CHAPTER THREE

WATER UTILISATION IN THE MAKOKO AND PHAMENI SETTLEMENTS

3.1 INTRODUCTION

This chapter describes the operation of the existing water facilities as well as the daily water utilisation patterns and practices of the residents of the two settlements where the research was conducted. This information serves as a basis to determine how the functioning of existing water facilities within a settlement influences the daily water utilisation practices of the residents. With this information, the effect of the current status of the two settlements' water systems on the residents' quality of life can be determined. It also gives a perspective on the manner in which the residents perceive water as a natural resource and their level of understanding of the concept that water supply is a service that has to be paid for (see Chapter Four).

3.2 THE STRUCTURE OF THE WATER SUPPLY SYSTEMS IN MAKOKO AND PHAMENI

3.2.1 The Northern Nsikazi Bulk Water Scheme

Both Makoko and Phameni, which are located in the northern section of the Nsikazi district, receive bulk water supply from the Sabi River in Mpumalanga via the Northern Nsikazi Bulk Water Scheme. This water scheme is currently still the responsibility of the Mpumalanga DWAF. As was mentioned in Chapter Two, bulk water supply to the northern section of the Nsikazi district was initiated in 1985/1986 under the government of the former homeland, KaNgwane, and the supply was then upgraded in 1994 by the Eastern Transvaal DWAF, now called the Mpumalanga DWAF (see Section 2.8.2).

Regional water supply systems such as the Northern Nsikazi Bulk Water Scheme tend to be a more economical option than cluster water schemes, which serve only a few settlements. Regional water schemes are developed to provide higher capacity to serve several settlements within a given region and where an adequate water source, such as the Sabi River, can be utilised (Sami and Murray 1998:6.20).

Bulk water supply in the Northern Nsikazi Bulk Water Scheme entails water reticulation pipes connecting the Sabi River to the settlements served by the Northern Nsikazi Bulk Water Scheme, but no reticulation pipe networks serving individual stands within these settlements. In other words, according to spokespersons from DWAF, the bulk water service provider extracts water from the river, sends the water through a cleaning process and pumps it to each settlement's reservoir. Here, the settlement's local authority is responsible for ensuring that the residents have easy access to the stored water by means of water reticulation pipelines serving settlement stand pipes.

The Northern Nsikazi Bulk Water Scheme provides eighteen settlements located within the Northern Nsikazi district with water from the Sabi River. Makoko and Phameni are the third and fourth last recipients among the eighteen settlements on the water reticulation pipeline, as they are situated approximately 25 kilometres from the Sabi River.

Makoko and Phameni have each been supplied by DWAF with one 10 000-litre plastic tank, which serves as a temporary reservoir. These temporary reservoirs are linked to the permanent reservoir at Numbi, which is one of eight permanent reservoirs within the area of the Northern Nsikazi Bulk Water Scheme. The pipeline from the Numbi reservoir to the temporary reservoirs of Makoko and Phameni is a gravitation line, which means that the water is not pumped to the temporary reservoirs but flows downward by means of gravitation along the contours of the geographic area. The implication of this is that the water flows to the temporary reservoirs for 24 hours per day. Each settlement's water reticulation pipeline is connected to the temporary reservoir located just outside the settlement. The residents of both Makoko and Phameni are supplied with water by means

of the water reticulation pipes via communal water taps located on street corners within the settlements.

According to an engineer directly involved in the water supply of the Northern Nsikazi Bulk Water Scheme, the temporary reservoirs' storage capacity of 10 000 litres is too small to provide the population of Makoko with the RDP minimum quantity of 25 litres per person per day (see Section 2.9.6). A simple calculation proves this statement. The estimated population figure of Makoko is 5 600 (see Section 2.6).

Thus:

5 600 × 25 litres = 140 000 litres

This means that 140 000 litres of water are needed per day in Makoko.

According to the engineer, the actual volume of water that the residents of Makoko have at their disposal per day can be determined by the following calculations. The bulk water supply line provides the temporary reservoir of Makoko with water at an average flow rate. The average flow rate is indicated in litres per second.

140 000 litres needed per day in Makoko	
÷	24 hours
÷	60 minutes
÷	60 seconds
	1.62 litres per second

The water enters the temporary reservoir of Makoko at an average flow rate of 1.62 litres per second. The temporary reservoir can only store 10 000 litres of water. At present, there are about 40 government-installed taps in Makoko. The engineer states that each

tap is designed to yield water at a flow rate of 15 litres per minute. To determine how long it takes for the 40 taps to use the 10 000 litres of water, the following calculation is made for water usage during peak times, such as early morning when all the residents use water to prepare breakfast and wash and all the taps are open.

15 litres per minute per tap
÷ 60 seconds

0.25 litres per second

0.25 litres per second
× 40 taps

10 litres of water per second

The peak flow rate of water in Makoko is therefore 10 litres per second. The 10 000 litres water stored in the reservoir is therefore used in the early morning (peak time) at a flow rate of 10 litres per second.

10 000 litres of water stored in the temporary reservoir
÷ 10 litres per second at peak flow rate

1000 seconds before all the water stored in the temporary reservoir is used

1000 seconds ÷ 60 = 16.6 minutes

This means that when the residents start to use water early in the morning, they use the 10 000 litres of stored water in the temporary reservoir within 16.6 minutes. During the rest of the day the water flows into the reservoir and subsequently into the reticulation

pipes of Makoko at an average flow rate of 1.62 litres per second (see Section 3.2.1). Therefore, no water is stored in the temporary reservoir after it has initially been emptied each morning. The result is no water stored in the temporary reservoir to accommodate the upcoming peak times for water use during the rest of the day. Other peak times are mid-afternoon, when children come back from school, and early evening when the residents prepare supper (see Section 3.2.3.3). The temporary reservoir therefore only fills up again at night when the residents are asleep and no one uses water. The 10 000 litres of water that fill the temporary reservoir at night is then used again the following morning within 16.6 minutes. These calculations obviously do not include the reality of the effect that private connections have on the flow of the water in the main pipeline to the reservoir (see Section 3.2.2.1).

According to the engineer, this problem can only be alleviated by building a permanent reservoir with adequate water storage capacity for each settlement. Such a reservoir could balance the water level throughout each day. A permanent reservoir would refill after peak times and there would be sufficient water in the reservoir to accommodate the upcoming peak times of the residents' water usage for the rest of the day. The engineer states that residents would then have approximately 60 litres of water per person per day. DWAF plans to build permanent reservoirs to serve Makoko and Phameni individually, but, due to a lack of funds, this project is delayed (see Section 2.8.3.1).

The small water storage capacity of the temporary reservoir at Makoko is not the only reason why the residents do not have a permanent water supply each day. The installation of private connections by the residents of Makoko also contributes to the residents' daily water shortage.

3.2.2 Private connections

According to spokespersons from the DWAF offices in Nelspruit, a private/ illegal/ unauthorised connection refers to a water connection on a resident's stand for which the resident has not obtained a legitimate permit from the local government authority.

Before 1994, when the KaNgwane Government was still in power, according to spokespersons, permits for legal water connections from the bulk water supply line to individual stands were obtained in the following manner:

- A resident would go to the tribal office.
- The resident would pay a fee for the permit.
- Tribal Office officials would negotiate with the relevant KaNgwane Government departments to grant the permit.

In other words, the indigenous authority had the responsibility to obtain legal water connection permits for its residents.

According to DWAF spokespersons, since 1994, local government authorities such as district councils or local councils themselves have the right to grant permits for water connections from the bulk water supply line to individual stands within rural settlements. Indigenous authorities consequently no longer play a role in granting permits for so-called "legal" water connections to stands in their areas of jurisdiction.

According to a Lowveld and Escarpment District Council spokesperson, there is no current legislation that stipulates the legal procedure for obtaining permits for water connections on individual stands within rural settlements. This situation obviously creates confusion when one tries to determine whether residents have so-called private water connections (illegal) or legal water connections to their stands. Moreover, one soon gains the impression that there is no system to follow to acquire a permit for a legal connection.

DWAF spokespersons state that in theory, the current acceptable procedure to follow when applying for a water connection from the bulk water supply line to a private stand in a rural settlement is the following:

- Residents apply for a written permit and pay a connection fee at the offices of their local government authority (local council or district council). Each individual local authority determines the fee.

