Water Demand Management:

A Case Study of Windhoek, Namibia

An Interactive Qualifying Project Report
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the
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Date: May 5th, 2004

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Executive Summary

Southern Africa has one of the most arid climates in the world. Rainfall in the region is very limited due to topography, ocean currents, and global air circulation (Pallett, 1997). Mountains along the south-western coast force precipitation from the clouds as the clouds gain altitude, in addition to creating impediments to global air circulation. Moreover, cold ocean currents from the Antarctic provide little moisture for air currents to absorb and carry inland. The small amount of rainfall that does occur is quickly evaporated because of prevailing dry air. As a result, there are few perennial rivers or longstanding bodies of water. This also means that water supply and water demand are crucial issues to the survival of the region.

Among the countries in southern Africa, Namibia is considered the driest (Pallett, 1997). Its capital, Windhoek, is located in the middle of the country on the Central Highlands. It is 700 km from the nearest perennial river located near Namibia's border in the northeast. Windhoek is supplied with water from local boreholes, dammed ephemeral river surface reservoirs, and reclamation of wastewater from sewage effluent (Van Der Merwe, 1999). The capital city has a population of 288,500 with a growth rate of 4 percent per year. After taking HIV/AIDS into account, the growth rate drops to 1.8 percent per year. With the population growth, the water sources are currently stressed and will soon be at risk of exhaustion (World Health Organization [WHO], 2000). One solution is to augment the current water sources with new projects that are farther and farther away, but this is not a very economical option. An alternative solution to Windhoek's water problem is to reduce the water demand.

Organizations such as the Desert Research Foundation of Namibia (DRFN) have done studies on water demand management (WDM), but it is only recently that residents have been concerning themselves with the issue. It was not until 1994 that a WDM policy was passed by the city council of Windhoek (Van Der Merwe, 1999). In 1998, NamWater was created as a subsidized company by the government to supply bulk water to municipalities and other authorities. NamWater is determined to sell water in order to recover its full operating costs. As a result, they are hesitant to implement WDM practices until times of drought. They believe if there is ample water to supply the city, then the water should be sold, claiming that water that stays in the dams for extended periods of time will eventually evaporate or leak out and be lost. The municipality, which buys water from NamWater, also hopes to achieve full cost recovery. This leads to further complications in developing and implementing WDM policies and practices within Windhoek. In contrast, experts at the DRFN and Africon Centre believe that WDM should be practiced at all times. They calculate that there will never be a time when Namibians can simply use water as they please.

The goal of our project was to develop and recommend innovative improvements to the WDM plan of Namibian cities. To accomplish our goal, our primary objective was to analyse past and present problems and successes in Windhoek's WDM. It was through completing our objective that we carried out our project and developed our results and recommendations for the DRFN. We expected that, with our recommendations, the DRFN could implement our solutions in the community to improve the management of water in the City of Windhoek, and Namibian cities.

We used several methods to accomplish our objective. To gain knowledge of WDM practices and policies in Windhoek, we performed archival research of WDM reports, water management studies, and assessments of the water situation in Windhoek. In addition to archival research, we also conducted several interviews. We interviewed experts in water management to gather information on what was being done regarding WDM today and where WDM was likely to be most effective in the future. We also interviewed residents, students, and school employees to learn about their water use practices and knowledge of water conservation. The last method we used was field research. We used field research to further our understanding how Namibians use water daily and if they practice water conservation techniques. To gather this information, we installed advanced water meters in nine volunteer households. These meters recorded the amount of water used every fifteen seconds over a period of three days. In addition, we investigated two hardware stores to examine the availability of water-saving devices. Lastly, we took a tour of Windhoek to study the landscaping practices around the city, where we looked for evidence of whether or not people were conserving water.

As stated earlier, the City Council of Windhoek started passing WDM practices and policies in 1994. Our research demonstrates that some practices and policies were successful and some had problems.

The experts feel that the block tariff system, which charges residents based on the amount of water used, has been the most successful policy in lowering domestic water use. Moreover, wet industries, especially Namibia's beer breweries, have become more water efficient. The breweries reuse grey water within their facilities to reduce their water consumption and only use four litres of water per litre of beer. Most breweries in

the world use six to eight litres of water per litre of beer (Van Der Merwe, 1999). Another successful system the city developed is a dual pipe system. One pipe is used for delivering potable water, while a second is used to deliver semi-purified effluent. Semi-purified effluent is treated wastewater that is not suitable for drinking but sufficient for irrigation. Now large irrigation schemes, such as municipal gardens and sport fields, are watered using the treated wastewater. This saves a considerable amount of drinkable water for the city.

Unfortunately, some practices and policies have not been effective. For instance, gardens are not supposed to be watered during the middle of the day, pools should be covered when not being used, and households should have showerheads limiting flows to ten litres a minute. These are all things that are hard to regulate and are not enforced by the city. Part of the reality is there are no certified people to enforce such regulations.

We also discovered there is a significant amount of wasted water throughout the city. For instance, Windhoek has many large green gardens that use a lot of water. Although many of these gardens use semi-purified water, this water could be saved by using indigenous plants that can be just as visually appealing and can survive on low rainfall. A different problem that is threatening Windhoek's water supply is leaks. Using our water meter studies, we discovered that some residents lose a significant amount of water through leaks and high-flow water fixtures. In one residence, over half of the overall household consumption was attributed to a leaking toilet. The leak costs the family N$1,527 over the course of a year. Another residence had a leaking toilet, which constituted 81 percent of the total household water consumption. This costs that family over N$2,400 a year. Therefore, one way in which people can limit their water use is

through timely repairs of leaks and the use of water-saving devices. Upon visiting two hardware stores, we found that water efficient technologies were available and comparably priced to regular flow devices.

In conclusion, we have found there are successes and problems with the current WDM practices and policies of Windhoek. Some practices, such as the block tariff system, have been highly successful, but others, such as gardening regulations, have seemingly failed. Moreover, there are discrepancies that must be addressed among experts in water management. Nevertheless, from our research and analysis of the successes and problems of past and current WDM practices and policies, we developed a prioritised list of recommendations for improving the WDM plans of Namibian cities. This is a summarized list of our recommendations.

1. Improve educational programmes on water conservation both in schools and in local communities, regardless of the current water situation.
2. Improve response and repair time of infrastructure breakdowns.
3. Practice more accurate accounting of metered water use.
4. Promote and increase availability of water-saving devices.

Along with recommendations for Windhoek, we developed several recommendations for continuing and extending our work on WDM.

1. Study what can be done to reduce the amount of water used for agriculture and livestock, since over 70 percent of Namibia's water is used for agricultural purposes.
2. Study how much water high-income residents, who have lawns and pools, use compared to middle-income and low-income residents.
3. Create a carrying capacity study for the central region of Namibia based on the available water supply. This study would determine how many people could live in and around Windhoek without running out of water or degrading the resources of the region.

Abstract

Among the countries in southern Africa, Namibia is considered the driest. The capital city of Windhoek has a population of 288,500 with an annual net growth rate of 1.8 percent. This population growth has put considerable strain on the water supplies of the city and threatens to exhaust them. The goal of this project was to work with the Desert Research Foundation of Namibia to develop and recommend innovative improvements to the water demand management plan of Namibian cities.

Authorship

All chapters of this report were jointly written and edited by Justin Braga, Jacob Castiglione, and Joseph Higgins. However, there are sections of which each team member has claimed primary authorship. Justin Braga was the primary author of the interviews for residents, school officials, and students. He was also the primary author of the residential data logging analysis. Jacob Castiglione was the primary author of the low-flow technology investigation section and the recommendations section. Joseph Higgins was the primary author of the background section on government policies and also the analysis of past and present water demand management practices and policies.

Acknowledgements

There are several people that our group would like to thank for their generous assistance in contributing to this project.

First and foremost, we would like to thank our advisor from the Desert Research Foundation of Namibia, Nadia Manning, for generously providing guidance and direction during our project. We thank Andre Botes for his assistance, particularly in contacting and scheduling investigations at Pioneerspark Primary School and Jan Mohr Secondary School. We thank Patrik Klintenberg for his computer and network support. We also thank Dr. Mary Seely for welcoming us into the DRFN community and for approving our project.

From the Africon Centre we would first like to thank Gerhard Fourie who helped us extensively through the installation of data loggers, the collection and analysis of recorded data, and assistance in translating between English and Afrikaans during our residential interviews. We would also like to thank Ben Van Der Merwe who graciously took time out of his studies to bring us on a tour of Windhoek and its gardens, and in addition, provided us with valuable information on water demand management.

We thank André Mostert from NamWater for his time and information regarding NamWater's policies and practices.

We thank Ferdi Brinkman and Reynard Steynberg from the Windhoek Water Department for their assistance in understanding how the municipality supplies water to consumers and tries to control water demand.

We thank our friend and guide Mbahupu “Hippie” Tjivikua for giving us a Namibian experience that was unforgettable. We also thank Dr. Walter Holch for introducing us to the data loggers used in our residential investigations.

We thank the students, teachers, and school officials from Pioneerspark Primary School and Jan Mohr Secondary School who allowed us to investigate their facilities and graciously answered the questions from our interviews. We also thank students from the Polytechnic of Namibia for allowing us to investigate their flats and interview them. We thank the residents from Khomasdal and Katutura for allowing us to investigate their water usage and interview them about their water usage.

Last, but certainly not least, we would like to thank Prof. Susan Vernon-Gerstenfeld and Prof. Arthur Gerstenfeld, our project advisors. For four months, both at WPI and in Namibia, they directed us and challenged us to go beyond our capabilities to complete a project that would make an impact in our lives and the lives of Namibians. Certainly without their input and the help of all those mentioned above, this project would not have been possible.

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Chapter 1 INTRODUCTION

Southern Africa has one of the most arid climates in the world. Rainfall in the region is very limited due to topography, ocean currents, and global air circulation (Pallett, 1997). Mountains along the southwestern coast force precipitation from the clouds as the clouds gain altitude, in addition to creating impediments to global air circulation. Moreover, cold ocean currents from the Antarctic provide little moisture for air currents to absorb and carry inland. The small amount of rainfall that does occur quickly evaporates because of prevailing dry air. As a result, there are few perennial rivers or longstanding bodies of water. This also means that water supply and water demand are crucial issues in the survival of the region.

Among the countries in southern Africa, Namibia is considered the driest (Pallett, 1997). Its capital, Windhoek, is located in the middle of the country on the Central Highlands. It is 700 km from the nearest perennial river, which is located near Namibia's border in the northeast. Windhoek is supplied with water from local boreholes, dammed ephemeral river surface reservoirs, and from the reclamation of wastewater from sewage effluent (Van Der Merwe, 1999). With a population growth of 5 percent a year, these sources are currently stressed and will soon be at risk of exhaustion (World Health Organization [WHO], 2000).

Water management in Windhoek over the past one hundred years has concentrated on increasing the supply of water (Van Der Merwe, 1999). The city government focused on the question: "Where can we get more water?" This question has become more difficult and costly to answer, as the city has had to look for new sources of water increasingly farther away. In 1970, the city augmented the existing water sources

by constructing the Von Bach Dam 70 km from the city limits (Van Der Merwe, 2000). In similar efforts during 1979 and 1982, the city constructed the Swakoppoort and Omatako Dams 100 and 200 km from the city, respectively. The city has also invested heavily in the Goreangab Water Reclamation Plant with a $N100 million technology and facility renovation in 2002 (Inambao, 2002). While these projects have brought new sources of potable water to the city, officials are now facing greater challenges in satisfying the increasing demand for water. The government, however, is not alone in its efforts to answer these challenges.

The Desert Research Foundation of Namibia (DRFN) is dedicated to creating and furthering awareness and understanding of arid environments and developing the capacity, skills, and knowledge to manage arid environments appropriately (http://www.drfn.org.na/). Therefore, they work closely with the Namibian government to keep officials apprised of current environmental information (http://www.drfn.org.na/). The DRFN has also positioned itself to investigate and clarify the major issues of water demand management (WDM) in Windhoek. They have some of the region's best resources including a dedicated research centre in the Namib Desert and an extensive library of books and reports on water management published by DRFN researchers and other experts. They also have close working relationships with universities such as the Polytechnic of Namibia, developmental organizations such as the Africon Centre, and governmental entities such as the Windhoek Municipality.

Even though the Namibian government's WDM practices have recently created some headway toward solving the water shortage problem, there is still more to do. The Namibian government has had limited success with past policies, such as a voluntary 10

percent reduction of water usage by all people (DRFN, 1994). They have had some success with block water tariffs, which charge a household for the amount of water they use. They have also identified major consumers of water, but there has yet to be a detailed analysis of where water is being wasted and what steps can be taken to reduce this waste. B. Van Der Merwe (personal communication, March 26th, 2004) believes that the city residents could reduce consumption by 13 to 14 percent because that was the increase in consumption when WDM practices and policies were relaxed.

The goal of our project was to develop and recommend innovative improvements to the WDM plan of Namibian cities. To complete this goal, we also analysed the water usage by three schools and nine residencies in Windhoek, to be discussed later in the field research techniques section. From these studies, we identified and investigated problems and deficiencies in the WDM practices. Once we created a list of successes and problems, we worked with the DRFN and other stakeholders to develop recommendations for improvements in Namibia's WDM that promote and maintain equitable, efficient and sustainable water practices.

Chapter 2 BACKGROUND and LITERATURE REVIEW

Water demand management, rather than focusing on the water supply itself, focuses on the infrastructure for the delivery of water to consumers and how those consumers utilize water. In order for us to effectively develop a water demand management plan for the DRFN, we needed to acquire a working knowledge of the city of Windhoek and its climate, the general water supply conditions of southern Africa, governmental policies aimed at maintaining water availability, and the variety of water consumers. In the following sections, we will describe the background of these areas that are necessary for the reader to gain a full comprehension of our project.

Windhoek

The largest city in Namibia, Windhoek, is also its capital. Windhoek is located in the Central Highlands of Namibia at an elevation of 1600m. It sits between the Eros Mountains in the north and the Auas Mountains in the south. Towards the west, the Khomas Highland stretches to the Namib Desert and the coast (Namibia-Travel, 2004). The city is one of the major traders in Karakul sheepskins (Columbia, 2003). The local companies make clothing from the skin and process the meat and bone meal within the city. Windhoek is also a transportation hub. It is connected into the Republic of South African's rail network and linked by highway to the major port of Walvis Bay (Columbia, 2003). First made into a seat of power by chief Nama, in the 19th century, after defeating the Herero inhabitants of the region, the territory was later occupied and ruled by Germany from 1895 to 1915 (Columbia, 2003). During World War I, South West Africa, as Namibia was formerly known, was captured by South African troops.

The city still displays its colonial history through the German architecture and language but it has a distinctly African flair (Namibia-Travel, 2004).

Population

With an estimated population of 147,000 in 1991, increasing to 288,500 in 2001 (223,000 in urban housing and 65,500 in informal settlements), Windhoek is growing at approximately 4 percent a year, while the country is only growing at a rate of 2.2 percent per year (City of Windhoek, 2002). Of this growth, approximately 70 percent is from immigration to the city while only 30 percent is from direct growth (Van Der Merwe, 1999). However, numbers from the City of Windhoek census in 2001 and recent research indicate the urban population growth rate, taking HIV/AIDS deaths into account, drops to approximately 1.8 percent (Windhoek Development and Planning, February 15, 2004). The reduction in population growth due to HIV/AIDS somewhat offsets the large influx of immigration. In addition, the population in Windhoek will remain relatively young as the disease reduces the number of people living to old age (http://www.dea.met.gob.na). The graph in Figure 1 shows that the population of Namibia is projected to increase at a significant rate into the near future. The Directorate of Environmental Affairs calculated these numbers in 2001.

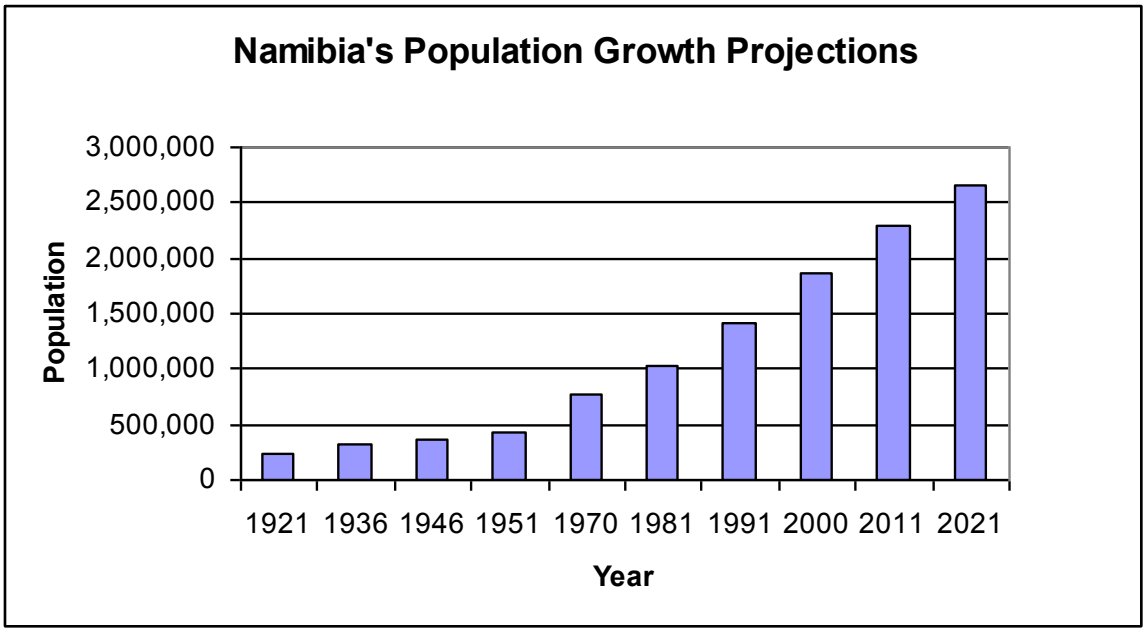

Figure 1. Namibia's Population Growth Projections (http://www.dea.met.gob.na)

Wide ranges of socioeconomic levels comprise Windhoek. The range spans affluent low-density neighbourhoods with large gardens and water piped directly to the residence to high-density informal settlements with little or no gardens and a communal water supply (Van Der Merwe, 1999).

Climate

As previously mentioned, the climate of southern Africa is very arid and Namibia's location on the continent makes it the driest country in the region (Van Der Merwe, 2000). A combination of ocean currents, global air circulation, and topography bring Namibia an average rainfall of only 450 mm each year (Pallett, 1997). Even within Namibia, rainfall amounts vary greatly. Annual rainfall in the capital city of Windhoek may total 400 mm. This stands in stark contrast to the western coastal cities of Walvis Bay and Swakopmund that may receive only one small rain event, which brings less than

50 mm of water during an entire year. In addition to low rainfall, yearly evaporation rates as high as 3,700 mm allow only 3 percent of the year's rainfall to accumulate as runoff or recharge groundwater (Tjijenda, 2002). The most challenging aspect of Namibia's climate for those who make water decisions is that any area can experience great fluctuations in rainfall from one year to the next (Pallett, 1997). Therefore, A. Mostert (personal communication, April 1st, 2004) claims Windhoek city planners take the median rainfall instead of the mode. For example, the city of Windhoek may receive almost 600 mm of rainfall one year, but the next year only receive 200 mm of rainfall, one-third of the first year's amount. In contrast, Boston receives 1054 mm of rainfall per year on average with a variation of around 100 mm between years (http://www.worldclimate.com).

Water Supply in Namibia

The Water Supply & Sanitation Report 2000 (WSSR) for Namibia assessed the water resources for the country and developed the following descriptive statistics. Namibia's renewable water resources equal 9,000 m^3/year (Pallett, 1997). Using these numbers and Namibia's population of 1,726,000, the WSSR claims a water allotment of 77 m^3/cap/year (2000) [1]. The personal daily water requirement depends on many variables; however, the amount of water the human body needs ranges from two litres/cap/day in temperate climates to 4.5 litres/cap/day for persons doing manual labour in hot climates (WHO, 2003). In addition, people require another two litres/cap/day for cooking (WHO, 2003).

[1] 1,000 litres = 1 m^3 = 264.172 gallons

Water Sources of Windhoek

Van Der Merwe (2000) reported that in 1998 Windhoek obtained its water from boreholes, dams in rivers near the city, ephemeral river retention structures, and wastewater reclamation. The amount of water supplied by each method varies from year to year slightly with the changes in weather; however, Figure 2 shows the average 95 percent assured safe yield total per year of each of Windhoek's sources. An assured safe yield of 95 percent means that the amount of safe water available for consumption is calculated to be within 95 percent of the number stated, taking into account normal weather patterns and natural events. In 1998, Windhoek relied primarily on catchments of runoff from ephemeral rivers to supply potable water to the city, while reclamation accounted for only 12 percent of the total supply.

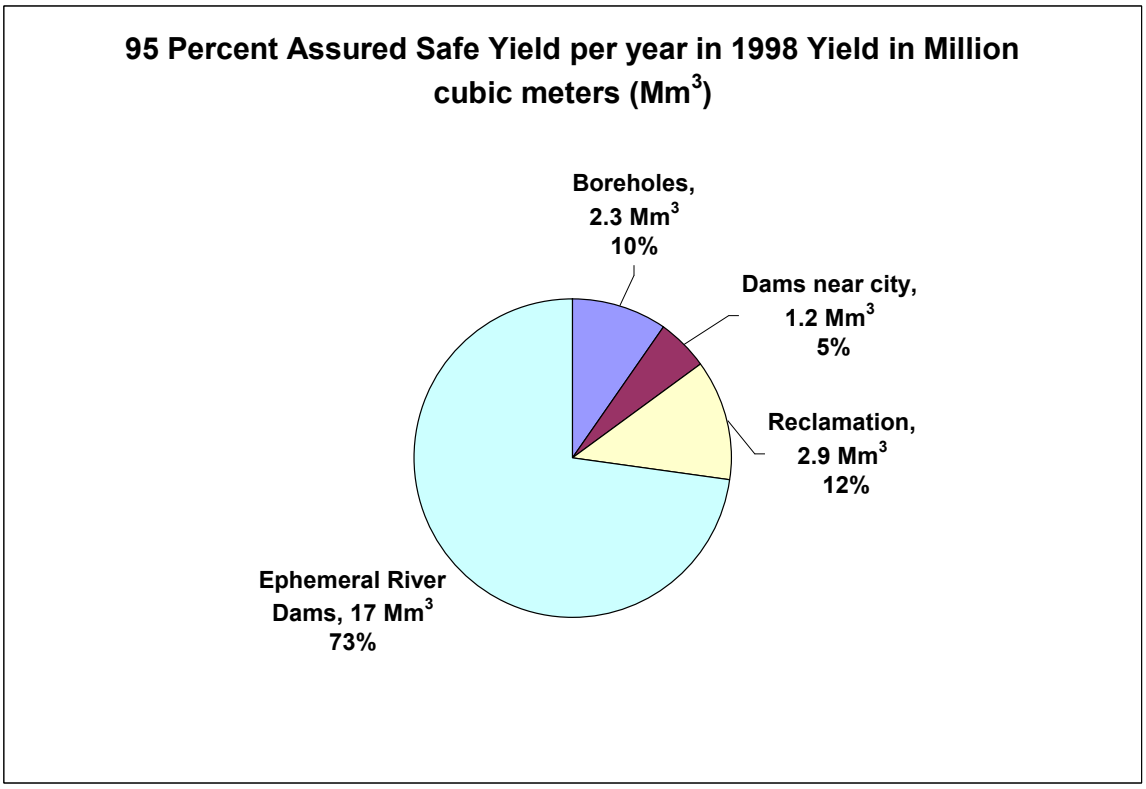

Figure 2. Windhoek's Water Supply Distribution (Van Der Merwe, 2000)

The nearby surface reservoirs behind Avis Dam (2.4 Mm^3), which was constructed in 1933, and Goreangab Dam (3.6 Mm^3), which was built in 1959, supply Windhoek with 1.2 Mm^3 of potable water a year (Van Der Merwe, 2000). Then in 1968, the city created the Goreangab Water Reclamation plant, which treats 100 percent of the wastewater from the public sewers. Upgraded periodically over the past 36 years, the plant generated 2.9 Mm^3 of potable water for the city in 1998 (Van Der Merwe, 1999). Figure 3 shows the new ozonation equipment that is part of the latest upgrades to the facility. Other upgrades included biologically activated carbon filtering and membrane filtration, which are not shown in the picture (http://www.windhoekcc.org.na). In 1969, the government decided to start creating bulk infrastructure in the ephemeral rivers around the city. Thus, in 1970 they created the Von Bach Dam (48.6 Mm^3) 70 km from Windhoek (Van Der Merwe, 1999). Later, in 1977, the government built the Swakoppoort Dam (63.5 Mm^3) 100 km outside the city (Van Der Merwe, 1999). In 1982, they constructed the Omatako Dam (43.5 Mm^3) 200 km from Windhoek (Van Der Merwe, 1999). While there is a management system in place to pump water from dams that have high evaporation rates to those with lower evaporation rates, these three combined reservoirs can provide only 17 Mm^3 of potable water to Windhoek (Van Der Merwe, 1999).

