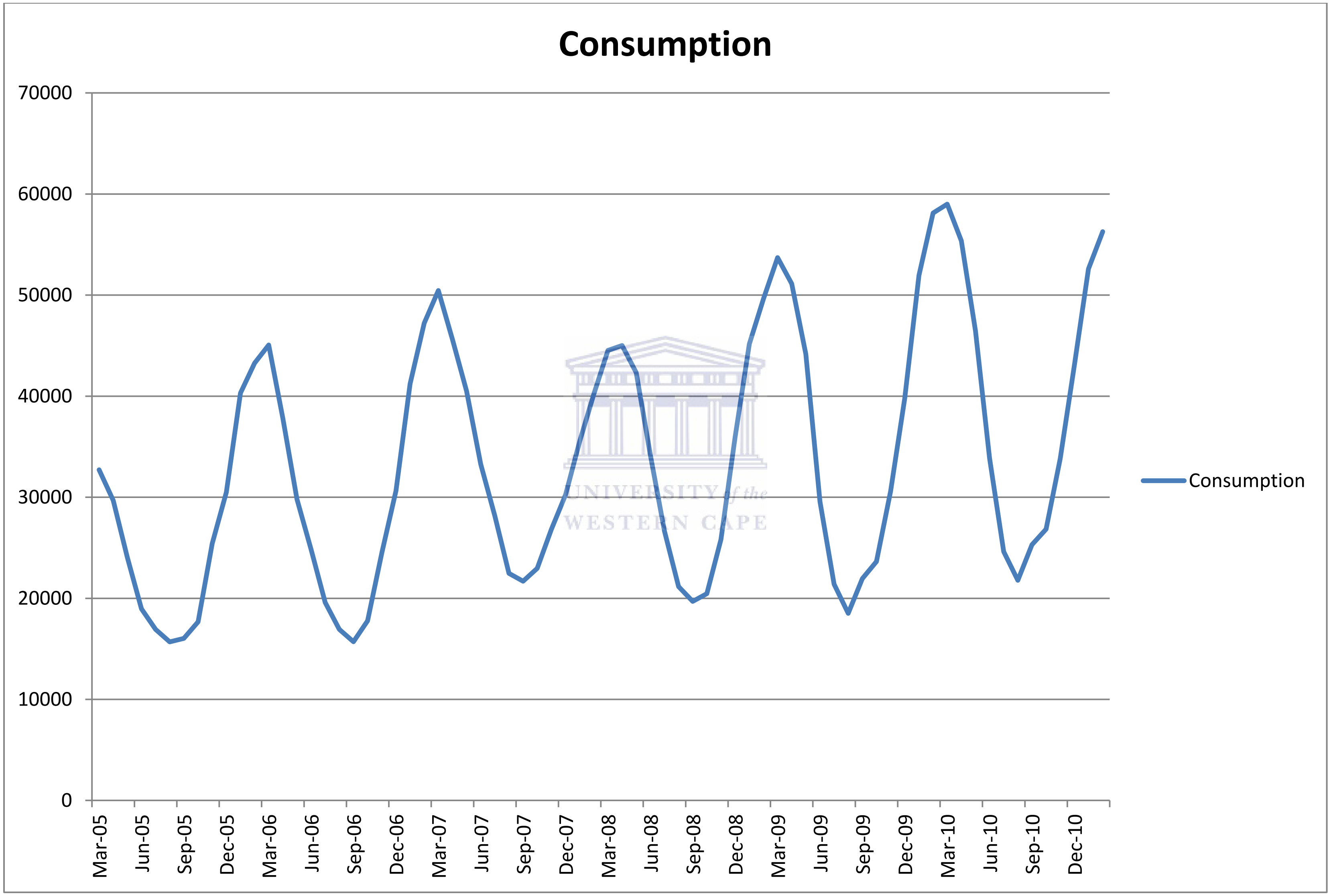

Figure 12: Franschhoek Town Water Consumption. March 2005 to February 2011. [Smoothed]

B.1.2: Cumulative Water Consumption Graph [March 2005 – February 2011]

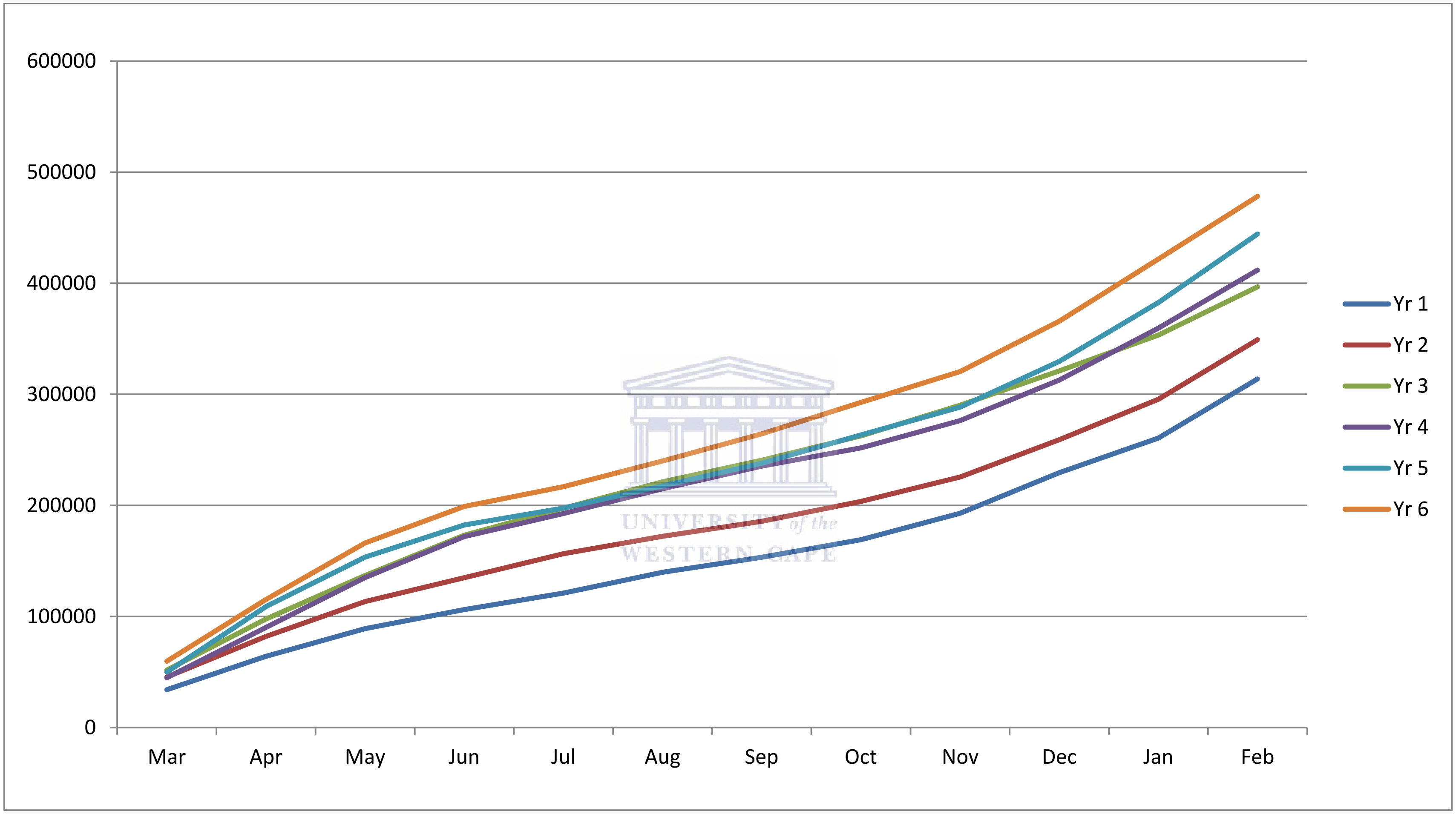

Figure 13: Franschhoek Town Comparison of per Annum Cumulative Consumption

B.1.3 Water Consumption Data

Table 35: Franschhoek Town Monthly Water Consumption

	Water Consumption Per Month					
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6
Mar	34035	45501	51689	44888	49903	59660
Apr	30083	36496	45989	45215	58934	55648
May	24933	31449	39135	44929	44554	50829
Jun	17111	21467	36378	36837	29000	32953
Jul	14844	21583	24304	20790	15175	17747
Aug	18812	15705	23782	22307	20020	23135
Sep	13400	13478	19316	20385	20331	24472
Oct	15892	17935	21988	16383	25497	28310
Nov	23741	21920	27597	24595	25098	27750
Dec	36615	33659	30857	36490	41159	45373
Jan	31127	36312	32274	46722	53027.84	55946
Feb	53194	53681	43471	52272	61685.607	56443

B.1.4 Cumulative Water Consumption Data

Table 36: Franschhoek Town Cumulative Consumption per Annum

	Cumulative Consumption Per Annum					
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6
Mar	34035	45501	51689	44888	49903	59660
Apr	64118	81997	97678	90103	108837	115308
May	89051	113446	136813	135032	153391	166138
Jun	106162	134913	173191	171869	182391	199090
Jul	121006	156496	197495	192659	197566	216838
Aug	139818	172201	221277	214966	217586	239973
Sep	153218	185679	240593	235351	237917	264445
Oct	169110	203614	262581	251734	263414	292755
Nov	192851	225534	290178	276329	288512	320505
Dec	229466	259193	321035	312819	329671	365879
Jan	260593	295505	353309	359541	382699	421824
Feb	313787	349186	396780	411813	444384	478267

B.1.5 Seasonal Index

Table 37: Franschhoek Water Consumption Seasonal Index

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.280	1.608	1.432	1.365	1.182	0.871	0.574	0.620	0.558	0.632	0.755	1.123

B.1.6: Average Consumption per Stand; per Annum

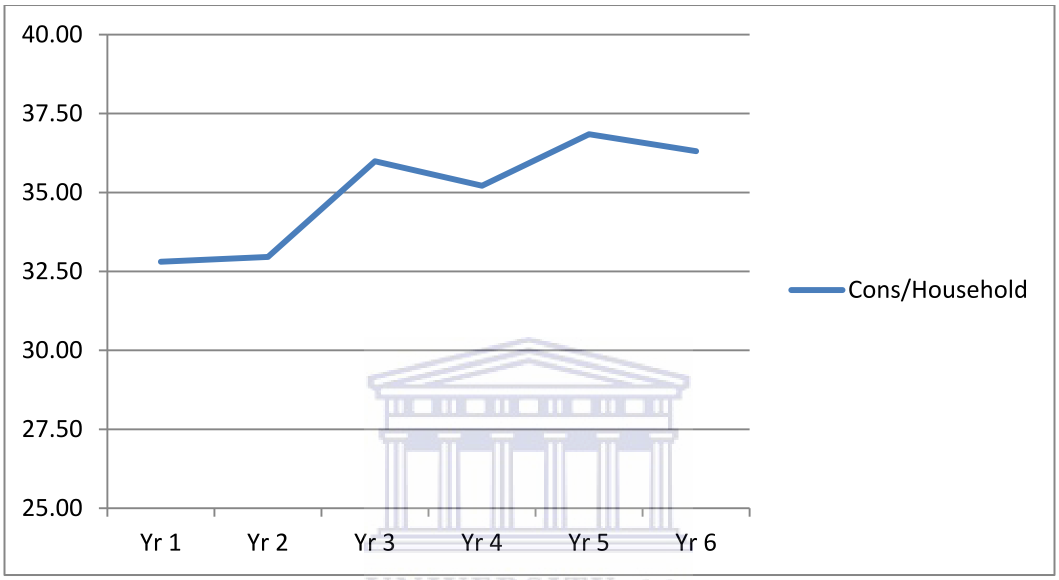

Figure 14: Franschhoek. Average Consumption per Stand, per Annum

Table 38: Average Consumption per Stand, per Annum

Cons/Household	
Yr 1	32.80
Yr 2	32.96
Yr 3	35.99
Yr 4	35.21
Yr 5	36.84
Yr 6	36.31

B.1.7: Average Price per Kilolitre

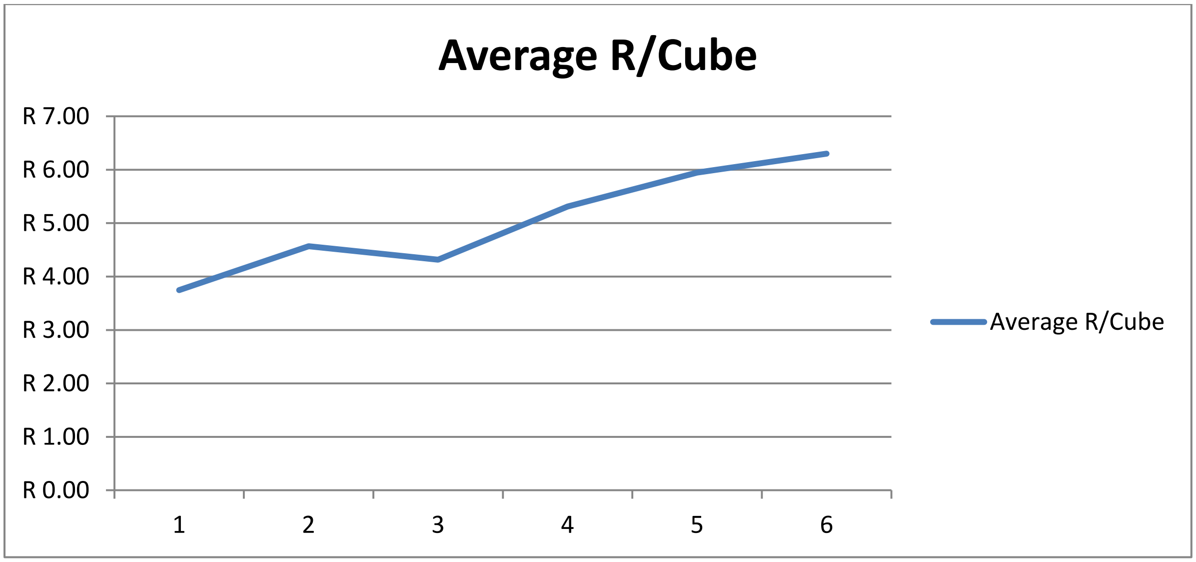

Figure 15: Franschhoek Town. Average Price per Kilolitre

Table 39: Franschhoek Town. Average Price per Kilolitre

Average R/Cube	
Yr 1	R 3.75
Yr 2	R 4.57
Yr 3	R 4.32
Yr 4	R 5.31
Yr 5	R 5.95
Yr 6	R 6.30

B.1.8 Real Price of Water

Table 40: Franschhoek Town. Price of Water Adjusted for Inflation and Economic Growth

Total Cost	1239808.48	1500286.76	1747675.53	2234857.44	2715502.58	3111479.86
Cost/ m^3	3.75	4.19	4.32	5.31	5.95	6.30
Eco Growth	1	6.275	5.225	1.675	-1.175	3.7
	1	1.06275	1.05225	1.01675	0.98825	1.037
	1	1.06275	1.118278688	1.137009856	1.12364999	1.165225039
	(Baseline)					
Inflation	1	4.98	7.69	11.33	8.99	3.9
	1	1.0498	1.0769	1.1133	1.0899	1.039
	1	1.0498	1.13052962	1.258618626	1.37176844	1.42526741
	(Baseline)					
(Adjusted Figures)						
Real Total Cost	1239808.48	1518793.82	1728736.92	2018923.67	2224336.38	2543785.27
Real Cost/ m^3	3.75	4.24	4.27	4.80	4.87	5.15

B.1.9 Analysis of Franschhoek Town's Water Consumption Using Linear Regression

Model 1

Dependent Variable: Consumption

Regression Statistics	
Multiple R	0.937751513
R Square	0.879377901
Adjusted R Square	0.875881608
Standard Error	4821.749311
Observations	72

	Coefficients	*P-value*
Intercept	-42227.95857	1.98803E-10
Households Fhoek	45.18266259	4.52943E-11
SI Fhoek	32781.48621	2.4835E-31

Model 2

Dependent Variable: Consumption

Regression Statistics	
Multiple R	0.938796531
R Square	0.881338928
Adjusted R Square	0.87610388
Standard Error	4817.429961
Observations	72