- The local government authority informs the local DWAF office of the resident's application and payment of a permit.
- The resident (applicant) consults with the local DWAF officials on the potential location of the planned water connection.
- DWAF officials inspect the potential location of the planned water connection to ensure that it does not fall within the area of an existing water pipe, and a final decision on the exact location of the water connection is made.

According to spokespersons from DWAF, one of two options can be carried out to make the water connection from the bulk water supply line to the resident's stand, if the DWAF officials approve the location of the intended water connection:

- The resident can decide to install the connection himself, if he has the proper knowledge of laying and connecting water pipes. (Spokespersons from the local DWAF offices were unclear on what specific qualifications such a resident would need and said that if the resident said he had the necessary knowledge it would suffice.) The entire process must be supervised by a DWAF official who advises the resident on issues such as water pipe sizes, where to lay the water pipes and how to make an effective connection between two separate water pipes.
- DWAF officials can make the connection for the resident. The resident does not have to pay DWAF for the connection because DWAF is only the water service provider (see Section 2.9.1). The local government authority (local council or district council) is the water service authority and is in charge of fees due for water connections, thus DWAF does not receive payment.

These procedures are not generally followed amongst residents of Makoko and Phameni, as is shown below.

To summarise, it can be concluded that the concept of a "private connection" refers to two things. Firstly it is a connection (from the bulk water supply line to a private stand) for which the owner of the stand does not have a legitimate permit from the correct authority. Secondly, it is a connection (from the bulk water supply line to a private stand)

that has been installed by the resident himself (or by someone employed by the resident who is not a DWAF official) and without DWAF's supervision. This means that private water connections from the bulk water supply line to individual stands are made without DWAF's knowledge or their approval. Obviously, the latter situation is bound to cause water system problems, due to, amongst other factors, poor water pipe connections, installed by unprofessional people, and the inappropriate locations of water pipes, such as where a bulk water pipe is already located.

Information about the existence of private water connections from the bulk water supply line to private stands within Makoko and Phameni was obtained by means of quantitative data, collected through questionnaires which were completed by 155 residents of both research settlements (see Section 1.5.3).

The quantitative data obtained in this study showed that residents of Makoko and Phameni started installing private water connections from the bulk water supply line to their stands in the late 1980's. The majority of residents with private connections installed the connections between 1992 and 1995. It is not known where the initiative came from, but spokespersons indicated that the practice spread by word of mouth from settlement to settlement. This practice clearly makes obtaining water much easier, as people do not have to walk to taps and carry heavy loads of water back home (see Section 3.2.3.3).

A total of 60.8% of the respondents to the questionnaire have water connections (private and legal) on their stands. Reasons given by respondents for installing water connections on their stands included wanting water close by to avoid daily trips to water points. Some respondents said they were told by fellow residents to make their own connections if they wanted water close to their homes. Others said they saw people from their settlement making these connections and decided to do the same.

According to Van Schalkwyk's report (1996:29), the creation of private water connections is motivated by a perception that they produce a more secure water supply. Spokespersons from Makoko and Phameni said that their reasons for installing water

connections to their stands were not necessarily that doing so would ensure a more secure water supply. Their main reasons were a need to avoid long queues at water points, the reduced walking distance to water points and a desire for convenience and comfort.

A total of 40% of the respondents to the questionnaire who had water connections on their stands indicated that they had legal permits for the connection. A further 11% of the respondents who had such connections indicated they did not and 49% indicated they did not know whether they had legal permits for their water connections.

The quantitative data on the procedure followed by respondents to obtain permits for water connections to their stands showed little correspondence. From all the different answers given in the questionnaire, it could be gleaned that the following procedure to obtain a permit for such a connection was generally followed by the majority of the residents:

- The resident would visit the tribal office where an amount of R20 was paid and a letter was received stating that permission from the *sikhulu* for the resident to install a water connection on his/her stand had been obtained.
- The resident then visited the Magistate's office at Kabokweni where the letter from the *sikhulu* was certified with a stamp.
- The resident then visited the DWAF offices in Malekuthu, where a stamped letter was given to him/her stating that the resident had applied for and received a permit to install a water connection to his/her stand. According to spokespersons, officials at the DWAF offices would also inform the residents of which DWAF employees would make the water connection to their stand for them. It appeared that DWAF personnel had installed very few of these connections.

As for the procedure followed by residents to install water connections to their stands, the data from the questionnaire showed the following: A total of 71.5% of the respondents with water connections to their stands had either made the water connections on their stands themselves, or had paid someone from their settlement or a neighbouring settlement to install the water connections. No involvement by DWAF officials, or any

other government department officials, during the installation of these water connections was mentioned by these 71.5% of the respondents.

According to spokespersons from Makoko and Phameni, residents install a water connection to their stands by linking a private water pipe, usually a "HDPE" (high density polyethylene) pipe (the cheapest option), to the government-installed water pipelines in the settlement. A hole is punched in the "government water pipe" using a pick or a similar tool and the private water pipe is simply attached and laid underground to the resident's stand. The joint is sealed with car tubing tied with wire. Van Schalkwyk (1996:60) reports similar practices. A tap is then attached to the end of the private water pipe (see Figure 1).

Interviews with the residents of Makoko and Phameni showed that it is common practice for neighbouring households to form groups and to share the cost of equipment needed for the initial water connection to the "government water pipe". Every household in the group gives an amount of money to a person elected from the group. This person makes the trip to town and buys the "group water pipe". Members of the group either make the connection to the government pipe themselves or the group pays someone from the community with knowledge of plumbing to make the connection. The "group water pipe" is then routed to a jointly chosen location and from there every household links up its own private water pipe and installs a connection from this pipe to individual stands.

The quantitative data of this study shows that the size of groups that residents form to share costs in such instances varies from two to twenty households, but, most commonly, varies from between four to ten households per group. The data shows that the average amount paid per household for the "group's water pipe" as well as the individual stand's pipe and tap is between R150 and R250. This immediately raises more questions about the official statistics on income in the Nsikazi district (see Section 2.7).

According to spokespersons, when members of a group hire a person from outside to make the water connections to their stands, this person is paid with money from the

group's communal fund. When the group makes the connection itself, it is because the group does not have sufficient funds to pay someone else with knowledge of plumbing.

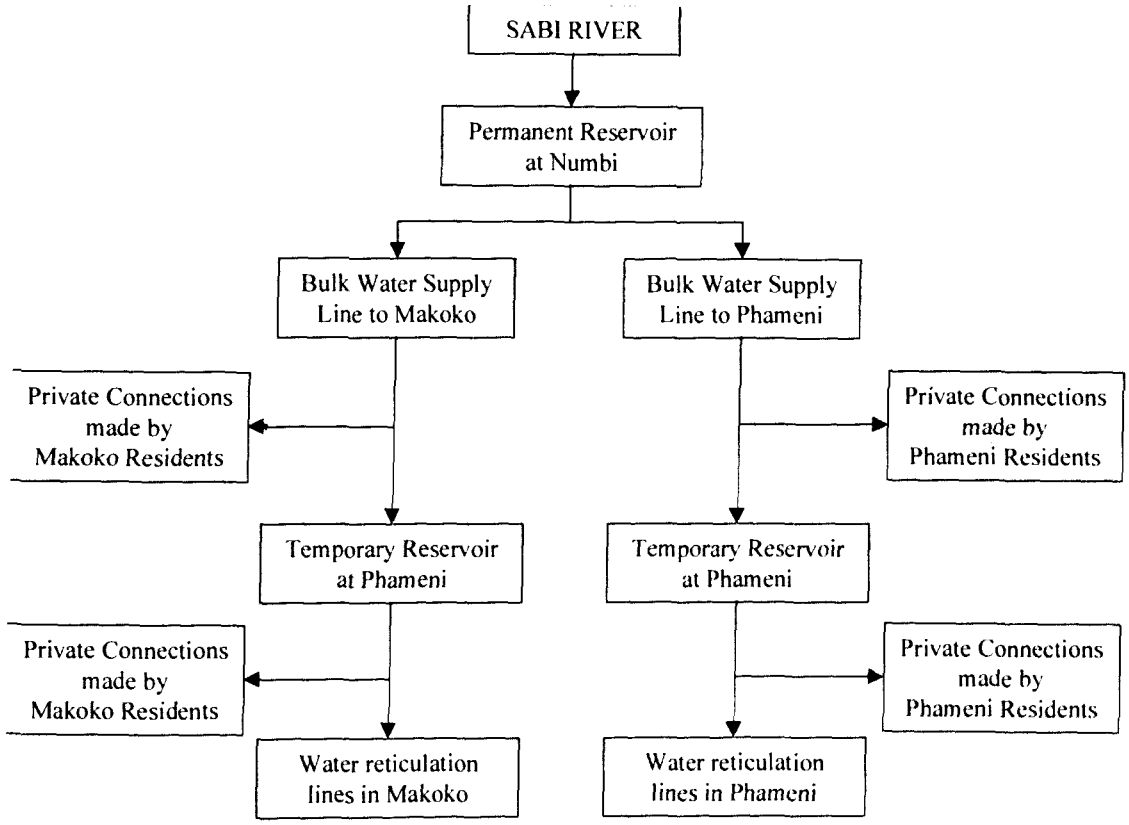
Probably the most important conclusion derived from the above information is that, although some residents made some sort of application for a water connection to their stands, whether to the correct authority or not, most of the respondents made the connections themselves. Respondents made these water connections without the help or supervision of the relevant government departments. Thus, the absolute majority of stand water connections in the two research settlements can be classified as "private connections" because the installation thereof was most probably unapproved.