Figure 3. Goreangab Wastewater Reclamation Plant (http://www.windhoekcc.org.na/)

Figure 4 shows the bulk water distribution capacity of the areas of Windhoek at normal operating levels. The primary suppliers of water to Windhoek are the ephemeral rivers under the NamWater scheme.

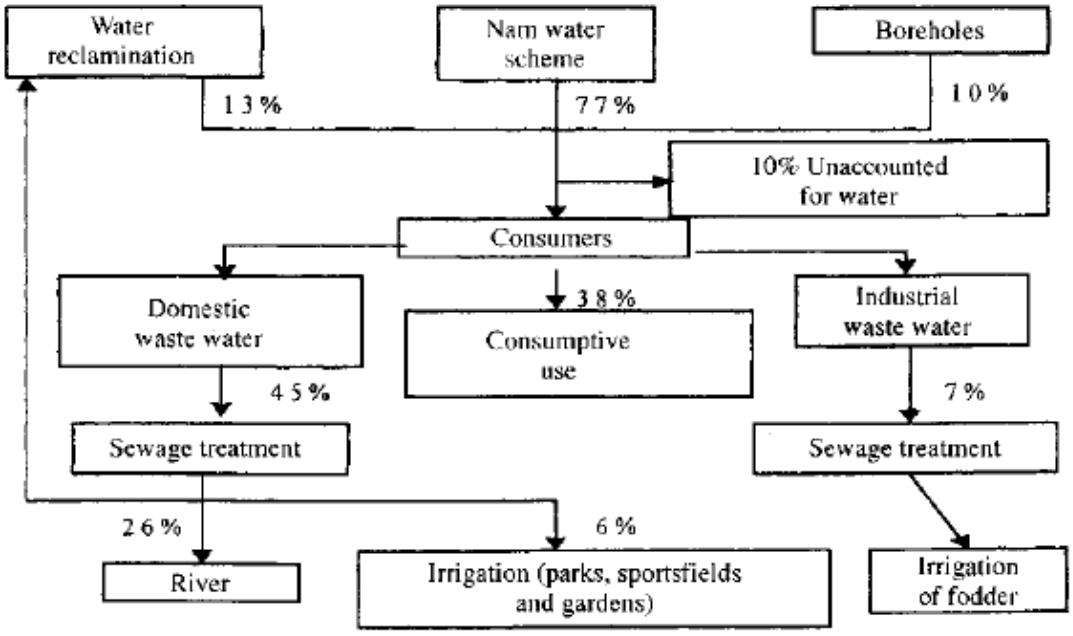

Figure 4. Existing Bulk Water Supplied to Windhoek based on 100 percent Supply 1998 (Van Der Merwe, 2000)

In addition to providing water directly to residents, the NamWater system also uses deep well injection of treated water to recharge local aquifers (Van Der Merwe, 2000). Deep well injection is an experimental process that is yielding encouraging results. Nearby boreholes are recovering four times faster than through natural recharge (Van Der Merwe, 2000). The water is taken from the Von Bach Dam and treated in the Goreangab Water Reclamation Plant before being pumped to special borehole pumping stations. The pumping stations are currently used to inject water into shallow boreholes to recharge the aquifer and raise the water table. This new project has exciting prospects as B. Van Der Merwe (personal communication, March 26th, 2004) and other experts calculate that the underground aquifer beneath Windhoek has an unused non-evaporative storage capacity of approximately 25-66 Mm^3 (2000). The gain in evaporative losses is significant, as shown in Table 1, with a minimal annual recharge capability of 10-15 Mm^3

(Van Der Merwe, 2000). This can only take place if there is more than sufficient water available for general use by Windhoek and central Namibia. In an average year, A. Mostert, the chief hydrologist for NamWater (personal communication, April 1st, 2004), believes there is enough water left over for artificial recharge if the previous years had average rainfall. However, Mostert also said he is concerned that the city will not be capable of extracting water fast enough from the recharged aquifer when the situation arises. He is worried that the extraction rate will be too slow for practical use using the currently available boreholes and pumps.

Table 1. Evaporative Losses Savings over 3 years (Van Der Merwe, 2000)

Artificial injection in first year only (Mm^3)	Saving in evaporation loss over 3 years (Mm^3)	Total saving* in surface water over 3 years (Mm^3)
10.00	3.95	11.95
15.00	5.70	17.70

*An allowance of 20% was made for losses in the aquifer during storage.

Windhoek's Current Water Supply

There are currently four sources of water supplying Windhoek and central Namibia: surface reservoirs, the new water reclamation plant, boreholes, and the old water reclamation plant. According to the City of Windhoek (2002), under normal conditions of rainfall, consumption, and evaporation, the Von Bach Dam is able to supply the 21 Mm^3 of water per year required by the city and surrounding areas.

Fortunately, the central area of Namibia has more resources than the Von Bach Dam. As seen in Figure 5, the red arrows show the flow of water from the dams to the city's residents. The shallow dams, Swakoppoort and Omatako, supply water to the Von

Bach Dam. This is done because the Von Bach Dam's reservoir is deep and narrow and has the lowest surface area to volume ratio of the three dams. These characteristics are helpful in reducing evaporation losses.

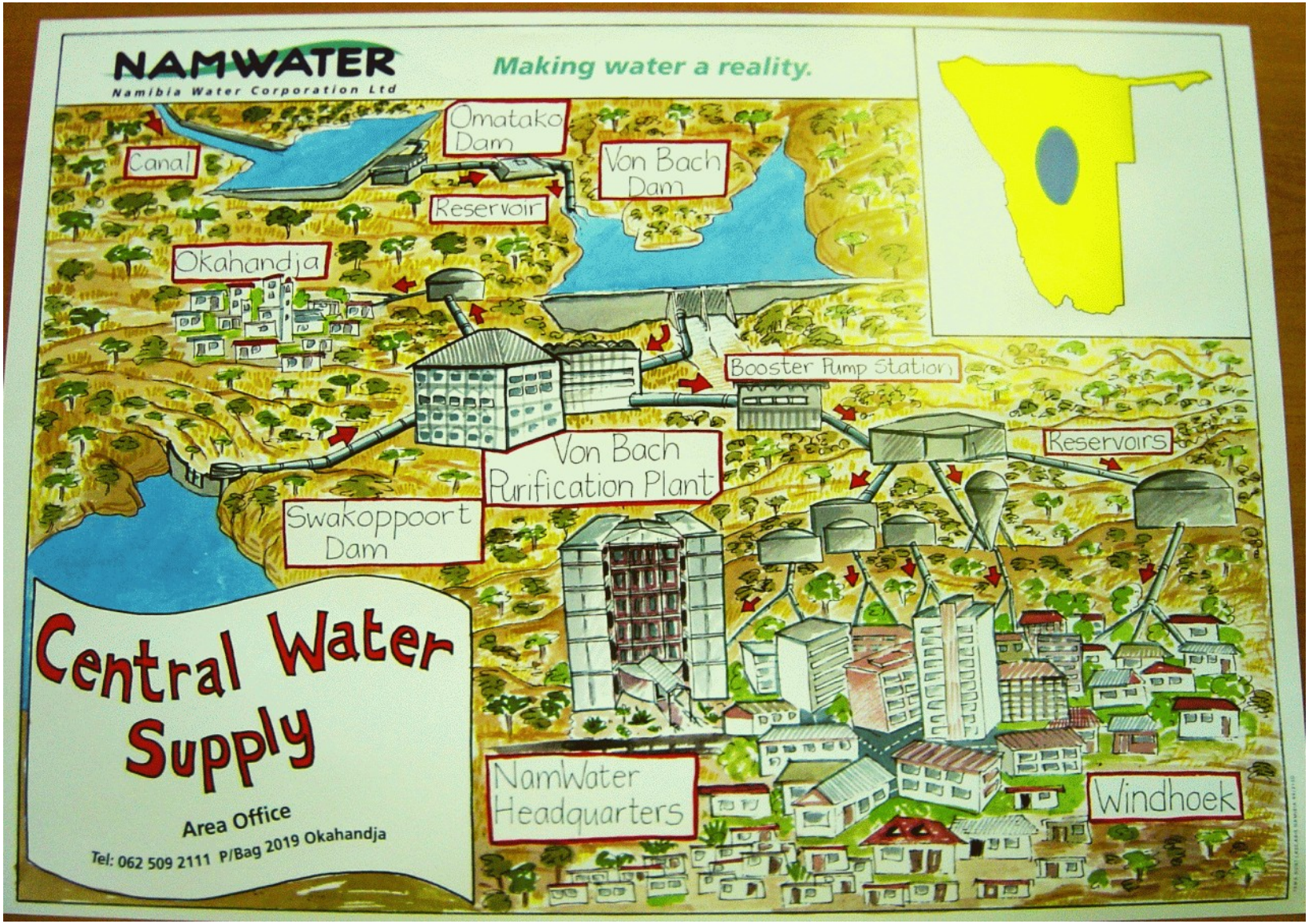

Figure 5. NamWater Map of Water Sources for Windhoek (not to scale)

In addition, the City of Windhoek (2002) claims the new Goreangab Reclamation Plant, constructed in 2002, purifies 5.5 Mm^3 of water per year. This is less than the maximum possible capacity of 7.5 Mm^3 calculated for the reclamation plant during emergency operation. The Goreangab Reclamation Plant has undergone seven renovations and upgrades in thirty-six years of operation and remains the only full effluent reclamation plant in the world operating 100 percent to create potable water for reuse (City of Windhoek, 2002).

Another source of water for Windhoek is boreholes. Boreholes supply approximately 1.73 Mm^3 of water annually, but they are able to supply five Mm^3 of water for three years in an emergency. After using the boreholes as an emergency supply, they must be allowed to recharge for at least as long as they were drained (Pallet, 1997). Sometimes it takes longer for the aquifer to recharge than it does for city engineers to extract water. To enhance the borehole's water source, the City of Windhoek (2002) is working on a plan to recharge the aquifer artificially. By 2010, the City of Windhoek (2002) intends to be able to recharge the aquifer at the rate of 16.5 Mm^3 per year.

The fourth source of water for Windhoek is the Semi-Purified Irrigation Water Project. The old Goreangab Reclamation Plant was modified to treat water more quickly and cost effectively for supplying irrigation water. The irrigation water is supplied to customers using one pipe while the new Goreangab Water Reclamation Plant supplies potable water to the city's water mains using a second. This practice lends its name to the system as a whole, which is sometimes referred to as a two-pipe system. The City of Windhoek (2002) estimates the old reclamation plant is capable of supplying 1.825 Mm^3 of water per year for irrigation.

Figure 6 describes the volume and distribution percentages of the four water sources supplying Windhoek and central Namibia. Note that the percentage of reclaimed water has more than doubled in just four years. It now accounts for 26 percent of Windhoek's total water supply.

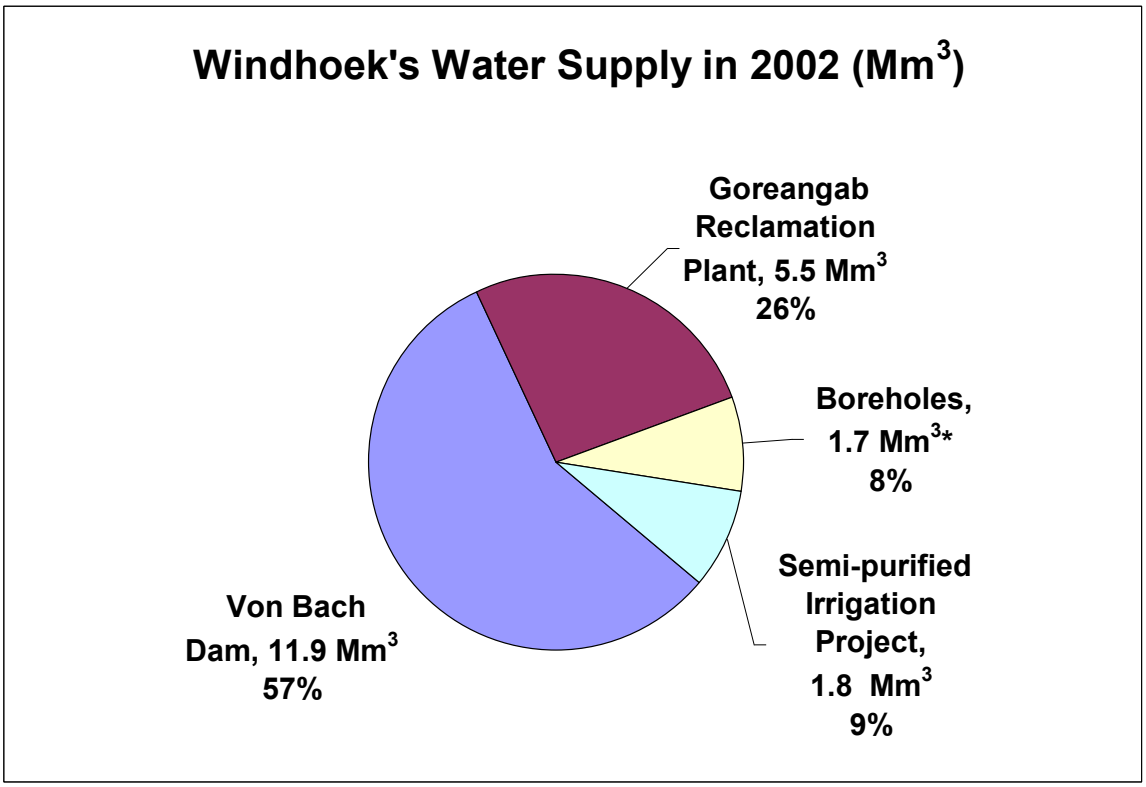

Figure 6. Windhoek's Water Supply in 2002 (City of Windhoek, 2002)

*Boreholes can supply five Mm^3 of water for 3 years in an emergency

Regardless of how the city obtains its current supply of water, the supply is finite and there is a high capital investment for new water augmentation schemes (Van Der Merwe, 1999).

The water supply system also faces several challenges. According to NamWater data, the need for water has grown 3 percent per year and shortages could occur after one or two seasons without adequate rainfall (http://www.namwater.com.na). Aging infrastructure and leaks also cause a major problem in the form of lost and unaccounted

water. In 1999, the most recent data available, the calculated total cost of water lost was N$4.56 million per year at a bulk unit price of N$2.40 per m^3 (Van Der Merwe, 1999).

Government Policies

Namibia gained independence from South Africa on March 21, 1990 (http://www.grnnet.gov.na/). Although relatively new, the government has already adopted and put into effect many policies and programmes pertaining to sustainable development. The president of Namibia, Dr. Sam Nujoma (2002), has made sustainable development one of his main goals because he believes it provides for those living in Namibia today and in the future. The government has started developing and employing five year National Development Plans to concentrate efforts on such needs as roads, clinics, and water outlets (Nujoma, 2002). For instance, the government hopes to provide 80 percent of the rural population with potable water within the next four years (http://www.grnnet.gov.na/).

There are two main suppliers of water in Namibia: the national government and the Namibia Water Corporation. Within the government, the Department of Water Affairs has two directors who are responsible for the water supply of Namibia: the Director of Resource Management and Director of Rural Water Supply. The second water supplier in Namibia, the Namibia Water Corporation, also known as NamWater, is the only commercialized company authorized to supply bulk water in Namibia (http://www.grnnet.gov.na/). They are responsible for bulk water supply in high population areas, whereas the government is responsible for supplying rural areas (http://www.grnnet.gov.na/). See Appendix B for more information on NamWater.

The government's administration of water is based on four pillars: the constitution, the Water Act (Act 54 of 1956), regulations issued in terms of the Water Act, and the Water Supply and Sanitation Sector Policy (WASP) (Heyns, et al., 1998).

Namibia's Constitution

The Namibian Constitution states "land, water, and natural resources below and above the surface of the land and in the continental shelf and within the territorial waters and the exclusive economic zone of Namibia shall belong to the [S]tate if they are otherwise not lawfully owned"(Hicks, et al., 2003). In addition, Article 95 of the constitution "primarily states that Namibia will promote and maintain the well-being of the people by instituting policies that maintain ecosystems and biological diversity for the good of all Namibians" (Jacobson, et al., 1995). Article 95 is directly related to many environmental issues and is often referred to in any recent publications (Jacobson, et al., 1995). Though Article 95 is not enforceable by law, it serves as a very important policy regarding the environment (Jacobson, et al., 1995).

Water Act No. 54 of 1956

The main basis of the Water Act No. 54 of 1956 is the difference between public and private water (Jacobson, et al., 1995). The Act contains several provisions such as the establishment of a water board, protection of water resources, prevention of water pollution, and other general provisions (Heyns, et al., 1998). Private water is defined as water that is contained on land that is owned by an individual, and public water is water that runs in a river or other type of natural flowing stream (Jacobson, et al., 1995). Special regulations can also be put into effect during times of water shortages through the

Act (Jacobson, et al., 1995). The existing Water Act of 1956 is quite old and has discrepancies with the constitution. It also does not consider the environment as a consumer of water (Heyns, et al., 1998). Namibians rely on the environment and must understand that the environment needs water as much as people do to survive (Jacobson et al., 1995).

Water Supply and Sanitation Sector Policy

The Water Supply and Sanitation Sector Policy, better known as the WASP document, has been an important policy, establishing changes in Namibia and playing an important role in creating the Director of Rural Water Supply as well as NamWater (Heyns, et al., 1998). According to the WASP, all Namibians should have essential sanitation and potable water services available to them (Heyns, et al., 1998). These services should be offered at a rate that is affordable to all the people of Namibia (Heyns, et al., 1998). The policy also requires private landowners to install their own water and sanitation services (Jacobson, et al., 1995). The Ministry of Agriculture, Water and Rural Development ([MAWRD], 2000) believes service enhancements should be done through neighbourhood interaction and responsibility. However, progress in this area continues. In 1991, 51 percent of rural areas were receiving potable water. In comparison, since the implementation of the WASP document, rural areas supplied with water have increased to 65 percent (MAWRD, 2000).

Pricing

To consumers in Namibia, the price of water is a very delicate subject, but it is very important to the management of water demand. In Windhoek, as in many large

cities throughout the world, there is a wide spectrum of people living at different financial levels. Some own luxurious homes with carefully cultivated lawns and landscapes. However, many people are able to afford only a one-room home made of corrugated iron. Moreover, for many years, water was viewed as a resource that everyone should have at no charge (Lange, 1998). However, with an increasing strain on water supplies and a great inequity in the water distribution due to water depletions in areas, it was clear that something needed to change (Pallett, 1997).

Water pricing plays a major role in controlling water consumption (Van Der Merwe, 1999). In general, putting a price on water has an inverse relationship with water demand. Consumers, aware that using more water will cost them more money, tend to reduce their use of water. However, the pricing of water must be done in such a way that demand is controlled, full cost of the water is recovered, and all people that use the water are treated fairly (Van Der Merwe, 1999). For example, instituting a price too low may prove ineffective in recovering costs or controlling demand, especially in regards to those families who enjoy a high income. Pricing water too high tempers the demand of high-income families; however, it also could make water unaffordable to low-income families.

Block tariffs

In 1995, Windhoek first introduced a monthly stepped-pricing system for water. It was created to offset the cost of subsidizing the supply of water to communal and commercial agriculture, low-income households, and rural communities (Lange, 1998). The pricing scale has evolved over the previous decade with increases in the price of water and in the volume of each step or usage level.

The lowest level of the block tariff scale is aimed at providing a fair price to those families that have low income (Lange, 1998). At the time of our study, the first six kilolitres of water were priced at N$4.17/kilolitre, giving a total monthly bill of N$25.02 for a full six litres of use (City of Windhoek). The next 39 kilolitres are priced at N$6.94/kilolitre, with a total monthly bill of N$295.68 for using a full 45 kilolitres (City of Windhoek). Consumers who use more than 45 kilolitres must pay a penalty tariff for every kilolitre over 45 kilolitres. This penalty tariff is priced at N$12.78/kilolitre. By raising these prices, the government can recover more of the full costs associated with the provision of water (Van Der Merwe, 1999).

In addition, experts in the field of natural resources accounting, such as Lange, have studied Namibia's water pricing system and have shown that, in many instances, the early tariff systems did not fully account for the true economic and social costs of supplying water (1998). Lange also exposed sectors in 1995, such as manufacturing, that could pay more for water and not lose much profit because of the low cost of water (1998). Moreover, experts believe that, at the very least, the blocking tariffs raise an acute awareness among consumers of the scarcity of water in the region. Moreover, they help to promote water conservation, making it a powerful tool in water demand management (Lange, 1998).

Consumers

In Namibia, agriculture is the main user of water with crop irrigation using 45.8 percent and livestock using 26 percent of the total water consumption. The second highest consumer of water is the urban domestic sector, which uses 19.2 percent. Mining is the next highest consumer using 4.5 percent of Namibia's water supply. Industry, rural

communities, and tourism combine for 4.6 percent of Namibia's water consumption (MAWRD, 2000).

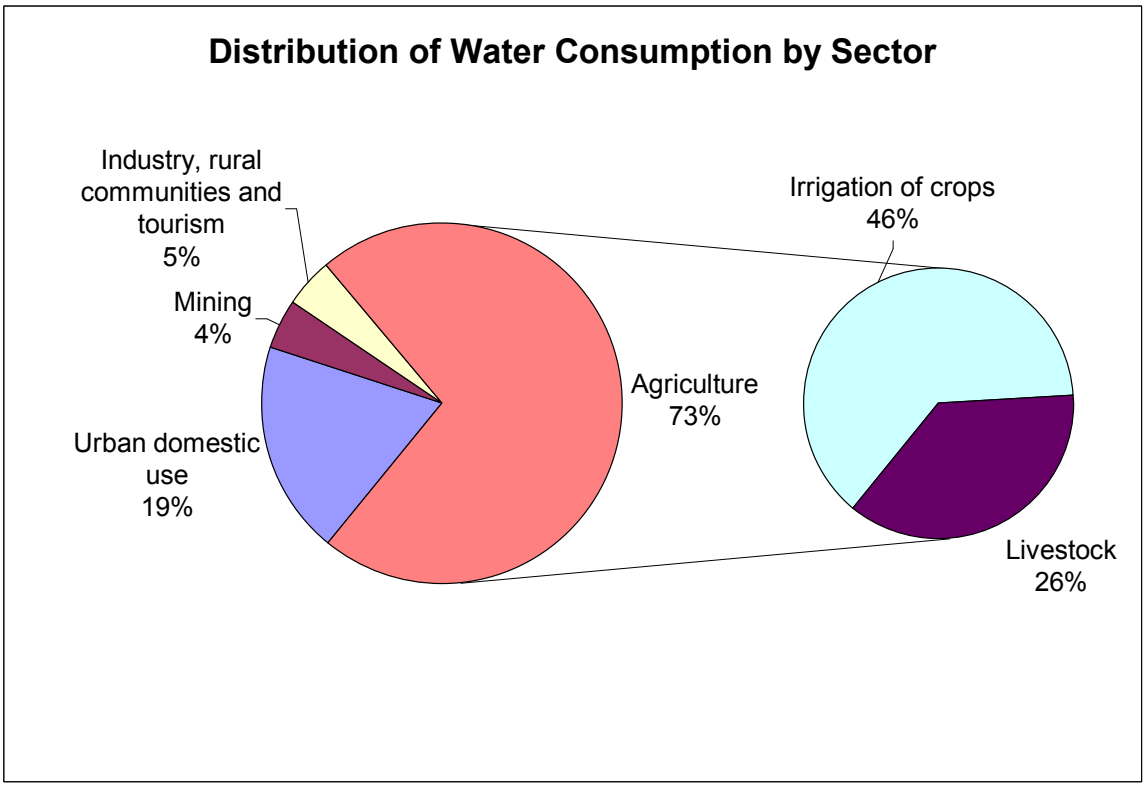

Figure 7. Distribution of Water Consumption by Sector (MAWRD, 2000)

See Appendix C for information on the effects of income on water consumption for urban residents.