	Coefficients	*P-value*
Intercept	-44579.46754	3.55188E-10
Households Fhoek	46.04646275	3.55585E-11
SI Fhoek	33637.3242	7.78005E-29
Rainfall	4.406634001	0.292855278

Model 3

Dependent Variable: Consumption

Regression Statistics	
Multiple R	0.504836695
R Square	0.254860089
Adjusted R Square	0.233261831
Standard Error	11984.22898
Observations	72

	Coefficients	*P-value*
Intercept	-2285.762683	0.871392336
Households Fhoek	42.72961856	0.00443263
Rainfall	-31.41125259	0.001086962

Appendix B.2: Groendal Water Use Trends [Graphs and Data]

B.2.1: Water Consumption over Time

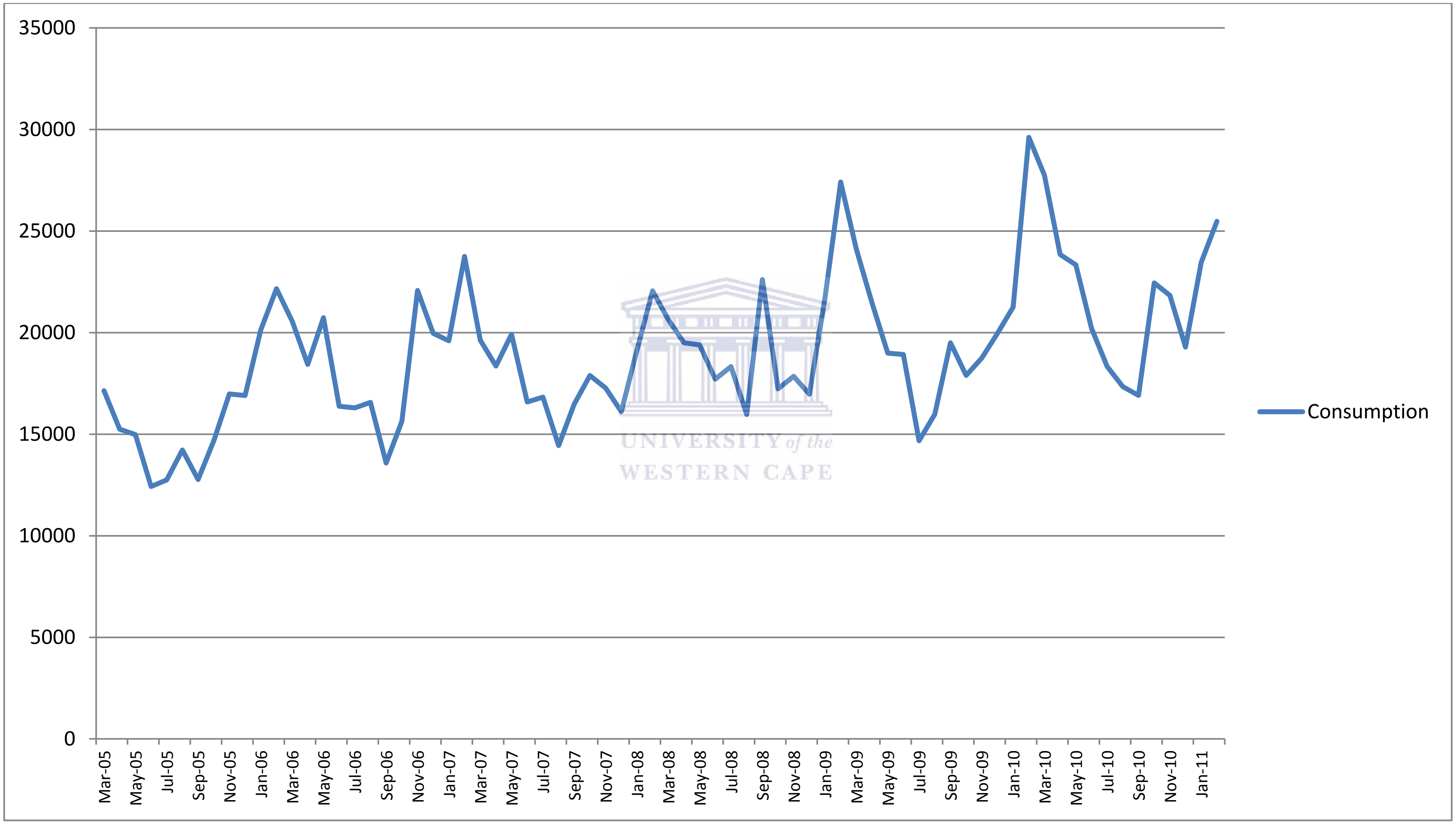

Figure 16: Groendal Water Consumption. March 2005 to February 2011

[Groendal Consumption Smoothed]

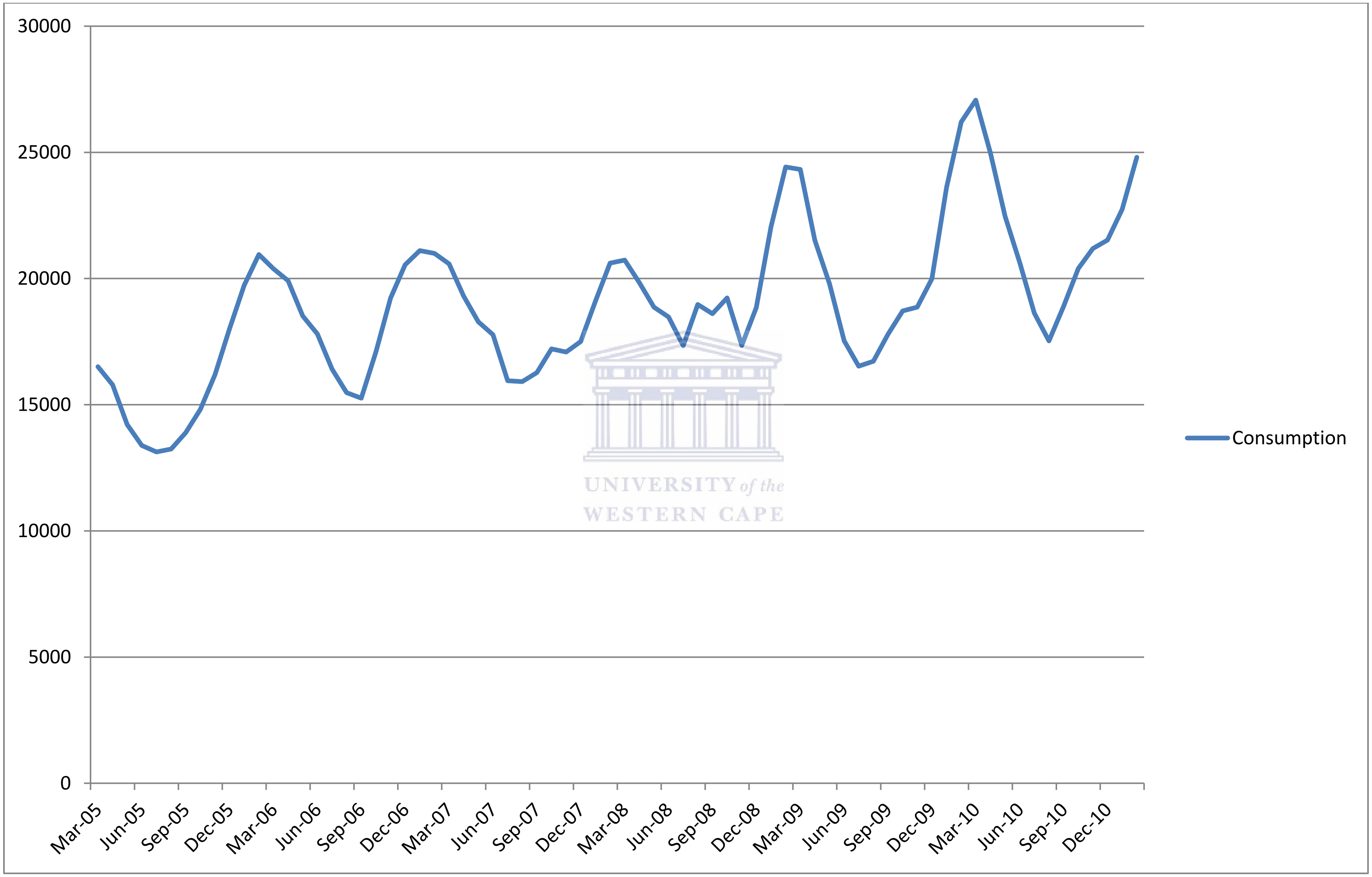

Figure 17: Groendal Water Consumption. March 2005 to February 2011. [Smoothed]

B.2.2: Cumulative Water Consumption per Annum

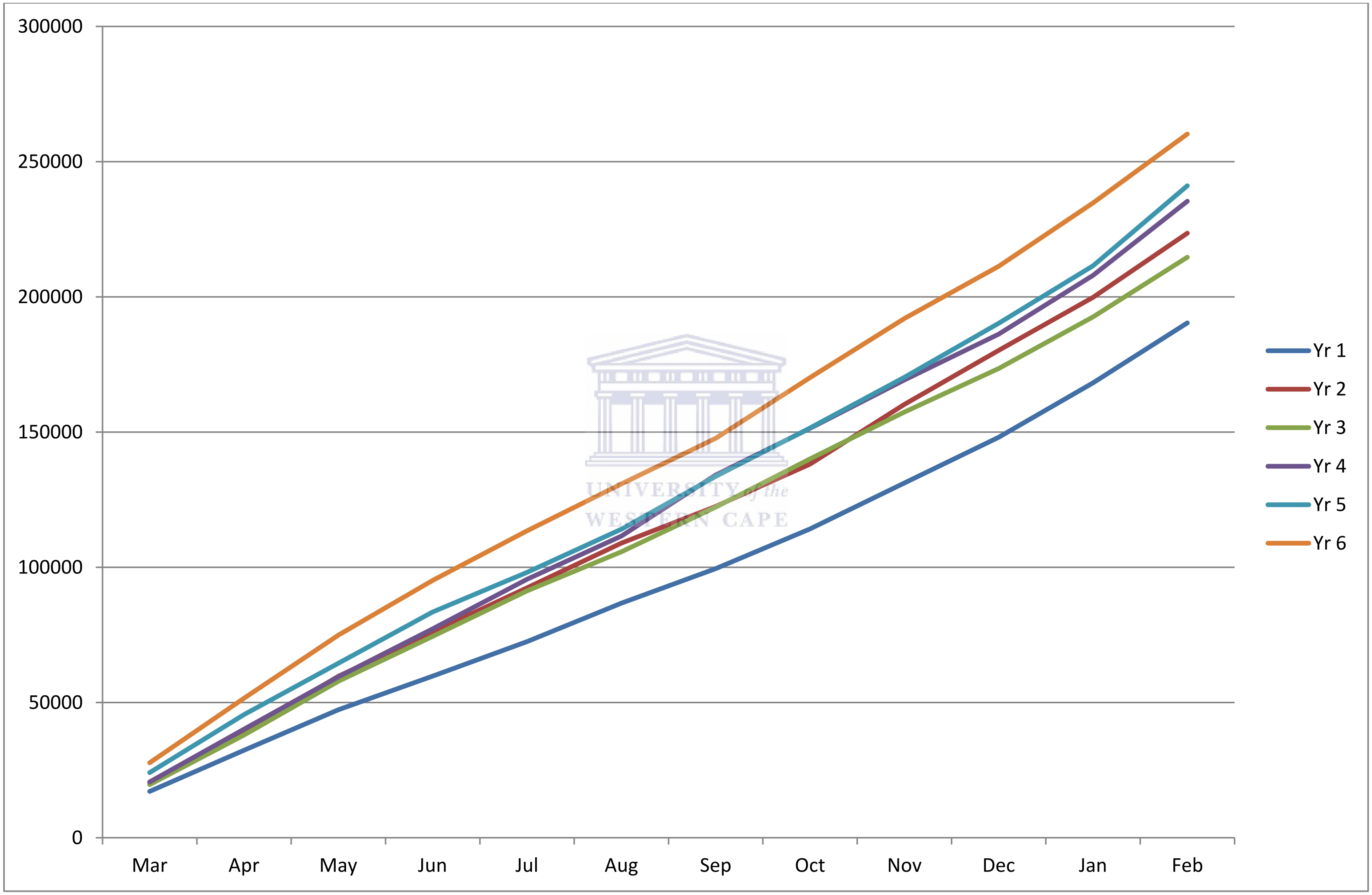

Figure 18: Groendal. Comparison of per Annum Cumulative Consumption

B.2.3: Water Consumption over Time; Data

Table 41: Groendal Monthly Water Consumption

	Water Consumption					
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6
Mar	17139	20561	19631	20644	24103	27748
Apr	15243	18437	18356	19498	21456	23846
May	14983	20738	19916	19393	18994	23340
Jun	12426	16376	16586	17711	18927	20214
Jul	12747	16297	16824	18332	14679	18339
Aug	14219	16564	14442	15974	15979	17343
Sep	12771	13578	16478	22610	19502	16910
Oct	14676	15635	17887	17235	17896	22448
Nov	16986	22073	17271	17849	18745	21831
Dec	16906	19970	16111	16969	19962	19287
Jan	20136	19600	19129	21745	21258	23456
Feb	22159	23754	22055	27415	29613	25477

B.2.4: Cumulative Water Consumption Data

Table 42: Groendal Cumulative Consumption per Annum

Cumulative Consumption						
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6
Mar	17139	20561	19631	20644	24103	27748
Apr	32382	38998	37987	40142	45559	51594
May	47365	59736	57903	59535	64553	74934
Jun	59791	76112	74489	77246	83480	95148
Jul	72538	92409	91313	95578	98159	113487
Aug	86757	108973	105755	111552	114138	130830
Sep	99528	122551	122233	134162	133640	147740
Oct	114204	138186	140120	151397	151536	170188
Nov	131190	160259	157391	169246	170281	192019
Dec	148096	180229	173502	186215	190243	211306
Jan	168232	199829	192631	207960	211501	234762
Feb	190391	223583	214686	235375	241114	260239

B.2.5 Seasonal Index

Table 43: Groendal Water Consumption Seasonal Index

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.101	1.322	1.141	1.027	1.031	0.899	0.854	0.831	0.895	0.930	1.009	0.960

B.2.6: Average Consumption per Household per Month; Graph and Data

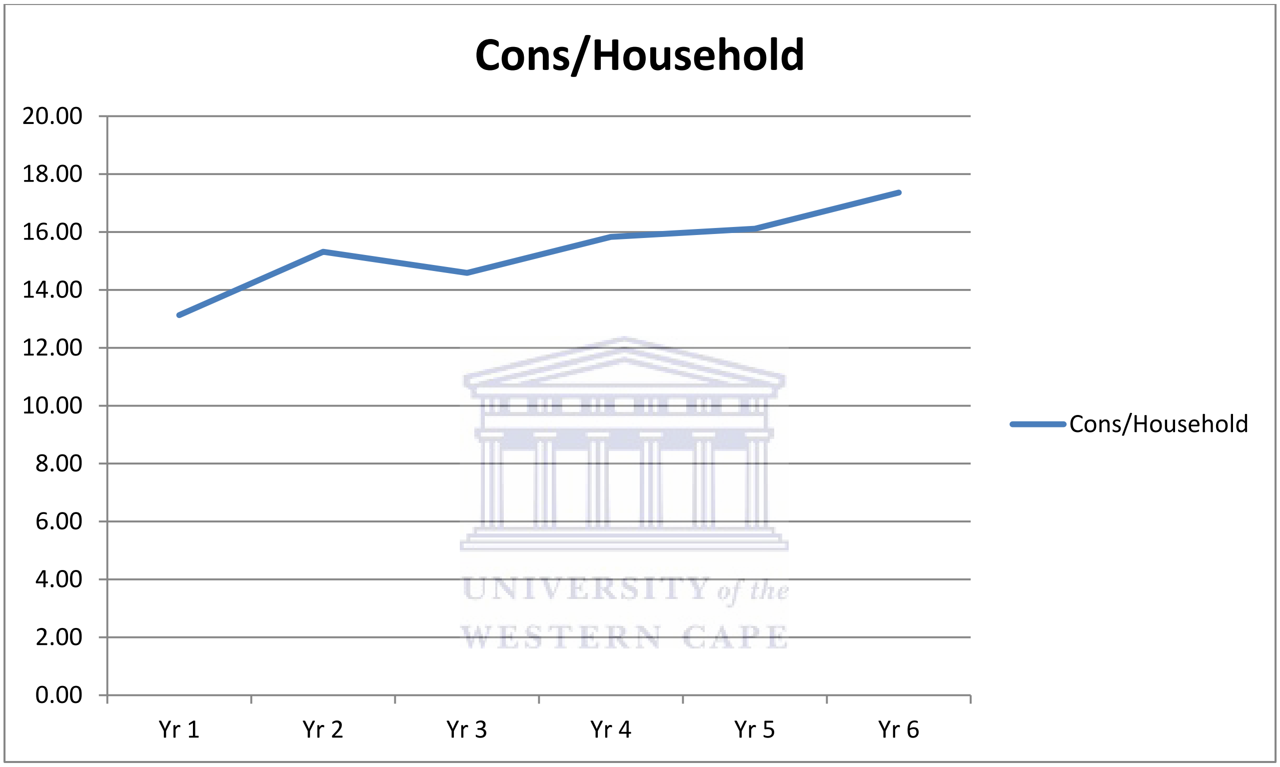

Figure 19: Groendal. Average Consumption per Stand

Table 44: Groendal Average Consumption per Stand

Cons/Household	
Yr 1	13.13
Yr 2	15.31
Yr 3	14.59
Yr 4	15.83
Yr 5	16.12
Yr 6	17.36