Answers to the questionnaire used in this study showed that there was confusion amongst the residents of Makoko and Phameni about whether the water connections on their stands were private connections or not. A total of 65.4% of the respondents with water connections stated that they did not have private connections, 27.3% answered they did have private connections and 7.3% answered that they did not know whether they had private connections. In the interviews, spokespersons indicated that the negative connotation linked to the concept of "private connection" may have influenced the residents' answers about whether they had a private connection or not – they would rather not admit to having a private connection or said they did not know whether they had private connections.

The questionnaire also showed respondents that gave a negative description of the term "private connection". Most respondents answered that it meant "stealing water" or "taking water from the government". Others answered: "The government won't help us, so we make a connection ourselves". Some respondents simply answered that they did not know what a private connection is. It can therefore be concluded that those respondents who had heard of a "private connection" perceived it as something negative directed towards the government. Respondents also perceived a private connection as something one did as a result of the disinterest of the government towards residents' well-

being and the government's unwillingness to help improve the respondents' water shortage situation.

Figure 3.1 Diagram of the bulk water supply line of Makoko and Phameni



According to the report by Sami and Murray (1998:15), private connections are directly linked to a lack of community participation in government decisions about water reticulation. When water systems are installed in a settlement without proper prior community consultation with regard to the source option, the level of service provided and so forth, residents often do not have a sense of ownership towards the water supply system. As a result, the system can be subjected to the installation of private connections, which cause severe pressure losses within the specific settlement's water supply system. This was also found to be the case in Makoko and Phameni.

3.2.2.1 The consequences of private connections

Private connections within the Northern Nsikazi Bulk Water Scheme are a major source of problems to the DWAF officials in Nelspruit. As mentioned in Section 3.2.1, the inadequate storage capacity of the temporary reservoir of Makoko causes residents to experience daily water shortages from the water reticulation system simply because of its inadequate capacity. The installation of private connections to stands aggravates this existing water shortage.

The residents of Makoko and Phameni install their private connections either to the bulk water supply line to the settlement or alternatively to the water reticulation line within the settlement, depending on the location of their stands. The bulk water supply line is the water pipe that connects the permanent reservoir at Numbi to the temporary reservoir of each settlement. The reticulation line of a settlement is the internal pipe network of a settlement linked to the temporary reservoir of the settlement. Some of the stands located closest to the bulk water supply line have private connections installed to this bulk water supply line. Some of the stands located deeper within the settlement have private connections installed to the water reticulation pipe lines of the settlement.

According to an engineer directly involved in the water supply to Makoko, the private connections linked to the bulk water supply line cause the most problems. The bulk water supply line is the source of the water that flows into the temporary reservoir from where it is channeled into Makoko. In other words, residents with private connections linked to the bulk water supply line have access to the settlement's daily quota of water before the water reaches the reservoir. The result is that residents with private connections linked to the bulk water supply line have a permanent water supply (see below). The remaining residents of Makoko start each day with the 10 000 litres of water flowing into the temporary reservoir minus the volume of the water used by the residents with private connections linked to the bulk water supply line.

According to the engineer, it is currently not possible to calculate the volume of water that residents with private connections to the bulk water supply line use per day because

these private connections are not linked to water meters. The fact that these residents have a permanent water supply through their private connections indicates a significant loss to the water stored in the temporary reservoir, with a further negative impact on the security of water supply in Makoko.

The engineer further explained that the private connections linked to Makoko's internal reticulation pipeline do not necessarily decrease the daily volume of water at the residents' disposal. Makoko's water reticulation system was originally designed to accommodate upgrading to individual stands (see Section 2.8.2). Therefore, if the private connections linked to the reticulation line were professionally done, the reticulation system would, at least in theory, operate normally.

As was explained in Section 3.2.2 above, many of the private connections that exist within Makoko and Phameni were made by the residents themselves or by someone employed by the residents and not by DWAF officials or under DWAF supervision. The fact that professional plumbers from the relevant government departments do not, as a rule, install the private connections results in continuous pipe leakage. According to spokespersons from the DWAF offices in Nelspruit, pipe leakages in the Northern Nsikazi Bulk Water Scheme cause the loss of hundreds of litres of water per day. The report by Van Schalkwyk (1996:60) indicates that water losses due to private connections in the rural settlements of South Africa can be up to 100% of the volume of water supplied to rural settlements.

Data from the questionnaire showed that a total of 34.7% of private connections of respondents in Makoko and Phameni did not yield any water at all. A total of 52.6% of private connections of respondents in Makoko and Phameni usually provided water between two and eight days per month. Only 12.7% of private connections of respondents in Makoko and Phameni provided water on a daily basis.

The private connections that yield water on a daily basis are those connected to the bulk water supply line of the settlement and those that are topographically lower down than other private connections. The weak downflow of the water is sufficient to keep the latter

private connections flowing most of the time. The researcher's qualitative research shows that households with this permanent water supply serve as a close water point to neighbours and have up to 50 people fetching water from their taps every day. Members of these households said they did not mind others using their taps because water is free for all. They did, however, experience damage to their taps caused by the many people coming into their stands. Neighbours were not expected to pay for repairs.

According to spokespersons of the remaining private connections, their water supply is erratic. In other words, residents do not know when to expect water from their private connections from day to day. Due to this fact, residents have come up with the solution of keeping their taps open at all times with a bucket underneath to collect any possible water. Spokespersons said that when the water flows at night they sometimes wake up from the noise and that they then fill more than one bucket if needed.

The poor water supply of Makoko and Phameni's water reticulation systems consequently results from the following:

- The water storage capacity of 10 000 litres of each settlement's temporary reservoir is inadequate to provide residents with the RDP minimum quantity of 25 litres per person per day (see Section 3.2.1).
- The private connections made to the settlement's bulk water supply line reduce the volume of water flowing into the temporary reservoir.
- Poorly constructed private connections to the reticulation pipes of the settlement result in pipe leakages, which cause the loss of immeasurable quantities of water per day.
- There is no official control over the installation of private connections, and thus also no official control over water lost due to poorly made connections.

The situation regarding private connections in Phameni is similar to that described in Makoko.

3.2.3 Boreholes

Makoko and Phameni residents have access to groundwater by means of hand pumps and diesel pumps located within the two settlements.

Although there is apparently little groundwater in the Nsikazi district (see Section 1.4.1), there are boreholes for extracting this water from underground sources. Boreholes are an economical water source, due to the low capital costs involved and the relatively short time needed to develop a borehole scheme. Depending on the scale of the project, a borehole scheme can be developed within a period ranging from two weeks to three months (Van Schalkwyk 1996:34,35). According to spokespersons from a consulting engineering firm, the cost effectiveness of boreholes is further influenced by water quality. If, like in Makoko and Phameni, the undergroundwater is not polluted, the water does not have to undergo a cleaning process. Consequently, this reduces the cost of water supply via boreholes because the water can be used immediately.

The five boreholes located in Makoko and Phameni are equipped with three hand pumps and two diesel pumps respectively. Diesel pumps are normally installed where the water yield is high (between 3 litres per second and more than 10 litres per second), but can be installed where there is a lower yield than 3 litres per second (Van Schalkwyk 1996:34,35). Hand pumps are usually installed where there is a lower yield (0.5 litres per second) (Van Schalkwyk 1996:34,35).