Chapter 3 METHODOLOGY

The goal of our project was to develop and recommend innovative improvements to the water demand management (WDM) plan of Namibian cities. Our primary objective in achieving our goal was to analyse past and present problems and successes in Windhoek's WDM. In this chapter, we present how we accomplished this objective.

The first task we had in achieving our objective was to gather the data on what has already been attempted or successfully done with WDM in Windhoek. We collected data by several different means. One method was archival research, in which we studied printed sources such as books and reports. The second method was interviewing experts in water management located in the city of Windhoek. Our final method was field research, for which we conducted investigations of WDM in the communities of Windhoek with the DRFN. This investigation consisted of garden and landscape research, residential water usage logging, resident and student interviews, and low-flow technology investigation. Upon completion of these tasks, we analysed the data compiled from the sources mentioned above. Using the analysed data, we generated and evaluated recommendations for the improvement of WDM in Windhoek and devised innovative ways in which those recommendations could be implemented in not only Windhoek but also other Namibian cities.

Archival Research

In order to understand the successes and problems of WDM in Namibia, we needed to know the detailed information on the pricing schemes, the reuse methods, the government policies, legislation, and public education and awareness campaigns that

have already been attempted or successfully implemented in Namibia, particularly in Windhoek.

One valuable resource that was utilized extensively was the library of the Desert Research Foundation of Namibia. As one of the leading organizations in the research of Namibia's arid environment, the DRFN has published numerous reports, books, and other materials that have influenced water management policies throughout the region. Information that we obtained from the DRFN included reports on water use, pamphlets on water practices, water research studies, and guidelines for WDM.

NamWater, the bulk supplier of water to Namibia, was also a key provider of information necessary to determining the detailed water situation in Windhoek. NamWater has a resource centre containing more than 2,500 pieces of literature, most of which is focused primarily on engineering, hydrology, and hydrogeology (http://www.namwater.com.na). From NamWater's resource centre, we obtained pricing scales, consumer reports, dam volume statistics, supply locations, reclamation efforts, government regulations, and further information regarding water demand management practices and water quality. WDM practices from NamWater gave us the supplier's perspective of demand management.

Windhoek city records were examined for census data, urban growth statistics, WDM policies, and city ordinances regarding water use. WDM policies enacted by the city of Windhoek represented the governmental perspective on water demand management. Finally, city ordinances were studied to learn how city council members have used the power of the law to enact water demand management statutes.

Expert Interviews

We conducted semi-structured interviews with five experts in water management in both the conservation sector and the supply sector. The semi-structured form allowed us to be flexible in these meetings. We were able to adjust our questions to explore additional information that we did not think to obtain with our first set of questions. Our primary objective for each meeting was to understand the failures and successes of past WDM programmes, the current challenges of WDM, the current state of WDM, and what direction WDM might move in the future. Secondary objectives included obtaining additional reports on WDM, understanding city and national governmental structures, gaining knowledge of water technologies, and identifying other key experts in the field of WDM.

The experts we interviewed included the following:

- Ben Van Der Merwe
  - Technical Advisor, City of Windhoek
- Dr. Walter Holch
  - Professor of Environmental Engineering, Polytechnic of Namibia
- Ferdi Brinkman
  - Chief Engineer of Bulk Water and Waste Water, City of Windhoek
- Reynard Steynberg
  - Senior Technician – WDM, City of Windhoek
- Andre Mostert
  - Chief Hydrologist, NamWater

We selected Ben Van Der Merwe as our first interviewee based on his extensive publication in the area of water demand management. In our interview with Van Der Merwe, we utilized the snowball technique to obtain the names of other experts in the field who referred us to still others, forming the complete list above.

Field Research

By employing methods of field research in the city public landscape, residential homes, schools, and local businesses, we were able to develop a hands-on perspective of WDM. We used informal and scientific observations, interviews, and surveys to investigate water use practices, water pricing, water leakage, water-efficient technology, and education about water conservation.

Garden and Landscape Research

Our first area of field research consisted of a city garden and landscape tour. Van Der Merwe took us on a tour of Windhoek gardens to gain an understanding of how the people of the city perceive the water shortage in the city. For instance, if the National Parliament's water-dependent gardens are lush and watered daily during drought situations, the local people may get the wrong idea and practice poor WDM practices. To gain this understanding, we examined the particular ways in which people and the local and national government used water to support landscaping in the city.

We visited Gammans Cemetery, NamWater Headquarters, the Parliament Gardens, the Namibian Supreme Court, the Bank of Namibia, the Windhoek Municipality Building, and Christus Kirche. These locations were selected by Van Der Merwe to give a balanced view of efficient and inefficient landscaping and examples of where semi-purified water is being used. We wanted to know if the green gardens were using high efficiency watering techniques or wasteful watering techniques.

The focus of our tour was observing how the semi-purified irrigation water was used to keep gardens and cemeteries around the city green. We took account of the lushness of the vegetation and the amount of water required to keep the plants healthy.

We also took note of who owned the property (i.e. the municipality, the national government, a business, a private resident.)

Residential Water Usage Logging

Concurrent with our arrival in Windhoek, Gerhard Fourie, a graduate student and Windhoek native studying with Van Der Merwe at the Africon Centre, began installing data loggers at nine households in Windhoek. The Africon Centre is a professional consulting service specializing in engineering and infrastructure-related development and management (http://www.africon.com). The homes the Africon Centre selected were homes in low-income areas of Windhoek who had participated previously in an energy logging project conducted by NamPower and the Polytechnic of Namibia. The homeowners worked for the Windhoek Municipality in some capacity and volunteered to have their homes used in the water consumption study being performed by the Africon Centre.

The loggers, provided by the Polytechnic of Namibia, were hooked into specialized water meters, which are attached to the water supply line outside the home. This was important because some of the homes had old meters that were suspected to give inaccurate measurements. The data logger polled the water meter every fifteen seconds for three days and recorded the water flow in litres per second. Following three days of logging, we manually interfaced with the data logger via a serial port on a notebook computer. The data was then downloaded to the personal computer through a data logger software suite named Radcom.

We organized the data gathered from the data loggers, and combined it with our residential interview to investigate the relationships between the two forms of data. The relationships we were particularly interested in are between and among:

- education
- water leaks
- water uses
- volume of water used
- water pricing
- exposure to conservation practices

(USEPA, 1998)

A computerized spreadsheet provided an excellent medium for analysis of the logged data because it allows one to display, manage, and calculate large amounts of data easily. In addition, computer spreadsheet programmes have the ability to create tables and graphs of the data they contain. Using graphs and tables of our data, we were able to find and analyse trends in water demand. For instance, we examined the nightly flow rates to determine if the house has water leaks, and we examined day flow rates to determine which residents use the least amount of water and why. Using this information we could estimate how much water was wasted over a period of time and how much money it would cost.

School Facilities Investigation

In addition to investigating residences in Windhoek, we studied three local schools: Pioneerspark Primary School, Jan Mohr Secondary School, and the Polytechnic of Namibia. We investigated these schools to see if any water-saving methods were applied within school facilities. Our group used informal observation to examine showers, faucets, and other water outlets for leaks and potential leaks. We then recorded

the location and severity of each leak. By observing the types of fixtures installed in the school facilities, we obtained an indication of how committed the schools are to spending money on water-efficient technology. In addition, fixtures such as leaking toilets, which are in need of repair, might portray a contradiction for students between the school's teachings and its actions.

The bathroom investigation at the primary school was done in four large bathrooms located in the 4th to 8th grade wing of the primary school. These locations were chosen because of their access by large numbers of students in all years of study. However, students in the lower grades, 1st to 3rd, have access to bathrooms within their classrooms, where they are under the supervision of the teacher. We chose not to investigate the supervised bathrooms because we felt those bathrooms would only give data on how well the teacher oversaw the bathroom and not on what the students practiced on their own.

The secondary school was not directly investigated for leaks. However, information about water usages and water-saving methods at the facility was obtained from discussion with the headmaster of the school.

Five flats from the Polytechnic of Namibia's Shangri-La hostel were investigated, in addition to our own accommodations in the Polytechnic's hostel. The flats had only male residents and differed in the total number of residents living in each flat.

Residential and School Interviews

To supplement and better understand the significance of the data logger information, we used interviews to gather information about water use from eight of the nine residences in Windhoek that volunteered to have their water usage logged. We

developed the questions for these residents in cooperation with the DRFN and Van Der Merwe. We chose to administer these questions in the form of a semi-structured interview so that we could modify the questions if there were misunderstandings. The full list of questions posed to residents is included in Appendix D.

We administered the interviews of residents at one of two times: when the data loggers were installed or when the data was downloaded from the logger. This was for two reasons. The first reason was that it was necessary for Gerhard to introduce us to the residents. The second reason was that, in some cases, when residents were not fluent in English, Gerhard assisted us by translating the questions and responses between Afrikaans and English.

We studied the three local schools named in the previous section to see what water conservation principles were built into the curriculum. We interviewed teachers and school officials in both the primary and secondary schools. The questions we asked in the interviews were adaptations of the questions used to survey household residents, and they can be viewed in Appendix E. We modified the residents' interview questions to focus primarily on the educational aspect of water conservation by asking questions regarding the integration of water conservation teachings in classrooms.

To comprehend how well students are actually learning from the curriculum, we interviewed students at all three schools using adaptations of the questions used to interview homeowners. We interviewed four students from the primary school. These students were arbitrarily chosen and interviewed at the midday break. The four students we interviewed at the secondary school were chosen by the headmaster. We only interviewed four people in each school because of time limitations with the students and

in this project; however, in both instances, we were able to interview two girls and two boys to obtain a gender balance. We interviewed five male students from the Polytechnic of Namibia who lived in the flats where we also investigated the bathroom facilities. Appendix E includes a full account of the questions posed to students from the three schools.

We examined the information we gained from our interviews by tabulating the information. Since our interviews were semi-structured, we needed to use an open coding scheme in order to evaluate the responses. We coded the responses to our questions by looking for similar responses to our questions for each group. Once we had an organization of the responses, we created coding categories for the experts such as successful WDM practices, WDM problems, and WDM improvement possibilities. The coding categories for school officials and students were: successful awareness campaigns, unsuccessful awareness campaigns, and potential improvements to education of WDM. Organizing the information in this way, we gained insight into the similarities and differences between the two groups and found potential ways to reduce those differences.

Low-Flow Technology Investigation

Another area of field research we found to be important was visiting two of the local plumbing stores to see what fixtures and devices are available to the people of Windhoek for their homes. We chose to visit and investigate the only two hardware stores for Windhoek that could be found in the Telecom Namibia Directory, Pupkewitz Megabuild and African Tiles. We focused on examining advertisement, availability, price, aesthetics, and water-efficiency of showerheads, toilets, and faucet aerators. One

limitation of this investigation was that we only investigated two hardware stores. Given more time, we could have found and investigated more hardware and plumbing supply stores around Windhoek to form a more comprehensive study.

Past and Present Windhoek WDM Practices Analysis

Once we obtained information on Windhoek's past WDM practices, we needed to analyse those practices to determine their effectiveness and what problems they created or encountered. To analyse the effectiveness, we reviewed the year a policy or practice was implemented, and we reviewed the per capita consumption data for that year in addition to several years after the implementation. We also had to take into account variables such as droughts, floods, and other WDM practices. Moreover, we used the information from the other topics we analysed to support and supplement the information we found in the archival research. We also relied on past studies to understand what practices and policies experts felt were successful or problematic and on what bases they made their assessments.

Chapter 4 ASSESSMENT OF PAST AND PRESENT WDM PRACTICES

Water demand management (WDM) is a multifaceted program that includes several different measures such as structured water pricing, legislation, education, and water-saving technology. These different measures, described in Chapter Two, have different levels of success and failure. In order to better develop recommendations that will be useful and effective in Windhoek, it was necessary for us, first, to understand those successes and failures of past WDM practices, present WDM practices, and those practices planned for future drafting and implementation through city regulations and policies.

This chapter explores the information we gathered from our investigations. We first discuss what experts in the field of water management explained to us. Then, we discuss our first investigation of gardens and landscaping around Windhoek, which familiarized our group with some of the basic issues of WDM within the city itself. Next, the water flow data, collected from the residential data loggers, is discussed along with the responses to our interviews with residents. Subsequently, we discuss our low-flow technology investigation. Our analysis concludes with our assessment of past water demand management practices and policies as it relates to the preceding investigations and their findings.

Water Demand Management Practices Successes and Problems

Many regulations and policies have been and are currently being created to help control the water problem in Windhoek, according to the World Conservation Union

(1999). Limited WDM practices have been put in place since 1992 in the city of Windhoek, but it was not until 1994 that the city council approved an integrated WDM policy due to the severe droughts of the early 1990's (Van Der Merwe, 2000). Several policies implemented over the past ten years on WDM have been successful, but there have been some problems (MAWRD, 2000).

One of the more successful WDM policies is the block tariff system, which is a punitive system that charges a consumer based on the amount of water used. In its first year of implementation, the city's water consumption reduced by an average of 31 L/capita/day. The second year the tariff was in place, water consumption reduced by 54 L/capita/day. Furthermore, the water consumption has never rebounded to levels close to those before 1994, even though the population grew 3 to 4 percent per year. This correlation suggests that the block tariff system may have been successful in reducing water consumption.

However, there are some problems with the block tariff system. From our interviews with residents, we found that many were not familiar with the block tariff system and how it explicitly worked. Moreover, many of those who are familiar with the pricing system feel that the price of water is too high and have repeatedly appealed to Helmut Angula, the Minister of Agriculture, Water and Rural Development, to have the government provide water free of charge. The idea of free water comes from the fact that water was supplied for free during the fight for independence to help enlist the support of the community. This created the idea that water was plentiful and that the government would continue to take care of the people in this fashion. Regardless of public sentiment, the block tariff system seems to have been very successful in making people use less

water, and Minister Angula has remained adamant in his stance that water is quite affordable, and that it will not be supplied free of charge (Dentlinger, 2004)[1]. In an effort to ensure that reasonable pricing is maintained the new Water Resources Management Bill (WRMB) that has been in Namibian Parliamentary Debate for the past three years includes the institution of an Independent Pricing Regulator, whose job is to fix reasonable prices for water consumption and effluent discharge (2001).

The WRMB mentioned above is intended to replace the outdated Water Act of 1956. However, the final draft of this bill has been delayed in the Namibian Parliament for quite some time. Although the WRMB addresses several important issues, such as basin management, management water supplies, and water pollution control, it seems to neglect the important issue of water demand management. Less than two pages of the 72-page document deal explicitly with efficient water use and water conservation. It empowers the Minister of Agriculture, Water and Rural Development to utilize instruments such as water metering, pricing structures, and public education to reduce water demand (WRMB, 2001). However, the bill does not get into any specifics on how or when these instruments will be implemented nationwide. Furthermore, WDM experts such as Ben Van Der Merwe (personal communication, March 26th, 2004) are concerned with the fact the WRMB does not deal extensively with water use in irrigation, livestock, and farming which constitute a bulk of the country's water use. This evidence suggests that this bill, if it becomes law, may not have the large impact that water conservationists had hoped.

One set of policies that has had limited success and numerous problems is the set of water use regulations. Windhoek claims that it is the only city in southern Africa with

[1] For full newspaper articles on water management published during our project refer to Appendix F.

a water control officer (http://www.grnnet.gov.na). This officer is supposed to enforce the laws set forth by the city to properly manage private water use (Van Der Merwe, 2000). Residents of Windhoek may not water their gardens during the middle of the day when evaporation is at its highest, and pools must be covered when they are not being used (Van Der Merwe, 2000). Unfortunately, F. Brinkman, Chief Engineer of Bulk Water and Waste Water for the City of Windhoek (personal communication, March 24, 2004), informed us that there are presently only two police officers who are certified to monitor water practices as water control officers. F. Brinkman claims that, as a result, the enforcement of gardening times, covering pools, and having a water control officer year-round is not a reality for the City of Windhoek.

Many programmes have also been set up to educate the public concerning their water usage. Educational programmes performed in schools such as lectures, appearances on radio and television, billboards along the road, and pamphlets inserted into water account statements have been identified as powerful vehicles in making residents more aware of ways in which to save water (Van Der Merwe, 1999). This claim is supported by comments in our residential and schoolteacher interviews. Those who were interviewed pointed out these practices as important ways to educate the public. In addition, articles in newspapers on landscaping methods such as suitable shrubs and trees for desert climates and recommendations on resourceful watering practices have also been helpful. However, according to several of the experts we interviewed and confirmed by a Windhoek resident (personal communication, April 6, 2004), most education programmes, especially on radio and television, only run during

years and seasons of limited rainfall. This practice reinforces the idea that water-saving measures are only important during times of severe drought.

Another important issue is the reduction of unaccounted for water. Water leakage recognition by residents and water audits by the municipality and NamWater are completed on a constant basis (Van Der Merwe, 1999). Moreover, the City of Windhoek implemented repair programmes and proper supervision of water meters (Van Der Merwe, 2000). This has increased the accuracy of the data used to account for all the water and has increased the accuracy of the block tariff system.

In addition, pipe replacement programmes are in position to help the city save water, but they still need some work (Van Der Merwe, 1999). F. Brinkman (personal communication, March 24, 2004) said that the city water department allocates approximately N$1 million a year to replace pipes. According to him, most pipe sections are replaced only as they fail, but if some sections have multiple leaks then that section will be replaced before there is a major problem.

Although the repair program, as described by F. Brinkman (personal communication March 24, 2004), seems to have been relatively effective, there are still leaks and problems throughout Namibia. One example of these problems was observed by our project team on a corner of the Polytechnic of Namibia campus. The cap, seen in Figure 8, leading to the water main shutoff valve, leaked sporadically, yet significantly, for two weeks starting on March 17th, 2004.

Figure 8. Leaking Water Main Shutoff Cap Near the Polytechnic of Namibia

Furthermore, F. Brinkman (personal communication, March 24, 2004) has seen formal reports and studies, created for his department, indicating that 18 percent of Windhoek's total water consumption is unaccounted. This percentage is well over the normal for Windhoek, which is 10 percent. An example that R. Steynberg, Senior Technician of Water Demand Management for the City of Windhoek's Department of Infrastructure, Water, and Technical Services (personal communication April 14th, 2004) provided to us was the discovery of a metered connection that had no designated account owner. This meter was read and the volume numbers discarded for several months because the city did not have an account owner in their system. Once the error was discovered, it was found that approximately 400,000 m^3 of water were consumed, uncharged for, and unaccounted for from this connection. Steynberg informed us that he

has several of these problematic accounts a year, but the situation is improving as the municipality continues to upgrade their accounting systems and practices.

Interviews with Experts

In our investigation of the WDM practices of Windhoek and surrounding towns, we interviewed five experts in the field. The experts presented a varied picture of the water management situation in Windhoek.

One expert working at NamWater and two experts working for the Municipality claimed that WDM practices are necessary only during times of drought and low supply. In times of higher supply, these institutions need the income generated by selling water to cover the costs of treating and supplying the water. If WDM practices are put into place, water use declines, as it is supposed to. However, a decline in water use represents a loss of revenue for NamWater. In addition, once the emergency passes, water consumption does not rebound. Rather, it remains low. This is a serious problem, because full cost recovery is important if the water suppliers are to remain solvent and sustainable. Furthermore, the experts from NamWater and the Municipality believe that the amount of water wasted from evaporation out of the surface reservoirs is substantial enough that the water should be used productively rather than simply being lost to the atmosphere.

Most experts working at the DRFN and the Africon Centre feel that the water supply in Namibia is always at a point when water-saving measures should be implemented in order for the population to maintain a sustainable water supply. They project that the water situation is never going to be at a level where people can use water as they please. Moreover, they conclude that since Namibia is a semi-arid country, Namibians must always be conscious of the amount of water consumed and the amount

of water wasted. In times of drought, the situation is critical, and every Namibian should feel responsible for managing their water use. However, during times of ample rainfall, the DRFN and Africon Centre experts feel that the water-saving practices and policies should remain in place to conserve the water available. Additionally, they believe excess water can be used to recharge the aquifers and thus be stored until times of greater need without the worry of evaporation.

Garden Investigation

By investigating a variety landscaping and gardening techniques throughout Windhoek, we observed what steps the city has taken to save water. The information gained from our investigation of gardens is important to analyse, because most of Namibia's water is used for irrigation. Even though Windhoek is an urban area, water that is used for irrigation purposes is apparent throughout the city.

There are two different types of gardens in Windhoek. The two types of gardens are colonial and indigenous. Colonial gardens are very green and contain plants that need to be watered frequently to stay alive. An example of a colonial garden is the garden outside the Namibian Parliament, featured in Figure 9.

Figure 9. The Namibian Parliament Garden

Indigenous gardens, such as the one in Figure 10, contain succulent plants that are natural to Namibia's environment and need very little water to survive.

Figure 10. An Indigenous Garden

There are many examples of colonial gardens throughout Windhoek. The Gammams Cemetery, Country Club, and Parliament Gardens are just a few examples of colonial gardens. The Country Club golf course, in particular, has a lot of green grass that uses a lot of water. To water these gardens, the city has developed a dual pipe system that uses one pipe to deliver drinkable water for people and another to deliver semi-purified effluent for large irrigation purposes. Semi-purified effluent is wastewater that has been treated but is not suitable for drinking.

The Parliament Garden in Figure 9 is watered using a sprinkler system, whereas the Gammams Cemetery uses a drip system. A drip system is more efficient in saving water but is just as effective. Even more effective than a drip system, however, is an indigenous garden that needs no watering system.

Residential Data Logging and Residential Interviews

Working with Fourie, a graduate student studying water consumption and water-efficient technologies in Windhoek, we recovered data from nine low-income houses in Windhoek. The data was recorded over a period of three full days.

The resident of the first household we visited explained that she did not know of any leaks in her home. The data presented in Figure 11 confirms this claim.