B.2.7: Average Price per Kilolitre; Graph and Data

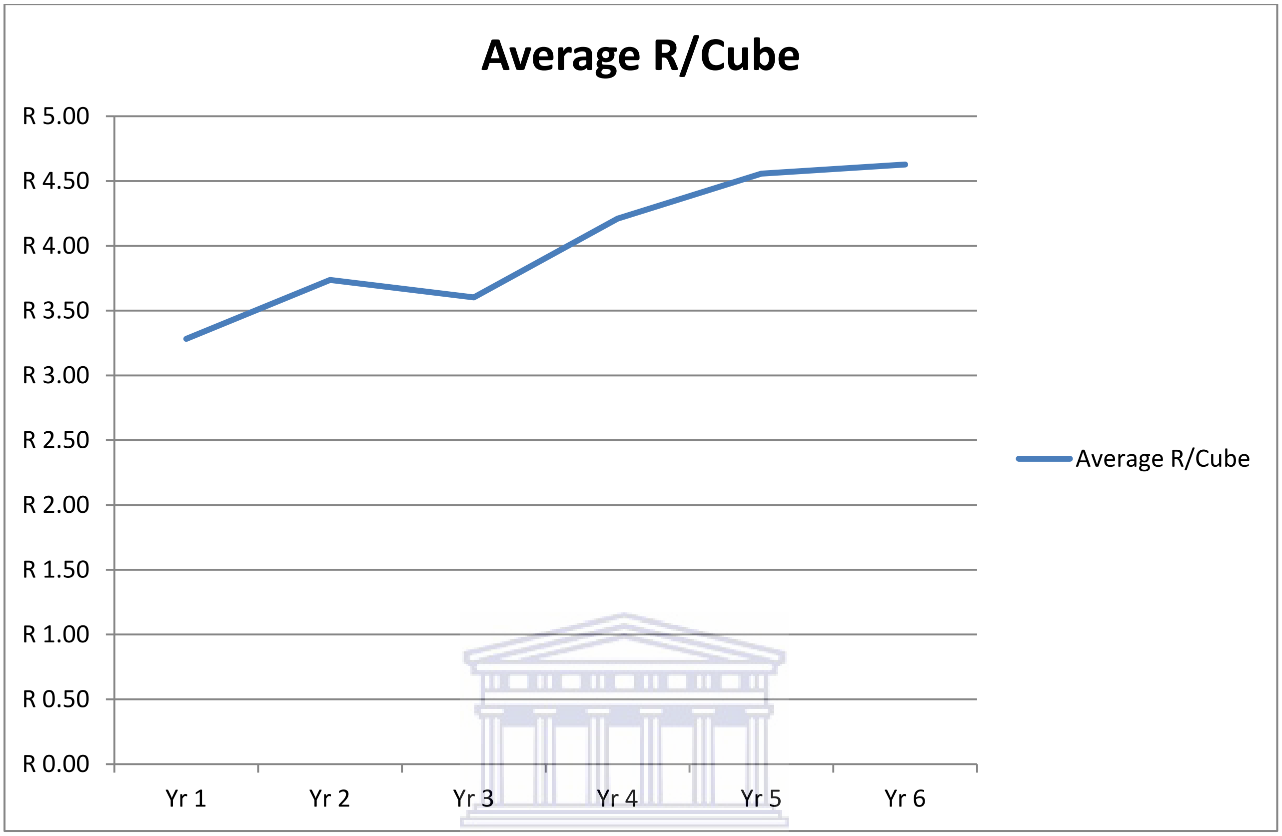

Figure 20: Groendal. Average Price per Kilolitre

Table 45: Groendal Average Price per Kilolitre

Average R/Cube	
Yr 1	R 3.28
Yr 2	R 3.74
Yr 3	R 3.60
Yr 4	R 4.21
Yr 5	R 4.56
Yr 6	R 4.63

B.2.8 Real Price of Water

Table 46: Groendal. Price of Water Adjusted for Inflation and Economic Growth

Total Cost	627858.31	763061.29	771591.17	981164.88	1095423	1208871.28
Cost/ m^3	**3.28**	**3.46**	**3.60**	**4.21**	**4.56**	**4.63**
Eco Growth	1	6.275	5.225	1.675	-1.175	3.7
	1	1.06275	1.05225	1.01675	0.98825	1.037
	1	1.06275	1.118278688	1.137009856	1.12364999	1.165225039
	(Baseline)					
Inflation	1	4.98	7.69	11.33	8.99	3.9
	1	1.0498	1.0769	1.1133	1.0899	1.039
	1	1.0498	1.13052962	1.258618626	1.37176844	1.42526741
	(Baseline)					
(Adjusted Figures)						
Real Total Cost	627858.31	772474.17	763229.86	886363.92	897288.50	988310.74
Real Cost/ m^3	3.28	3.50	3.56	3.80	3.73	3.78

B.2.9 Analysis of Groendal's Water Consumption using Linear Regression

Model 1

Dependent Variable: Consumption

Regression Statistics	
Multiple R	0.862058561
R Square	0.743144963
Adjusted R Square	0.735699889
Standard Error	1811.255624
Observations	72

	Coefficients	*P-value*
Intercept	-130630.3261	8.52539E-11
Household Gdal	106.3889987	7.41312E-11
SI Gdal	18627.71324	6.52626E-18

Model 2

Dependent Variable: Consumption

Regression Statistics	
Multiple R	0.86492946
R Square	0.748102971
Adjusted R Square	0.736989867
Standard Error	1806.83009
Observations	72

	Coefficients	*P-value*
Intercept	-133658.5036	5.9556E-11
Rainfall	1.868889105	0.251360371
Household Gdal	107.6996766	5.58334E-11
SI Gdal	19754.3129	5.75361E-16

Model 3

Dependent Variable: Consumption

Regression Statistics	
Multiple R	0.579197693
R Square	0.335469968
Adjusted R Square	0.316208227
Standard Error	2913.35233
Observations	72

	Coefficients	*P-value*
Intercept	-109334.849	0.000172065
Rainfall	-7.001606332	0.002431414
Household Gdal	105.0987054	1.25416E-05

Appendix B.3: La Motte

B.3.1: Water Consumption over Time; Graph

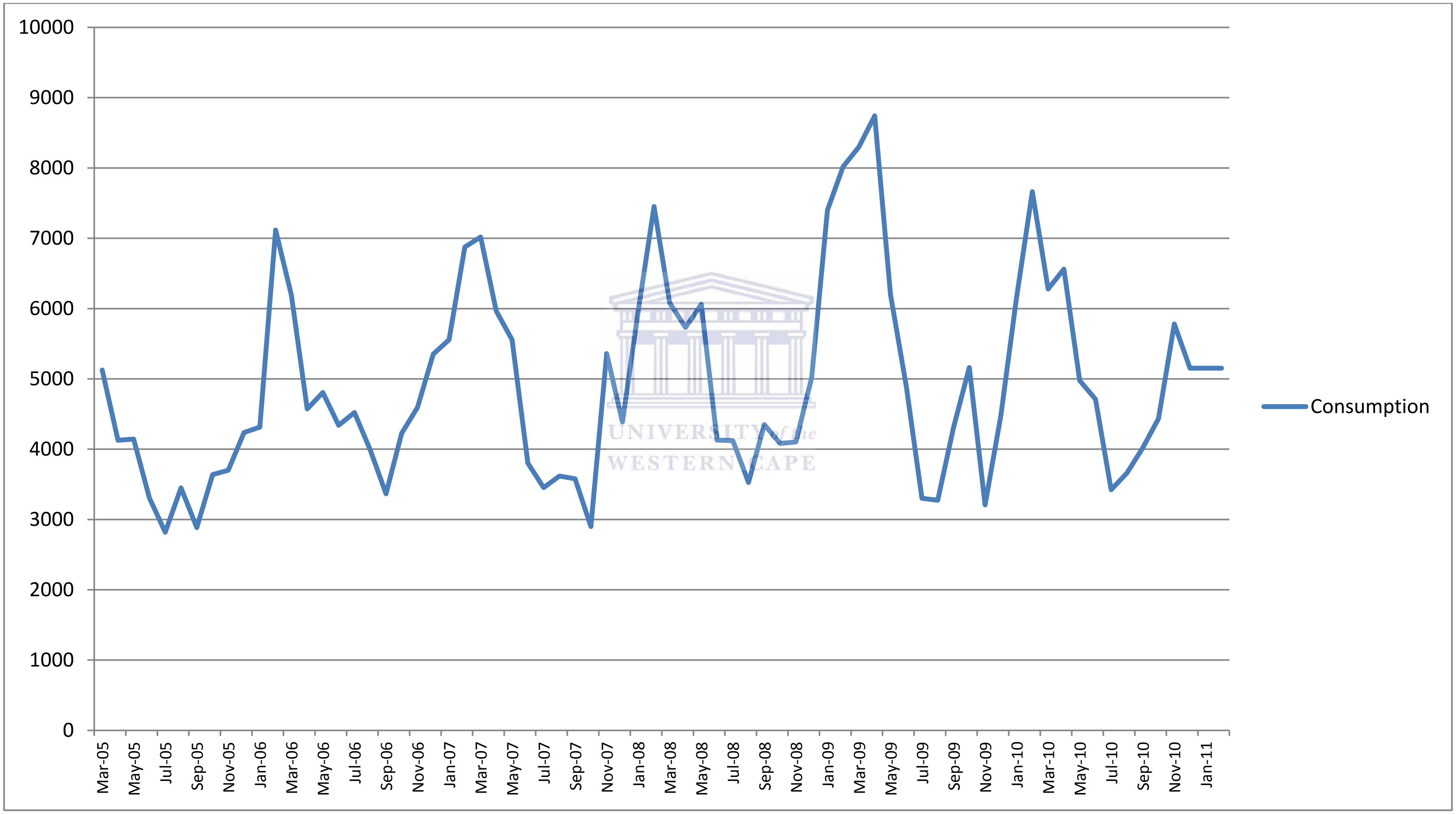

Figure 21: La Motte Water Consumption. March 2005 to February 2011

[La Motte Consumption Smoothed]

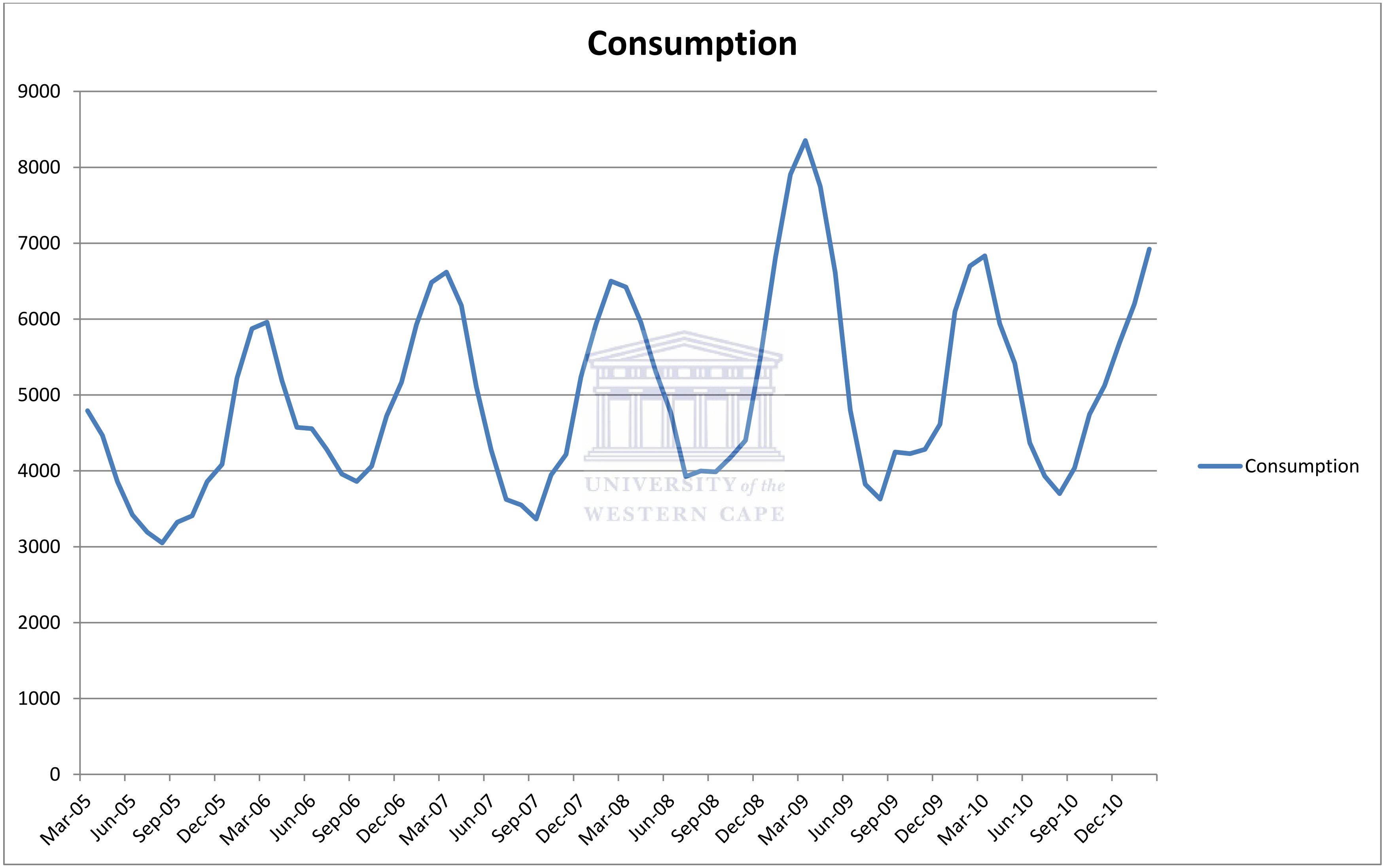

Figure 22: La Motte Water Consumption. March 2005 to February 2011. [Smoothed]