Makoko residents have access to one hand pump, located in Makoko A, and two diesel water pumps, one in Makoko A and one in Mashonisa (Makoko B). Phameni residents have access to two hand pumps. According to the data gathered by the questionnaire, close on 60% of respondents from Makoko and Phameni make use of borehole water on a daily basis.

Thus, at the end of 1999, the situation in Makoko and Phameni meant that the majority of households had a private connection which erratically provided water to their stands. Members of the household had to fetch water on a daily basis from the closest water point

(boreholes, a neighbour's working private connection or a street tap). This is an indication of the inadequacy of the current water reticulation systems of these two settlements.

3.2.3.1 Diesel pumps

An employee from the regional DWAF offices (who is also a resident in the settlement concerned) operates the diesel pumps. The "pump operators" are usually men who were employed by the former KaNgwane Department of Public Works. These men retained their positions as pump operators in their settlements when the present South African Government came into power in 1994 and when the regional offices of DWAF replaced the Department of Public Works.

A diesel water pump is located underground and its motor is located above ground in a corrugated iron pump house with a roof to prevent damage to the pump, motor and control devices by wind, rain or vandalism. It is always necessary to house pumps where the power source is a diesel or petrol motor (Sami and Murray 1998:12.44). A free-standing 2 000 litre plastic water tank is connected to the diesel pump and stands next to the corrugated iron pump house. Residents obtain water from the connected tank by means of a tap connected to the tank (see Figure A2).

In Mashonisa (Makoko B), the diesel pump and water tank are located in an open field relatively close to all residents. In Makoko A, the diesel pump is connected to two 2 000 litre plastic water tanks located next to each other. Obtaining water from these water tanks is more effective and faster than using a hand pump, because there is a tap (the water flows due to gravity) instead of a lever that has to be operated manually.

Pump operators must ensure that the 2 000 litre plastic water tanks which are connected to each diesel pump and from which residents fill their containers with water are full at all times. The pump operator starts the diesel pump at 7:30 every morning and keeps it running until the connected water tank is filled with water. The pump operator then switches the pump off until such time that the tank needs to be filled again. This process

continues throughout the day until 4:30 PM, when the pump is finally switched off for the day.

Employees from the regional DWAF offices at Malekuthu service these diesel pumps. The pump operator must inform the DWAF regional office of any repairs needed to the diesel pump. The DWAF office sends an employee to repair the pump as soon as possible. Pump operators reported that diesel pumps are usually repaired within three days after a problem has been reported.

3.2.3.2 Hand pumps

Hand pumps in Makoko and Phameni have a helical rotor which turns in a fixed groove. These hand pumps are unlike conventional single action reciprocating piston pumps, which only deliver water on the downward stroke, because the rotary screw hand pumps continuously deliver water as the actuator is turned. The rotary pump is designed in such a way that, with every complete turn of the handwheel, the pump turns more than once. Thus the manual effort to produce water using the rotary pump is less than the effort needed to produce water using a piston pump. The rotary pump operates on the principle of increasing the pressure of the water by creating a progressive cavity that screws the water in the direction of flow and delivers water in a steady stream (Van Schalkwyk 1996:38).

The Mono hand pumps used in Makoko are examples of such rotary hand pumps. Mono hand pumps are commonly used throughout South Africa. These hand pumps eliminate the need for plungers and seals because they utilise a rotary motion to lift water (Sami and Murray 1998:12.33,36). Mono pumps can successfully pump water with a significant sand load without producing pumped water that contains sand particles (Sami and Murray 1998:12.33,36).

Two different versions of the rotary screw hand pump are used in Makoko and Phameni: a single bar and a double bar version. The single bar is turned in a circular motion with one or both hands (see Figure A3). The double bar hand pump is designed to be operated

with both hands using a motion similar to that performed with the legs and feet when one rides a bicycle. However, residents do not operate the double bar hand pump in the way it was designed to be operated, but usually turn only one of the two bars with both hands to pump water. The reason why residents operate the double bar hand pump "incorrectly" is that the hand pump can be operated much faster when only one bar is turned with both hands, and water is produced at a stronger flow rate. Another reason is that children and petite women cannot turn both bars simultaneously with ease because their arms are too short.

3.2.3.3 Fetching water from boreholes

The task of fetching water from a water point, such as a hand pump or diesel pump point, traditionally falls to the women in a household. The mother and daughters take turns performing this daily chore, although young children of both sexes are often sent when the older women are busy with other domestic tasks such as collecting firewood (see Figure A4). The distance that each household's residents walk to the nearest water point obviously depends on how far the stand is located from the water point. Measurements done by the researcher on foot produced a rough estimate of a maximum distance of one kilometre (return trip) and a minimum distance of roughly 30 metres (return trip).

Water is collected in 20 litre and 25 litre plastic containers, which have a small opening on top of about five centimetres in diameter. These containers, previously used for storing liquid soap, cost R10 each and are bought pre-cleaned in Hazyview and Whiteriver at various places, such as restaurants. Spokespersons say these water containers are popular because they can easily be transported on people's heads or on a wheelbarrow without water spillage (see Figure A5). Els (1996: 257-258) also discusses this practice.

The water containers are carted to and from the water points in a wheelbarrow, which costs approximately R170 (see Figure A5). When a household's wheelbarrow breaks, which often happens, since it is used every day, the heavy water containers are carried home on the head until such time as the household can afford to buy a new wheelbarrow.

Most respondents to the questionnaire report filling three water containers during one trip to the water point, as one wheelbarrow can transport three containers at a time (see Figure A5).

Data from the questionnaire indicate that:

- 32% of respondents make one trip to the water point per day;
- 29.4% of respondents make two trips to the water point per day;
- 29.8% of respondents make three trips to the water point per day;
- 7.6% of respondents make four trips to the water point per day; and
- 1.2% of respondents make five trips to the water point per day.

Spokespersons say that the number of trips per day depend on the size of the family and the consequent amount of water needed.

Surveys done in the Thabamoopo district of Lebowa show that two to three trips per day are made by residents to water points. The number of trips made per day is reported to be related to the walking distance, water availability and queuing time at the water point (Van Schalkwyk 1996:47).

In KwaZulu Natal, Van Schalkwyk (1996:47) found that accessibility tended to reduce the need for home storage of water since trips are made to collect water as it is required. The incidence of home storage of water is limited in Makoko and Phameni to those residents living farthest from water points, and who consequently store water, but mainly for early morning use.

The report by Van Schalkwyk (1996:38) states that the two peak times for fetching water are early morning and late afternoon.

Data from the questionnaire show that most of the women in Makoko and Phameni fetched water between 6 am and 7 am and again between 2 pm and 3 pm or between 4 pm and 5 pm. Reasons given by the respondents for the preference of these times include that, in the early mornings, a lot of water is needed in the household for cooking and

bathing. It is also the coolest time of day. In the mid-afternoon (2 pm to 3 pm) children usually fetch water after school or they look after small children while the mother goes to fetch the water. In other words, afternoons are a convenient time of the day to fetch water, because there are more family members at home to help with the chores. Late afternoon is again a cooler time of the day and water is needed for the evening's cooking and bathing.

Naturally, there are queues at the water points at the preferred times. Residents of Makoko reported that there are queues at the water points 80% of the time and that they wait for between one and two hours for their turn at the water point, especially in the early morning. Early morning (between 6 am and 7 am) tends to be the busiest time at the water point because everybody in the settlement needs water for eating and washing before they can start the day at around 8 am. Residents of Phameni, which has a much smaller population figure than Makoko (see Section 1.3), also reported queues at water points but they usually wait for between 30 minutes and one hour. Queues tend to be longer over weekends because the residents who work outside the setlements are at home and consequently more water is used.

The daily task of standing in a queue at the water point for a few hours does not appear to be something residents loathe, and is usually accompanied by a great deal of chatting and laughter. Schoolchildren especially seem to enjoy this after-school get-together at the water point. Fetching water is, in fact, so much part of the residents' lives that their daily routine revolves around it and it creates an opportunity for the women to socialise at the water point. Despite the social function that the water point serves, neither women nor schoolchildren are seen lingering about after their water containers have been filled. They go straight home to finish the tasks of the day.