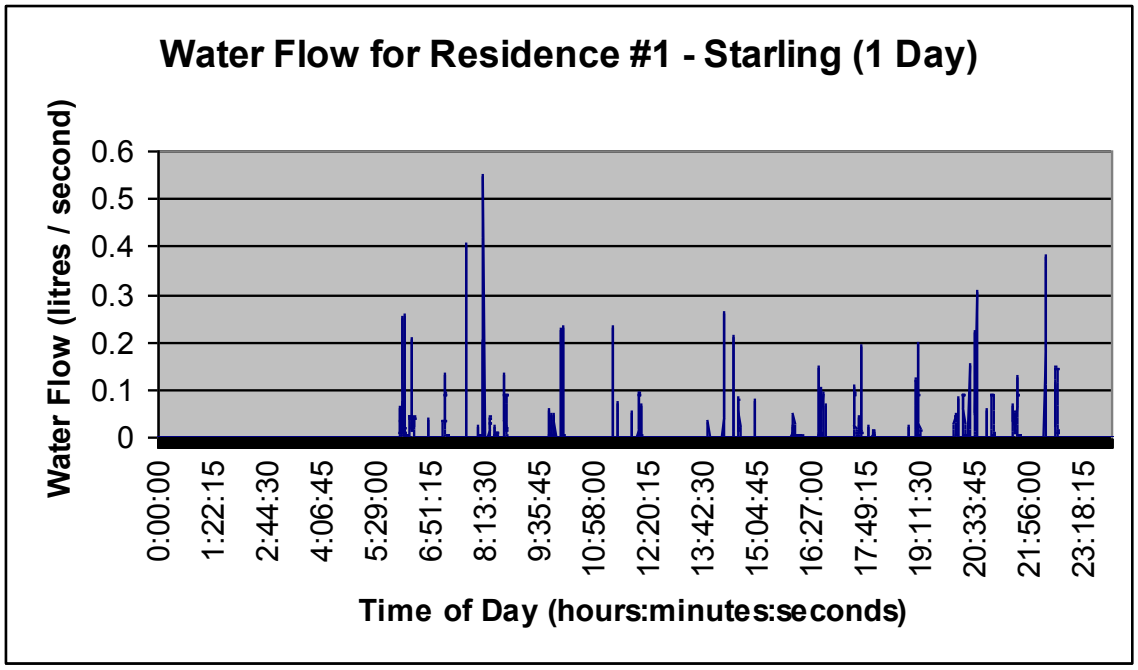

Figure 11. Water Flow for Residence #1 – Starling (1 Day)

Note that during the night there is no water flow being detected by the water meter. The main instances of water consumption occur during the morning and evening hours, with less water being used during the middle of the day when, presumably, most people in the household are working or are at school. The figure also shows that this household, which has six occupants according to our interview, has a very modest water consumption of 445 litres per day. The short duration of the water flow spikes support the household's claims of low water usage made during the interview.

In an interview at our second residence, the homeowner described a sink tap and toilet that had been leaking for quite some time. The resident said that he did not pay much attention to how severe the leaking toilet was. However, from the data logger information presented in Figure 12, it is clear just how severe the leak is.

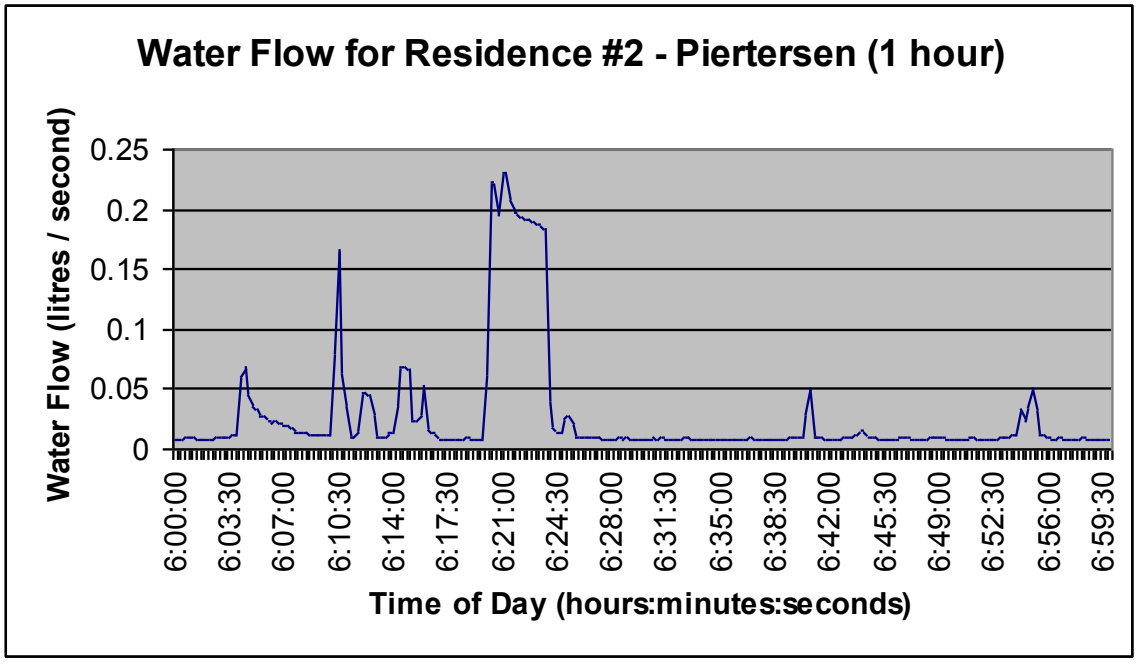

Figure 12. Water Flow for Residence #2 – Piertersen (1 hour)

The water flow when water is not being used in the house is approximately 32 litres per hour. This family of six uses a considerably greater amount of water than our first residence mainly due to garden watering and showering. However, leakage accounts for most of the water flow at this residence, as seen in Figure 13.

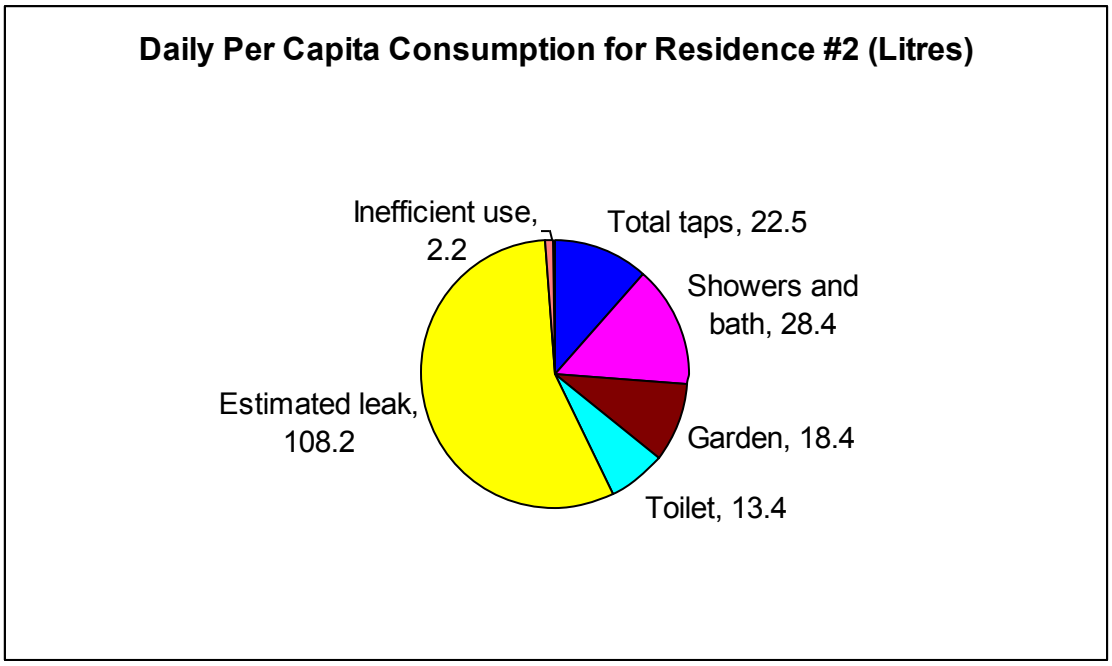

Figure 13. Daily Per Capita Consumption for Residence #2

This household leaks an estimated 20.74 kilolitres of the 40.55 kilolitres of water that flows into the house each month. If the leaks were not repaired, this household would pay an estimated N$1,527 over one year for wasted water.

Residence number three did not have a leak as substantial as has residence number two. The homeowner cited that a sink tap and toilet were leaking in the house. The monthly leakage for this residence totals an estimated 7.78 kilolitres. However, this leakage over time accounts for over one quarter of the total monthly water flow in the household and costs and extra N$37 a month in the water bill for every month it leaks. In one year, this amount totals over N$448.

The homeowner of residence number four noted in his interview that the only leak he was aware of was his toilet, which leaked throughout the day. This leakage can be clearly seen from the logger data in Figure 14.

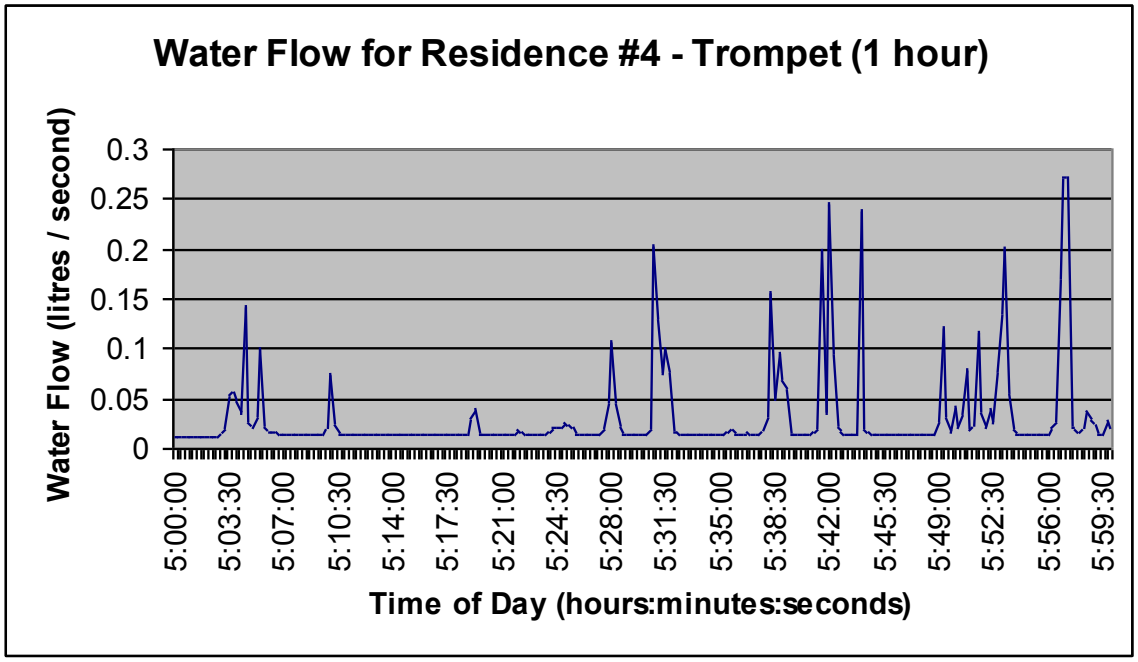

Figure 14. Water Flow for the Residence #4 – Trompet (1 hour)

The logger recorded a water flow of 0.012 litres per second consumed throughout the day when water was not being explicitly used. This leakage totals 1,059 litres per day. When that daily leakage is projected over one month it totals 31.8 kilolitres, or 77 percent of the total water flow into the household, as seen in Figure 15.

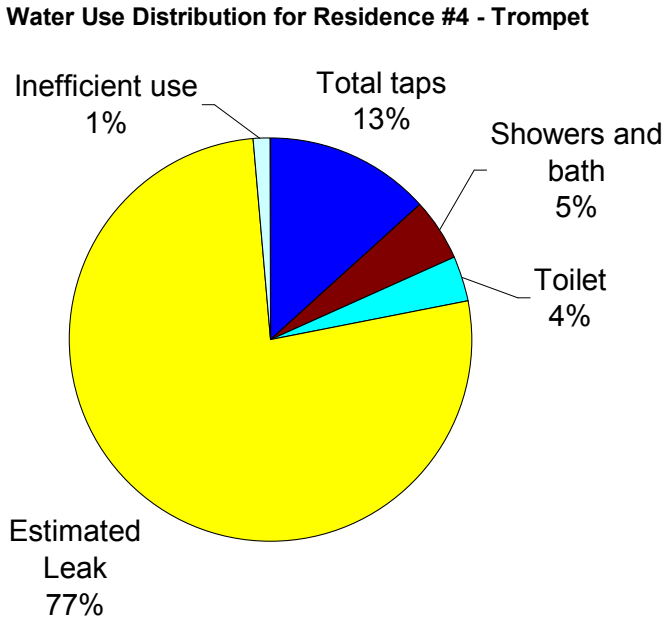

Figure 15. Water Use Distribution for Residence #4 - Trompet

Therefore, each month this homeowner wastes roughly N$204 in leaking water. Out of all the residents we interviewed, this homeowner was the only one who indicated that he felt water was too expensive. For one month's payment for leakage, this resident could fix the problem with the toilet, as long as the toilet did not need to be totally replaced. Moreover, this resident would have enough money in just over four months to buy a new porcelain dual flush toilet, which is described in more detail later in this chapter.

The information collected from the data loggers showed that many houses did not have leaks, and the residents of these homes used a modest volume of water. Figure 16 shows the estimated monthly water usage for the nine homes investigated.

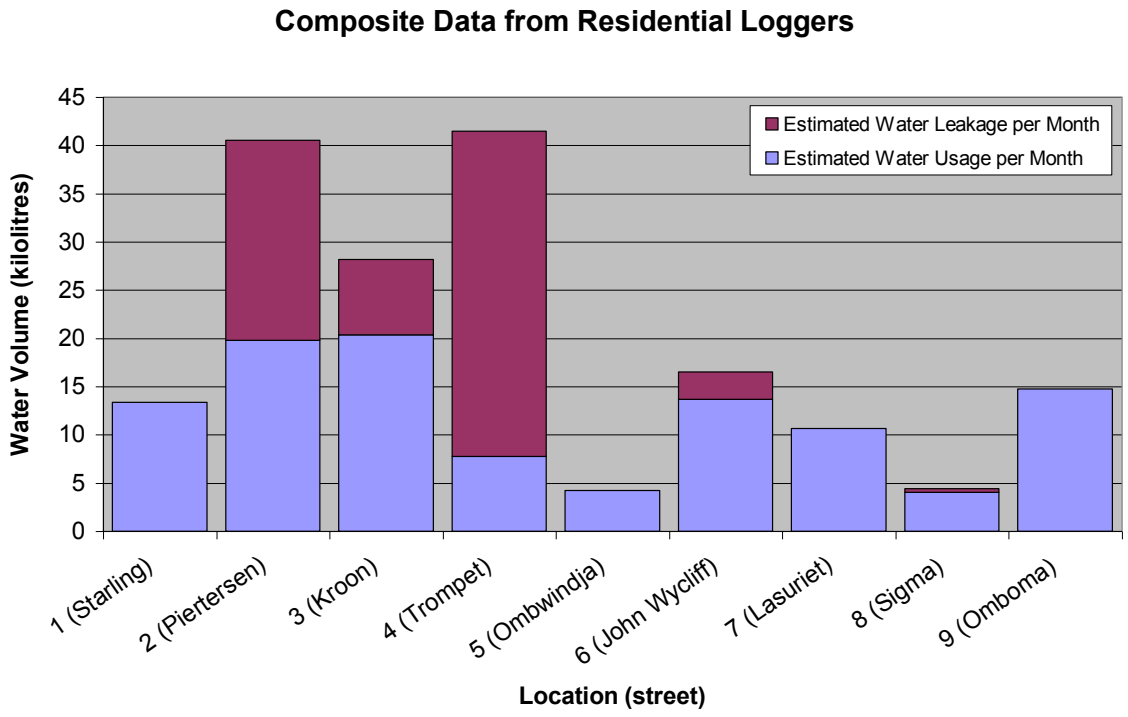

Figure 16. Composite Data from Residential Loggers

The average monthly water usage of the six homes that had little or no leakage was only 10.65 kilolitres. This stands in stark contrast to the 36.72 kilolitres used each month by the three homes with severe leaks. If the leaks in residences two and four were eliminated, those homes would only be using around twenty kilolitres each month instead of over forty kilolitres. Residence four would barely exceed the bottom level of the block tariff system if the homeowner eliminated the leak there.

Additional Information from Residential Interviews

In addition to this information, there were several correlations found between the residential interviews. Some of the themes indicated a lack of water conservation techniques and water in Namibia. Nearly all of the residents interviewed felt that water was available in good quantity here in Namibia and only that attention should be paid so

that it is not needlessly wasted. Most residents were not familiar with water-saving devices such as low-flow showerheads, dual flush toilets, and aerators. In addition, half of the residents interviewed were not familiar with how water is priced in Namibia at all.

Other themes from the interviews with residents showed some effort to practice good water use. Even though many residents did not know about particular devices or water-saving technology, they understood that water must be conserved for the future. Most households cited rather modest water usage despite several people living in one residence. Some residents check their water meters from time to time to identify leaks and figure out their water use. Most residents had seen or heard about water conservation and water-saving techniques through posters, newspapers, and television. The residents also suggested some important ideas on how to further the awareness of the water situation in Namibia including education, particularly of younger people, and also campaigns that are conducted in all of the indigenous languages of Namibia, not just English and Afrikaans.

Although our sample of residents in Windhoek was non-representative and non-random, the information we obtained may be suggestive of a much larger portion of the population. A more thorough investigation would have taken more time and money than is reasonably possible for an eight week project, but may have yielded more substantive results.

A full tally of responses to our residential interviews can be found in Appendix G.

Investigation of Water-Saving Devices

To determine the availability of water-saving devices in Namibia, we visited two separate stores. The first store we visited was a large hardware store, Pupkewitz

Megabuild, which had a rather extensive plumbing section. The second store, African Tiles, concentrated mostly on bathroom and sink fixtures. We only examined two stores because there were only two stores we could find within Windhoek as advertised in the Telecom Namibia Directory, and because we had a limited amount of time to conduct our investigation.

We found water-saving technology advertisements in place in one store, while the other store was helpful in pointing out low-flow technology upon request. Figure 17 is a picture taken of an advertisement placard for the RST Company. The advertisement displays physical devices, explains how they work, and describes how much water one would save if these devices were installed.

Figure 17. Water-saving devices available at Pupkewitz Megabuild (Not including dual flush toilets)

We discovered that water-saving toilets were available at both stores. These water-saving toilets were dual flush models that are operated by using two different flush

buttons. One button is for a full flush and the other for a half flush. A full flush would commonly be used for solid waste, while a half flush would be used for liquid waste. In addition, there are different cistern sizes available to save water. The nine-litre cistern uses the same volume for a full flush as most standard flush toilets, therefore only providing savings when a half flush is used. However, the six-litre cisterns use three litres less water with a full flush and six litres less water with a half flush making them very water efficient compared to standard flush toilets.

Even though low-flow technology is important in saving water, other aspects are also considered when purchasing a toilet. For instance, many people look at design and style when looking to purchase a new toilet for their home. A porcelain dual flush toilet is comparable in aesthetic design to standard flush porcelain toilets. In contrast, the plastic toilets we observed seemed "low-cost" and appeared less stylish than porcelain toilets. However, other people feel the cost of a toilet is an important consideration. As seen in Figure 18, the dual flush porcelain toilets are more expensive than most standard flush porcelain toilets, but the dual flush plastic toilets are the least expensive of the three.

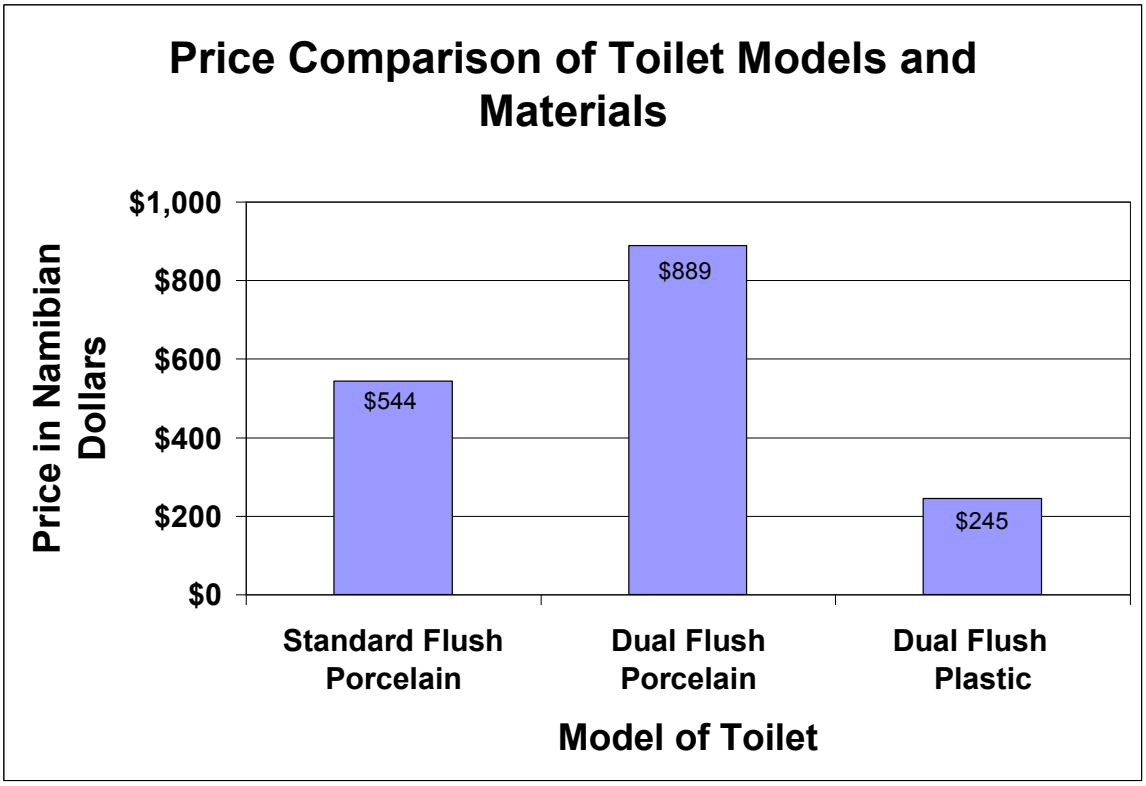

Figure 18. Price Comparison of Toilet Models and Materials

R. Steynberg, senior technician of water demand management for the Windhoek Department of Infrastructure, Water, and Technical Services (personal communication, April 14, 2004), feels dual flush toilets are not worth the money since a toilet stop, which was available at Pupkewitz Megabuild for N$118, could be put in a regular toilet and save just as much water. A toilet stop, shown in Figure 18, is a device that delivers a "demand flush." When the lever is pushed and released, the toilet stop, which is attached to an arm in the toilet's cistern, allows only two to three litres of water to flush, with the option of holding down the lever to flush more. Another inexpensive way of forcing a toilet to use less water is to place a rock or a brick in the cistern of a toilet to take up volume and, therefore, reduce the amount of water that fills the cistern.

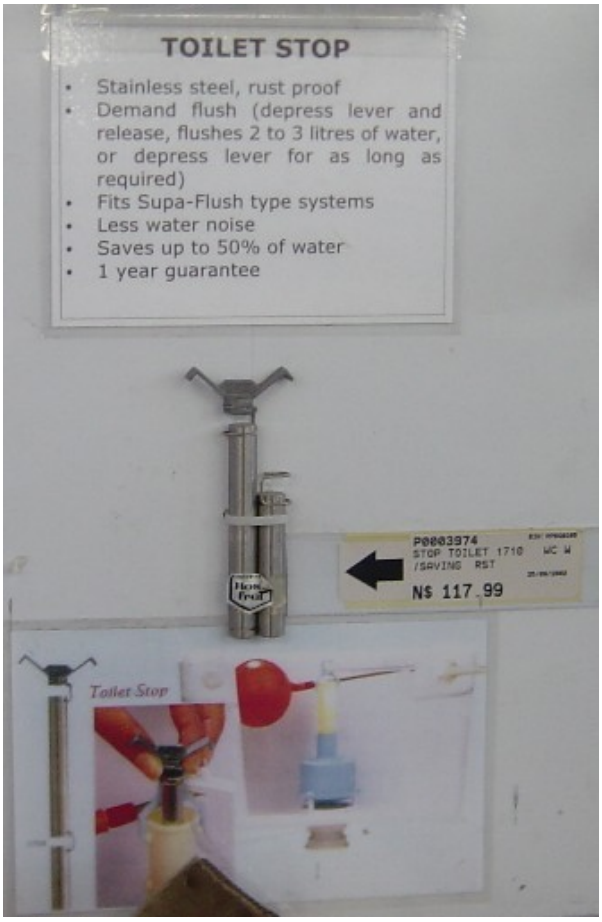

Figure 19. A Toilet Stop

When we looked at the cost-benefit analysis of using low-flow toilets, we discovered that it is feasible for a family to recover the initial cost in anywhere from two months to six years depending on the toilet model and family size. Looking at

Figure 20, we see that the high cost of dual flush porcelain toilets can be recovered within a minimum of five years, though with most households this would happen much sooner. In Figure 21, we see an even faster cost recovery time for the inexpensive dual flush plastic toilets. The dual flush plastic toilet's cost recovery time is under one year. These calculations were made assuming two liquid and one solid use per person per day and a monthly water tariff of N$6.94 per kL.