B.3.2: Cumulative Water Consumption Graph

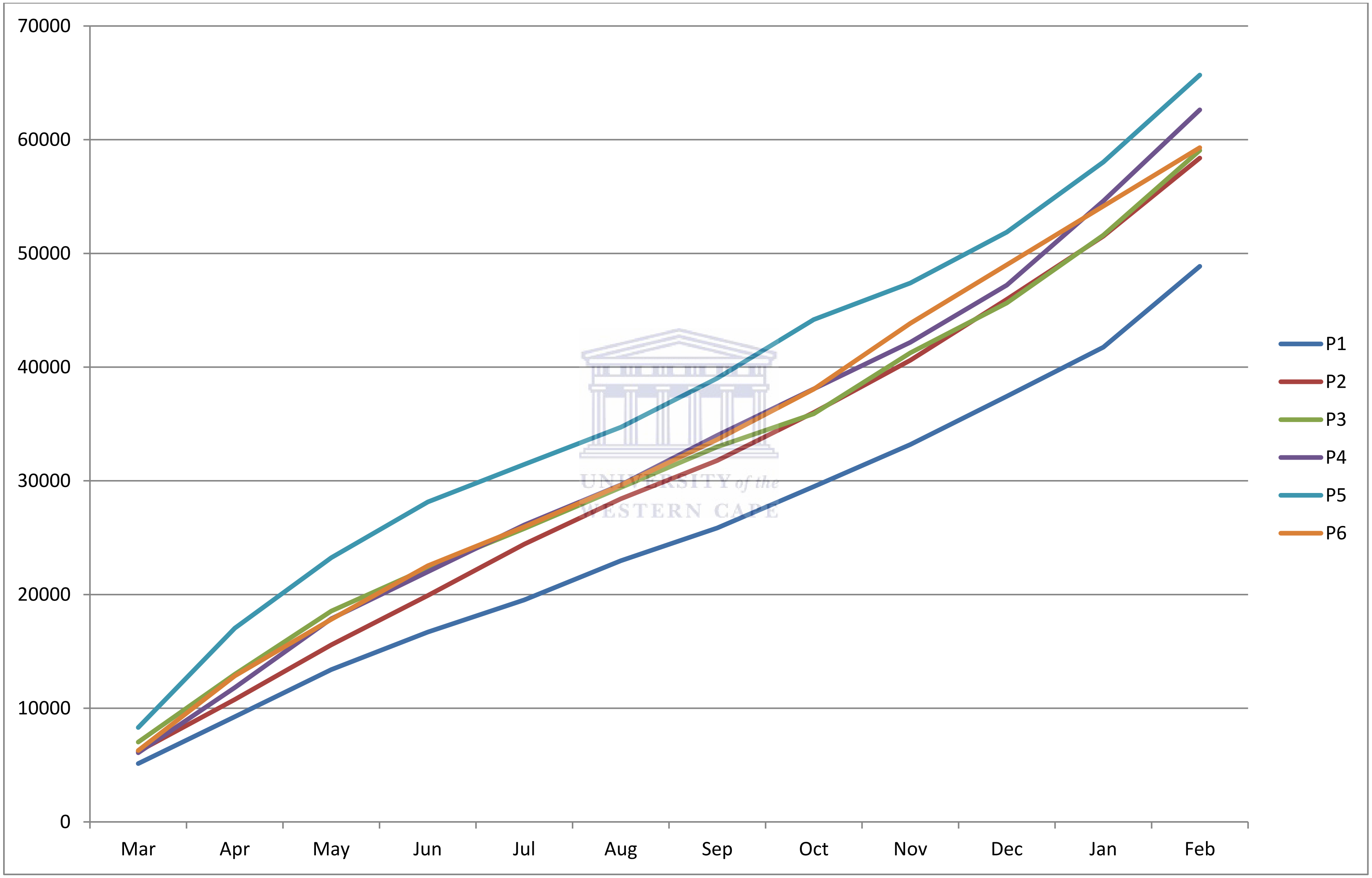

Figure 23: La Motte Comparison of per Annum Cumulative Consumption

B.3.3: Water Consumption over Time Data

Table 47: La Motte Monthly Water Consumption

	Cumulative Consumption					
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6
Mar	5127	6189	7018	6081	8300	6278
Apr	4127	4572	5964	5732	8742	6562
May	4143	4806	5557	6059	6200	4977
Jun	3305	4340	3801	4129	4895	4710
Jul	2819	4521	3454	4121	3302	3423
Aug	3450	3990	3617	3526	3274	3660
Sep	2884	3366	3579	4350	4308	4019
Oct	3638	4226	2900	4082	5162	4435
Nov	3701	4593	5360	4103	3208	5781
Dec	4237	5352	4387	5020	4481	5153
Jan	4314	5556	5969	7402	6155	6124
Feb	7117	6876	7452	8019	7663	7322

B.3.4: Cumulative Water Consumption per Annum Data

Table 48: La Motte Cumulative Consumption per Annum

Cumulative Consumption						
	P1	P2	P3	P4	P5	P6
Mar	5127	6189	7018	6081	8300	6278
Apr	9254	10761	12982	11813	17042	12840
May	13397	15567	18539	17872	23242	17817
Jun	16702	19907	22340	22001	28137	22527
Jul	19521	24428	25794	26122	31439	25950
Aug	22971	28418	29411	29648	34713	29610
Sep	25855	31784	32990	33998	39021	33629
Oct	29493	36010	35890	38080	44183	38064
Nov	33194	40603	41250	42183	47391	43845
Dec	37431	45955	45637	47203	51872	48998
Jan	41745	51511	51606	54605	58027	55122
Feb	48862	58387	59058	62624	65690	62444

B.3.5 Seasonal Index

Table 49: La Motte. Water Consumption Seasonal Index

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.171	1.434	1.322	1.210	1.076	0.854	0.734	0.730	0.763	0.829	0.907	0.971

B.3.6: Average Consumption per Household; Graph and Data

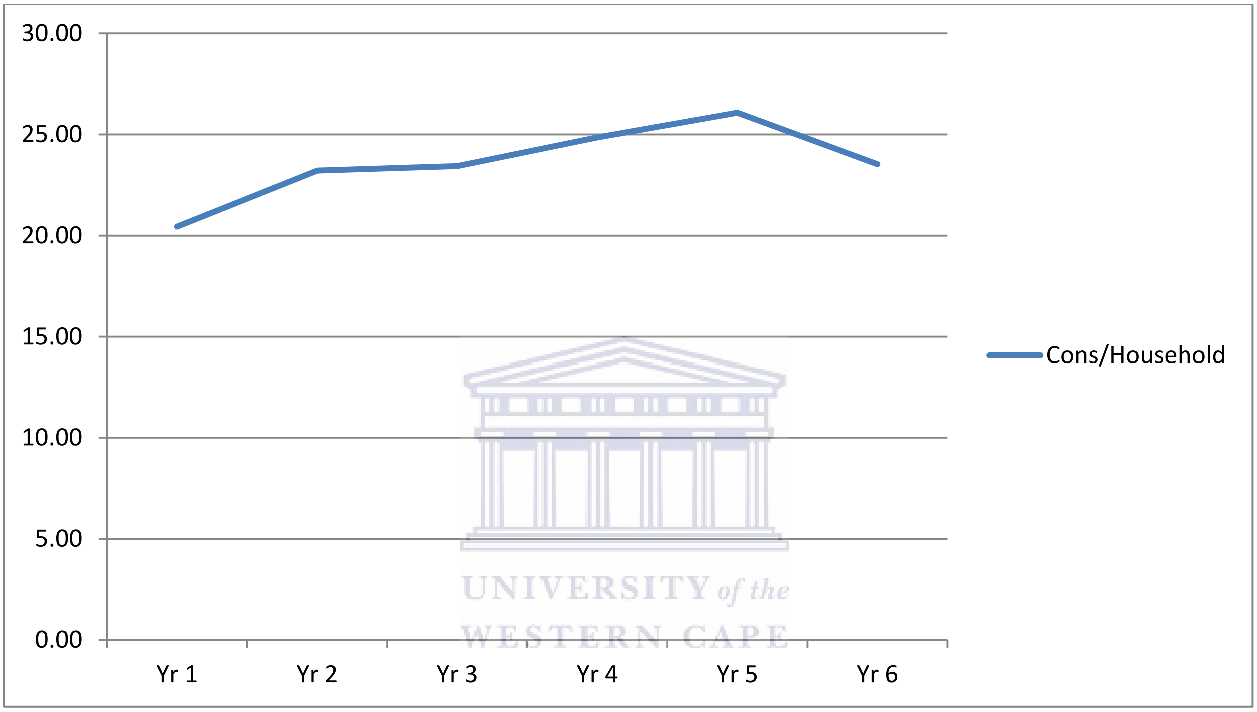

Figure 24: La Motte. Average Consumption per Stand

Table 50: La Motte. Average Consumption per Stand

Cons/Household	
Yr 1	20.44
Yr 2	23.22
Yr 3	23.44
Yr 4	24.85
Yr 5	26.07
Yr 6	24.78

B.3.7: Average Price per Kilolitre, Graph and Data

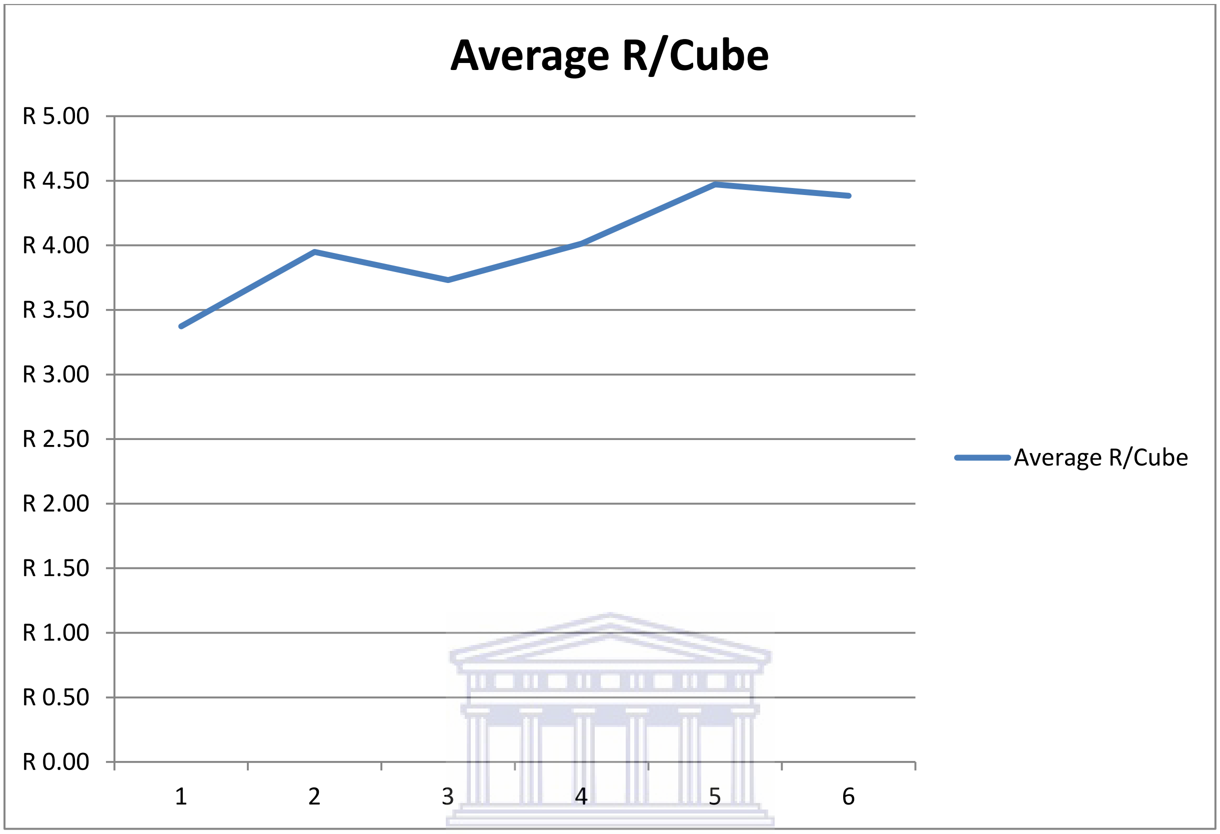

Figure 25: La Motte. Average Price per Kilolitre

Table 51: La Motte. Average Price per Kilolitre

Average R/Cube	
Yr 1	R 3.37
Yr 2	R 3.95
Yr 3	R 3.73
Yr 4	R 4.01
Yr 5	R 4.47
Yr 6	R 4.45

B.3.8 Real Price of Water

Table 52: La Motte. Price of Water Adjusted for Inflation and Economic Growth

Total Cost	164351.36	214910.7	212439.3	247829.71	278598.11	275769.65
Cost/ m^3	3.37	3.70	3.73	4.01	4.47	4.45
Eco Growth	1	6.275	5.225	1.675	-1.175	3.7
	1	1.06275	1.05225	1.01675	0.98825	1.037
	1	1.06275	1.118278688	1.137009856	1.12364999	1.165225039
	(Baseline)					
Inflation	1	4.98	7.69	11.33	8.99	3.9
	1	1.0498	1.0769	1.1133	1.0899	1.039
	1	1.0498	1.13052962	1.258618626	1.37176844	1.42526741
	(Baseline)					
(Adjusted Figures)						
Real Total Cost	164351.36	217561.77	210137.21	223884.20	228206.71	225455.03
Real Cost/ m^3	3.37	3.75	3.69	3.63	3.66	3.64

B.3.9 Analysis of La Motte's Water Consumption using Linear Regression

Model 1

Dependent Variable: Consumption

Regression Statistics	
Multiple R	0.891874741
R Square	0.795440554
Adjusted R Square	0.789511295
Standard Error	657.3079388
Observations	72

	Coefficients	*P-value*
Intercept	-20122.13498	4.74E-07
Household LM	95.85448268	5.64E-07
SI LM	5139.21649	1.02E-23

Model 2

Dependent Variable: Consumption

Regression Statistics	
Multiple R	0.892201431
R Square	0.796023393
Adjusted R Square	0.787024425
Standard Error	661.1794992
Observations	72

	Coefficients	*P-value*
Intercept	-20363.32674	5.47932E-07
Rainfall	0.259183122	0.660758305
Household LM	96.39070153	6.17832E-07
SI LM	5228.888235	1.99857E-20

Model 3

Dependent Variable: Consumption

Regression Statistics	
Multiple R	0.523146944
R Square	0.273682725
Adjusted R Square	0.252630051
Standard Error	1238.574958
Observations	72

	Coefficients	*P-value*
Intercept	-14371.80589	0.039372373
Rainfall	-3.724257948	0.000192511
Household LM	95.67885321	0.004792863

Appendix B.4: Farms

B.4.1: Water Consumption over Time; Graph

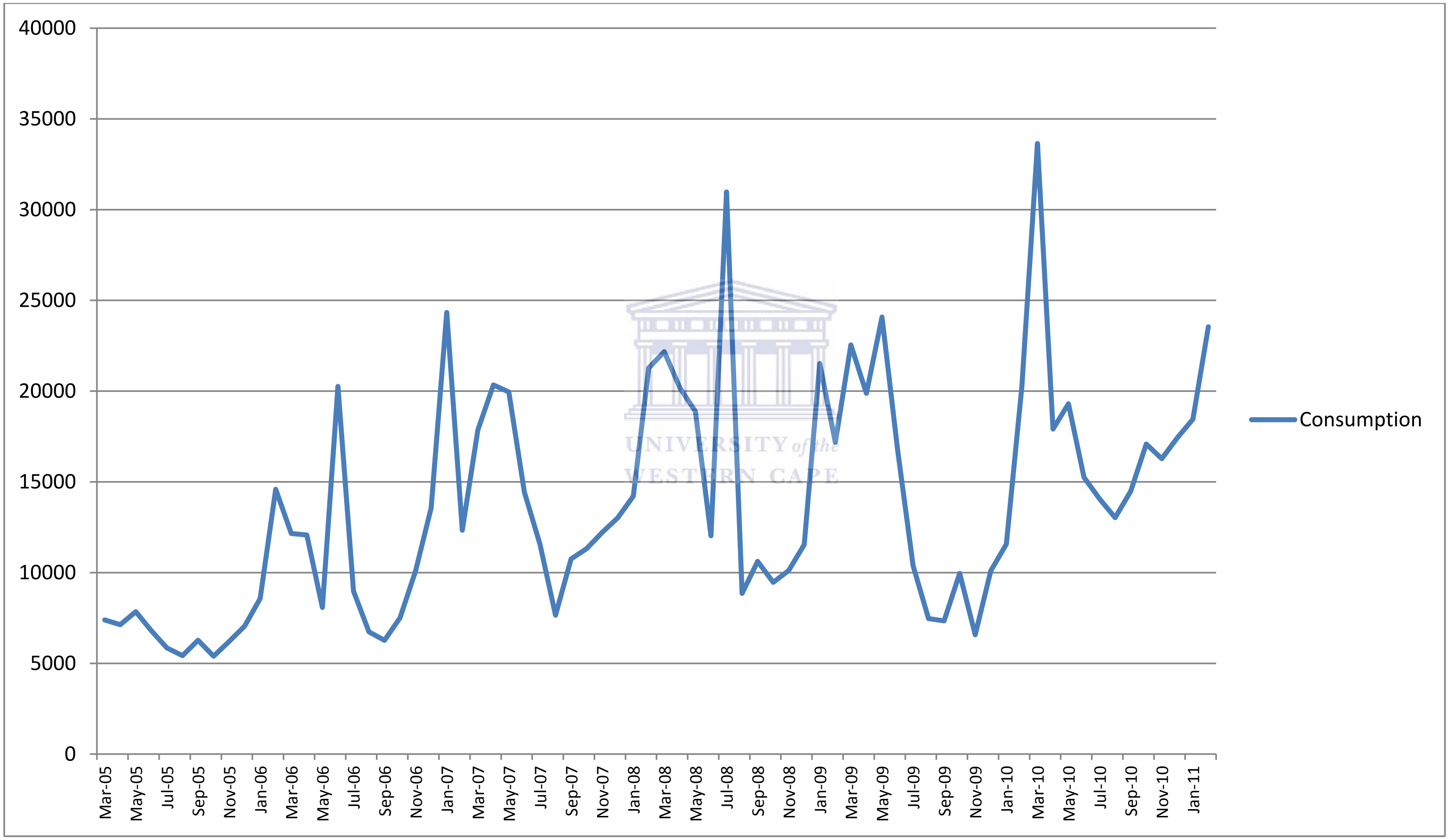

Figure 26: Farmland Water Consumption. March 2005 to February 2011

[Farm Consumption Smoothed]