3.2.4 Private water tanks

Residents with a higher than normal income in Makoko and Phameni, such as taxi owners and teachers, often install private water tanks on their stands. One such household in

Makoko owns a 1 000 litre plastic tank, bought at White River in 1995 for R1 600. The tank is kept full by means of a hosepipe attached to the stand's private connection (see Figure A6), which, according to the resident, provides water on an almost daily basis (see Section 3.2.1 for detail on regularity of water supply). The spokesperson said her husband had bought the tank because he did not want her to make trips to the water point. She said her husband did not approve of other residents using the tank as a water point because they had not helped to pay for it.

In this particular case, the water tank serves as a status symbol because the husband perceives the chore of fetching water at a water point as something that is beneath his wife's status and is unnecessary. It is interesting to note that this particular house has a distinct western (untraditional) look, and is built of brick in a conventional western style with a flower garden. The household also does not own cattle, goats or chickens.

However, water tank owners' private connections do not always provide water on a regular basis. In one particular case, a resident owns a tin water tank, bought in 1984 for R300. The stand's private connection usually provides water one day in the week only, and on that day the tank is filled by means of a hosepipe connected to the stand's tap. According to the resident, she installed the water tank because she works full time and does not have time to fetch water for the household. She said that her neighbours made use of her tank to fetch water for their own households and that she did not mind, because water is free for all people in Makoko (see discussions on the residents' value judgements about water in Section 4.6). In this case, it can be concluded that the water tank was purchased purely for practical reasons and not as a status symbol.

3.2.5 Natural springs

Makoko has another source of water in the form of a natural fountain (or spring), located within Makoko C, the smallest part of Makoko. The fountain occurs as a distinct "eye", approximately 1.5 metres in diameter. A spring or fountain appears where the

underground surface of groundwater intersects the surface and is commonly found in rolling topography, incised with water courses (Sami and Murray 1998: 9.1).

Water from this fountain in Makoko C is used only by the handful of households that are situated around it. The residents who use the fountain as a daily water point scoop the water up with a shallow dish and pour it into a larger container, which is then carried home (see Figure A7). This process obviously takes much longer than fetching water from a hand pump or diesel pump, and is not worthwhile for residents who live far from the fountain. The process of scooping water limits the volume available to households to about 5 to 10 litres per person per day, as it takes much longer than fetching water from a borehole or a tap (Van Schalkwyk 1996:36).

A fountain needs to be protected to prevent water contamination as a result of, amongst other factors, the poor sanitation facilities common to rural areas (Sami and Murray 1998:6.18). A corrugated iron sheet that protects the water from inflowing impurities encircles Makoko's fountain. The water from the fountain in Makoko is opaque with a greenish colour and contains visible organisms. Frogs were also seen in the fountain. Spokespersons from Makoko said that the occurrence of frogs in water is perceived as an indication of cleanliness, as they believed the frogs' urine makes the water taste sweet.

Apart from the water's appearance, the hygiene of the fountain is doubtful because it is not fenced off and spokespersons said that both animals and humans drink directly from the fountain. Spokespersons in Makoko agreed that the fountain's water is probably not very clean, but to those residents living close by, the conveniently short distance to the fountain is the decisive factor for making use of it.

3.2.6 Rainwater

Data from the questionnaire showed that 63% of responents from Makoko and Phameni use rainwater for domestic purposes. Residents can store only limited volumes of rainwater, as only makeshift collecting facilities are used. Spokespersons revealed that rainwater is collected by placing plastic basins under gutters and the edges of corrugated

iron roofs during rainstorms. Residents who have houses with corrugated iron roofs benefit more from this alternative water source than residents with thatch roofs. Water of "relatively pure" quality can be collected from corrugated iron roofs, while water collected from weathered thatch roofs has a "significant debris load" and is not always potable (Sami and Murray 1998:10.1).

Van Schalkwyk (1996:50) states that the practice of rainwater harvesting is significant in areas where other sources of water are not reliable and water shortages often occur. As discussed above, the water reticulation supply in Makoko and Phameni is unreliable and it can thus be assumed that this unreliability contributes to the practice of rainwater harvesting.

A rainstorm producing 8 mm of water is required to yield sufficient water to meet the needs of an average family for 3 to 4 days (Van Schalkwyk 1996: 50). In Makoko and Phameni, rainwater is considered a bonus on top of the water supplied through the other sources. Residents do not necessarily rely on rainwater to fulfill their domestic water needs, although it makes a welcome contribution.

Spokespersons in Makoko and Phameni said that rainwater is used for all kinds of domestic chores as well as for drinking. Some spokespersons said that they like to wash white garments in rainwater, since it does not turn the washing brown as water from other sources, especially from the Sabi River during the rainy season, often does.

Collected rainwater is stored in water containers of various sizes in the yard, but is always used within three days, since spokespersons said that after this period the water contains larvae and is not considered safe to drink. Algae, bacteria and insect larvae eventually occur in stored rainwater because dead leaves, dust and bird droppings, which accumulate on roofs with time, contain the essential nutrients for such organisms to grow (Sami and Murray 1998:10.1). According to spokespersons, rainwater is not perceived to be cleaner or safer to drink than water from any other source.

3.3 WATER LOSS

According to Van Schalkwyk (1996:59), water losses are caused by poor maintenance of water distribution facilities. This situation is aggravated when the water distribution facilities are in a poor condition. The extent of water loss is difficult to determine in areas where there are no water metering facilities (Van Schalkwyk 1996:59).

The biggest cause of water loss in developing areas is poorly made private connections (Van Schalkwyk 1996:61). The crudely made "HDPE" (high density polyethylene) pipe connections can be responsible for as much as a 100% loss of the volume of water supplied (Van Schalkwyk 1996:61). As discussed above, private connections are very common in Makoko and Phameni and create many problems for DWAF due to the water loss experienced.

As Makoko and Phameni have no metering facilities, the extent of the two settlements' water loss through private connections cannot be determined. Therefore, spokespersons from DWAF could not give specific figures of water loss in Makoko and Phameni.

The occurrence of water puddles at water points is common throughout Phameni and Makoko. All communal water points tend to have a puddle of quite a significant size during the day. At hand pumps these puddles are the result of the pumped water's dwindling flow, which occurs when the bar ceases to be turned and containers have been removed. At the taps of diesel boreholes, the puddles result when residents keep the water tap running while filling different containers and when residents switch places to fill containers. Water also goes to waste when residents rinse containers before filling them. A significant amount of water is wasted in this manner, since water points are used throughout the day.

According to Van Schalkwyk (1996:59), the volume of water lost at street taps in several villages in Venda was about 10% of the volume supplied by the water supply system or about 2 litres per person per day. The report by Van Schalkwyk (1996:59) states that in areas where water shortages often occur, taps are left open at all times to alert residents

when the water is available and this leads to water losses in excess of 10%. The practice of leaving taps open occurs in both Makoko and Phameni, as discussed above (see Section 3.2.2.1). Huge volumes of water are wasted, especially at night when the water suddenly becomes available through the taps (see Section 3.2.2.1). It takes some time until residents realise that water is flowing and fill their containers.

3.4 PATTERNS OF WATER UTILISATION IN MAKOKO AND PHAMENI

3.4.1 Domestic water utilisation

Domestic chores performed every day involving water utilisation include cooking, bathing and providing drinking water for the household's animals. Information regarding the amounts of water used by the residents of Makoko and Phameni for each particular chore was obtained by means of quantitative research (see Section 1.5.3).

3.4.1.1 Cooking and drinking water

The quantity of water used for cooking by residents of Makoko and Phameni differs from household to household, depending on the number of family members. The approximate daily quantity of water per household used for cooking is ten litres per day. Studies done by Van Schalkwyk (1996:14) to determine the volume of water used for cooking amongst residents of developing areas or "communities having a very low level of living" indicate that the average volume is 1.5 litres per person per day[3].

---

[3] The concept "very low level of living", as described in Van Schalkwyk's report (1996:14), is one section of a value orientation scale ranging from "subsistence" to "very high". The latter refers to expensive Western style houses whilst the former refers to "limited traditional untreated cement blocks" not unlike the dwellings found in the two research settlements. Other factors determining the level of living include income, education, population, business activity and household size. The water demand of people from each level is then determined on the basis of these factors. Although the aim of this study and Van Schalkwyk's report (1996) are not similar, the comparison drawn between Van Schalkwyk's scale's "very low level of living" section and Van Schalkwyk's study's residents' water utilisation practices serve as a useful guide to compare the residents from the research settlements' water utilisation practices with those of Van Schalkwyk's report.