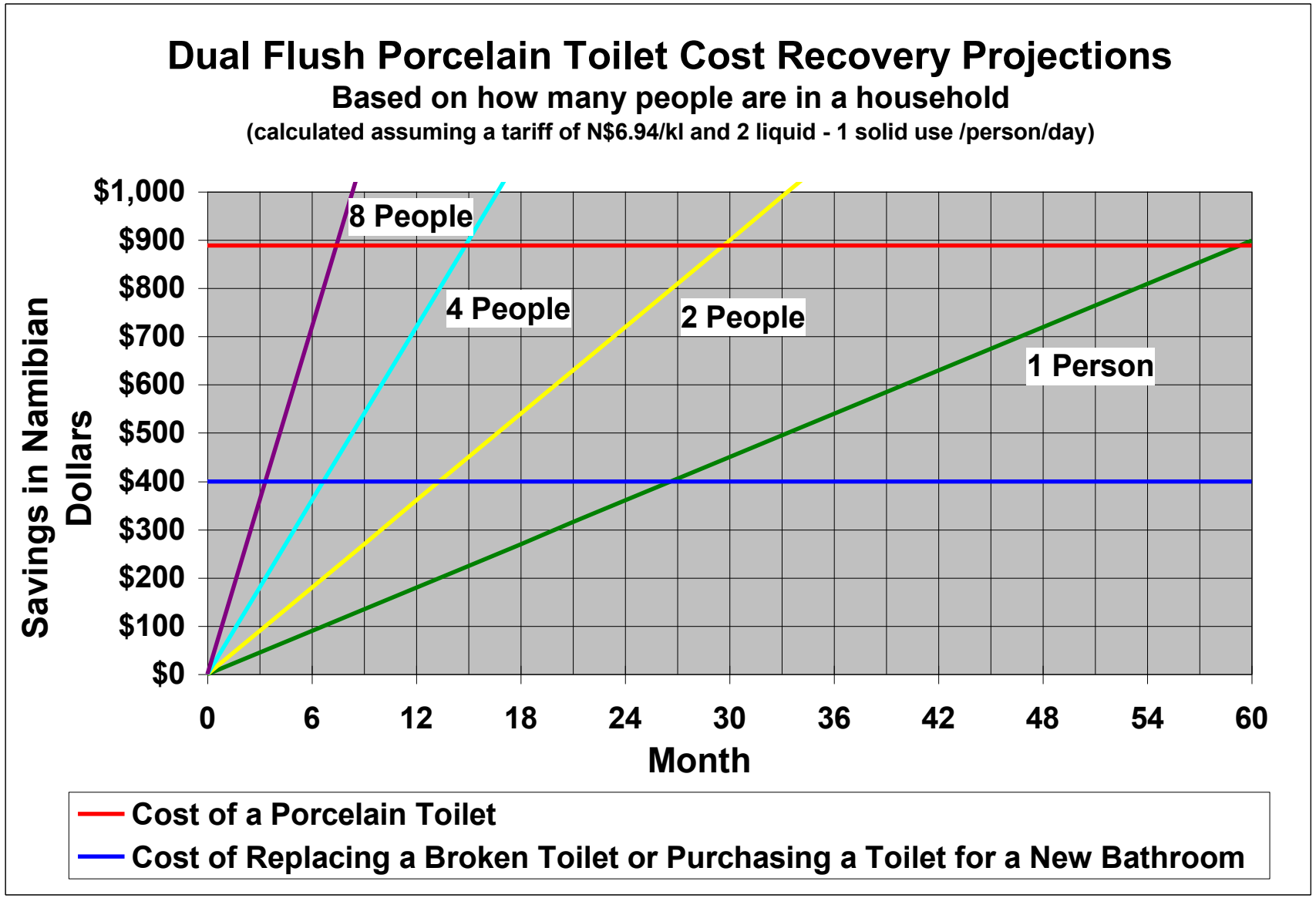

Figure 20. Dual Flush Porcelain Toilet Cost Recovery Projections

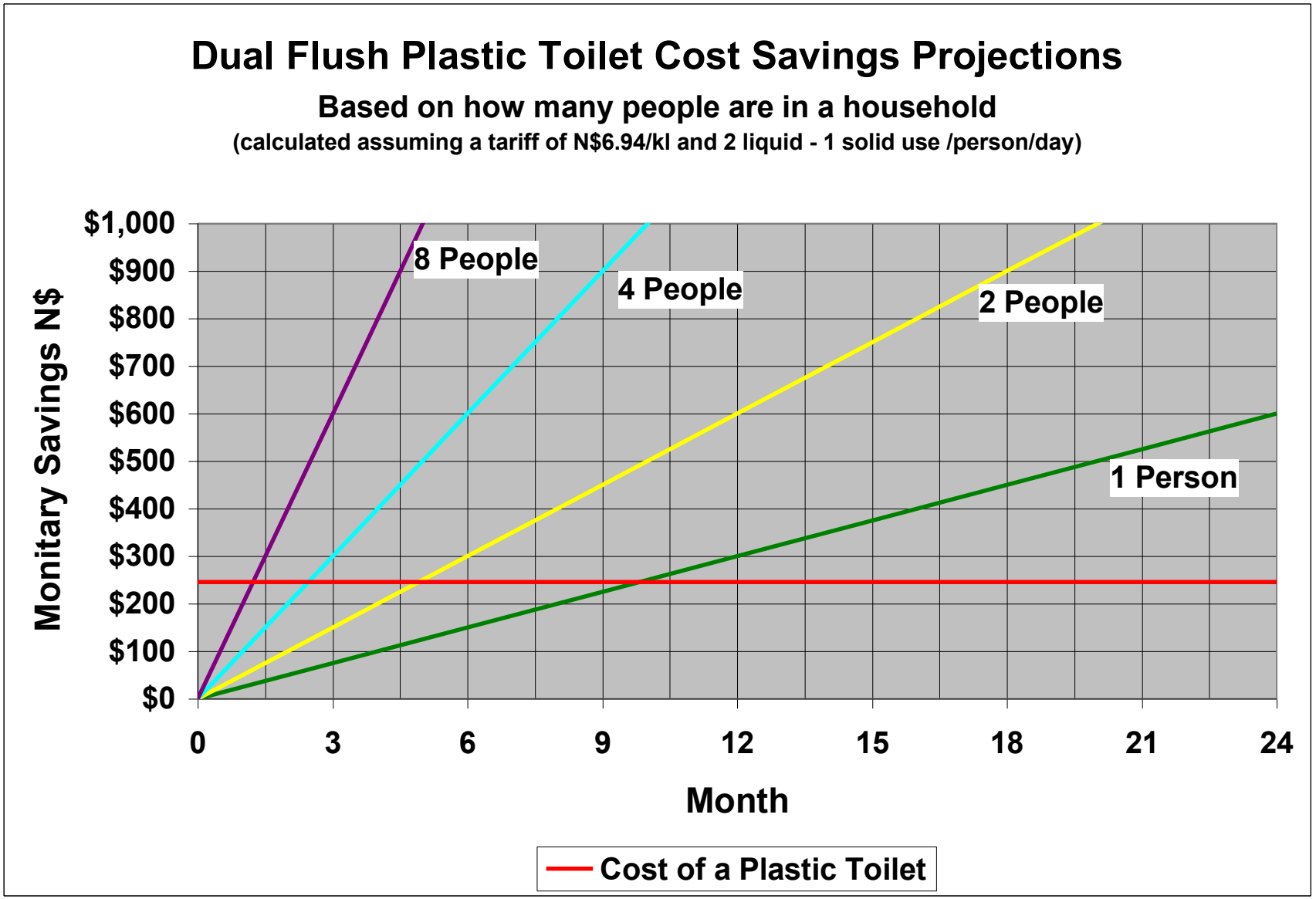

Figure 21. Dual Flush Plastic Toilet Cost Recovery Projections

One more low-flow technology found in the stores was an aerator insert for water taps. An aerator, shown in Figure 22 and Figure 23, reduces the water volume coming out of a tap by replacing some of the water with air.

Figure 22. Aerators

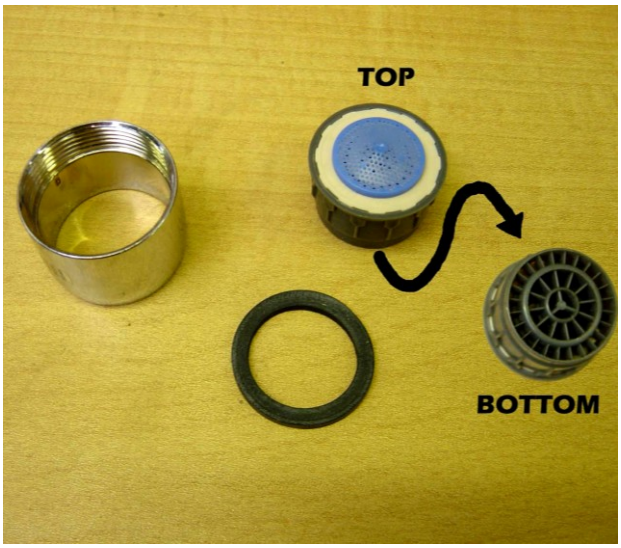

Figure 23. Disassembled Aerator

A homeowner can easily add this type of device to most taps by simply screwing it onto the mouth of the tap, or by replacing the whole tap with a different fixture that uses a built-in aerator. Both aerators and aerator taps were available at Pupkewitz Megabuild, primarily, and we found them competitively priced with normal-flow taps.

Low-flow showerheads were a third technology we found available at Pupkewitz Megabuild. One of these showerheads is shown in Figure 24. The flow rate is reduced by lowering the amount of water that can pass through the low-flow showerhead in a certain period of time. These devices also had similar prices to regular-flow showerheads.

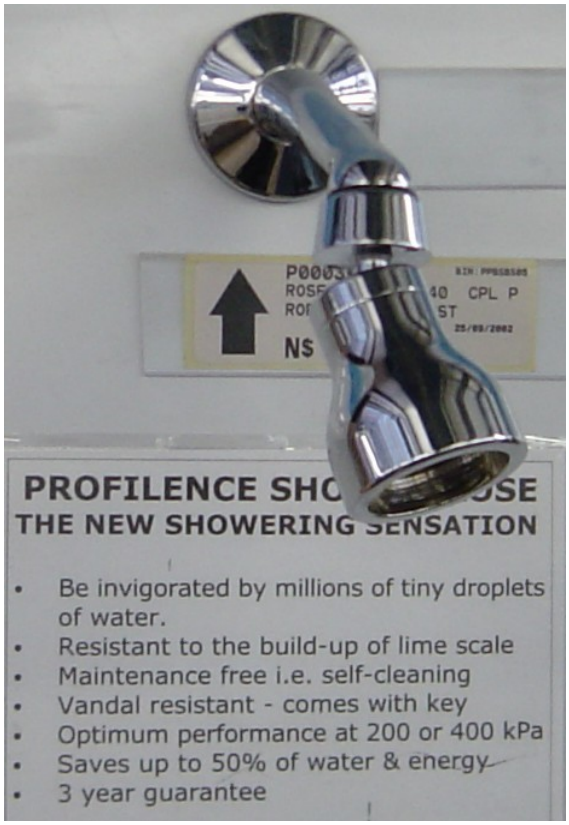

Figure 24. Low-flow showerhead

For a price comparison of water-saving devices to regular-flow devices, refer to Table 2.

Table 2. Comparison of Water-Saving Devices to Regular-Flow Devices

Plumbing Device	Water-Saving Device Cost	Regular-Flow Device Cost
Toilet	N$245.50 (plastic)	
	N$887.51(porcelain)	N$544.99(porcelain)
Toilet Cistern	N$127.99(plastic)	N$198.55(porcelain)
Showerhead	N$342.71	N$118.00
Kitchen Tap	N$92.48-N$111.03	N$60-N$80

From our investigation, we found that water-saving devices were available but not nearly as common as regular flowing faucets, toilets, and showerheads.

Investigation of Water Demand Management Practices in Schools

We found that education taught in schools is extremely valuable for teaching young children the importance of saving water and instructing students to save water everyday. As with the goals of primary and secondary education, the hope of water conservation education is that pupils will remember the things they learned and continue to exercise water-saving practices throughout their entire lives. In addition, they may have a positive impact on others. For example, one science teacher we interviewed at the primary school said that he is constantly reminded by his young nephew to turn of the faucet when he is brushing his teeth.

Currently, schools in Namibia do a good job of addressing the issue of saving water. Water awareness programmes seem to be more focused in primary schools with dedicated curriculum in the fifth and sixth grade science classes. There are some water conservation principles that are built into the curriculum for secondary schools; however, at this point in a child's education he or she starts to become more focused on specific studies that will help him or her upon leaving school for the workplace or for university studies. Notwithstanding this fact, both the primary school and secondary school have participated in several water conservation poster contests sponsored by NamWater, Windhoek Municipality, and the Ministry of Agriculture, Water and Rural Development.

The schools also practice water conservation, which helps instil the message in the students. In the secondary school hostels, for instance, the residents are only allowed to shower during a one-hour window each day after dinner. Moreover, bathing in tubs is not allowed, so the taps have been removed from the tubs. In addition, the secondary

school has taps installed in several areas that automatically shut off after use by means of a spring-loaded mechanism. The watering of sports fields is automatic. The fields are scheduled, using a computerized timer, to be watered during the nighttime hours to reduce the amount of water that is evaporated. During the rainy season, the water to the sprinkler system is shut off or greatly reduced. All of these measures help conserve water and help reinforce the water conservation message of the curriculum.

Our small investigation at the Polytechnic of Namibia's facilities revealed that the school is currently replacing broken toilets in some of the hostels with newer demand flush toilets with smaller cisterns. A demand flush toilet allows one to flush a toilet normally with the option of stopping at any point during a normal flush when the waste has been sufficiently eliminated, thus saving water. This evidence of water-efficient replacements suggests good water conservation practices in the long term. In the meantime, however, most toilets in the Polytechnic hostels have regular toilets with large cisterns that use at least nine litres of water for every flush.

A full tally of student responses to our interviews for the three schools investigated can be found in Appendix H.

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Chapter 5 RECOMMENDATIONS and CONCLUSIONS

After completing the data analysis, we developed recommendations for the DRFN, the Namibian Government, residents, the City of Windhoek, and other Namibian cities on water demand management (WDM). We also created recommendations for future researchers working on WDM in Namibia. In this chapter, we explain these recommendations, the implementation plans we created for several of them, and possible areas for future work on this topic.

Recommendations

After analysing the data gathered in our archival and field research, we have come to understand many of the successes and problems of previous WDM plans, policies, and practices conducted in Namibia. From this understanding, we have developed the following prioritized list of recommendations for improvements in the WDM plans of Namibian cities grouped by specific individual stakeholders.

Desert Research Foundation of Namibia and similar conservation organizations need to:

1. Inspire policy change in Namibia on the national and local levels.
    a. Create a grassroots movement that works to change the policies of local governments, which can then lend their support for national policy change.
        i. Start a student environmental organization and develop it into a national front for environmental conservation throughout the whole country.
        ii. Combine environmental clubs, like the Scouts of Namibia and Girl Guides Association of Namibia, across the nation to make a cohesive and unified organization dedicated to positive change in environmental conservation and policy at all levels of government.
        iii. Get student environmental organizations involved and active in student government to enact and affect environmental policies.

iv. Start a new and/or work with existing professional conservation organizations to lobby local and national governments for changes in policy that take a more sustainable path to Namibia's future.

b. Create mentoring programs to help develop the next generation of policy makers, environmentalists, engineers, scientists, and community leaders into environmentally conscious adults.
    i. Sponsor research projects on conservation topics such as: water demand management, desertification, basin management, resource management, and many others.
    ii. Create positions for Namibian students to complete internships, under DRFN tutelage, as the Practical portion of their education.

c. Create workshops and education programs for local communities on how they can enact positive change in their lives.
    i. Create and implement a workshop on how local government operates and how people can affect change.
    ii. Organize community meetings to discuss water and environmental issues and brainstorm possible solutions to these problems for the local, regional, and national levels.

d. Create closer working relationships with primary and secondary schools, colleges, and higher learning organizations to influence the curriculum.
    i. Pressure instructors to teach more problem solving and communication skills. In addition, include more knowledge of environmental conservation, modern technology, and scientific methods in the curriculum.
    ii. Create or press for competency exams at several levels during a student's educational experience to ensure problem solving skills and communication skills are being learned. In addition, ensure knowledge of environmental conservation, modern technology, and scientific methods information.

2. Create closer ties with other research and conservation organizations in southern Africa and around the world to increase funds and access to information.
    a. Create joint workshops on conservation and research topics to help foster working relationships between the DRFN and like-minded organizations.
    b. Develop exchange programs for researchers and conservationists to explore new ideas and gain fresh knowledge in different areas throughout the world.
    c. Create an international water conservation lobby to share resources and increase support for regional and global policy change.

3. Use the Gobabeb Training and Research Centre to help influence policy makers on the importance of environmental and resource conservation.
    a. Hold training and "fact-finding" retreats at Gobabeb to persuade government officials to learn about conservation issues, sustainable development issues, resource exploitation issues, and other issues concerning the environment and Namibia's future.

b. When Gobabeb is contracted for an independent training mission, insist on including programs on conservation, sustainable development, and other environmental issues concerning Namibia and its future.

4. Work to create cooperation and partnerships with organizations that must enact, carryout, or otherwise enforce the national, regional, and local polices.
    a. Create a closer working relationship with NamWater so that the DRFN can help shape how national policy is translated into regional operation.
    b. Work with the municipal departments to influence how Windhoek's policy is enforced.
    c. Try to hold seminars and meetings with the Windhoek Police to create an appreciation for water conservation regulations and polices so that these statutes will be accurately and rigorously enforced.

5. Work with end users to create change in water demand through community development in order to go beyond the wording of city or national policy.
    a. Do not wait for policy to take control of the situation. Create community involvement that works to reduce waste and advance the conservation process.
    b. Create community initiatives for water-saving and other environmental issues to improve awareness and increase the "popularity" of "green living" practices.

Namibian Government needs to:

1. Create a distinct National and Regional Water Demand Management Policy to raise awareness of the scarcity of water and to focus the players in the water sector on the issues of water conservation and efficiency of supply (Van Der Merwe, 1999).

2. Improve educational programmes in school and in communities regardless of the current water situation.
    a. Areas in which to improve include:
        i. The overall water situation in Namibia
        ii. The impact of leaks
        iii. The cost-benefit analysis of low-flow technology
        iv. The Windhoek block tariff system
        v. The non-homeowners
        vi. No-cost and low-cost measures for saving water
        vii. Reusing grey water for gardens and lawns
        viii. How much water is used for everyday activities
    b. Use new, innovative education tools to get the water conservation message across to people. (n.b. The three commercials below are described in greater detail later in this chapter)
        i. Modify the concepts in "Truth" commercials for water.
        ii. Modify the concepts in "Got Milk?" commercials for water.

iii. Modify the concepts in "MasterCard" commercials for water.
iv. Invent or investigate new conceptual learning and role-playing games (especially games that look at the "Tragedy of the Commons" scenario).
v. Create hands-on experiments for students to complete on water conservation.
vi. Reinstall the billboard that projected the run-dry date for the water supply and use it to display water conservation information in addition to the water supply projections.

c. Use more languages and possibly more dramatic pictures to describe the water situation and to describe how the public should react.
    i. Translate the English and Afrikaans messages, pamphlets, TV and radio advertisements, and billboards into indigenous languages so that more of the population can understand the conservation messages, get involved, and gain knowledge on the situation.
    ii. Create or find universal symbols for water conservation to include with dramatic pictures so more cultures will understand the message being conveyed.
    iii. Use scrolling marquees with billboards and posters to send a message in several languages at once.
d. Encourage landscapers and gardeners to create and promote water efficient gardens.
    i. Hold competitions on water-saving garden designs in Zoo Park and communal parks for display to be voted on by the general public.
    ii. Publish and advertise water-saving landscaping tips, manuals, and pamphlets to be distributed at nurseries, landscaping stores, and hardware stores.

Municipality of Windhoek needs to:

1. Educate and certify more water control officers.
    a. Create a new or improved water control officer training program
    b. Once officers are certified, begin an enforcement program to reduce water waste.

2. Improve response and repair time of infrastructure breakdowns.
    a. Use preventative maintenance techniques to avoid future problems.
    b. Budget more money for repairs and skilled personnel.
    c. Create a program of continuous improvement for both the workers and the supply system.
        i. Organize workshops and seminars on specific skill sets to keep workforce current with state-of-the-art knowledge in their area.
        ii. Create an incentive program for workers and managers that will encourage and reward constructive suggestions for improving any aspects of the system that are not part of their direct responsibility.

d. Run special problem solving and brainstorming sessions with a "diagonal slice" of the organization.
    i. Use a stratified random sample to obtain the personnel for the workgroup to ensure a diverse mixture of people, experiences, and backgrounds.
    ii. Combine directors, managers, overseers, workers, engineers, human resources, janitors, secretaries, truck drivers, et cetera into one working group to solve one or two specific problems.

3. Practice more accurate accounting of metered water use.
    a. Continue to make meters more accessible and easier to read.
    b. Read the meters monthly.
    c. Reduce the number of times a meter must be estimated for the monthly bill.
    d. Check for and replace broken meters in a timely manner.
    e. Create a system for checking that active meters are consistent with accounts.
    f. Investigate upgrading the water meter system so that it can be read electronically and from a distance of up to 15 m similar to electricity meter readers in the US.

Municipalities and Businesses need to:

1. Promote and increase availability of water-saving devices
    a. Encourage low-flow technology use in industry, residential homes, office buildings, hotels, shops, stores, and malls.
    b. Encourage salespersons to promote sales of low-flow technology.
    c. Encourage foreign companies to export water-saving products to Namibia and encourage local companies to make water-saving products for sale in Namibia.

2. Reuse water in as many areas as possible, not just irrigation. For example, semi-purified effluent can be reused for toilet flushing and the cooling of air conditioning systems of large buildings.

3. Install water flow logging devices in buildings to measure and account for water use and leakage.

4. Run programs to help people understand the water situation, block tariff system, how to read their metres, etc.

5. Obtain copies of, and run investigations using the United States Environmental Protection Agency's free "Wave Saver" software package for investigating water and energy waste in office buildings, hotels, and schools.

Residents need to:

1. Check for leaks more frequently using water meters.
2. Repair leaks quickly to save water and money.
3. Reuse more grey-water.
    a. Plug the drain when showering to collect grey water for reuse.
    b. Reuse dishwater and bath water for gardens, indoor plants, or washing vehicles.
4. Collect rainwater runoffs from house roofs and use it for gardening and outdoor washing of vehicles, windows, walls, fences, and any other exterior item that needs cleaning.

Please see Appendix J for other valuable water-saving recommendations for residents.

Implementation of Several Recommendations

Once we had a prioritized list of recommendations, we created implementation plans for several of the recommendations. In this section, we describe our implementation plans for improving the education outside of schools.

Television and Radio Advertisements

One of the most effective methods of educating the public on water conservation, according to our research, is television and radio advertisement. Using our knowledge of basic advertising principles, previous experience as targets of advertisement, and basic principles of visual design, we developed the following outlines and storyboards for water conservation commercials.

"REALITY" or "TRUTH" Commercial

The first television/radio commercial we created an implementation plan for was a modification of "Truth" anti-smoking commercials that are aired in the U.S. These

commercials get across their message in a unique and memorable way. The original "Truth" commercials are filmed and demonstrated to a live public audience in a public place. The video footage is then edited and played on television and radio for the larger public population that were not present for the filming. Below is a sample storyline of a "Truth" commercial with its message modified for water conservation education.