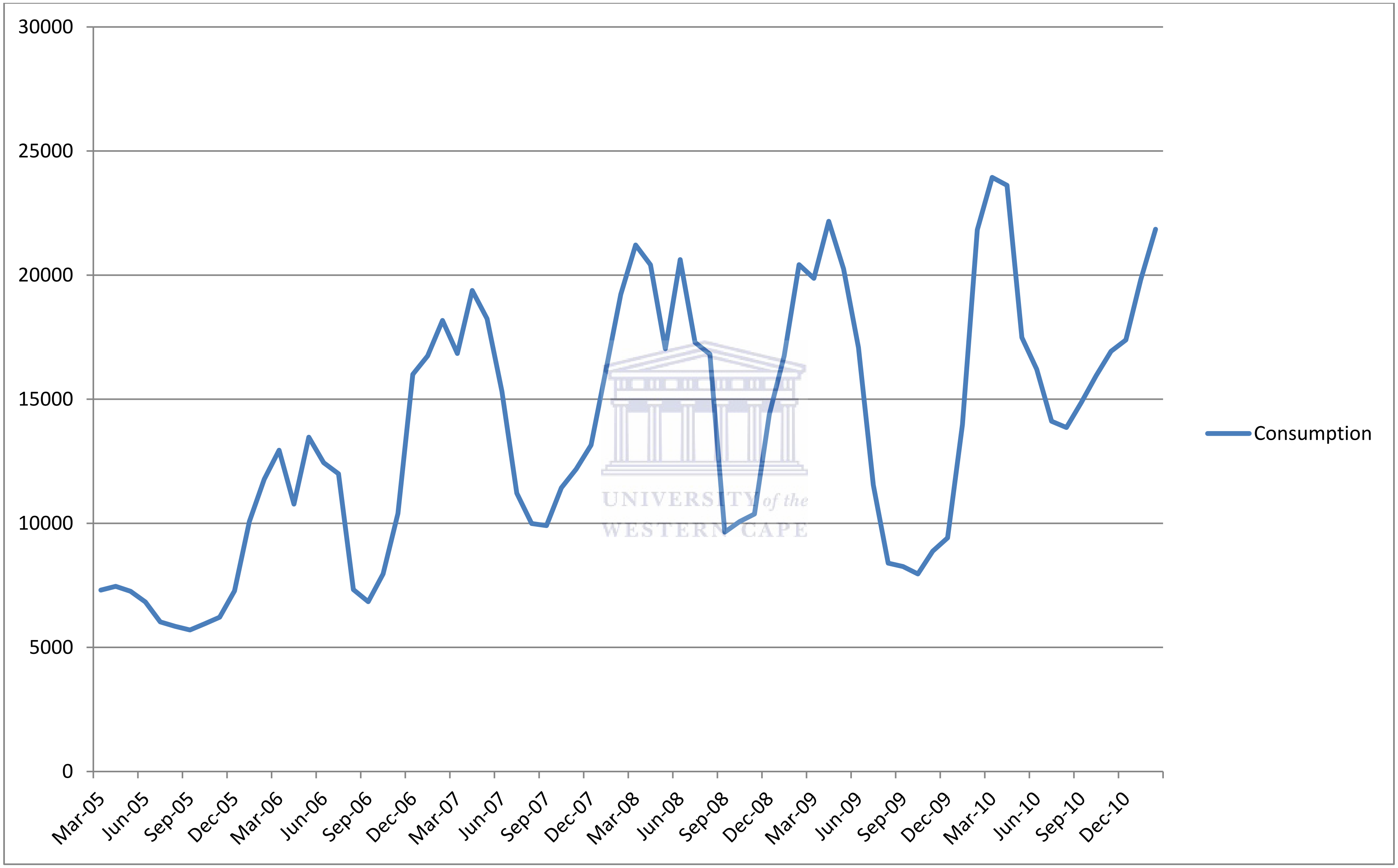

Figure 27: Farmland Water Consumption. March 2005 to February 2011. [Smoothed]

B.4.2: Cumulative Water Consumption Graph

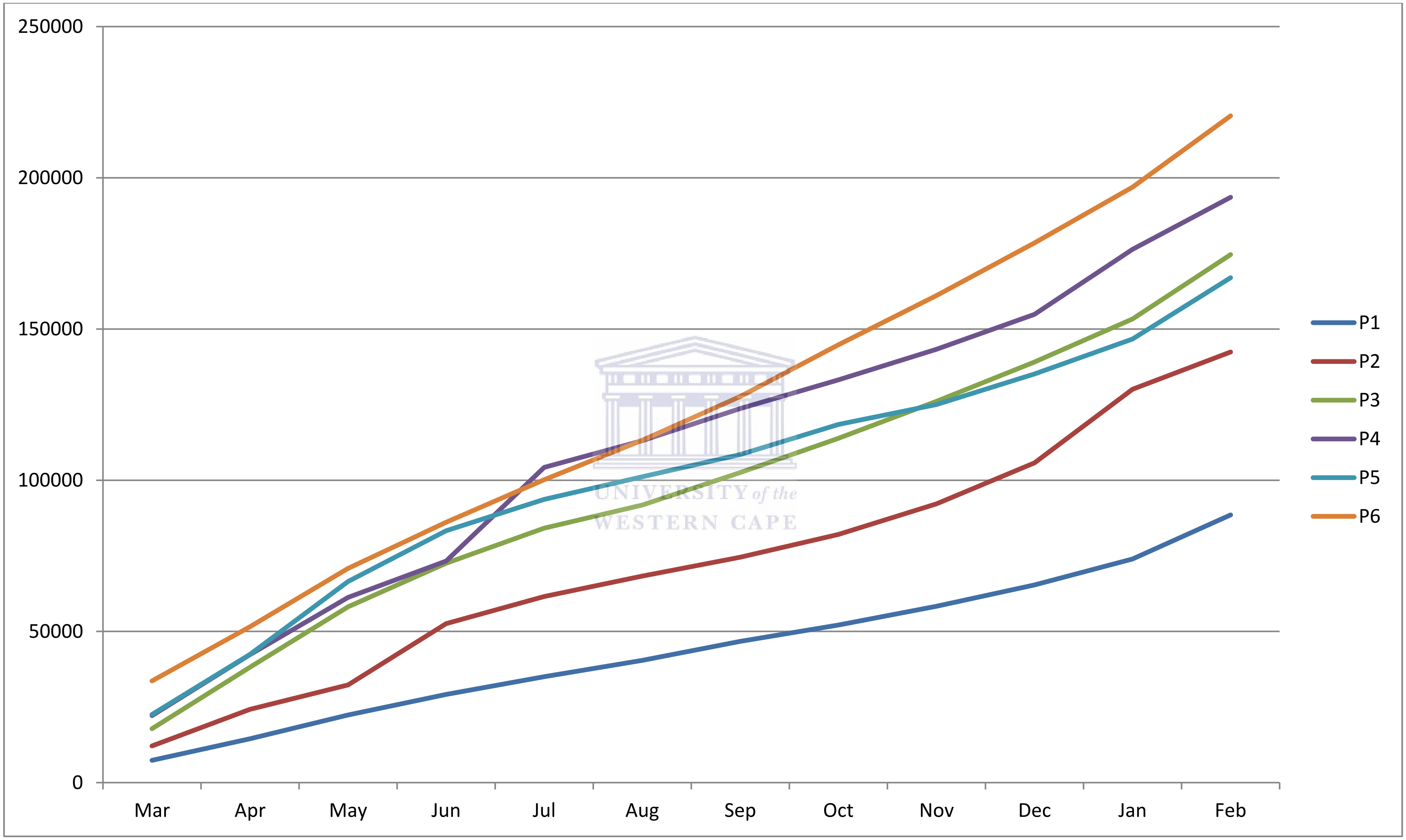

Figure 28: Farmland Comparison of per Annum Cumulative Water Consumption

B.4.3: Water Consumption over Time Data

Table 53: Farmland Monthly Water Consumption. March 2005 to February 2011

Water Consumption over Time						
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6
Mar	7395	12160	17855	22178	22550	33644
Apr	7134	12076	20340	20185	19882	17907
May	7848	8076	19953	18880	24081	19308
Jun	6799	20261	14429	12031	16785	15249
Jul	5850	8984	11564	30976	10378	14063
Aug	5427	6737	7652	8852	7467	13031
Sep	6274	6267	10753	10623	7344	14484
Oct	5396	7515	11321	9463	9961	17082
Nov	6197	10100	12217	10115	6577	16276
Dec	7054	13576	13018	11536	10101.458	17436
Jan	8573	24333	14211	21525	11568.291	18456
Feb	14597	12332	21279	17183	20272.414	23546

B.4.4: Cumulative Water Consumption per Annum Data

Table 54: Farmland Cumulative Water Consumption per Annum. March 2005 to February 2011

Cumulative	Consumption					
	P1	P2	P3	P4	P5	P6
Mar	7395	12160	17855	22178	22550	33644
Apr	14529	24236	38195	42363	42432	51552
May	22377	32312	58148	61243	66513	70860
Jun	29176	52573	72577	73274	83298	86108
Jul	35026	61557	84141	104250	93676	100171
Aug	40453	68294	91793	113102	101143	113202
Sep	46727	74561	102546	123725	108487	127686
Oct	52123	82076	113867	133188	118448	144768
Nov	58320	92176	126084	143303	125025	161044
Dec	65374	105752	139102	154839	135126	178480
Jan	73947	130085	153313	176364	146695	196936
Feb	88544	142417	174592	193547	166967	220482

Appendix B.5 Total Water Supply Breakdown

Table 55: Water Consumption According to Source. Presented in m^3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
All Sources	897415.9	910876.9	786082.8	560028.7	116785.2	79912.9	55037.3	67566.5	89861.5	330511.6	740065.4	813841.3
SW Irrigation	545448.5	531048.5	525846.1	388876.5	7800	0	0	4340	12590	137698.9	493658.5	545848.5
GW Irrigation	171789	165904	131074.1	52523.45	0	0	0	2030	14285	116558.1	169674.7	171789
GW Drink	3762.4	4607.4	4247.6	3887.7	3457.2	2743.9	2358.3	2345.5	2451.5	2663.6	2914.2	3119.8
Mont Rochelle	69543	58237	55324	44492	27611	36900	25188	0	30424	58533	49123	53766
Wmmershoek Dam	106873	151080	69591	70249	77917	40269	27491	58851	30111	15058	24695	39318

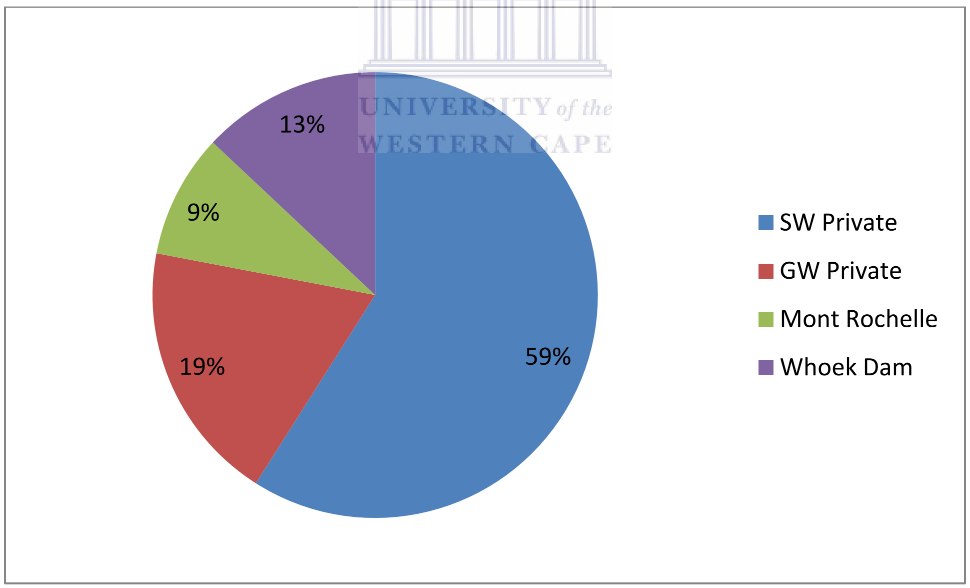

Figure 29: Water Consumption According to Source

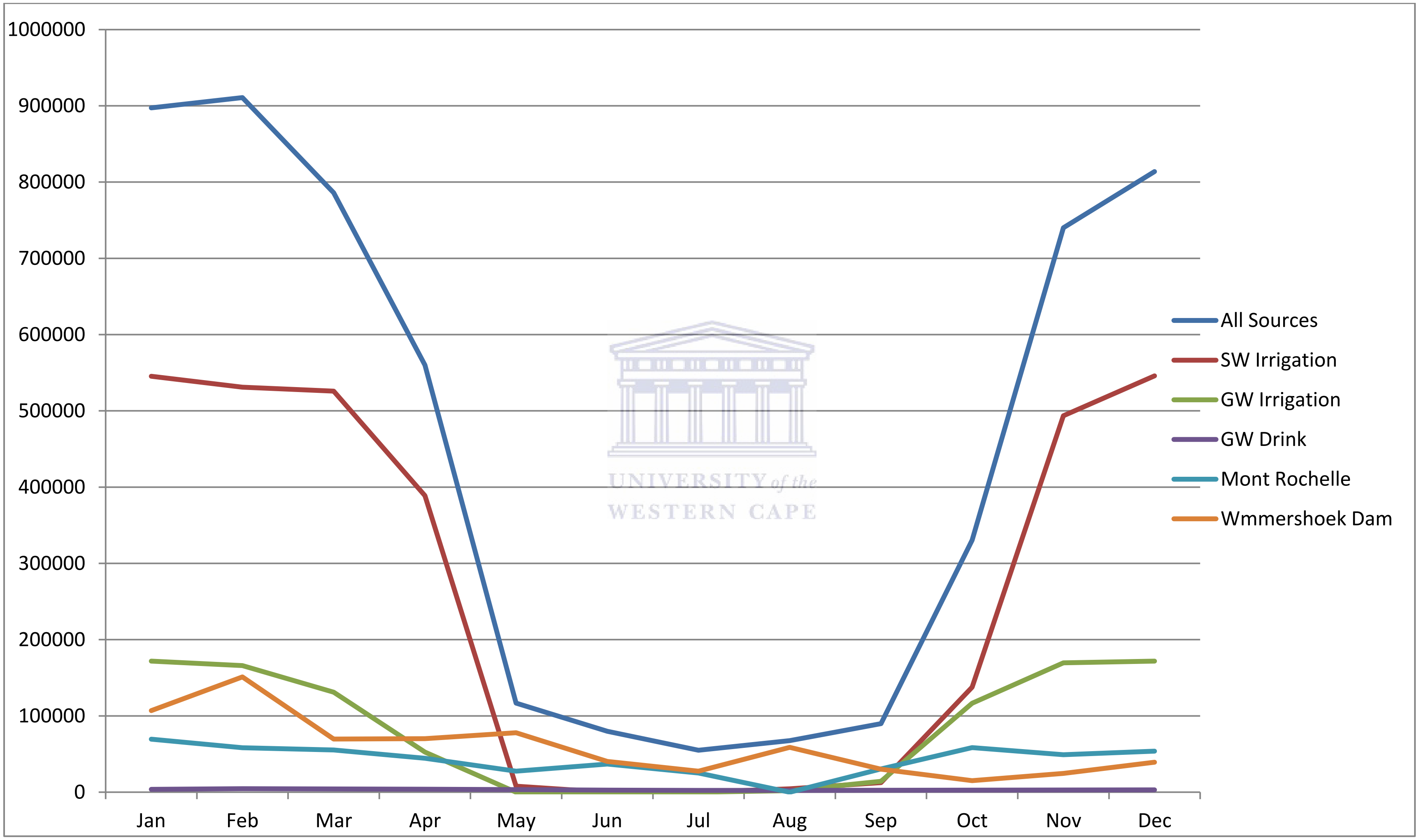

Figure 30: Water Usage According to Source and Time of Year

Appendix C: Agricultural Activity in Franschhoek

Appendix C.1: Crop Breakdown [Pie Chart and Data]