Data from the questionnaire indicate that the average household size of respondents in Makoko and Phameni is 7.5 members. If the volume of ten litres per household per day, as used for cooking by residents of Makoko and Phameni, is converted to litres per person per day, the usage comes to 1.3 litres per person per day. The volume of water used by the residents of Makoko and Phameni for cooking is therefore very close to the average volume used for cooking by residents of developing areas in other parts of South Africa.

Data from the questionnaire also show that five of the ten litres of water used for cooking by the respondents in Makoko and Phameni are used for cooking porridge. The remaining five litres of the water is used for cooking vegetables and making tea. According to spokespersons, the average resident drinks about three cups of tea per day, and children drink instant cold drink. During the hot summer months, residents who own refrigerators keep a jug of water in the refrigerator for drinking water. It is common practice to offer visitors a glass of ice cold water, and the researcher was often treated to this welcome refreshment.

The residents of Makoko and Phameni do most of their cooking on a wood fire, either in the open yard or in a separate hut on the stand used only for this purpose. The residents themselves gather firewood in the fields. According to spokespersons, it is primarily the women and children who perform the chore of gathering firewood. Some residents' homes have a kitchen as part of the main house and all cooking takes place there. This new practice stands in contrast to the traditional separate cooking hut and is an example of acculturation towards house-building patterns in the western style.

Spokespersons found it difficult to indicate the exact volume of water a person drinks per day. They often drink water directly from the water source and are not sure how much water they drink. Studies undertaken to determine the volume of water used by humans for drinking, regardless of value orientation or home environment, indicate 1.5 litres per person per day (Van Schalkwyk 1996:66). These studies were done, *inter alia*, amongst people in KwaZulu-Natal and the black population of Cape Town.

3.4.1.2 Dishwashing

Dishes are washed in a small plastic basin and, according to the data gleaned from the questionnaire, residents use 7.5 litres of warm water per day. Residents of Makoko and Phameni who have western-style kitchens wash their dishes in a built-in sink. The sink is not connected to a water tap and has to be manually filled with warm water. Spokespersons reported using commercial dishwashing liquids such as Sunlight Liquid.

Studies done to determine the volume of water used for dishwashing by households with a "very low level of living" (see Footnote 3) indicate that about 2 litres per person per day is used (Van Schalkwyk 1996:67).

If the average household size of Makoko and Phameni is 7.5 members, the volume of water used for dishwashing (7.5 litres per household) is 1 litre per person per day.

The studies referred to in Van Sckalkwyk's (1996) report thus indicate a slightly higher average volume of water used for dishwashing in developing areas of South Africa, in comparison to that found among the residents of Makoko and Phameni.

3.4.1.3 Personal hygiene

Van Schalkwyk (1996:69) indicates that the volume of water used for personal hygiene amounts to more than 50% of the total water demand of the domestic water user.

Data from the questionnaire indicated that in the summer months, due to the extreme heat, respondents in Makoko and Phameni often bath two to three times a day. During the cooler months, everybody baths once a day. Bathing takes place in the house, usually in a small room used only for this purpose. People bath in a plastic basin, which is filled with warm water and soap.

Studies done by Van Schalkwyk (1996:69) indicate that the residents of settlements with a "very low level of living" (see Footnote 2) use on average about 14 litres per person per day for bathing.

The questionnaire provided data which suggest that some households' members use ± 5 litres of water per person per bath while others use ±20 litres per person per bath, depending on the size of the basin. If the volume of water that the residents of Makoko and Phameni use for bathing per person per day is determined and compared to Van Schalkwyk's (1996:69) findings of 14 litres per person per day, the result is the following:

- If the average volume of water used per bath is taken at 12.5 litres and the average number of baths per person per day is two, the average volume water used for bathing is 25 litres per person per day.

- With the average household population estimated at 7.5 persons per household, it is estimated that the volume of water used for bathing equals 187.5 litres per household per day.

The average volume of 25 litres per person per day for bathing in Makoko and Phameni is significantly higher than Van Schalkwyk's (1996:69) estimated average volume of 14 litres per person per day. However, if the situation is viewed realistically, the facts are the following: the minimum volume of five litres per person per bath, can become 15 litres per person per day during the summer months, when residents of Makoko and Phameni bath three times per day. During the winter months, when residents bath once a day, the maximum volume would be 20 litres per person per day. It is only when the maximum volume of 20 litres per person per bath becomes 60 litres per person per day during the summer months that the volume of water used for bathing by the residents of Makoko and Phameni seems excessive in comparison to Van Schalkwyk's (1996:69) volume of 14 litres of water per person per day.

3.4.1.4 Animal water use

According to spokespersons, cattle and goats are taken by their owners to nearby water streams on a daily basis to drink. Water for cattle and goats is not included when determining the daily water consumption per household. According to spokespersons, if

streams do not flow due to extreme drought in the winter months, the cattle and goats need to be given about 200 liters of water per household every day by their owners.

According to spokespersons, pigs are kept in pens on the owner's stand and are given an average of about 10 litres of water per pen daily. Chickens are kept loose on the stand or in pens and are given an average of about five litres per pen per day. Chickens that are not kept in pens often drink water from the puddle formed under the stand's tap or from a plate or even a rubber tyre, cut in half, which is permanently kept under the tap. Dogs and cats also get their drinking water from this makeshift water point or are given an average of about one litre communal drinking water per day. The total average volume of water given to animals per day is therefore 16 litres per household.

Not all the households in Phameni and Makoko own domestic animals or livestock. Spokespersons indicated that residents who work full-time usually do not keep cattle, goats or pigs because they do not have enough time to care for these animals. Residents with very small stands usually do not own such animals either, because they simply do not have the space to keep them.

During interviews with residents it was noticed that some residents have flower gardens on their stands and that these residents tend not to keep animals. When these residents were asked why they had no animals, the usual answer was that they did not have time to care for animals. For residents who work full-time, flower gardens are an alternative to an empty stand with no animals. The residents who have flower gardens are also among the fortunate few whose private connections yield more water than those of the general population in the two research settlements (see Section 3.2.2.1). It would therefore seem that ample water supply does contribute to the practice of gardening.

3.4.2 Weekly domestic chores

According to spokespersons, household chores performed one to three times a week and that involve water utilisation include cleaning house, washing clothes, watering gardens and the cleaning of pit toilets.

3.4.2.1 Housecleaning

According to data gathered in the questionnaire, respondents in Makoko and Phameni clean their houses once or twice a week using between 10 and 20 litres of used-water per respondent's household for cleaning windows, floors, cupboards and other things. Research done in Inandi, KwaZulu-Natal, indicated that water used for house cleaning is often first used for other purposes, such as washing clothes, and was then ultimately used in the garden (Van Schalkwyk 1996:67). According to spokespersons in Makoko and Phameni, the practice of reusing water is common, and is favoured for water utilisation activities that do not require fresh water, such as house cleaning.

3.4.2.2 Washing clothes

Research done in Inandi, KwaZulu-Natal, indicated that laundry is done twice a week, with the most popular day being Saturday (Van Schalkwyk 1996:67). Questionnaire respondents in Makoko and Phameni indicated that they wash their clothes once a week and usually on a Friday. All washing is done by hand with commercial washing powders, such as Surf.

Patterns of domestic chores are formed around different factors within each individual settlement, such as distances to water points and the frequency of water supply. Thus, residents of individual settlements develop unique trends in practising domestic chores.

Within Makoko and Phameni, spokespersons said some women prefer to do their washing at home while others prefer to take their loads to the nearest water point and wash it there. The preference for doing washing at the water source, which can be a hand pump, the nearby Nsikazi River or even the fountain, is due to the effort involved in fetching large volumes of water for washing clothes (see Figure A8).

Women who do their washing at the water point reported they cannot indicate how much water they use because it is not measured but used straight from the hand pump or tap.

Women who do their washing at home reported using, on average, 125 litres of water per wash load, although some reported using as little as 40 litres or as much as 250 litres per wash load. Surveys undertaken in the Thabamoopo district of Lebowa (Van Schalkwyk 1996:68) revealed that residents use about 120 litres per household per week for washing clothes, which is similar to the volume used in Makoko and Phameni.

A volume of 125 litres per household per week for washing clothes amounts to 17.8 litres per household per day. The residents of Makoko and Phameni therefore use 2.38 litres per person per day for washing clothes.