"Reality" or "Truth" Commercial Outline:
(Please refer to Appendix K for screen shots of each scene)

Scene 1: Blue screen with the words "Reality" in quotes.
Narrator: Reality…

Filmed live before during a non-specific weekend day.
Scene 2: Parliament Gardens on a sunny day.
Narrator: "There are many beautiful gardens in Namibia. For instance, this garden is full of flowers, green plants, shrubs, and trees."

Scene 3: Parliament Garden on a sunny day with a toilet in the middle of the grass.
Narrator: "Did you know this garden is special? It is irrigated using treated waste water from the Gammams Sewage Treatment Plant."

Scene 4: Parliament Garden on a sunny day with as many toilets (with people sitting on them) as it would take, flushing once a day, to water the garden for one day.
Narrator: "Did you also know that it takes XXXX litres of water a day to keep this garden green. That is the equivalent of YYY nine litre toilet flushes."

Scene 5: Two scenic and aesthetically pleasing indigenous gardens at the Bank of Namibia and at NamWater.
Narrator: "That green garden could be converted a beautiful, indigenous garden like those seen here. Using local, water efficient, plants, trees, and shrubs, the old gardening water could be used for other purposes."

Scene 6: Blue background with the word "Truth" or "Reality"
Narrator: "Precious water is wasted every day. You can make a difference. Conserver Water!"

"Got Water?" taken from "Got Milk?" Commercial

The second television/radio commercial that we created an implementation plan for was a modification of the "Got Milk?" diary milk promotion commercials seen in the U.S. In these commercials, the message is presented to the audience in a memorably humorous way. The "Got Milk" commercials set up a scenario where a person is enjoying a food item but then needs to drink a glass of milk to finish off the meal. At that point, they realise that they do not have any milk. Then the person acts obviously desperate for milk. The scene usually ends with the person in despair over his or her lack of milk and a narrator asking the rhetorical question, "Got Milk?" This commercial lends itself to educating the public on the water situation in Namibia. Below we describe a modified "Got Milk?" commercial.

"Got Water?" Commercial Outline

Scene 1: Namibian neighbourhood on a Saturday afternoon slowly pan by the houses on the street:
House 1 has a person washing their vehicle with a running hose
House 2 has a person watering their garden in the middle of the day when evaporation is at its highest
House 3 has a family playing that has just finished playing in the pool and have run inside the house, leaving a hose refilling the lost water while the pool remains uncovered
House 4 has the sound of a shower running while a child complains to a parent "It's my turn now. She (he) has been in there for an hour."
House 5 is shot through the open bathroom window where we see a person brushing their teeth and walking out of the room while the tap continues to run.

Scene 2: Night in the same neighbourhood from a bird's eye view. House 4 catches on fire. The fire brigade arrives and sets up their equipment to fight the blaze. They hook up their hoses to the fire hydrants and start fighting the fire. However, the water pressure quickly fades to nothing. Everyone runs to carry buckets of water from the pool at house 3, but it is not enough to stop the fire and once the pool is empty, House 4 burns to the ground.
Narrator: "Got Water?"

(Alternatively, in the second scene, the lack of water would not allow anyone in the neighbourhood to shower and therefore creating amusing situations in the neighbourhood or in the workplace.)

MasterCard Commercials "Water = priceless"

A third television/radio commercial implementation plan we developed for improving the education of the public outside of schools used a modification of the MasterCard commercials. In these commercials, the narrator talks about a stereotypical parent-child experience or romantic situation and the costs involved. Approximately four items are mentioned with the cost of the item increasing as the list continues. Then, at the end of the commercial, the narrator concludes, "Cost of [the experience]…Priceless." The same idea is applied to water in the sample commercial script below.

Water = Priceless Commercial

Scene 1: A steamy shower scene
Narrator: "Shower: N$0.11 a minute"

Scene 2: A house with a running sprinkler or someone watering lawn by hose
Narrator: "Watering the yard: N$6.94 an hour"

Scene 3: A scene with just a running toilet.
Narrator: "A leaking toilet: N$50.61 a week"

Scene 4: Person walks up to sink and turns the squeaky faucet on only to have a few drops come out. The person is confused and in despair.
Narrator: "Saving Namibia's water: Priceless… Water is precious. Please use it wisely"

These commercials should be run several days a month during average rainfall years and several times a day during drought years. In addition, the content should be updated twice a year to keep the message fresh and current.

Billboards and Posters

Advertisements on television are useful for educating the public, but not all people have television or watch it regularly. Therefore, we created an implementation plan for multilingual billboards and posters. Producing messages in many languages was a frequent suggestion in our interviews of the public and of experts. In this section, we discuss the implementation plan we developed.

Billboards advertising water conservation principles, practices and situations are useful tools for enhancing the knowledge of the public. However, most billboard messages are written in Afrikaans or English. This keeps many people in Namibia, where 13 separate native languages and a multitude of foreign languages are used, from understanding the point contained within the written message. Therefore, we suggest replacing fixed billboard messages with scrolling marquees or with flip or blind billboards. These devices keep the same background or picture and only change the language of the written message.

Posters could also be handled using marquees and flip/blinds in the same manner as described for billboards. In addition, posters could be printed in multiple languages and distributed in a package containing several languages. Moreover, specific locations could order posters in languages specific to the location.

Conclusions

From our data analysis and recommendations, we have come to several conclusions. The water situation is a very important topic and needs to be stressed as more of an important issue in Namibia, especially if the influx of people into the capital and the middle of the country continues at its current rate. The City of Windhoek must

be realistic about how many people it can supply with water in the future and make the people aware of this figure now, before a crisis occurs. Experts in water management, especially those working in the Department of Infrastructure, Water and Technical Services, need to close the gap between their knowledge and the knowledge of the general public.

There are many sides to the water problem in Namibia. NamWater needs to sell water when they have ample supply to recover the costs of supplying water to Namibia. However, during times of drought or low supply, NamWater feels they need to conserve water for the good of all Namibians. In contrast, Van Der Merwe of the Africon Centre and researchers at the DRFN, among others, feel water conservation must be practiced at all times. Some of the residents of Windhoek feel quite the opposite. They feel that water is abundant and should be provided free of costs (Dentlinger, 2004). Another side is presented by Minister Angula, who stated that water is affordably priced but people sometimes choose to spend their money on other things (Dentlinger, 2004). No matter what each side presents as their position, it comes down to Namibians taking care of their homeland and not wasting a precious resource in their country. It should be clearly known by all that there is not an abundance of water in Namibia, and therefore, it is paramount that water be managed properly. The DRFN is just the type of organization who can take our recommendations and ensure that the interests of all parties are to conserve and preserve water for Namibia's future.

Future Work

Our project has ended but its completion does not mark the end of the problem or society's needs. We, therefore, present the following recommendations for furthering and extending our work in the topic of water demand management.

1. Study what can be done to reduce the amount of water used for agriculture and livestock. Over 70 percent of Namibia's water is used for agricultural purposes. Possible areas of study include the feasibility of switching to drip irrigation, green houses, and low water dependent cash crops.

2. Study how much water high-income residents, who have lawns and pools, use in comparison to middle-income and low-income residents.

3. Create a carrying capacity study for the area surrounding Windhoek based on the available water supply and the growing population.

4. Study the feasibility of installing a household data logger for each home in Windhoek in a location that would be seen regularly by the people living there. The data logger might also be able to show how much a household is being charged for their water use. Another area the study could examine is the possible benefits of knowing one's water consumption.

5. Create a feasibility study for a "conservation tariff" system where people can be rewarded for using less water. Examine a credit system in which people are allotted a certain number of credits and they can be traded, bought, or sold based on how much people use. This would be similar to the gas mileage credits and pollution credits used in U.S. industries.

6. Study how to improve gardening techniques for arid and semi-arid climates.

7. Study the social and technical aspects of converting public spaces from "colonial gardens" to indigenous gardens. In particular, investigate the Parliament Gardens, the Country Club Golf Course, and the Gammams Cemetery.

8. Study the feasibility of creating a "Water Management Information Centre." What are the costs involved with organizing and maintaining a computerized facility? What are the possible benefits of creating and maintaining such a facility year after year?

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Appendix A: Desert Research Foundation of Namibia

The Desert Research Foundation of Namibia (DRFN) is an independent, arid environment research organization based in Windhoek, Namibia. The DRFN's mission statement is, "The DRFN is dedicated to furthering understanding and competence to appropriately manage arid environments for sustainable development." (http://www.drfn.org.na). The DRFN carries out its mission through community-based programmes, environmental impact assessments, research, synthesis and networking, and environmental education and awareness (http://www.drfn.org.na).

Funded mainly through outside donors, DRFN conducts arid land studies that facilitate appropriate, participatory, and applied short and long term research on the environment (http://www.drfn.org.na). Though they have done much good in the past, the DRFN continues to ensure it is a leading expert in sustainable development of arid environments (Bruckner, 2001/2002). Towards that end, the DRFN director, Dr. Mary Seely, is very involved in working for Namibia's future. She is especially dedicated to sustainable development and is part of the core team working on Vision 2030 as well as serving as deputy Vice Chairman of the Task Force of Namibia's Water Resource Management Review (Bruckner, 2001/2002,).

The Gobabeb Training and Research Centre (GTRC) is one of DRFN's research centres and is an essential part of the DRFN's long term research projects. GTRC is located in the Namib Desert where scientists, educators, post-graduate, as well as undergraduate students come from all over the world to conduct research on and in Namibia's arid environment (http://www.drfn.org.na). Research done at the GTRC is focused on climate change, biodiversity, and desertification (http://www.drfn.org.na).

The DRFN also works with many other organizations in its research efforts such as the Polytechnic of Namibia, Department of Water Affairs, and NamWater (Montgomery, 2001/2002). Together they have completed several research projects, workshops, and published materials covering water related issues. In addition, the DRFN is working closely with educators to teach Namibians about water awareness. Working with other NGOs and the Namibian government, the DRFN has made progress in combating desertification and creating a knowledgeable and aware public.

The following is a table with the names and positions of DRFN employees:

Position	First	Last name	Project
Accountant	Anne-	Dunaiski-Brandt	Core
Accountant	Sigi	Gustafsson	NAPCOD
Accountant	Maria	Kambatuku	DRFN Core
Admin Manager	Justine	Kamati	DRFN Core
Administration & Finance	Helen	Kolb	Gobabeb
Casual Labour	Annanias	Levi	DRFN Core
Chief Accountant	Cloete	Etienne	Core
Cleaner	Teopoldine	Lamek	DRFN Core
Community Mobiliser	Salomon	Boois	Elak/Napcod
Community Mobiliser	Douglas	Uandara	Desert
Consultant	Nadia	Manning	Elak
Co-ordinator	Nickey	Gaseb	SDDI
Creditors Officer	Lesley	Fourie	Core
Deputy Director	Bertus	Kruger	Core
Desktop publishing	Alie	Thaniseb	DRFN Core
Desktop Publishing	Mandine	Van Wyk	DRFN Core
EE Advisor	Georgina	Frohlich	EE
Energy Desk Co-ordinator	Catherine	Matthew	Energy
Executive Director	Mary	Seely	Core
Field Liaison Officer	Otilie	Amaambo	NAPCOD
Finance Clerk	Lorraine	Kasuto	DRFN Core
Human Resource	Geraldine	Cupido	DRFN Core
Inform. Comm. Unit Co-	Magareth	Gustavo	DRFN/Core
Junior Researcher	Arnoldt	Gaseb	Napcod
Junior Researcher	Ganeb	Kenneth Lucky	Napcod
Librarian	Inge	Henschel	Core
Logistics Manager	Moizelle	Dall	Core
Maintenance Technician	Josef	Golombowski	DRFN Core
Managerial Support	Cecilia	De Klerk	NAPCOD
Norw. Exchange	Shilunga	Bertha	Core
Norwegian participant	Pettersen	Silje	Napcod
Project Manager	Matros	Anna	WADE
Receptionist	Laura	Moncho	DRFN Core
Research Assistant	Olavi	Makuti	DRFN Core
Research Assistant	Vilho	Mtuleni	Core
Research Assistant	Veronika	Siteketa	Biota S10
Researcher	Patrik	Klintenberg	Napcod
Researcher	Aitana	Shekupe	DRFN Core
Scientific writer	John	Pallet	DRFN Core
SEEN Course Co-ordinator	Mathias	Nengola	SEEN (EE)
Senior Technician	Aubrey	Prinz	DRFN Core
Site co-ordinator	Hartmut	Kolb	Gobabeb
Support Service Manager	Andre	Botes	Core/Elak

Appendix B: Namibia Water Corporation

NamWater was officially registered as a company on December 9, 1997 through the Namibian Water Corporation Act No. 12 of 1997 (The Water & Environment Team, 1999). It is a parastatal company. The commercial company is represented by a board of directors but the government of Namibia is the sole shareholder (http://www.namwater.com.na). This is because the Namibian Government owns and controls the State's water sources but issues permits to NamWater to extract, distribute, and sell water from these sources (http://www.namwater.com.na).

The purpose of NamWater is to supply bulk water to municipalities, the Directorate of Rural Water Supply, and other authorities (The Water & Environment Team, 1999). NamWater also supplies water for large irrigation schemes (Van Der Merwe, 1999). In addition to providing bulk water for use by the public and private sectors, NamWater also supplies artificial recharge water. They take surface water, treat it, and pipe it to specially fitted borehole stations where it is pumped into the ground to refresh the aquifer (Van Der Merwe, 2000). NamWater charges for the chemicals and electricity used to treat the water plus a fifteen percent mark-up (Van Der Merwe, 2000).

By 1999, NamWater had not yet achieved full cost recovery. However, through improved management and awareness programmes they hoped to have full cost recovery by 2003 (Van Der Merwe 1999). This worked. In only their second year of operation, (2000) NamWater actually recorded full cost recovery and achieved a profit (NamWater annual report, 1999-2000). Though the company is determined to recover its full operating cost, it realizes the importance of providing potable water at an affordable price (http://www.namwater.com.na).

Appendix C: Interview Questions for Residents of Windhoek

Below are the questions asked to residents in the areas of Khomasdal and Katutura. These questions cover a variety of topics to see how aware residents are of Namibia's water situation and how they use water.

Interviewee Name: **Interviewer:**

Gender: **Date:**

Location:

Introduction

We/I are students from Worcester Polytechnic Institute located in the United States. We/I are working in a group in conjunction with the Polytechnic of Namibia and the Desert Research Foundation of Namibia on a water demand management project here in Windhoek. Your willingness to allow the recording of water use in your home is greatly appreciated and will prove very helpful to both Gerhard and us. We would like to ask you some further questions to supplement the data from the logger that was installed if that is alright with you…It will take roughly 20 minutes

Questions

- How many Adults live in your house? How many children (under 18)?
- Do you have a separate flat that you rent out? How many people live there? (Adults / Children under 18)
- What is the highest level of education you have achieved?
- Where does your water comes from?
- Please describe the water situation in Namibia?

  Options in case open ended answer is insufficient:
  - Water is plentiful and can be used without reservation.
  - Water is available in good quantity but attention should be paid so that it is not needlessly wasted.
  - Water is available in low quantity and should be used sparingly.
  - Water is at a critical level and drastic reduction in water use is necessary.

- Are you familiar with water-saving devices?

    - If so, do you use any water-efficient fixtures (e.g. Dual-flush toilet, low-flow shower heads, aerators on taps)?

    - If you do not use them, why not?

- Do you reuse grey water in your household or yard?

- What are your most common water uses (whole family)?

Activity	Frequency / Duration	Comments (volume?)
Showers		
Flushing Toilets		
Washing Hands		
Drinking Water		
Cooking		
Washing Dishes		
Watering Gardens		
Filling Pool / Pond		
Washing Pets		
Washing Vehicle		

- Are you familiar with the tariffs that the city charges for the use of water?

    - If so, what do you think about the water tariffs?

    - Also, have the city water tariffs had on how much water you use?

- If there was an increase in the water tariff, would you use less water or about the same as you do now?

    - If less, in which activities would you cut back your usage of water?

- How often do you check your water meter to see how much water you have used in a particular period of time? Do you use your meter to check for leakages?

- Are you aware of any leaks currently in your household (e.g. running toilets, dripping tap, etc.)?

    - If so, how severe are they and how long have they existed?

Location	Severity	Duration

- Have you had any significant leaks in the past?

    - How did you realize the leak(s)?

    - Did you fix the leak(s) yourself or hire somebody? Why?

    - How much time/money did you spend to fix the leak(s)?

- Have you seen / heard anything about saving water? Do you know of any water awareness programmes?

- Have you ever tried to reduce your water consumption?

    - If so, what was the reason? (Save money, Save water, etc.)

- Do you have any ideas of what would make people more aware of the water situation in Namibia?

Appendix D: Interview Questions for School Officials / Teachers of Windhoek

Below are the questions asked to school officials at Pioneerspark Primary School and Jan Mohr Secondary School. These questions were aimed to discover what programs are taught in the school concerning water conservation.

Interviewee Name: **Interviewer:**

Gender: **Date:**

Location:

Introduction

We/I are students from Worcester Polytechnic Institute located in the United States. We/I are working in a group in conjunction with the Polytechnic of Namibia and the Desert Research Foundation of Namibia on a water demand management project here in Windhoek. We are seeking information about the educational aspect regarding water demand management and would like to ask you some questions about water conservation teachings and programmes within your school.

Questions

- How many students are enrolled in this school?
- How many teachers work here?
- What are the core courses taught at this school?
- On average, how often is the issue of the region's water supply discussed in classes?
- On average, how often is the issue of water use and conservation discussed in classes?
- What methods do you employ to teach students about the importance of water in the region and ways to use water wisely?

- Are you familiar with water-saving devices?

    - If so, does the school use any water-efficient fixtures (e.g. Dual-flush toilet, low-flow shower heads, aerators on taps)?

    - If you do not use them, why not?

- Does the school reuse greywater in any way?

- If there was an increase in the water tariff, would there be any action you would take as headmaster?

    - If so, what would those actions be?

- Have you seen / heard anything about saving water? Do you know of any water awareness programmes?

- Have you ever tried to reduce the school's water consumption?

    - If so, what was the reason? (Save money, Save water, etc.)

- Do you have any ideas of what would make people more aware of the water situation in Namibia?

Appendix E: Interview Questions for Students of Windhoek

Below are the questions asked to students at Pioneerspark Primary School, Jan Mohr Secondary School, and the Polytechnic of Namibia. These questions were to see if students were aware of Namibia's water situation and how they save water.

Interviewee Name: **Interviewer:**

Gender: **Date:**

Location: **Age:**

Introduction

We/I are students from Worcester Polytechnic Institute located in the United States. We/I are working in a group with the Polytechnic of Namibia and the Desert Research Foundation of Namibia on a water demand management project here in Windhoek. We would like to ask you some questions to understand the view of young people on water…It will take only a few minutes.

Questions

- What year of school are you in?

- Where does the water in Windhoek come from?

- Please describe the water situation in Namibia?

  Options in case open ended answer is insufficient:

  - There is plenty of water in Namibia
  - There is a good amount of water in Namibia, but not as much as other nearby countries
  - There is low supply of water in Namibia
  - There is very little water in Namibia

- Are you familiar with water-saving devices?

    - If so, do you use any water-efficient fixtures at home (e.g. Dual-flush toilet, low-flow shower heads, aerators on taps)?

- Do you feel that people here in Namibia should have to pay for water? Why or why not?

- Have you seen / heard anything about saving water? Do you know of any water awareness programmes?

- What do you learn in school about saving water? How often?

- Have you ever tried to reduce your water use?

    - If so, in what way?

- Do you have any ideas of what would make people more aware of the water situation in Namibia?

Appendix F: Newspaper Articles Concerning Water Demand Management

The following articles were taken from The Namibian newspaper published during our project while in Namibia between March 12th, 2004 and May 5th, 2004. We used these articles along with our other sources to understand the current water management situation and possible future water management projects.

Labour study slams water charges as 'new Apartheid'

• LINDSAY DENTLINGER

AN in-depth study of privatised water services in Namibia says that while prepaid water systems are being marketed as the solution to bad debts and water conservation, they are in fact worsening the plight of the country's most vulnerable.

Titled 'Water Privatisation in Namibia: Creating a New Apartheid?', the report released by the Labour Resource and Research Institute (LaRRI), contends that the system is exposing thousands of the country's poor to preventable diseases and death.

"The prepayment water system is hostile to public health and negatively affects the social and environmental conditions of the poorest sections of society," says the author of the report, Jade McClune.

Using the experiences of the DRC informal settlement at Swakopmund as an example of the hardships people suffer as a result of the system, the study questions whether this policy is becoming "the new apartheid".

"Prepaid meters are not being installed in the rich suburbs nor in the industrial areas where vast amounts of water is being consumed. They are only being installed in the working class areas, where the majority of the black population live," says the report.

According to the study, thousands of people go without sufficient water to meet their daily personal hygiene, nutritional health or childcare needs.

"The pricing and method of prepaid water supply inhibits consumption by the poor in a drastic way," the study contends.

The situation in a number of towns and villages across the country which use this system is also documented and the report subsequently concludes that the argument that the poor must pay for basic water infrastructure is flawed.

The LaRRI report maintains that the national housing policy is also being contradicted in situations where defaulters are evicted from their homes for being unable to pay their water bills.

Placing basic water services beyond the reach of the country's poorest citizens is impoverishing the rural population further making them unable to secure water for their farming activities, claims the study.

LaRRI recommends that access to clean drinking water be protected by legislative and institutional guarantees as a basic human right.

It further suggests that an assessment be undertaken to establish the correlation between the privatisation of water services and disease prevalence.

A free minimum amount of household water supply should be implemented "to safeguard the interest of indigent families, children and pensioners", it says.

Ideally, the provision of basic water services should be re-incorporated into the public sector as a core function of Government, the labour institute says.

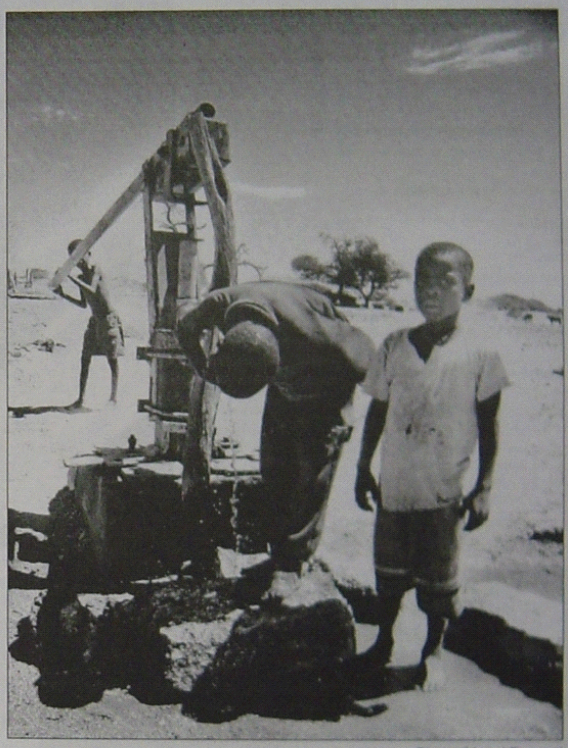

Photo: Maggi Barnard

FORTUNATE ... Boys at Omihana village, north of Uis, drink from a water pump, seemingly unaware what a precious commodity water is, especially in rural areas. According to calculations, Government will have to provide clean water to 20 370 additional rural people a year in order to meet the Millenium Development Goal of halving the number of people without access to clean water and sanitation.

Dentlinger, L. Namibian April 7, 2004 Vol. 19 No. 67 pg. 5

No free water, says Angula

• LINDSAY DENTLINGER

A TOP Government official has dismissed claims that water is unaffordable for most Namibians and ruled out the possibility of the precious resource being supplied free.

Inaugurating the new board of water utility NamWater last week, Minister of Agriculture, Water and Rural Development, Helmut Angula, said claims that Government was making water unaffordable had not been considered within the context of social realities.

"Water does not come cheap. It comes with a lot of investment," said the Minister. "There is no way possible to provide free water in this country otherwise the whole system will collapse."