Grapes	Premium Grapes	Plums	Olives	Citrus	Pears	Blueberry	Orchard	Figs	Peach	Persimmon	Other	All
1090	165	211	74	49	130	3	2	3	11	33	3	**1774**
61.44	9.30	11.89	4.17	2.76	7.33	0.17	0.11	0.17	0.62	1.86	0.17	**100**

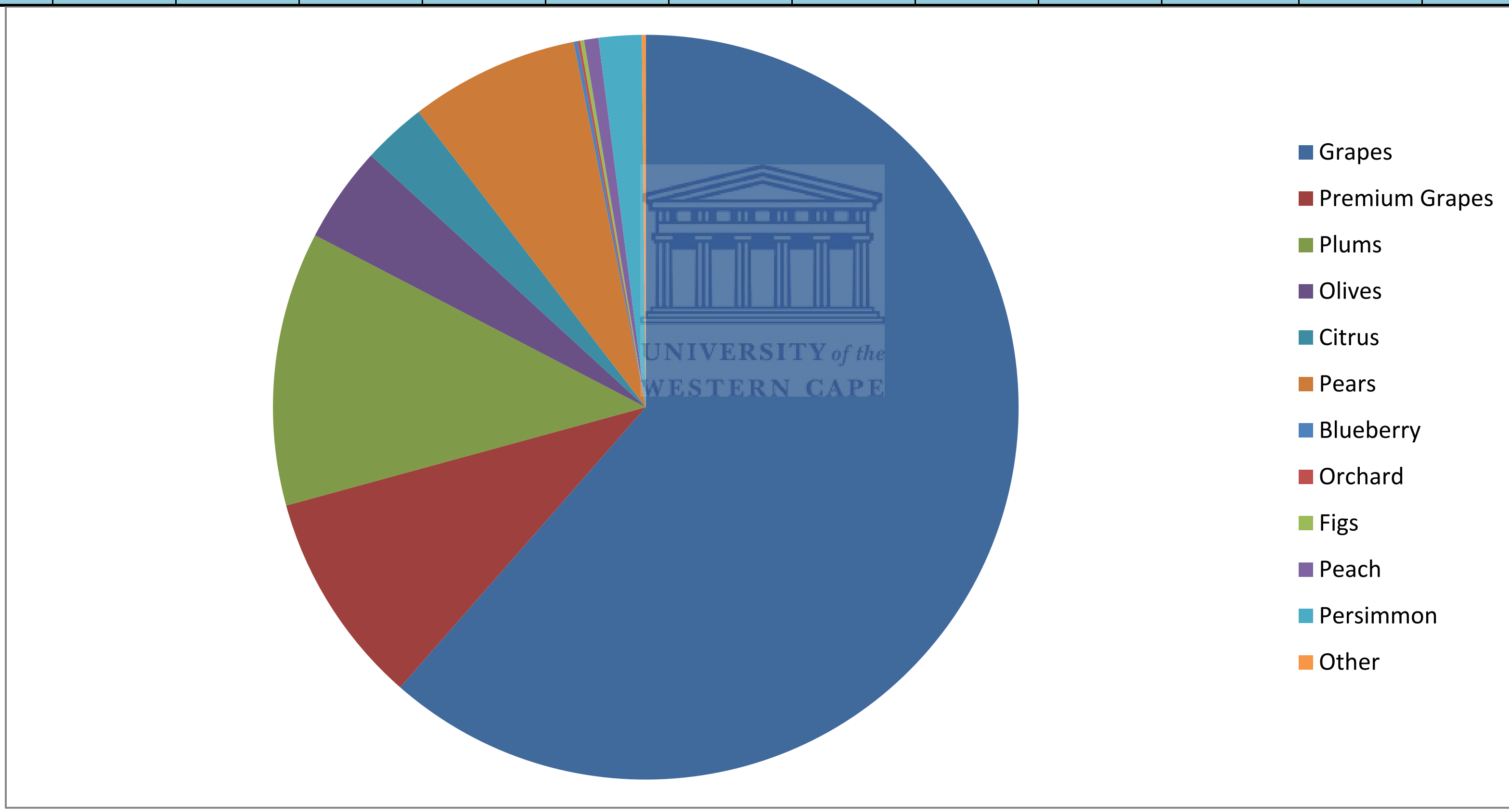

Figure 31: Crop Breakdown

Appendix C.2: Water Use for Irrigation [Graph and Data]

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
All	728843	699558	659526	443030	0	0	0	6370	26875	255832	674939	729243
SW	545448.5	531048.5	525846.1	388876.5	7800	0	0	4340	12590	137698.9	493658.5	545848.5
GW	171789	165904	131074.1	52523.45	0	0	0	2030	14285	116558.1	169674.7	171789

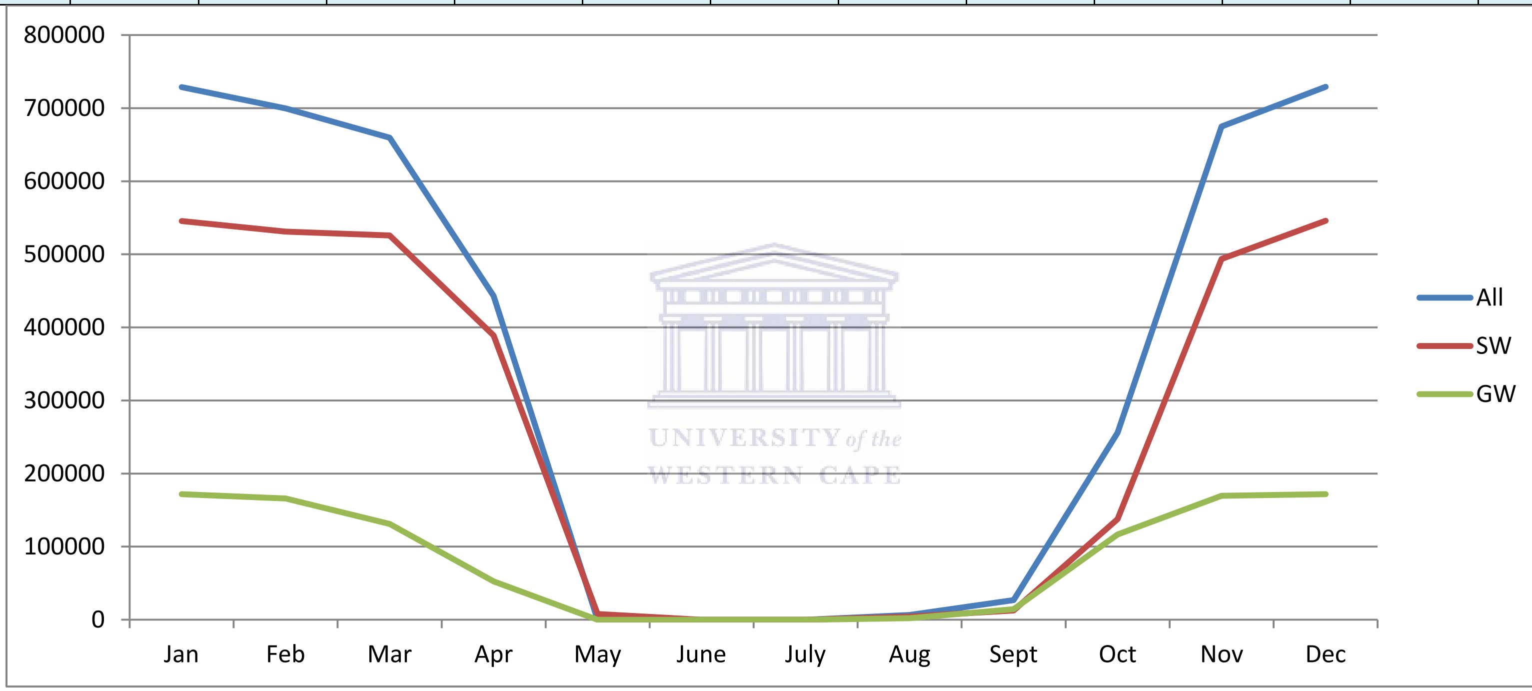

Figure 32: Irrigation Water Usage According to Source and Time of Year

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
All	100	100	100	100				100	100	100	100	100
SW	74.83758	75.912004	79.730913	87.776561				68.131868	46.846512	53.823955	73.141202	74.851387
GW	23.570097	23.715546	19.873985	11.855506				31.868132	53.153488	45.560407	25.139264	23.557168

Appendix D: Survey Components

Appendix D.1: Survey Questionnaire

Date:	
Start Time:	
Finish Time:	

Enumerator:	
Quest Code:	

Introduction

Good day Sir / Maam. My name is _______________ and I am a researcher working for the University of the Western Cape.

First of all, allow me to thank you for agreeing to participate in our research project. Your participation is greatly appreciated and will go a long way towards helping achieve our objectives.

This survey is being conducted by the University of the Western Cape in collaboration with the Water Research Commission. Permission to conduct this research has been granted to us by the Cape Winelands Municipality. The information collected in this survey will be used by Government to improve service delivery to communities like Franschhoek

This interview will take approximately 10 minutes.

General Household Details

We would like to start by asking a few questions about you and the people, family members and non-family members, who live in this household.

1. Firstly, who is the head of this household? [ ]

If respondent is not the head…

What is your relationship to the head of this household?

Partner / Spouse	
Son / Daughter	

Other ____________

2. How many people live in this household? [ ]

3. Next we would like to summarize the ages of the people who live in this household…

How many people younger than 10?	
How many people between 10 - 17 years?	
How many people between 18 - 35 years?	
How many people between 36 - 55 years?	
How many people older than 55 years?	

4. What is your age? (Year and month of birth will be OK.) [ ]

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5. What is your marital status?

Single	
Married	
Divorced	
Widowed	

Other ______________

6. Do you own this property or are you renting it?

Own	
Rent	

Other ______________

7. Do you conduct any business activities from this property and if so what kind?

Accommodation	
Agriculture	

Other (specify) ______________

(If the respondent provides accomodation)

8. How many guests can you accommodate? [ ]

(If the respondent conducts agricultural activities)

9. What kinds of produce do you grow here?

______________ ______________ ______________

______________ ______________ ______________

10. Do you have any pets, animals or livestock, and if so what kind?

None	

______________ ______________ ______________

______________ ______________ ______________

11. Do you have a borehole on your property?

Yes	No

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Awareness, Attitudes, Preferences, Perceptions

12. Please listen to the following statement:
Many people say that Franschhoek is a very beautiful place. They say that the environment, the mountains, rivers, plants and animals are what makes Franschhoek so beautiful.

Do you agree or disagree with this statement?

Agree		Disagree		I don't know	

13. Please listen to the following statement:
Creating more jobs is a very big challenge here in South Africa. It is very important that we create more jobs so that we can grow the economy and help the poor.

Do you agree or disagree with this statement?

Agree		Disagree		I don't know	

14. Which do you feel is more important, preserving the environment or creating jobs?

Creating jobs is more important.	
Protecting the environment is more important.	
Both are equally important	

15. What is the reason for your answer?

____

16. Please rate your level of satisfaction with water service provision in your municipality in general. Are you...

Satisfied	
Somewhat satisfied	
Unsatisfied	
Very Unsatisfied	

If respondent answers "unsatisfied" or "very unsatisfied"

17. What is the reason for your answer?

____

18. Do you know the source of the water that comes out of your taps?

Yes	No

If "Yes" ask respondent to indicate source.

If respondent says "No" or answers incorrectly, please inform them of the sourece of the water.

Only tick box if the source is correctly stated by the respondent, more than one box may be ticked.

Mont Rochelle Nature Reserve	
Wemmershoek Dam	

19. Do you know what groundwater is?

Yes	No

If "YES" proceed to the short quiz.

If "NO" skip to information about groundwater.

Short Quiz

In the following section we would like to ask you a few questions to test your knowledge of groundwater.

If the respondent answers incorrectly please give him/her the correct answer.

20. What do we call the underground areas of rock and sand that store water?

Answer: Aquifer **Tick box if respondent answers correctly -** ☐

21. What do we call the process by which water enters an aquifer?

Answer: Recharge **Tick box if respondent answers correctly -** ☐

22. What is the name of the aquifer that lies beneath the Western and Eastern Cape?

Answer: TMG Aquifer **Tick box if respondent answers correctly -** ☐

23. Is the TMG Aquifer a porous aquifer or a fractured rock aquifer?

Answer: Fractured Rock **Tick box if respondent answers correctly -** ☐

24. What type of rock is the TMG aquifer primarily made up of?

Answer: Sandstone **Tick box if respondent answers correctly -** ☐

25. What is the approximate maximum depth of the TMG Aquifer?

Answer: Approximately 4km **Tick box if respondent answers correctly -** ☐

Some Information about groundwater:

Groundwater is water that is found underground. When it rains water soaks into the ground and is stored in tiny spaces in the sand or in the cracks of rocks. The underground areas of rock and sand that store this water are called aquifers. Sometimes the water can be found just below or very near to the surface, but sometimes the water can be found very deep in the ground, more than 1km.

In Franschhoek, the mountains catch the rainfall and force the water to collect into rivers and streams. A lot of this water also soaks into the ground and becomes groundwater. You can sometimes see this groundwater when it comes out of the cracks in the side of the mountain. This water is flowing through the cracks in the mountain rocks and is eventually forced out. This water that comes out of the ground by itself is called a groundwater spring. There are several groundwater springs like this in the Franschhoek Valley.

It is also possible to pump this water out from underground. A place where we pump groundwater out is called a borehole. Many farmers use boreholes to pump out groundwater for their farms.

Environmentally Oriented Habits

How often do the members of your household participate in the following activities.

Members of your household includes you, your spouse or partner and any other family member who reside in this household.

		Daily	Once a week	Twice a Month	Once a month	Very Rarely	Never
26.	Hiking						
27.	Fishing						
28.	Bird Watching						
29.	Camping						
30.	Swimming						
31.	Working in the garden						
32.	Recycling Household Waste						

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33. LSM Grading

Metropolitan Dweller	
House / Cluster House / Town House	
Tap in house / on plot	
Flush toilet inside house	
Hot running Water	
HomeSecurity service	
Built in Kitchen Sink	
Domestic Worker	
Number of Cellphones in House	
Radio	
Music Centre	
TV set/s in household	
VCR	
DVD	
Fridge or combined Fridge/Freezer	
Electric Stove	
Deep Freeze Freestanding	
Microwave Oven	
Tumble Dryer	
Dishwashing Machine	
M-Net/DSTV	
Home Theatre System	
Vacuum Cleaner	
Motor Vehicle	
Computer Desktop or Laptop	
Landline (Excl. Cellphone)	

34. How many flush toilets on the property?

(If the respondent can't provide an exact number, an aproximation will do.)