The washing of clothes is a chore that is seen to serve an additional social function. Because washing is done in Makoko and Phameni by all on a Friday, women tend to form groups at the water points and engage in this communal task while chatting and laughing. Consequently, washing clothes at a water point becomes a social gathering and thus an enjoyable chore.

3.4.2.3 Watering fruit gardens

Residents of Makoko and Phameni have between two and twenty fruit trees on their stands. Mango, banana, paw-paw, avocado and peach trees are the most common. According to spokespersons, before the fruit trees are watered, the resident sweeps away all dry leaves underneath it and digs a shallow furrow around each tree trunk. This is done to ensure that no water is wasted. The fruit trees are watered one to three times a week with about 20 litres per tree.

Residents tend to water their fruit trees with used water. Water used for dishwashing or bathing is usually reused in the garden. According to spokespersons, residents reuse water for two reasons. Firstly, they believe in the concept of saving water and, secondly, the reuse of water saves some effort in fetching water.

According to spokespersons, the dissolved soap present in used water does not have a negative effect on the quality of the fruit produced by fruit trees. Spokespersons motivated their conviction by stating that fruit trees receive the bulk of their water supply

from undergroundwater through their roots. Therefore the volume of reused water used for watering fruit trees is not so high that the soap can affect the fruit. Spokespersons furthermore believed that soap actually protects fruit trees from disease as well as from ants that attack the fruit and the tree.

3.4.2.4 Sanitation water

Although every household in Makoko and Phameni has a pit latrine on the stand, not all residents clean theirs in the same manner. Most spokespersons reported that they pour the water that was used for washing clothes into the toilet every Friday. Others report pouring bath water into the pit latrine every other day. Some add chemical toilet cleaners to this bath and dishwashing water, or to fresh water, before pouring it into the latrine. Others reported using ash from wood fires, which they put in the toilet to neutralise odours. Van Schalkwyk's report (1996:69) states that no water for sanitation is required with the use of pit latrines. Theoretically, no water is required for the use of a pit latrine, but, in practice, the residents of Makoko and Phameni pour water into the pit latrine to keep it clean and free from odours.

On the basis of the estimated figures mentioned in Section 3.1, the following table can be drawn and an average volume of water used per household per day and per person per day within the two research settlements can be determined. It must be borne in mind that the results show only a rough estimate that is subject to variation. The average household population in Makoko and Phameni is estimated at 7.5 persons, as derived from the data in the questionnaire. Therefore, the average volume of water used per household per day is divided by 7.5 to determine the average volume of water used per person per day.

Table 3.1 Average volume of water used per household per day and per person per day in Makoko and Phameni (Nsikazi district, Mpumalanga)

CHORE	VOLUME WATER PER HOUSEHOLD PER DAY	VOLUME WATER PER PERSON PER DAY
DRINKING	11.25 litres	1.5 litres
COOKING	10 litres	1.3 litres
BATHING	187.5 litres	25 litres
HOUSECLEANING	USED WATER	USED WATER
DISHWASHING	7.5 litres	1 litre
WASHING CLOTHES	17.85 litres	2.38 litres
WATERING GARDEN	USED WATER	USED WATER
PIT TOILET	USED WATER	USED WATER
WATER FOR ANIMALS	16 litres	2.13 litres
TOTAL	**250.1 litres**	**33.3 litres**

The estimated volume of water of 33.3 litres per person per day used by the residents of Makoko and Phameni is higher than Van Schalkwyk's (1996) indication of 25 litres per capita per day estimated for settlements with a "very low level of living".

3.4.3 Water utilisation during brickmaking

Residents of Makoko and Phameni make bricks as needed for building, for example, when a house needs to be enlarged to accommodate a growing family. According to spokespersons, bricks are made with a mixture of sand, water and cement which is poured into moulds and turned out immediately. The wet bricks are then left in the sun to dry until ready for use. The sand used for brickmaking is found on the outskirts of the settlement. Residents pay R150 to have one truckload of sand delivered to their stand. The sand is used sporadically over a period of time as bricks are made.

The volumes of water used to make bricks differ. Some respondents to the questionnaire reported using 100 litres per bag of cement poured into the mixture, while others reported using 150 litres per bag of cement.

Overall, residents use large volumes of water for brickmaking. According to some residents, as much as 500 litres per day is used. However, brickmaking is not a daily or weekly chore. During the time that a house is under construction, the household's daily water usage will consequently be much higher than during normal times.

3.4.4 Water utilisation in vegetable gardens

Residents of Makoko and Phameni practise subsistence horticulture. The majority of the residents own cattle, pigs, goats and chickens, which they keep for their own use. Residents also cultivate crops such as maize (*immbila*), ground nuts or "jugo beans" (*tindlubu*), cassava and sugar cane (*umhoba*). These crops are cultivated in the fields (*masimini*) outside the settlements. These crops only receive water during the rainy season and are not otherwise watered, because spokespersons say it is unnecessary. Some residents also cultivate maize and sugar cane on their individual stands.

The women of the settlement cultivate ground nuts in the fields (*masimini*). Groups of women go together to the field where they each gather their own amount of ground nuts. Each woman then takes her batch of ground nuts home where she cleans them and sorts the nuts into piles of different quality. The nuts are laid out to dry in the sun, either in the yard or on big slabs of rock outside the settlement. According to spokespersons, the residents themselves eat the nuts of lesser quality, while those of better quality are sold. Maize and sugar cane are mainly cultivated for own use, although small quantities are sold.

In Makoko, residents also cultivate small patches of land in Makoko's communal vegetable garden. The Sukumane Women's Club is the founder of a two-hectare communal vegetable garden in the centre of Makoko. Each of the 46 members of the Sukumane Women's Club has an individual patch to grow cabbage (*liklabishi*), onions (*anyanisi*), tomatoes (*tamatisi*) and lettuce (*lilethisi*) (see Figure 9). According to spokespersons, most of the vegetables are grown for own use, but some are sold at the monthly market in Kabokweni.

Members of the Sukumane Women's Club pay an annual R12 membership fee. These funds are used to send members of the club to the Mzinti training centre where they are trained in vegetable cultivation skills. The fees also allow all members to attend the Department of Agriculture's annual Farmer's Day at Kanyamazane.

According to spokespersons, the Sukumane Women's Club received an electric water pump, commonly referred to as a "generator", to pump water from a borehole from the former KaNgwane Government's Department of Agriculture in 1988, to facilitate irrigation within the communal vegetable garden. The "generator" was installed at an unused borehole on the primary school grounds opposite the communal garden. The principal of the primary school was not prepared to use the schools' funds to pay for the electricity used by the "generator". Since a diesel machine can also turn the "generator", the principal suggested that the members of the Sukumane Women's Club buy their own diesel and use the "generator" after school hours. The members did not consider this to be a good idea, because, according to them, non-members would also use the water produced by the "generator" without paying for the diesel. Consequently, the "generator" is not being used and is stored at one of the member's houses.

Spokespersons say that the only time that the "generator" was regularly used was in 1994, when there was very little rain. Consequently, irrigation within the communal vegetable garden is currently done by hand. Women fetch water at the diesel water pump about 300 metres down the street from the garden, and water their vegetables manually.

The cultivation of crops such as maize and ground nuts is more extensive in Makoko and Phameni than the cultivation of vegetables such as pumpkin, tomatoes and onions. This is so only because the cultivation of maize, sugar cane and nuts is not affected as much by the poor water supply from the water reticulation network as the cultivation of vegetables, which need to be watered daily.

3.4.5 Water utilisation for religious practices

The Swazi of Makoko and Phameni do not only have a biological and domestic need for water but a religious need as well. *Tinyanga* (traditional healers) and church ministers from the research settlements utilise water in unique ways.

The Twananini Apostolic Church of Makoko has 35 members and has services every week on Tuesdays, Fridays, Saturdays and Sundays. According to the minister, the church needs water for cleaning and drinking as well as for "holy water" used during religious rituals. Water for cleaning and drinking is fetched by the minister from the nearby diesel water pump, but water needed for the rituals is always fetched from the Nsikazi river, which flows approximately one kilometre from Makoko. The minister uses only natural flowing water for religious purposes, because he believes it is filled with healing powers. According to the minister, water from a tap or borehole does not have such healing qualities. The river water is boiled before it is used (drunk), because the minister believes it is unclean.