Angula, who compared the affordability of water to the purchase of beer, said: "How much is the price of a 340 millilitre bottle of beer? How many Namibians buy beer? We know how much that costs. Some buy about seven a week. It is incredible how people make [others] believe that water is not affordable in Namibia."

NO FREE WATER ... Minister Angula.

Bulk water supply for pensioners, he said, was being sold by NamWater at N$3,70 per cubic metre (1 000 litres) a month – about 30 cents less than the standard rate of just over N$4,00.

Angula also dismissed as "incredible propaganda" allegations that the country's water provision system had been privatised through the establishment of NamWater.

NamWater, he said, would remain a wholly-owned State entity.

"State remains state. It doesn't mean it [water provision] is privatised because it [NamWater] charges its citizens".

Angula said a new Water Bill was in the pipeline and would give rise to new institutions to regulate the industry – among these an Independent Pricing Regulator to deal with issues of affordability.

He said it was the board's responsibility to ensure reliable and affordable services and acceptable tariff policies and structures.

The NamWater board has been trimmed from nine to five members in accordance with Government policy.

Engelhard Haihambo from the Engineering Council of Namibia was elected Chairman. Other members who will serve for the next three years are: Moses Shakela, a NamWater employee; Abraham Nehemia of the Ministry of Agriculture, Water and Rural Development; Nangula Hamunyela from the Namibia Chamber of Commerce and Industry; and Jacobus du Toit from the Institute of Chartered Accountants of Namibia.

They face the immediate challenge of introducing increases in water tariffs for next year in line with a Cabinet decision.

According to the Minister, many Ministries and other State institutions defaulted on water payments because increases were introduced after their budgets had already been approved.

The Minister said that water providers were faced with the challenge of overcoming a cultural belief that water should be free of charge. Coupled with this, he said, were the broader social realities that led to the non-payment of bills.

He said the price of water would not be deemed exorbitant for pensioners if they were only responsible for paying for their own water.

Angula said critics should also distinguish between the amount of water needed for personal use and that needed for economic activities.

According to NamWater, provision is made for a daily supply of 25 litres of water per person – more than the United Nations prescribed amount of 15 litres per day.

Angula said he could understand farmers' complaints that they were unable to pay for water for their cattle but, on the other hand, they were reluctant to reduce their livestock herds.

Photos: Lindsay Dentlinger

NEW BROOMS ... NamWater's new board was inaugurated by Minister of Agriculture, Water and Rural Development Helmut Angula (seated, centre). The new members are, standing: Abraham Nehemia, Engelhard Haihambo, Moses Shakela, Nangula Hamunyela and Jacobus du Toit. Seated are Agriculture Permanent Secretary Kahijoro Kahuure (left) and NamWater CEO Vaino Shivute.

Dentlinger, L. Namibian April 13, 2004. Vol. 19 No. 68. pg. 5

City to recharge major aquifer

• LINDSAY DENTLINGER

THE pressing need to meet the demand for potable water as Windhoek's population grows has led the municipality to actively pursue recharging a natural aquifer, which runs into the Auas Mountains from the southern part of the city.

At least three boreholes up to 500 metres deep have already been drilled in the Kleine Kuppe area, as well as another near Luiperdsvallei, to test the viability of the idea.

Immo Peters, a Chief Engineer in the Department of Infrastructure, Water and Technical Services, said that in the long-term the project was expected to yield at least 16 million cubic metres of water a year.

A study, three years ago, on the potential of recharging the aquifer gave a major impetus to the project.

At present, the City consumes about 20 million cubic metres of water a year.

The City said on Tuesday night that an oversight in planning led to the establishment of the Prosperita Industrial Park directly on the City's main groundwater source.

On Tuesday, the City called together about 60 businesses operating in the area to make them aware of the resource on which their businesses were situated and to inform them of pollution control measures to ensure that the groundwater remained safe for human consumption.

"It is regrettable to note that the security of the Windhoek aquifer was not taken into consideration during the early history of the City of Windhoek, simply because its potential to store large volumes of water was not realised," said Deputy Mayor Joseph Auala. He said some current developments were situated directly where they posed a threat to the groundwater source.

Following a presentation from a pollution specialist from the Ethekwini Municipal Council (previously known as the Durban Metropolitan Council), the City's Strategic Executive for Infrastructure, Water and Technical Services, Piet du Pisani, told the business community that the City's intention was not to threaten or scare them about what could happen, but rather to make them extremely aware of the vulnerability of the area where their businesses are located.

So far no major incidents of pollution directly related to businesses in this area have been picked up.

The City hopes that the aquifer will be fully utilised as a major source of water for residents within the next four years. However, considering the projected costs of N$140 million mostly for the infrastructure, Peters said, it could take double that time.

The project is due to enter its second phase now during which an analysis of the blending of the natural groundwater with surface water from dams and the reclamation plant will be considered.

The City's main water supply currently comes from the Von Bach, Omatako and Swakoppoort dams as well as the Goreangab Reclamation Plant.

Peters said investigations had shown that the best quality groundwater lay below the Auas Mountains.

The third phase of the project will look into drilling more boreholes in the eastern parts of the City.

Although social factors indicate that Namibia is not likely to experience much population growth in the coming years, urbanisation is set to continue.

Without conserving that which is available and pursuing other options for water supply, Windhoek would continue to experience high water stress, said the City's Chief Scientist in the Department of Infrastructure, Water and Rural Development, Jurgen Menge.

Dentlinger, L. Namibian April 22, 2004 Vol. 19 No. 75 pg. 3

Nampa-AFP

The struggle for water

South African children on their way to a water tap in Bhambayi township north of Durban. People in some townships in South Africa still have to walk to get water for drinking and washing every day. The theme of Earth Day this year is 'Water for Life'.

Make it Earth Day every day

• MAGGI BARNARD

EARTH DAY will be celebrated worldwide and provides an opportunity to renew the fight to protect the environment every day. With the environment under siege, it is more important than ever for conservationists to be vigilant and active in their efforts, according to the World Wildlife Fund (WWF) site on Earth Day.

This year's theme is 'Water for Life'. The focus on water will help many people to reconsider their daily activities and find ways to improve the health of the environment.

In Namibia activities related to this year's water theme started with the celebration of World Wetland Day on February 2.

Activities organised by the Ministry of Environment and Tourism will focus on awareness creations among schoolgoers.

Started 33 years ago, Earth Day was designed "to shake up the political establishment and force [the environment] on to the national agenda," said

Earth Day founder Gaylord Nelson, then a US senator from Wisconsin.

Over the past 30 years, the observance of Earth Day has grown steadily with more and more people the world over uniting to increase awareness of the Earth and environmental responsibility.

In fact, it is estimated that over a half a billion people will participate in the Earth Day celebration.

Earth Day also presents an ideal opportunity for educators to increase students' awareness of environmental issues and to teach them ways to protect and conserve natural resources.

Today, such a shake-up is more necessary than ever, says the WWF.

The idea of Earth Day is not only for conservationists and environmentalists to renew their efforts, but for every consumer to think about the many ways they use energy.

Every time you turn on the light, plug in an appliance or get in a car you are using energy. Changing the way you make simple day-to-day decisions can help combat global warming.

Even the simplest daily activities can make a real difference in preserving the planet.

These include educating yourself and your family, switching off lights, buying recycled products, using safe alternatives to household chemicals and voicing environmental concerns to Government and corporations.

For anyone who wants more information on Earth Day, there is a vast amount of information available on the Internet.

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Nampa-Reuters

Winning woman

Kenya's assistant Environment Minister Wangari Maathai (64), seen in this December 2002 file picture, was awarded the Sophie Prize for her work for the environment, justice and human rights in Oslo in March. She won the US$100 000 prize for leading a campaign to combat deforestation by planting more than 25 million trees across Africa.

Water activist rewarded

• ALEX KIRBY

A GHANAIAN lawyer and human rights campaigner has won recognition for his work to stop water being privatised.

Rudolf Amenga-Etego, who is campaigning against a privatisation scheme being backed by the World Bank, has won a 2004 Goldman environmental prize.

The prizes, worth US$125 000 each, have been described as "the Nobel prize for the environment", and honour activists.

This year there are winners from North and Latin America, Africa, Europe, island nations, and two from Asia.

Rudolf Amenga-Etego founded Ghana's National Coalition Against the Privatisation of Water, an attempt to halt a US$400 m project which would have meant water being sold at full market rates.

In a country where about 70 per cent of the people have no access to clean water, he says, it would be disastrous for the poor.

Some Ghanaians already spend up to 20 per cent of their income on drinking water, Amenga-Etego says, and poor urban families sometimes have to choose between water and education.

Last year, the government of Ghana agreed to suspend the project, but it is now working on a new plan along similar lines. Amenga-Etego told BBC News Online: "The overwhelming majority of Ghanaians are poor. Water privatisation is predicated on handing over our assets to a multi-national corporation for profit.

"So it will automatically price water out of the reach of the poor. It's important to keep water in the public domain with accountable officials, not shareholders." - ***BBC***

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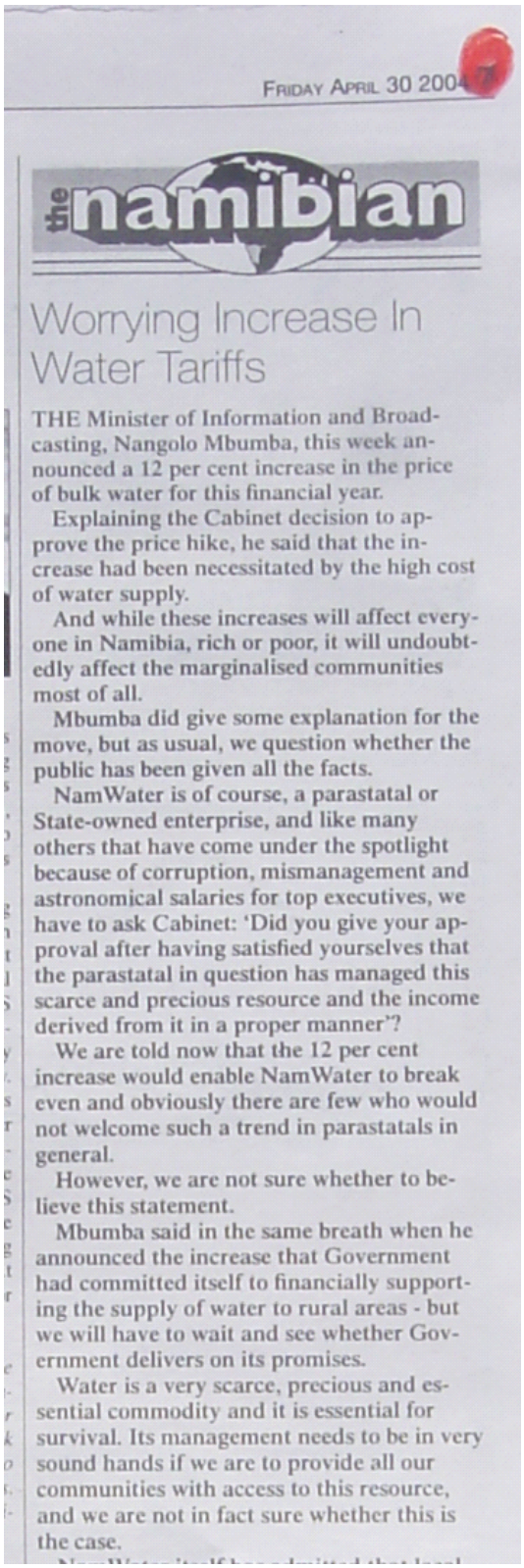

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the namibian

Worrying Increase In Water Tariffs

THE Minister of Information and Broadcasting, Nangolo Mbumba, this week announced a 12 per cent increase in the price of bulk water for this financial year.

Explaining the Cabinet decision to approve the price hike, he said that the increase had been necessitated by the high cost of water supply.

And while these increases will affect everyone in Namibia, rich or poor, it will undoubtedly affect the marginalised communities most of all.

Mbumba did give some explanation for the move, but as usual, we question whether the public has been given all the facts.

NamWater is of course, a parastatal or State-owned enterprise, and like many others that have come under the spotlight because of corruption, mismanagement and astronomical salaries for top executives, we have to ask Cabinet: 'Did you give your approval after having satisfied yourselves that the parastatal in question has managed this scarce and precious resource and the income derived from it in a proper manner'?

We are told now that the 12 per cent increase would enable NamWater to break even and obviously there are few who would not welcome such a trend in parastatals in general.

However, we are not sure whether to believe this statement.

Mbumba said in the same breath when he announced the increase that Government had committed itself to financially supporting the supply of water to rural areas - but we will have to wait and see whether Government delivers on its promises.

Water is a very scarce, precious and essential commodity and it is essential for survival. Its management needs to be in very sound hands if we are to provide all our communities with access to this resource, and we are not in fact sure whether this is the case.

NamWater itself has admitted that local authorities are in arrears to the tune of N$70 to N$80 million, and we fail to see how an increase in the price of water is going to reduce this debt. In fact it will probably skyrocket, since many communities will be unable to afford the trickle-down effect of the bulk water price increase.

In the light of the increases and in light of government transparency in such matters, we believe that people have the right to know whether they are being fully informed that all is well at NamWater - that there is fiscal responsibility. Also, hopefully, salaries for top executives are not as excessive as that of the Agribank CEO, which was recently revealed after his departure from the parastatal in question.

We are not implying wrongdoing, but simply questioning, in view of other startling revelations about mismanagement and waste at other parastatals, in order that the public can arrive at a conclusion that the increase is indeed justified.

If indeed the increase is based on improving water supply lines and extending these to areas formerly neglected, there is merit in the move. But perhaps NamWater needs to be more specific as to the actual costs and details of the water infrastructure improvements before people can accept the increase is in fact necessary.

We would request that Government ensure that the parastatal fully justify the reasons for the increase if they haven't done so already. Only then can the public decide whether the price hike is merited.

Opinion Section Namibian April 30, 2004

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Water is life

• Marietjie Naudé

IN terms of the Local Authorities Act municipalities have some mandates, but also responsibilities when it comes to infrastructure, water and technical services.

This department usually comprises of six different divisions, some complimentary to one another, others operating individually.

The architecture division caters mainly for the architectural needs of the municipality, while the division for building maintenance is responsible for maintaining the existing buildings of the municipality.

The division for bulk water and wastewater is responsible for producing, distributing and supplying potable water to the customers of the municipality. They also provide semi-purified water to irrigation customers. Wastewater includes the collection, conveyance and the treatment of wastewater.

The division for technical support designs and oversees the construction of all water- and sewerage-related infrastructure. This is usually a relatively small and specialised division.

The scientific services division oversees the quality control of water and wastewater. It controls the quality of wastewater and prevents, among others, the occurrence of water-borne diseases.

The last division deals with all solid waste in a city, town or village. Providing collection systems, it goes and collects waste and ensures that the waste gets disposed in an environmentally acceptable way.

environmentally acceptable way.

In Namibia the body with the mandate and the obligation to supply bulk water is NamWater. It supplies water to municipalities in the country and also to some private customers. Some municipalities in the country also have their own water sources complimentary to the water that they receive from NamWater. In the case of Windhoek, almost 20% of the city's water demand can in times of emergency be retrieved from boreholes. Under normal circumstances about 4% of the city's demand is retrieved from the boreholes. In addition Windhoek also has a reclamation plant that provides in 35% of the city's water demand.

The obligation of the municipality is to treat this water through their network and in their reservoirs.

Water received from NamWater however is fully treated.

Some of the bigger municipalities in the country have industrial and commercial customers, as well as the domestic customers.

They have a responsibility to bring the water up to a water meter, which could be situated inside or outside the property of the consumer. According to Mr. Piet du Pisani, Strategic Executive: Infrastructure, Water and Technical Services at the City of Windhoek, the municipality is responsible to maintain the water supply system upstream of the installed meter. "Any problems downstream of the meter is the responsibility of the consumer," says Mr. Du Pisani. If a customer in other words has a water leak on his premises, it is his own responsibility to repair it.

It is also the duty to read these meters and present consumers with an account for the use of water.

In informal areas the municipality is also responsible for the communal water points like standpipes

where more than one family collect water.

In most towns, cities and villages the municipality has to apply their service to certain service levels. These levels vary from 1 to 5. A level 5 area would be a fully serviced area, while the lower areas have some restrictions as to how far for example the people have to go to fetch water. These levels are mainly determined according to the income capacity of the area.

"One of a municipality's main obligations is to ensure that the water they offer to clients is safe for consumption," says Mr. Du Pisani.

This is where the scientific service division plays a very important role concerning the sampling, testing and analysing of water in the supply network. The big danger here is that the water analysis can take from 24 to 48 hours to deliver a result, during which time most of the water has already gone through the system. "That is why it is important for municipalities to monitor and test reservoirs on a daily base. You can rely on indicators such as a drastic reduction in chlorine levels and act pro-actively."

Concerning sanitation, local authorities also have the responsibility to collect sewerage from connected customers and transport it to the treatment works by way of pipes or, in some cases, in trucks. It is their duty to treat the water to a standard where it is acceptable to be released back into nature.

This is done under a discharge permit from the Ministry of Agriculture, Water and Rural Development. The permit also allows the municipalities to set the standard for the release of sewerage water back into the municipal system.

"This means that if a municipality has an industry as a customer, the municipality has the mandate to dictate to that industry what the standard of the water should be, before it is released back into the municipal sewerage system," says Mr. Du Pisani.

The industry can do onsite treatments to ensure that the water is on standard before releasing it or they can be penalised financially for the additional strain that they put on the municipal sewerage system.

The municipality's responsibility concerning the maintenance of the drainage system starts from the connection from the main line to the connection of the consumer, which is usually a junction or a manhole. From this connection point to the residence is the responsibility of the consumer.

Municipalities are obliged to adopt the model regulations under the Ministry of Regional and Local Government and Housing for the supply of water and drainage regulations. Bigger municipalities often draft their own additional regulations based on these two models.

By doing this they can regulate exactly what is happening in their own city or town.

In Windhoek alone, there are more than 42 000 water connections, 1 200 km of water pipes and some 960 km of sewerage lines.

■ Piet du Pisani, Strategic Executive: Infrastructure, Water and Technical Services at the City of Windhoek explains the operations of the Goreangab Water Re-clamation Plant to Pres. Sam Nujoma.

Nandé, M. Namibian April 30, 2004 Vol. 19 No. 81 pg. 14

Appendix G: Tally of Residential Interviews

Below are the answers we received from residential interviews. Each resident's response is followed by the residence's street name.

How many adults and children live in your house?		
Adults	***Children***	***Location***
5	1	Starling
4	2	Pietersen
3	4	Kroon
4	5	Trompet
4	0	Ombwindja
3	2	John Wycliff
2	2	Lasuriet
2	0	Sigma

Do you have a separate flat that you rent out how many people live there?		
Adults	***Children***	***Location***
0	0	Starling
2	1	Pietersen
3	5	Kroon
0	0	Trompet
0	0	Ombwindja
0	0	John Wycliff
0	0	Lasuriet
0	0	Sigma

What is the highest level anyone in the house has achieved?	
Response	***Location***
Secondary School	Starling
(blank)	Pietersen
Technical Background but didn't finish school	Kroon
Some post seconday	Trompet
Secondary School	Ombwindja
Secondary School	John Wycliff
Grade 9	Lasuriet
Little Undergrad	Sigma

Where does you water come from?	
Response	***Location***
Dams	Starling
Not sure	Pietersen
Dams	Kroon
Gammons	Trompet
Namwater	Ombwindja
Not sure	John Wycliff
Don't know	Lasuriet
Dams	Sigma

Please describe the water situation in Namibia. (1 of 4 options)	
Response	***Location***
2	Starling
2	Pietersen
2	Kroon
2	Trompet
2	Ombwindja
2	John Wycliff
3	Lasuriet
2	Sigma

Are you familiar with water-saving devices?		
Response		***Location***
	No	Starling
	No	Piertersen
Yes, low flow showerheads		Kroon
	No	Trompet
	No	Ombwindja
	No	John Wycliff
	No	Lasuriet
	No	Sigma

If so, do you use any?		
Response		***Location***
	N/A	Starling
	N/A	Piertersen
	No	Kroon
	N/A	Trompet
	N/A	Ombwindja
	N/A	John Wycliff
	N/A	Lasuriet
	N/A	Sigma

If you do not use them, why not?	
Response	***Location***
N/A	Starling
N/A	Pietersen
They would put one in if it was needed	Kroon
N/A	Trompet
N/A	Ombwindja
N/A	John Wycliff
N/A	Lasuriet
N/A	Sigma

Do you reuse grey water?		
Response		***Location***
	No	Starling
	No	Piertersen
Yes, use washing machine water for gardens		Kroon
	No	Trompet
Yes reuse wash water		Ombwindja
Yes bathing and washing car		John Wycliff
	No	Lasuriet
	No	Sigma

Are you familiar with the tariffs the city charges for water?		
Response		***Location***
	No	Starling
	No	Piertersen
Doesn't understand completely but does look at it		Kroon
Yes		Trompet
Sometimes		Ombwindja
	No	John Wycliff
Husband's "job" in house		Lasuriet
Yes		Sigma

If so, what do you think about the tariffs?	
Response	***Location***
N/A	Starling
N/A	Pietersen
The meters are not read every month but if they did then it	Kroon
It is expensive	Trompet
N/A	Ombwindja
N/A	John Wycliff
Can afford it	Lasuriet
It is ok	Sigma

Have the tariffs affected your water use?	
Response	***Location***
N/A	Starling
N/A	Pietersen
N/A	Kroon
Doesn't have gardens or plants	Trompet
N/A	Ombwindja
N/A	John Wycliff
N/A	Lasuriet
N/A	Sigma

If there were an increase in the water tariff, would you use less water or about the same as you do now?	
Response	***Location***
Less	Starling
Less	Pietersen
Less	Kroon
Less	Trompet
Less	Ombwindja
less	John Wycliff
use the same	Lasuriet
less	Sigma

If less which activities would you cut down you usage	
Response	***Location***
Shorter showers	Starling
Should cot back on gardening (would if it came to that)	Pietersen
Bathing, they would try to cut down on the time	Kroon
Showering and garden	Trompet
Doesn't know	Ombwindja
Washing , bathing, and washing cars	John Wycliff
N/A	Lasuriet
shower and washing plates	Sigma

What are your most common household water uses?										
Showers	***Flushing Toilets***	***Washing Hands***	***Drinking Water***	***Cooking***	***Washing Dishes***	***Watering Gardens***	***Washing Vehicle***	***Washing Machine***	***Washing the Floor***	***Location***
2 per person per day	2 per person per day	2 per person per day	4 litres	1 time evening meal	1 time evening	no	1 time per week (with bucket)	no	2 times a week (with bucket)	Starling
1 per person per day	2 per person per day	2 per person per day	2 litres	1 time evening meal	2 times per day	every 3 days	once per month (with bucket)	(not asked)	(not asked)	Pietersen
1 per person per day	3 per person per day	3 per person per day	1 litres	1 time evening meal	3 times per day	not very often	never	Use water from machine to water gardens	(not asked)	Kroon
1 per person per day	10 times a day total	No answer	10 containers per 3 days	1 litre per day	3 litres per day	no	no	once a week (top loading)	(not asked)	Trompet
4 a day	20 times a day total	6 times a day	3 litres a day	2 litres 3 times a day	5 litres 2 times a day	no	no	2 times a week 9 litres each time		Ombwindja
2 per person per day	2-3 per person per day	3 per person per day	1 litres	3 litres	2 litres	no	1 time every 2-3 weeks	no	(not asked)	John Wycliff
2 per day per adult + 1 per day per child	10 times a day total (more on weekend)	3 times a day	2 litres a day	2 litres a day	3 litres per sinkful	2 per week (2 litres each)	no	1 per week 5-6 loads	2 times a week (with bucket)	Lasuriet
2 times a day per person	3 times a day per person	4 times a day per person	2 litres a day	4 litres a day	1 litre	1 time per month	N/A	1 time per month	weekends	Sigma