35. How many taps on the property?

(If the respondent can't provide an exact number, an aproximation will do.)

Household Income

For the following section, I must state that all information provided will be kept strictly confidential. Your personal details are not recorded on this sheet and as such any information you provide cannot be traced back to you.

We would like to know about your personal income, and the income of the other members of this household.

36. Firstly, if I may ask, are you currently employed? **(Self-employed may be counted as employed.)**

Yes	No

37. How many other individuals in this household are employed and contribute to this household? ____________

38. Who are these other individuals and what is their relationship to you? **(Fill in their details on the income reporting sheet below.)**

Next I would like to ask how much you earn on a monthly basis. This should include income from formal employment, own business income, earnings from investments and any income provided by government welfare.

If you are not comfortable giving us the exact amount we can talk in terms of income ranges.

Respondent (If the respondent is empoyled.)

Exact Figure ____________

Less than R5,000		R50,000 - R75,000	
R5,000 - R10,000		R75,000 - R100,000	
R10,000 - R25,000		More than R100,000	
R25,000 - R50,000			

Member #1 Relationship to respondent: ____________

Exact Figure ____________

Less than R5,000		R50,000 - R75,000	
R5,000 - R10,000		R75,000 - R100,000	
R10,000 - R25,000		More than R100,000	
R25,000 - R50,000			

Member #2 Relationship to respondent: ____________________

Exact Figure ____________________

Less than R5,000		R50,000 - R75,000	
R5,000 - R10,000		R75,000 - R100,000	
R10,000 - R25,000		More than R100,000	
R25,000 - R50,000			

Member #3 Relationship to respondent: ____________________

Exact Figure ____________________

Less than R5,000		R50,000 - R75,000	
R5,000 - R10,000		R75,000 - R100,000	
R10,000 - R25,000		More than R100,000	
R25,000 - R50,000			

Member #4 Relationship to respondent: ____________________

Exact Figure ____________________

Less than R5,000		R50,000 - R75,000	
R5,000 - R10,000		R75,000 - R100,000	
R10,000 - R25,000		More than R100,000	
R25,000 - R50,000			

Member #5 Relationship to respondent: ____________________

Exact Figure ____________________

Less than R5,000		R50,000 - R75,000	
R5,000 - R10,000		R75,000 - R100,000	
R10,000 - R25,000		More than R100,000	
R25,000 - R50,000			

Total Monthly Household Income ____________________

(This is to be determined by the enumerator once the interview has been concluded)

39. What is the highest qualification held by a member of this household?

Primary	Some High	High
Diploma	Degree	Post-Grad

Contingent Valuation

40. In Franschhoek groundwater benefits us in many ways. Can you name some of the ways that groundwater benefits us?
(Tick every option correctly stated by the respondent)

Water Supply:	About one quarter of the water supply of Franschhoek comes groundwater from the Mont Rochelle Nature Reserve.	
Irrigation:	Many of the farmers in the area pump out groundwater and use it to irrigate their crops.	
Rivers and Streams:	Some of the streams in the valley, including the La Cotte stream and the Varkblaardrift stream get their water from groundwater springs in the mountains.	
Wetland:	There are wetlands in the lower part of the valley that are completely dependent on groundwater.	
Plants and Animals:	Groundwater helps to feed the plants during the dry season, once all the surface water has dried up. These plants are also important for animals, birds and insects that rely on the plants for food and shelter.	

41. The town of Franschhoek has expanded a lot in the last five years. This has had some negative effects on the local water systems and the local groundwater. Can you name some of these negative effects?

Wastewater:	During the busy tourist season, the Franschhoek sewerage system is unable to process all of the wastewater from the town. This wastewater spills into the local rivers and contaminates the groundwater in the immediate area	
Domestic Pollution:	Many forms of pollution come from homes. These include cleaning agents, oil, chemicals (Eg. Batteries) and human or animal waste. These wash into the local water systems when it rains and contaminates the streams and local groundwater.	
Agricultural Runoff	Fertilizers and pesticides from the farm are washed into the local water systems and contaminate the groundwater.	
Salination	Agricultural activity in the area may be releasing natural salts that were previously trapped in the soil, into the groundwater.	

(Pause for a moment, and ask the respondent if they understand. Let them ask one or two questions if they want to, once you have answered their questions proceed with the interview.)

This will have the following effect on the local environment:

People who come into contact with or consume contaminated groundwater/water can get sick.
Reduced Bird Populations
Reduced populations of native animal species
Increased populations of invasive alien animal species and pests
Increased number of invasive plant species and pests
Reduced amounts of groundwater (Alien plants species use a lot more water than native species)
Groundwater might become unusable for farming because of the high salt content.

In Addition, the City of Cape Town is investigating the possibility of extracting large amounts of groundwater to supply the growing population of Cape Town with drinking water. When this happens, there is a very strong possibility that it will have an effect on the amount of groundwater available in the Franschhoek Valley.

(Pause for a moment, and ask the respondent if they understand. Let them ask one or two questions if they want to, once you have answered their questions proceed with the interview.)

In view of what we have just discussed, let's consider the following hypothetical scenario:
Members of the communities in the Berg River Valley have expressed their concerns that not enough is being done to monitor and protect the groundwater resources in the area. In Response to this the local authority has proposed to start a Groundwater Management Program.

The proposed Groundwater Management Program will run for a period of 5 years after which it will be reviewed for renewal by the municipality. The projected cost of running the program for the five years is R7 million.

The goals of the program will include:

Monitoring and documenting the quality of the groundwater in the area.
Monitoring and documenting the groundwater levels (quantity) in the area.
Identifying and documenting sources of groundwater contamination.
Informing the community (residents, farmers, etc.) of contaminated groundwater/water sources and of the risks associated with the type of contamination.
Organize and manage efforts to reduce/prevent groundwater contamination.
Organize and manage legal actions, where deemed necessary.
Promote the sustainable use of groundwater.
Preserve our groundwater resources for the benefit of future generations.
Educate and inform members of the community about our groundwater resources.

The government relies on TAX to fund such a project an thus, in order to pay for the program the local authority is considering passing a bill/legislation/rule/regulation that calls for a mandatory water levy to be charged to ALL the residents of the Berg River Valley. The levy will be included in your monthly water bill.

However, before passing this bill/legislation/rule/regulation the local authority is to hold a referendum where you are required to freely vote for or against the program.

Voting for the program will result in an improvement in the state of the local groundwater resources and better protection of those resources, but this will also come at a cost. Voting against the program will result in things staying as they are and there will be no extra cost.

42. Do you understand the situation thus far? | Yes | No |

(If the respondent says they do not understand, then explain the hypothetical scenario again.)

43. Would you vote YES or NO ? | Yes | No |

Information
Opening Bid Amount =
Iteration Amount =

If you vote yes the local authority will charge a levy of R________

(Be sure to check what the opening price is for the area you are surveying.)

44. Would you be willing to pay this amount?

Yes	No

In the table below iterate the bid amount upwards or downwards depending on the response.

Initial Bid		Opening Response		YES	NO

Iterate upwards until response is NO	
Iterate downwards until response is YES	

45. If you vote NO, what are your reasons for doing so?

This is government's responsibility; I should not have to pay extra for this.	
I can't afford to pay for this.	
I don't trust the government to run a program like this.	

Other
(Specify) ____

Observation Questions

46. What is the gender of the Respondent?

Male	
Female	

47. What is the race of the respondent?
(Circle the appropriate block)

Black	White	Colored
Indian	Asian	Other

48. What type of dwelling/property is it?

House	
Farm	
Informal Dwelling	
Town House / Flat	
Small Holding	

49. How long have you and your family lived in Franschhoek/Groendal? ______________

Appendix D.2: Tatler Article

Groundwater study to take place in valley

Unknown to most Franschhoekers the University of the Western Cape has been undertaking water related research in the Upper Berg River Valley for the past 7 years. During October another study will be undertaken and this time the assistance of residents is required.

The aim of the research, led by Masters student Darian Pearce and Professor Yongxin Xu of the University's Groundwater Division, is to produce knowledge about the socio-economic value of groundwater that is derived from the so-called Table Mountain Group Aquifer. (This aquifer lies under most of the Western Cape and stretches roughly from Nieuwoudtville to Port Elizabeth.) Although there is some understanding of the potential benefits of tapping into this aquifer the monetary value of doing so is little understood.

According to Darian, "Only by understanding the value of groundwater will we be motivated to adequately develop this resource and sufficiently protect it." In the past decision-making has been based on the value of groundwater as a resource in its own right. "However, in order to ascertain the total economic value of groundwater, we also need to incorporate the value of groundwater as a contributor to surface water resources, to the sustainability of ecosystems that are dependent on groundwater and to natural beauty," says Darian.

Franschhoek and Groendal were chosen for the study for a number of reasons. These include: the community makes significant use of groundwater for domestic, commercial and agricultural use; the area's very divergent demographic profile makes it possible to study how different population segments use and understand groundwater; and the valley's recent rapid development is placing strain on it's natural resources that could harm it's economy in the longer term.

UWC students will be undertaking an extensive residential survey in the valley during October to gather data. The survey will be conducted on the 2nd, 3rd and 4th weekends of October - weekends were chosen as that is when residents will most likely be home. If you are approached by one of them, please invite them in!

For more information contact Darian Pearce on 082 452 6756 or dazzpeace@gmail.com

Taking water samples on Matoppie

Appendix E: Bulk Water Supply Data

Table 56: Municipal Water Usage Breakdown According to Area

	Fhoek	Gdal	La Motte	Lang	FHPLA	Total
Jan	53027.84	21258	6155	9000	11568	**132312**
Feb	61685.607	29613	7663	9000	20272	**156988**
Mar	59660	27748	6278	9000	33644	**93686**
Apr	55648	23846	6562	9000	17907	**86056**
May	50829	23340	4977	9000	19308	**79146**
Jun	32953	20214	4710	9000	15249	**57877**
Jul	17747	18339	3423	9000	14063	**39509**
Aug	23135	17343	3660	9000	13031	**44138**
Sep	24472	16910	4019	9000	14484	**45401**
Oct	28310	22448	4435	9000	17082	**55193**
Nov	27750	21831	5781	9000	16276	**55362**
Dec	45373	19287	5153	9000	17436	**69813**
Total	***480590.447***	***262177***	***62816***	***108000***	***210320***	***1123903.45***

* Municipal Estimate

	Mont Roch	Wemm Hoek
Jan	69543	106873
Feb	58237	151080
Mar	55324	69591
Apr	44492	70249
May	27611	77917
Jun	36900	40269
Jul	25188	27491
Aug	0	58851
Sep	30424	30111
Oct	58533	15058
Nov	49123	24693
Dec	53766	39318
Total	**509141**	**989396.93**
Perc.	**33.98**	**66.02**

** Estimate

Non Revenue Water	0.25

* Estimated average monthly consumption for Langerug Community (Informal Settlement)

** Wemmershoek Figures estimated as:

Appendix F: In-Depth Interview Guide

In Depth Interview Guide

Section A: Interviewee Details

- Please state your name and occupation.
- Please elaborate on your experience within the South African Water Industry.
- What is your current role/position/job within the South African Water Industry?
- Please elaborate on your area of expertise / What kind of services do you provide?
- Who would you say are the primary clients that you serve?
- Could you please briefly describe an average day on the job?

Section B: SA Water Industry

2.1What are your impressions of the public/governmental component of the South African Water Industry?

2.2 What are your impressions of the Private component of the South African Water Industry?

2.3 How would you describe the relationship between the public and private sectors in the South African Water Industry?

2.4 Who are the big players/companies in the South African Water Industry?

2.5 Who are the most influential individuals in the South African Water Industry?

2.6 What is your opinion on the concept of *integrated* water resource management?

2.7 Are these principles of *integration* reflected in the South African Water Industry?

2.8 What, in your opinion are the biggest challenges that the South African Water Industry currently faces?

2.9 Do you feel that there is a sufficient response to these challenges?

2.10 What do you feel are the strengths of the South African Water Industry?

2.11 What do you feel are the weaknesses of the South African Water Industry?

2.12 What are the major skills shortages in the South African Water Industry?

Section C: Water Users in the Western Cape

3.1 What are your opinions on the water market in the Western Cape?
3.2 Who are the biggest domestic users of water?
3.3 Who are the biggest agricultural users of water?
3.4 Who are the biggest industrial users of water?
3.5 In terms of collecting payments for water usage, does the DWA classify users according to their type of water use?
3.6 How is water use tracked by the municipality?
3.7 Are billing records kept and archived by the department?
3.8 Does the DWA use this billing information for any sort of meaningful purpose?

Section D: Water Supply in the Western Cape

4.1 Does the Western Cape have sufficient water supply to meet current demand?
4.2 How fast is the demand for freshwater growing in this region?
4.3 What are our options for expanding bulk water supply?
4.4 Which option is your favorite and why?
4.5 How does the DWA track current water usage/demand?
4.6 How does the DWA estimate the growth in water demand?
4.7 What is driving the growth in demand for water?

Section E: Brief Discussion Topics

- The Journey from Source to end user
- The relationship between water/sanitation and the cycle of poverty
- The relationship between Economic Development and Water Supply/Services.
- Groundwater / Desalination
- Important Developments in the Water Industry

Appendix G: Water Use Census Information

File Code	Farm Name	Total Agri Ha	Total Irrigation	SW %	GW %
1	La Rouche	13	27000		100
2	Robert Vallei		0		
3	La Bri Holiday + Olive Farm	7	0		
4	La Brie Landau Du Val	20	0		
5	La Brie	34.1	168000	100	
6	La Colline	33	85800	20	80
7	La Corrine	21.5	17200	100	
8	Le Franschhoek		0		
9	Le Petite Dauphine: Guest Farm	8	20400		100
10	3 Streams		0		100
11	Klein Keerweder	3.2	11400	100	
12	Keerweder	50	144000	90	10
13	Boekenhoutskloof	0.8	700	50	50
14	Bourgogne Burgandy	23	42000		100
15	Klein Champagne	10	21000	100	
16	Clermont	12	22800		100
17	Champagne	2.1	2205		100
18	La Vigne	5.7	6000	100	
19	Grand Provence	22.3	11700		100
20	La Croix Du Sud	2	2800	100	
21	Chamonix spring water	50	0		
22	Bergsicght	25	150000	0	100
23	Blueberry hill	0.6	480		100
24	Bourgonne	11	60	80	20
25	La Providence	1.8	3780		100
26	Oude Kelder	7.5	10500		100
27	La Brie	15	60000	5	95
28	Le Cotte	18	0	0	0
29	Riverstone wine estate	20	37800		100
30	Dieu Donne	22	0	0	0
31	Lermitage	32	63000		100
32	La Petite Ferme	11	6600	100	
33	La Chataiege	17	20400	0	100
34	Bo la motte farm	16	40200	100	

File Code	Farm Name	Total Agri Ha	Total Irrigation	SW %	GW %
35	Haute Cabtiere	3	6300	100	
36	Allee Bleue	93	262500	100	
37	Lekkerwijn	10	30000	100	
38	The riverside	0	0		
39	Two river development	17	17850	100	
40	Klein waterval	9	18900		100
41	Richenu wine estate	2	2800		100
42	Bakenshoek	0	0		
43	Chanteclair	5	11550		
44	La verbure	6	8000		100
45	La Combe	14	41580	50	50
46	holden manz wine estate(klein genot)	16	0		100
47	Colmant cap classique and champagne	2.72	2176		100
48	Klein Dassenberg	2.5	2500		100
49	von ortloff (dassenberg)	9	14850	100	
50	Mont Rochelle	16.5	14435	20	80
51	Hugo Bros	10	37500	20	80
52	La Chanelle	6	0		
53	Solms Delta	20	33000	100	
54	Hueguenot valley		0		100
55	Rickety Bridge and basco bans	30	12000	100	
56	Normandy winery	55	90750	100	
57	Klein goederust	6.5	8580		100
58	welgelegen	9	15750		100
59	Middekraans estate	13.5	45000	100	0
60	akkerdal wine estate	22	33000	100	
61	vigne de or	13.5	18000	80	20
62	de hollandshe molen		0		
63	morelig	40	240000	100	
64	chesnut hill	17	13600	100	
65	Matrahontane topiary wines	18	40000	100	
66	Cabrierre	15	48750	100	0
67	La vie de luc	46	85500		100
68	La petite provence	3.6	5400		