According to the minister, the notion that water has healing powers is derived from the Bible which says that Jesus healed people in rivers. He believes the power of Jesus is in the river water. River water can therefore be used for healing after the minister purifies the water through prayer because, as a minister, he believes that the power of Jesus is also in him. According to the minister, if a sick person drinks this "holy water", this person will be healed within a few days. This holy water is used to cure anything from headaches and chest-coughs to strokes.

The local *tinyanga* in Makoko use water in a unique manner for *inyanga*-students and local patients. The *inyanga* in Makoko trains between ten and twenty *tinyanga* students every year (see Figure A10). In the final stage of training, the students are immersed in a small swimming pool filled with about 400 litres of water, in which a bottle of special medicine is "hidden" which they have to "find" before being declared an *inyanga*. The details of this process were not researched because it is not part of the study. According to the *inyanga*, he does not have a particular preference for natural flowing water and

uses tap water. In the past, this final stage of the student's training was done in a river, but due to crocodile and hippopotamus attacks, a swimming pool is considered safer.

The *tinyanga* boil a medicine called "*imbita*" for their patients. This medicine is added to the water of the same swimming pool that is used for the initiation of *tinyanga* students. The patient is then immersed in the treated water to wash his/her body. The "*imbita*" is believed to give one power if one wants to "achieve something great". This water is also believed to help women fall pregnant and to cure the disabled.

According to one *inyanga*, the shortage of easily accessible running water in Makoko impedes his business to such an extent that he cannot treat as many patients as he would like to, and thereby loses income.

3.5 SUMMARY

The water supply systems in Makoko and Phameni which were installed by the government include the Northern Nsikazi Bulk Water Scheme and boreholes.

Bulk water supply in the Northern Nsikazi Bulk Water Scheme entails bulk water pipes connecting the Sabi River to the settlements served by the Northern Nsikazi Bulk Water Scheme, but with no reticulation pipe networks to serve individual stands within these settlements.

Makoko and Phameni are each supplied by DWAF with 10 000-litre plastic tanks, which serve as temporary reservoirs. These temporary reservoirs are linked to the permanent reservoir at Numbi. Each settlement's water reticulation pipeline is connected to the temporary reservoir located just outside each settlement. The residents of the settlement are supplied with water by means of the water reticulation pipes via communal water taps located on street corners within the settlement.

The temporary reservoirs' storage capacity of 10 000 litres is not enough to provide the population of Makoko with the RDP minimum quantity of 25 litres per person per day. With a population of 5 600, the volume of water needed per day in Makoko is 140 000

litres. The water enters the temporary reservoir of Makoko at an average flow rate of 1.62 litres per second. The peak flow rate of water in Makoko is 10 litres per second. This means that when the residents start to use water in the early morning (peak time) they use the 10 000 litres of water in the temporary reservoir within 16.6 minutes. During the rest of the day, the water flows into the reservoir and subsequently into the reticulation pipes of Makoko at an average flow rate of 1.62 litres per second. Therefore, no water is stored in the temporary reservoir after it has initially been emptied each morning. The result of this is that no water is stored in the temporary reservoir to accommodate the upcoming peak water use times during the rest of each day. The reservoir can only fill up during the night when people are not using water.

The installation of private connections to stands aggravates the existing water shortage.

The concept "private connection" refers to a water connection from the bulk water supply line to a private stand, and for which the owner does not have a legitimate permit from the relevant authority. A private connection is also a connection that has been installed by the resident himself or by a person employed by the resident, a person who is not a DWAF official and without DWAF's supervision. This means that the water connection on the resident's private stand is made without DWAF's knowledge or approval.

Data gathered by the questionnaire show that although some respondents did make some sort of application for a water connection to their stands, whether to the relevant authority or not, 71.5% of respondents still made the connections themselves. Furthermore, respondents made the water connection without the help or supervision of the relevant government departments. Thus, almost all stand water connections in the two research settlements must be classified as "private connections" as they were installed in an unprofessional, non-approved manner.

The residents of Makoko and Phameni install their private connections either to the bulk water supply line to the settlement or alternatively to the water reticulation line within the settlement. The residents with private connections linked to the bulk water supply line have access to the settlement's daily quota of water before the water reaches the reservoir.

The rest of the residents of Makoko start each day with the 10 000 litres of water in the temporary reservoir and receive their supply minus the volume used by the residents with private connections linked to the bulk water supply line. Private connections linked to the internal water reticulation pipes of the settlement are not installed by professional plumbers, but by the residents themselves and therefore cause severe leakage.

The private connections that are connected to the bulk water supply line of the settlement yield water on a daily basis. Private connections that are topographically lower down in the settlement than others also yield water on a daily basis because the weak downflow of the water is sufficient.

Residents with private connections can, however, not tell when or if they can expect water from their private connections from day to day.

The poor water supply of Makoko and Phameni's water reticulation systems is consequently the result of the following:

- The water storage capacity of 10 000 litres of each settlement's temporary reservoir is inadequate to provide residents with the RDP minimum quantity of 25 litres per person per day.
- The existence of private connections made to the settlement's bulk water supply lines reduces the rate of water flowing into the temporary reservoir.
- The existence of poorly constructed private connections to the reticulation pipes of the settlement result in pipe leakage, which cause the loss of innumerable litres of water per day.

The residents of Makoko and Phameni also have access to groundwater by means of boreholes installed by the former KaNgwane government. About 60% of the residents of Makoko and Phameni use boreholes on a daily basis. The boreholes are linked to hand pumps or diesel pumps. Diesel pumps are operated by assigned "pump operators" who are also residents in the settlements. The pump operators start the diesel pumps at 7:30 every morning. The water tank connected to each diesel pump must be kept full by the

pump operator during each day. The operators switch the pumps off at 4:30 pm every afternoon.

The hand pumps in Makoko and Phameni are Mono pumps with a rotary hand pump. Such hand pumps need less manual effort to produce water than, for example, piston pumps.

The task of fetching water at the boreholes is traditionally that of the females of the households in Makoko and Phameni. Water is fetched in 20 and 25 litre water containers and taken home in a wheelbarrow or on people's heads. Residents usually make two to three trips to the borehole per day. During one trip, residents usually fill about three water containers.

The most popular times of the day to fetch water in Makoko and Phameni are between 6 am and 7 am, between 2 pm and 3 pm (usually schoolchildren see Section 3.2.3.3) and between 4 pm and 5 pm. During these times to fetch water, there is usually a queue at the water point. Residents can wait up to two hours in such a queue, especially when they go to fetch water at 6 am, as all the residents of the settlement need water for cooking and washing before they can start the day.

Apart from the water supply systems installed by the government, the residents of Makoko and Phameni also utilise other water points. Natural water points include a fountain, such as the one located in Makoko C. Residents of Makoko and Phameni also make use of rainwater. Residents collect rainwater by placing basins under the edges of corrugated iron roofs. Rainwater is always used within three days because, after this period, the water contains larvae.

The detail of water utilisation in Makoko and Phameni was summarised in Table 3.1.

The estimated volume of water of 33.3 litres required per person per day used by the residents of Makoko and Phameni is higher than Van Schalkwyk's (1996) indication of 25 litres per capita per day estimated for settlements with a "very low level of living".

Apart from the water used by the residents during daily and weekly household chores, water is also used for brickmaking. Residents of Makoko and Phameni make their own bricks with a mixture of water, sand and cement. When they are building (and thus making bricks) residents use large volumes of water, up to 500 litres per household per day. However, a household only makes bricks during the initial building and subsequent enlarging of a house as the family grows. Therefore brickmaking seldom occurs and the large volumes of water used on these odd occasions do not significantly influence the estimated volume of water used per household per day.

In Makoko, residents also cultivate small patches of land in a communal vegetable garden. Irrigation within the communal vegetable garden is currently done by hand. Women fetch water at the diesel water pump about 300 metres down the road from the garden and water their vegetables manually. Apart from the vegetables, residents also cultivate crops such as maize, sugar cane and ground nuts. These only receive rainwater during the rainy season and are not otherwise watered. The cultivation of maize, sugar cane and nuts is more extensive than the cultivation of vegetables such as tomatoes and onions.

Water is furthermore used in unique ways by church ministers and *tinyanga* in Makoko and Phameni. In these instances, water serves a religious purpose quite apart from biological and domestic purposes. Church ministers use "holy water" to heal church members and *tinyanga* boil special medicines, such as *imbita,* in water in which patients bathe for healing purposes.