How often do you check your water meter?	
Response	***Location***
not checked	Starling
Step father regularly checks meter	Pietersen
periodically	Kroon
weekly	Trompet
Occasionally	Ombwindja
not checked	John Wycliff
1-2 times a week	Lasuriet
Brother checks meter	Sigma

Do you use your meter to check for leaks?		
Response		***Location***
	No	Starling
Yes		Piertersen
	No	Kroon
Yes		Trompet
	No	Ombwindja
	No	John Wycliff
	No	Lasuriet
Yes		Sigma

Are you aware of any current leaks in your household?		
Response		***Location***
	No	Starling
Yes, sink tap is leaking and the toilet is running		Piertersen
Yes, but fixed now		Kroon
Toilet all day		Trompet
	No	Ombwindja
	No	John Wycliff
	No	Lasuriet
	No	Sigma

If so, how severe are they and how long have they existed?		
Fixture Leaking	***Severity***	***Surname***
N/A		Starling
sink tap	not too bad	Piertersen
toilet	don't pay much attention to it	
toilet		
taps		Kroon
Toilet		Trompet
N/A		Ombwindja
N/A		John Wycliff
N/A		Lasuriet
N/A		Sigma

Have you had any large leaks in the past?	
Response	***Location***
N/A	Starling
(no answer)	Pietersen
no big leaks	Kroon
Geyser	Trompet
Sink and geyser, Pipe burst inside yard main supply	Ombwindja
N/A	John Wycliff
Toilet for 3-4 months	Lasuriet
No	Sigma

How did you realize the leaks?	
Response	***Location***
N/A	Starling
picked up with water meter	Pietersen
visible and underground they hope they	Kroon
N/A	Trompet
N/A	Ombwindja
N/A	John Wycliff
Saw it	Lasuriet
N/A	Sigma

Did you fix the leaks yourself or hire	
Response	***Location***
N/A	Starling
Tried to fix it themselves	Pietersen
fixed it themselves	Kroon
Hired someone	Trompet
Fixed it themselves	Ombwindja
N/A	John Wycliff
Hire	Lasuriet
N/A	Sigma

How much time/money did you spend?	
Response	***Location***
N/A	Starling
(didn't know)	Pietersen
(didn't know)	Kroon
N$100	Trompet
N$450-geyser N$250-sink, 15 minutes	Ombwindja
N/A	John Wycliff
N$250	Lasuriet
N/A	Sigma

Have you ever seen/heard anything about saving water?	
Response	***Location***
yes	Starling
no	Pietersen
yes	Kroon
yes	Trompet
yes	Ombwindja
yes	John Wycliff
yes	Lasuriet
yes	Sigma

Do you know of any awareness programmes?	
Response	***Location***
TV and radio commercials and posters on saving water	Starling
No	Pietersen
Talks of water-saving schemes during drought. Municipality gives out pamphlets. In water bill received stuff about water-saving	Kroon
TV and books from father's work and ads.	Trompet
Radio	Ombwindja
TV commercials	John Wycliff
Not really	Lasuriet
Municipality Meetings NBC reports papers	Sigma

Have you ever tried to reduce your water consumption?		
Response		***Location***
	No	Starling
Yes		Piertersen
Yes, talked with children, but it is difficult because they are so young		Kroon
Yes		Trompet
Yes		Ombwindja
Yes		John Wycliff
	No	Lasuriet
Yes		Sigma

If so what was the reason?	
Response	***Location***
N/A	Starling
They realized that they kept using more and more water as time	Piertersen
to save money	
Other people were coming to use their water.	Kroon
No answer	Trompet
Other people use his water. Big problem	Ombwindja
Not much water in country	John Wycliff
N/A	Lasuriet
Save money and water for community and other people	Sigma

Do you have any ideas of what would make people more aware of the water situation in Namibia?	
Response	***Location***
No	Starling
No	Piertersen
Pamphlets, during drought advertise on radio/TV	Kroon
She thinks they should make people aware of it all the time and intensify during times of drought	
Literature in more languages than just English and Afrikaans	Trompet
Radio	Ombwindja
There are things that can be done, but didn't mention any	John Wycliff
Keep kids form running taps and close taps while people are washing their hands	Lasuriet
Give examples to younger generations. Older people should set examples for younger generations	Sigma

Appendix H: Tally of School Interviews

Below are the answers we received from student interviews. Each student's response is followed by his or her first name.

What year of school are you in?	
Pioneerspark Primary School	***Student***
6th grade	Marlanda
7th grade	Johann
7th grade	Mariette
7th grade	Alex
Jan Mohr Secondary School	
10th grade	Consteinz
10th grade	Charne
10th grade	Jenny
10th grade	Katjekua
Polytechnic of Namibia	
3rd year	Joe
3rd year	Daniel
3rd year	Kawala
3rd year	Fredrick
2nd year	Muronga

Where does the water in Windhoek come from?	
Pioneerspark Primary School	***Student***
Dams	Marlanda
Hardap	Johann
Goreangab Dam	Mariette
Don't know	Alex
Jan Mohr Secondary School	
Hardap dam, Big dams and boreholes	Consteinz
Hardap dam	Charne
Omatako dam, purified water	Jenny
Rucana River	Katjekua
Polytechnic of Namibia	
Hardap dams and next to Okahandja	Joe
1-2km from Polytechnic…NamWater Dam	Daniel
Goreangab Reclamation	Kawala
Don't know	Fredrick
Doesn't know	Muronga

Please describe the water situation in Namibia (1 of 4 options)	
Pioneerspark Primary School	***Student***
option 2	Marlanda
option 3	Johann
option 4	Mariette
option 3	Alex
Jan Mohr Secondary School	
option 3	Consteinz
option 4	Charne
option 3	Jenny
option 2	Katjekua
Polytechnic of Namibia	
option 3	Joe
option 3	Daniel
Dry country.3 Major Rivers. Bringing water into central is difficult, affects agriculture. Farmers depend on boreholes. Option 4	Kawala
option 3	Fredrick
option 2	Muronga

Are you familiar with water-saving devices	
Pioneerspark Primary School	***Student***
Yes	Marlanda
No	Johann
No	Mariette
No	Alex
Jan Mohr Secondary School	
No	Consteinz
No	Charne
Yes	Jenny
No	Katjekua
Polytechnic of Namibia	
Yes.	Joe
No	Daniel
Yes.	Kawala
Yes	Fredrick
No.	Muronga

If so, do you use any water-efficient fixtures at home?	
Pioneerspark Primary School	***Student***
Low flow toilet	Marlanda
N/A	Johann
N/A	Mariette
N/A	Alex
Jan Mohr Secondary School	
N/A	Consteinz
N/A	Charne
No	Jenny
N/A	Katjekua
Polytechnic of Namibia	
Low-flow showerhead	Joe
N/A	Daniel
Low flow devices	Kawala
Dual flush toilet and low-flow shower head	Fredrick
N/A	Muronga

Do you feel people here in Namibia should have to pay for water? Why or why not?	
Pioneerspark Primary School	***Student***
Yes it's very precious	Marlanda
Yes. There is a little amount of water.	Johann
Yes. Many people use it for fun.	Mariette
Yes. Not enough water	Alex
Jan Mohr Secondary School	
Yes people waste a lot of water and must pay for its purification, fixing pipes, and constructing new dams	Consteinz
People should have to pay because it has to be purified.	Charne
Yes water supply is low.	Jenny
Yes. It was free people would use more.	Katjekua
Polytechnic of Namibia	
Yes. People would waste water. Controls use.	Joe
Yes it keeps NamWater running. People will waste it otherwise	Daniel
Yes it costs to bring water to people. Low income should maybe get it for free	Kawala
Yes. Costs to recycle water.	Fredrick
Yes it has to be cleaned and treated.	Muronga

Have you seen / heard anything about saving water? Do you know of any water awareness programs?	
Pioneerspark Primary School	***Student***
TV, posters	Marlanda
TV, posters at school	Johann
News / NBC / Posters	Mariette
No.	Alex
Jan Mohr Secondary School	
Advertisement about saving water, TV	Consteinz
Posters	Charne
NamWater projects, Pictures for camp.	Jenny
NamWater teaching at school.	Katjekua
Polytechnic of Namibia	
TV, newspaper, billboards	Joe
TV ads, Radio	Daniel
Reuse water for garden. Turn on/off shower	Kawala
Word of mouth. Radio	Fredrick
Community program to conserve water.	Muronga

What do you learn in school about saving water? How often?	
Pioneerspark Primary School	***Student***
Close taps and use wisely. Science class	Marlanda
Close taps when brushing teeth, small baths	Johann
Most teachers talk about it. Don't leave taps open	Mariette
Close tap when brushing teeth. Don't flush toilet too much.	Alex
Jan Mohr Secondary School	
Often, use water wisely and don't waste due to limited supply	Consteinz
In primary school learned about why and how to save water. They also had to do assignments and speeches on why to save water.	Charne
All the time have to save it because there isn't much available and we shouldn't waste it.	Jenny
To make sure to close taps	Katjekua
Polytechnic of Namibia	
Reusing water, primary and high school	Joe
Close the taps, but not at the Polytech	Daniel
In high school water would stop running (2 weeks), Use water wisely.	Kawala
Nothing.	Fredrick
Grade 7 to preserve water, reuse grey water	Muronga

Have you ever tried to reduce your water use?	
Pioneerspark Primary School	***Student***
Yes.	Marlanda
No.	Johann
No.	Mariette
No.	Alex
Jan Mohr Secondary School	
Yes.	Consteinz
Yes.	Charne
Yes.	Jenny
Yes.	Katjekua
Polytechnic of Namibia	
Yes.	Joe
Yes.	Daniel
Yes.	Kawala
Yes.	Fredrick
No.	Muronga

If so, in what way?	
Pioneerspark Primary School	***Student***
Less water in bath tub	Marlanda
N/A	Johann
N/A	Mariette
N/A	Alex
Jan Mohr Secondary School	
Takes showers instead of baths, water plants at night to reduce evaporation	Consteinz
Shower instead of bathing	Charne
Use dishwater for watering plants, water plants at dusk	Jenny
Use bowl to wash clothes instead of running water	Katjekua
Polytechnic of Namibia	
Not using water to wash car and plants. No 3+ showers a day.	Joe
Turn shower off/on during shower	Daniel
Shower once a day. Reuse water.	Kawala
Water meter tempers usage. Less watering of plants once a day.	Fredrick
N/A	Muronga

Do you have any ideas of what would make people more aware of the water situation in Namibia?	
Pioneerspark Primary School	***Student***
Without water you will die.	Marlanda
No.	Johann
Water pipes must be fixed	Mariette
No.	Alex
Jan Mohr Secondary School	
Projects to teach about using water wisely	Consteinz
Tell public quantity of available of water in Namibia for the amount of people.	Charne
Education, Tell northern parts about the importance of water in Namibia.	Jenny
Increase the water tariff	Katjekua
Polytechnic of Namibia	
Keep educating community/ advertising to use low flow technology. Rainfall collection.	Joe
Telling the public, TV Radio, go around to villages, more languages.	Daniel
Learn through difficult situation. TV, Water Day New water distribution system. Card system like phones.	Kawala
Representatives to promote water conservation. Regional Counselors.	Fredrick
No.	Muronga

Appendix I: Summary of Assessment of WDM Policies and Practices

Problems and Successes on WDM Policies in Windhoek as well as ongoing solutions to them

Policies	Successes	Problems	Ongoing Solutions
Block tariff System (punitive tariff system)	By making residents pay for potable water, they are less likely to use more than is actually needed.	Some people are too poor to pay for water	Highest block tariff adjusted with the availability of water
Restrictions on Garden Watering	Along with education, this regulation helped inform the public. While there is no evidence of more people using	Although this policy is in place it is only enforced during times of drought. Only 2 police officers are qualified to enforce this policy.	
Water efficient equipment installation (all fixtures in the house are required to have less than 10 L/minute flow rate)	The technology is becoming more available and the number of manufacturers is growing. In addition residents of Windhoek claim they would use low-flow technology if and when they were to reduce their water consumption	Dual flush toilets and other water-saving devices are not readily available and not of high quality. The higher cost of these devices is also an issue.	Plumbing stores in the area of Windhoek have low-flow technology available but there is a limited selection. (e.g. aerators, hose burst safety devices, and toilet stops) Most prices seem comparable to high flow devices
The city government is to create and maintain a government agency with responsibility, authority, and institutional and financial capacity to address problems in the sanitation sub-sector	The sanitation organization is more efficient and more people have access to sanitation facilities.	A detailed master plan was slow in the making and no one government agency/dept. was responsible for coordinating and implementing policy around sanitation (1995) Bulk water was under funded and mired in bureaucracy .	The government of Windhoek instituted the Department of Infrastructure, Water and Technical Services
Swimming pools must be covered	This regulation helped educate the residents of a major source of water loss.	This policy is also not enforced very similar to the water gardening policy.	
Raise awareness of cost and scarcity of water	Education Programs have improved the knowledge of the community concerning the water situation in Namibia	Public knowledge is not in line with actual situation.	

Problems and Successes on WDM Practices in Windhoek as well as ongoing solutions to them

Practices	Successes	Problems	Ongoing Solutions
Wet Industries	Guidelines were developed for companies that use large amounts of water such as Breweries for the efficient use of water.		The City discourages wet industries from investing in the area
Raise awareness of cost and scarcity of water	Education Programs have improved the knowledge of the community concerning the water situation in Namibia	Public knowledge is not in line with actual situation.	
Generate revenue to cover capital, maintenance, rehabilitation and operational costs	Some cities are making progress towards full cost recovery reaching 90% cost recovery or more.	Full cost recovery is not happening.	Pricing schemes have been adjusted and the price of water distribution increased. In addition to cost saving measures (i.e. reduction in force) have been implemented
New Water Bill for Namibia (currently in Parliamentary Debate)	Namibia's Water Act 54 of 1956 was based on SA's water act and therefore not appropriate for the situation and the country. New Water Bill in Parliament debate will update National Water Policy for Namibia.	The water bill does not address irrigation, which is approximately 72% of the water consumption in Namibia.	People and NGOs are petitioning Parliament for amendments to the current bill that address irrigation
Reusing and recycling water	Grey water is reused by several industries and semi-purified water is used for large irrigation schemes including municipal gardens.	Currently the New Goreangab Water Reclamation Plant is having operational difficulties.	
Water efficient equipment installation	The technology is becoming more available and the number of manufacturers is growing. In addition residents of Windhoek claim they would use low-flow technology if and when they were to reduce their water consumption	Dual flush toilets and other water-saving devices are not readily available and not of high quality. The higher costs of these devices is also an issue.	Plumbing stores in the area of Windhoek have low-flow technology available but there is a limited selection. (e.g. aerators, hose burst safety devices, and toilet stops) Most prices seem comparable to high flow devices

Appendix J: Residential Water-Saving Recommendations

FOCUS ON WATER SAVING

WHAT YOU CAN DO TO GET WATER WISE

Are you using more water than you thought? Take a look at your bill. The average daily water use in the capital in 2002 was between 90 litres (in the low income areas) and 230 litres (in high income areas) per person a day, calculated on an average household of five persons per household. You'd be surprised at how much water you are using. But you can save money by following these conservation tips.

- Inside your house, bathroom facilities claim nearly 75 per cent of the water used. Never pour water down the drain when there may be another use for it, such as watering a plant or garden, or for cleaning around your home.
- Verify that your home is leak-free. Many homes have hidden water leaks. Read your water meter before and after a two-hour period when no water is being used. If the meter does not read exactly the same, there is a leak.
- Repair dripping taps by replacing washers. If a tap is dripping at a rate of one drop per second, you can expect to waste a staggering 12,150 litres per year. This adds to the cost of water and sewage utilities and, of course, adds to your water bill.
- Retrofit all household taps by installing aerators with flow restrictors to slow the flow of water.
- Check for toilet tank leaks by adding food colouring to the tank. If the toilet is leaking, colour will appear in the toilet bowl within 30 minutes. Check the toilet for worn out, corroded or bent parts. Most replacement parts are inexpensive, readily available and easily installed. (Flush as soon as test is done, since food colouring may stain the tank.)
- If the toilet handle frequently sticks in the flush position letting water run constantly, replace or adjust it.
- Install a toilet dam or displacement device, such as a bag or bottle, to cut down on the amount of water needed for each flush. Be sure installation does not interfere with the operating parts.
- When purchasing new or replacement toilets, consider low-volume units which use less than half the water of older models.
- Take shorter showers. Replace your showerhead with an ultra-low-flow version or install a flow restrictor. The City's Water Regulations make this compulsory. The maximum discharge on a showerhead is 10 litres per minute. Some units are available that allow you to cut off the flow without adjusting the water temperature knobs. Place a bucket in the shower to catch excess water and use this to water plants. The same technique can be used when washing dishes or vegetables in the sink.
- In the shower, turn water on to get wet; turn off to lather up; then turn back on to rinse off. Repeat when washing your hair.
- Operate automatic dishwashers and washing machines only when they are fully loaded. Set the water level for the size of load you are using.
- When washing dishes by hand, fill one sink or basin with soapy water. Quickly rinse under a slow-moving stream of water from the tap.
- Store drinking water in the refrigerator. Don't let the tap run while you are waiting for cool water to flow.
- Do not use running water to thaw meat or other frozen foods. Defrost food overnight in the refrigerator or use the defrost setting on your microwave.
- Kitchen sink disposals require lots of water to operate properly. Start a compost pile as an alternate method of disposing of food waste.
- Consider installing an instant water heater on your kitchen sink so you don't have to let the water run while it heats up. This will also reduce water-heating costs for your household.
- Insulate your water pipes. You'll get hot water faster and avoid wasting water while it heats up.
- Don't let water run while shaving or washing your face. Brush your teeth first while waiting for water to get hot, then wash or shave after filling the basin.
- Avoid flushing the toilet unnecessarily. Dispose of tissues, insects and other similar waste in rubbish containers rather than the toilet.

GENERAL WATER SAVING TIPS

- **Be aware of and follow all water conservation and water shortage rules in effect in the City. Don't assume that you need not observe good water use rules. Every drop counts.**
- **Encourage your employer to promote water conservation in the workplace. Suggest that water conservation be made a component of employee orientation and training programmes.**
- **Report all significant water losses (broken pipes, open hydrants, errant sprinklers, abandoned free-flowing wells, etc.) to the property owner, or the City of Windhoek at telephone 290-2402.**
- **Encourage your school to help develop and promote a water conservation ethic among children and adults.**
- **Support projects that will lead to an increased use of reclaimed wastewater for irrigation and other uses.**
- **Make sure your visitors understand the need for, and benefits of, water conservation.**
- **Encourage your friends and neighbours to be part of a water-conscious community. Encourage your friends, neighbours and co-workers to "do their bit".**
- **Conserve water because it is the right thing to do. Don't waste water just because someone else is footing the bill, such as when you are staying at a hotel.**
- **Try to do one thing each day that will result in saving water. Don't worry if the savings are minimal.**

Every drop counts. You can make a difference

WATER WORD PUZZLE

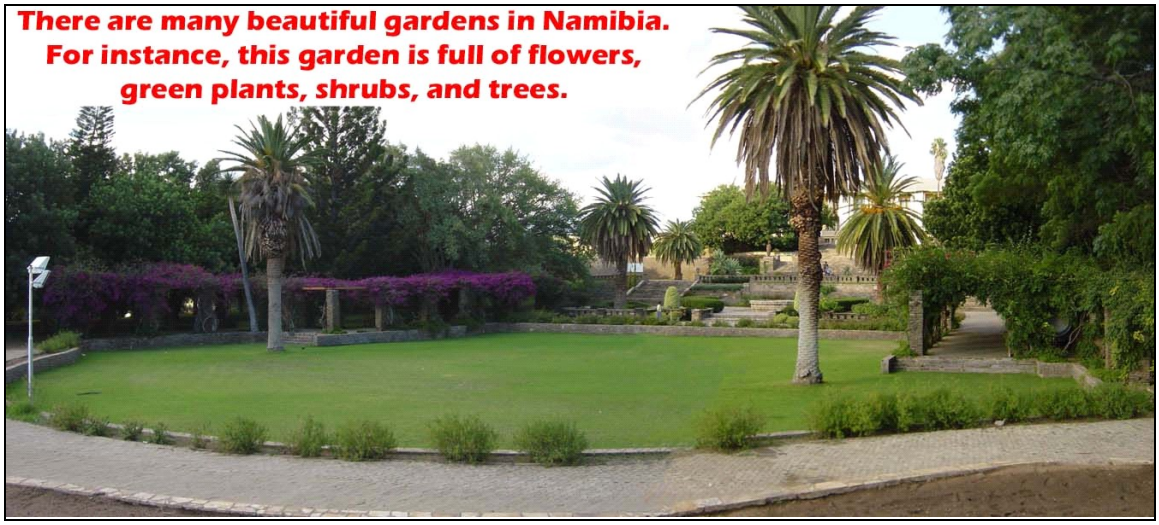
Find the following words: Conservation, Water, Von Bach Dam, Goreangab, Water Meter, Consumption, Kilolitre, Drought, Namwater, Municipality, Rainfall, City, Nation, Namibia, Save

M	M	R	W	G	M	G	S	I	T	L	C	O	M	G	K	F	C	D	G	N	X
U	S	A	X	K	U	O	O	N	O	I	R	M	E	A	A	J	N	T	O	A	B
N	O	I	T	P	M	U	S	N	O	C	I	R	T	T	B	K	O	G	R	I	L
I	I	F	K	O	I	W	N	O	N	I	S	E	A	O	K	L	I	E	E	B	O
C	C	A	I	P	C	I	F	P	R	T	T	T	R	I	O	Y	T	O	A	I	E
I	R	L	L	R	P	N	H	D	O	Y	O	A	O	N	N	E	A	G	W	M	V
P	P	V	O	N	B	A	C	H	D	A	M	W	V	S	M	F	N	W	N	A	A
A	I	O	L	T	A	M	D	O	R	H	W	A	L	R	R	A	A	Q	S	N	S
L	L	O	I	N	L	W	A	U	O	O	M	E	E	O	E	A	F	L	D	A	W
I	T	L	T	M	I	A	M	S	U	M	T	T	E	R	T	S	O	Z	L	W	N
T	T	M	R	D	T	T	N	E	G	A	A	R	O	D	R	N	N	X	C	T	M
Y	Y	E	E	R	I	E	R	R	H	W	K	G	O	A	O	O	E	O	L	U	F
M	U	T	Y	I	F	R	P	G	T	Q	E	S	M	M	F	M	E	S	C	I	O

Appendix K: “Reality” Commercial Screenshots

These are screen shots of the commercial that our group developed for distribution by the DRFN to the public or to a responsible advertising agency for national distribution. We created these images using digital photographs taken by Jacob Castiglione and the photo editing software package, Photoshop 6.

First "Reality" Scene: Blue Screen with Yellow words “REALITY” centered at the top.



Second “Reality” Scene: Parliament Gardens on a Sunny Day.

Third "Reality" Scene: Parliament Gardens with a Toilet in the Foreground.

Fourth "Reality" Scene: The Parliament Gardens start to fill up with Toilets.

Fourth "Reality" Scene: The Parliament Gardens are Filled to Capacity with Toilets Representing the Volume of Water in Number of Nine Litre Toilet Flushes it Takes per Day to Keep this Garden Green.

Fifth "Reality" Scene: Two Different Aesthetically Pleasant Indigenous Gardens in Windhoek.

Sixth and Final "Reality" Scene: Blue Background with the words "REALITY" in Yellow and "Precious Water is Wasted Every Day. YOU CAN MAKE A DIFFERENCE. CONSERVE WATER!" in a Few Colors to Emphasize the Important Words.

Appendix L: Work Pictures

The following photos document some of our work throughout our project.

Our group's first meeting at the DRFN

Justin and Joe looking at the information gained from the data logger (blue box)

Jacob observing a resident's water meter in Windhoek

Justin and Joe discussing data loggers

Justin and Joe jumping over a wall to observe a Windhoek city dam

Jacob at the Gammans Cemetery in Windhoek

Our group standing on top of a mountain overlooking Windhoek

Our group outside the DRFN