File Code	Farm Name	Total Agri Ha	Total Irrigation	SW %	GW %
69	La Chanelle ferme	8	10800		100
70	Waterfall farm	5.3	6360	100	
71	Eikehof	20	36000	100	
72	Moxon	0	0		
73	Le Manoir de Brenden	26	54600	50	50
74	LYNX	14.7	34200	95	5
75	Waterfall farm	5	4500	100	
76	Maison	12	4800	100	
77	Mont Michelle	4.97	10750		100
78	Lens Farm	6	2700	100	0
79	Le Arc de Orleans	9	26400	100	
80	La Marron	5	12250	50	50
81	L'Or Marins Wine Estate	60	144000	85	15
82	Lenons Orchard	0	0		
83	Boeschendal PTY.LTD	230	699000	100	
84	Graham Beck	63	108400	100	
85	Glenwood	22	22000	100	
86	Dennehof	12	37800	100	
87	Antioch	29	74000	100	
88	Franschoek Pass Winery	3.5	7350		100
89	Franschoek Pass Winery		0		
90	La Provence	16.7	74040		100
91	Bien Donne	90	366000	100	
92	Hevelsig	8.86	30000		100
93	La Motte	100.5	154770	65	35
94	Rupert &	50	80000	75	25
95	Val d'	6	12600		
96	Vrede en Lust	35	28000		
97	St Croix Vineyards	22	54600		
Total		**1766.65**	**4232016**	**75.59%**	**24.41%**

Appendix H: Groundwater Goods and Services

Potential Services Flows and Effects of Those Services for Groundwater stored in an Aquifer:

- Potable water for residential use
- Landscape and turf irrigation
- Agricultural crop irrigation
- Livestock watering
- Food product processing
- Other manufacturing processes
- Heated water for geothermal power
- Cooling water for power plants
- Prevention of land subsidence
- Erosion and flood control through absorption of surface runoff
- Medium for wastes and other byproducts of human economic activity
- Improved water quality through support of living organisms
- Nonuse services (existence/bequest values)

Modified from NRC (1997, as quoted by Boyle and Bergstrom, 1994)

Potential Service Flows and Effects of Those Services for Surface Water and Wetland Surfaces Attributable to Ground Water Reserves:

- Surface water supplies for drinking water
- Surface water supplies for landscape and turf irrigation
- Surface water supplies for agricultural crop irrigation
- Surface water supplies for watering livestock
- Surface water supplies of food product processing
- Surface water supplies for manufacturing processes
- Surface water supplies for power plants
- Erosion, flood and storm protection
- Transport and treatment of waste and other byproducts of human economic activity through surface water supplies

- Recreational swimming, boating, fishing, hunting, trapping and plants gathering.
- Commercial fishing, hunting, trapping, and plants gathering supported by groundwater discharges
- On-site observation or study of fish, wildlife, and plants purposes supported by groundwater discharges for leisure, educational or scientific purposes.
- Indirect, off-site fish, wildlife, and plant uses (eg. Viewing wildlife photos)
- Improved water quality resulting from organisms related to groundwater discharges
- Regulation of climate through support of plants
- Provision of nonuse services associated with surface water bodies or wetland environments or ecosystems supported by groundwater discharges.

Modified from NRC (1997, as quoted by Freeman, 1993)

Appendix I: Franschhoek Water Woes Article

Water woes

During a particularly hot spell in late January parts of Franschhoek were left without water for the third time in as many months. The Tatler investigated Franschhoek's water supply situation, what caused the supply problems and what is being done to ensure they don't recur. This is what we found:

Water sources:

Franschhoek is currently served by two primary water sources. The first is a pipeline (constructed in approx. 2005) from the Wemmershoek dam that brings water that is purchased from the City of Cape Town to, mostly, Groendal. The quantity of water available from this source is determined by a contractual arrangement between the City of Cape Town and Stellenbosch Municipality. This water is pumped to the Langrug reservoir.

The second source is the historic source from the Mont Rochelle Nature Reserve. This source has three components. A perennial spring that has been tapped for water since 1825, an upstream weir in the Perdekloof stream that also dates from 1825 and a pump station lower down the DuToits River that has been operating since the mid-1990s. The quantity of water that may be extracted from the DuToits River is limited to 667.2 kilolitres/day by a 1994 order of the Water Court. Water from the reserve flows to a reservoir above the Fransche Hoek Estate where it is treated and then on to a reservoir at Bagatelle Street.

The problem:

The supply problem that occurred in November was in reality a series of problems. Firstly there was a particularly high demand for water as summer temperatures soared. Secondly a leak developed in the pipeline from the reserve. Finding and repairing this in the mountainous terrain proved difficult for understandable reasons. Once the leak was fixed the municipality expected the reservoir to fill again and for supply to be restored. This didn't happen and it was subsequently discovered that there was a problem with the generator that powers the pump in the reserve. The generator was then replaced, only to find out that there had been damage to the pump itself and that it also had to be replaced.

While there was a problem with the supply from the Mont Rochelle Nature Reserve greater reliance was placed on the supply from Wemmershoek. More of this water was pumped to Franschhoek South. This was however hampered by the age of the reticulation system in Franschhoek South as increasing the pressure from the Wemmershoek side too much would cause the old pipes in Franschhoek South to burst.

The municipality keeps track of the water supply system through a monitoring system that transmits flow rates, reservoir levels, etc. to a central point. This enables them to identify problems early and respond to them. However the Mont Rochelle pump station is not covered by this system, as there is no electrical supply in the reserve. Problems in this part of the system can therefore not be identified early and the municipality only becomes aware of them when a crisis has already developed.

The Tatler gathers that because of the inaccessibility of the reserve there is a second pump in the DuToits River to enable the municipality to switch to the alternate one when a pump problem occurs, or the other pump has to be serviced. The second pump was however incapable of pumping enough water and also had to be replaced.

To compound the issue, according to the Tatler's sources, no annual maintenance was performed on the DuToits River pumps during winter 2010, which could have avoided the later breakdown. Apparently municipal staff was instructed, for safety reasons, not to service the pump and rather make use of a contractor.

Breech of Court Order:

To add to the miserable picture it also emerged that during the warm part of the year (defined as the period from 1 September to 30 April) the Municipality has been extracting far more water from the DuToits River than it is allowed to in terms of the Water Court order. Indeed the municipality has been in breach of the court order since at least 2004/2005 – the earliest period for which records are available.

The percentage of days during the Sept – April period that the court order was breached ranges from 23,5% in 2007/2008 to a whopping 60,7% in 2006/2007. The peak over extraction shows a growing trend since 2004/2005 when it was 993,14kl/day during one week in February 2005 (148,9% more than the court order allows). In January 2009 the over extraction reached an unbelievable 463% before declining back to 214,5% in January 2010.

What should be clear from the above is that the DuToits River source is hugely over extracted (read mismanaged) for prolonged periods every year. The effect of this over extraction on ecosystems in the reserve remains unquantified as no baseline studies exist to enable comparisons.

What is also clear is that if this illegal over extraction were to be stopped immediately a large part of Franschhoek would be without water during high summer. Franschhoek South had in fact already outgrown its legally available water supply by 2004/2005.

Proposed solution:

According to Stellenbosch Municipality a 5-year Water Services Development Plan (WSDP) is being undertaken to study all available sources of supply and their utilisation.

An immediate proposal (contained in the next municipal budget) is the construction of a new reservoir to supply water during periods of peak demand. This proposed reservoir is to be located between the existing ones to which it is to be connected. This will facilitate the greater use of Wemmershoek water in Franschhoek South without having to increase the pressure from the Groendal side resulting in the aged pipes bursting – as is currently the case. It will also alleviate reliance on water from the DuToits River.

Concerns:

The solution proposed by the municipality seems to address the immediate problem of peak supply, but is it a viable long-term solution?

Assuming that Stellenbosch Municipality is using the full quantity of Wemmershoek water that it is allowed to in terms of its agreement with the City of Cape Town and further assuming that they will desist from over extracting from the DuToits River it begs the question as to how the proposed new reservoir is to be kept full. Certainly there won't be a problem filling it during winter, but what happens in high summer? More specifically what happens if there are consecutive periods or an extended period of peak demand? The Wemmershoek supply is after all limited by a contractual arrangement and the Mont Rochelle supply by a court order.

The reservoir doesn't constitute a new water source for Franschhoek, only an increase (of a few day's worth of water) in storage capacity. It will not address the overall increase in water demand that goes along with continued development and population increases in the valley.

It cannot be assumed that water will be available from Theewaterskloof or the Berg River Dam, or that more will be available from Wemmershoek as all these dams serve Cape Town that has its own water supply problems to deal with.

The bottom line seems to be that:

· Notwithstanding the proposed new reservoir Franschhoek's safe water supply was already exceeded several years ago.

· No major untapped water sources exist as the dams around Franschhoek all serve the City of Cape Town that has it's own water supply problems.

The logical implication of the above would seem to be twofold:

· Existing peak water demand will have to be reduced to a level in line with the existing safe supply. This would have to include actions such as replacement of old pipes to minimise wastage.

· Further development in the valley will have to be severely curtailed or even stopped in its tracks. In fact, unless a developer is able to show that a proposed development will be entirely independent of the municipal water supply system, the application should not even be considered - let alone approved.

The Tatler asked Stellenbosch Municipality (via the Director: Engineering Services) to respond to this article. This is what they said:

The situation regarding stress on raw water sources as described above is a reality for numerous municipalities across South A[...] Identification of sustainable strategies to deal with scarcity of [...] resources and increasing water demand is a priority for the Stellen[...] Municipality.

To this end, consulting engineers were appointed in October 2[...] to update the Water Services Development Plan as part of a s[...] quo assessment of the bulk water infrastructure for the Stellen[...] Municipal area. This also includes a Water Sources study, which [...] includes the assessment of current water sources (as mentioned i[...] article), as well as identifying potential additional sources of wat[...]

The ultimate deliverable of this appointment is a bulk [...] master plan, to be completed towards July 2011, after which a de[...] implementation plan will be available to inform development deci[...] This master plan will address the water sources and all bulk [...] supply issues for the whole Stellenbosch municipal area, incl[...] Franschhoek.

The Water Services Development Plan is expected in April 2[...] and constitutes the sector plan for water services within the IDP.

Within this process, the municipality will continuously [...] towards better-integrated water resource management practices [...] improved water conservation and demand management. This [...] inclusive process which will also deal with issues as discussed in [...] article, e.g. ensuring adequate water supply, water quality and [...] water treatment.

Regarding development pressures, it is correct to state tha[...] consideration of development proposals will have to includ[...] consideration of the availability of bulk services, not only th[...] water services. This already is part of the approvals process emp[...] at the municipality.

Regarding the issues of maintenance and operations, as well [...] extraction history from the Du Toits River, this municipality has [...] in consultation with various role-players in Franschhoek, e.g[...] Ratepayers Association, where the status quo was explained. [...] municipality (the current administration) has identified [...] acknowledged that there exists in the broader Stellenbosch [...] including Franschhoek, a backlog of infrastructure needs as w[...] gaps in the level of service delivery.

The status quo is the result of various historical issues [...] practices. Apart from infrastructure challenges, there are [...] challenges relating to a shortage of staff as well as a lo[...] institutional knowledge through the years. There are many initi[...] currently undertaken to rectify this situation as urgently as po[...] The studies as mentioned above are one example. Capital works [...] as the proposed reservoir as well as the upgrading of the waste [...] treatment works (to be commissioned in March) are other exa[...] that illustrate the commitment to the area.

The administration is also in the process of establishin[...] increased presence in the area by way of amendments t[...] management structure to include a dedicated focus in Franschhoe[...]

It is our belief that through these measures the issues as rai[...] the article will be addressed in the short and medium term. I[...] illustrates that the municipality is currently dealing with these iss[...] a pro-active manner and confirms the commitment of [...] administration to improve services and service delivery throug[...] area.

Appendix J: Water Use Census Structured Interview Guide

UNIVERSITY of the WESTERN CAPE

WATER RESEARCH COMMISSION

Franschhoek Agricultural Hydrocensus
WRC Project K5-1974

Farm Name:	
Farm Owner:	
Farm Manager:	
Address:	
Contact Details:	
Note:	

Key Measurements

1 hectare = 10,000 square meters

1 acre = 4046.86 square meters

1mm water* ha = 10,000 liters

Key Question Guide: What do we need to know???

Irrigation and Water Sources

What is grown/raised on this farm?

When does irrigation take place and how much water is applied?

Is the amount of applied irrigation water varied over the year or is it constant?

What are the sources of water for irrigation utilized by this farm?

If there is more than one source of water for irrigation, then what is the proportion of the irrigation water that comes from each of the sources?

If there is one than one source of water for irrigation, then during which periods of the year are each of the sources utilized?

Does the farm have a reservoir, and if it does how much water can it store?

Does the farm have a dam, and if it does how much water can it store?

If the farm utilizes surface water, what is the origin of the surface water?

If the farm utilizes groundwater, how many boreholes are used, and what is their depth?

Do the boreholes ever run dry?

How often do they run dry, when do they run dry, under what conditions do they run dry?

Does the farm use municipal water, and what is it used for?

Residents

How many permanent residents does the farm have?

How many seasonal residents does the farm have?

Hospitality

Does the farm have a restaurant?

Does the farm provide accommodation? (Hotel, chalets, Villas, etc…)

How many people can be accommodated on this farm?

What is the source of the drinking water provided in the restaurant/accommodation?

Irrigation Schedules

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

Water Sources

Notes

Appendix K: Water Use Census Farmers Letter

Earth and Water Research Group
University of the Western Cape
Department of Earth Sciences
Bellville
Cape Town
May 2011

Agricultural Water Use Census in the Franschhoek Valley
9th May – 20th May 2011

Dear Sir / Maam,

The University of the Western Cape, mandated and funded by the Water Research Commission of South Africa is currently conducting research in the Franschhoek Valley.

The objective of the research is to determine the quantity of water that is required by the agricultural sector for irrigation purposes, and the periods during which that water is required. The information that is collected in this study will be used to build sustainability plans that will help to ensure the ongoing viability of water resources for agricultural usage.

We would greatly appreciate your assistance in this regard and would like to thank you in advance for your contribution. By working together can overcome the future challenges as we ensure the appreciation and ongoing protection of our water resources.

Should you have any queries as to the specifics of this project, please feel free to contact me. My details have been presented below.
Sincerely yours

Darian Pearce (Principle Researcher)

Appendix L: Focus Group Guide

Focus Group Guide

Facilitator: Darian Pearce

Participants: Micah Dominic, Josue Bahati Chisugi, Micah Dominic, Kim Adams, Melissa Ruiters, Ilse Kotze [and others…]

Phase One: Introduction and Purpose of the Focus Group (10 minutes)

Explain the core purpose of the research project and the role of the focus group in the context of the project. Discuss the "Total Economic Value" of Groundwater. Allow some time for any questions.

Phase Two: Generating the Concepts (15 – 20 minutes)

Do a spider diagram around the central theme of "Groundwater" and expand further on key issues that are identified.

Phase Three: Role of Groundwater (15 – 20 minutes)

Discuss the important role that groundwater plays in supporting environmental systems/ecosystems and human populations. Identify cause and effect. (Funnel Approach)

Phase Four: Threat to Groundwater (15 – 20 minutes)

Discuss the negative effect that human actions have on groundwater resources and the impact that has on the environment and society. (Funnel Approach)

Phase Five: Scenario Sketch (15 – 20 minutes)

Generate "hypothetical scenarios" that correspond to certain human actions. (Include time-scale)

Phase Six: Conclude the Proceedings (10 minutes)

Highlight key findings. Explore possibility of follow up interview if necessary.

<u>Thank Participants. Close Session</u>