APPLICATION OF A WATER-RELATED ENVIRONMENTAL HEALTH EPIDEMIOLOGICAL PROCESS: A GUIDE FOR ENVIRONMENTAL HEALTH PRACTITIONERS

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OPSOMMING

Die epidemiologiese proses is een van die meer geskikte metodes om te volg vir die bepaling van die impak van omgewingsgesondheidsfaktore op menslike gesondheid. Omgewingsgesondheidspraktisyns in Suid-Afrika is egter nie na behore toegerus om die proses toe te pas nie derhalwe gaan 'n effektiewe hulpmiddel verlore uit hul diensleweringsvermoë. Hierdie situasie word vererger deur die gebrek aan 'n geskikte gids wat so 'n proses kan lei.

'n Besluit is geneem om 'n studie uit te voer wat kan dien as 'n grondslag vir die ontwikkeling van 'n gids vir die gebruik van die epidemiologiese proses in omgewingsgesondheidspraktyk in tipiese Suid-Afrikaanse toestande.

'n Epidemiologiese opname is uitgevoer as deel van 'n omvattende navorsingsprogram waartydens die effek van gestoorde huishoudelike water op die gesondheid van die gebruikers in seksie K, Botshabelo, 'n ontwikkelende stedelike gemeenskap in die Suid-oos Vrystaat, bepaal was.

In die studiegebied word 'n verskeidenheid van houers gebruik om drinkwater te vervoer vanaf 'n munisipale voorsieningspunt (gemeenskapskrane of werf krane) tot in die individuele wonings waar dit gestoor word vir daaglikse gebruik. Die hoofdoel van die studie was om te bepaal of die gemeenskap se waterverbruikgewoontes, wat rondom hierdie metode van watervervoer en -berging ontwikkel het, 'n nadelige effek, spesifiek diarree, op hul gesondheid gehad het.

Die studieontwerp het behels 'n omgewingsgesondheidsopname wat terselfdertyd die geleentheid gebied het om 'n gids saam te stel oor die toepassing van so 'n opname. Die gids is gebaseer op die ondervinding wat opgedoen was tydens die uitvoering van die gemeenskapsopname.

Tydens die opname is die voorkoms van diarree gebruik as 'n indikator van die gesondheid van die teikengemeenskap. Data is versamel deur 'n vraelys wat ontwikkel is vir huisgesin-respondente en ingesamel is deur studente. 'n Proporsionele, gestratifiseerde steekproef van 300 huishoudings uit 'n populasie van ongeveer 3362 huishoudings is ewekansig geselekteer. Watervoorsiening, waterberging, watergebruik, sanitasie en persoonlike higiëne was van die sleutel veranderlikes wat tydens die studie ondersoek is.

Resultate toon dat kleuters (ouer as 1 jaar, tot met 5 jaar oud) die groep is wat die meeste geaffekteer word deur diarree. Houerhigiëne, houertipe (plastiek of metaal) en berging van drinkwater, sowel as swak sanitasie in die omgewing was veranderlikes wat 'n verband getoon het met die voorkoms van diarree. Ander praktyke wat deur die opname uitgewys is as moontlike oorsake, was onhigiëniese skep van water vanuit die houers (insluitend die higiëne van die koppie / beker) asook die teenwoordigheid van diere op die erf.

Die studie dui daarop dat 'n epidemiologiese opname wel toegepas kan word om omgewingsgesondheidsimpakte te bepaal, hoewel die resultate slegs op tendense dui. Verskeie ander potensiële veranderlikes soos voedselhigiëne, babavoeding - higiëne sowel as ander persoonlike- en omgewingshigiëne-praktyke is nie tydens die studie ondersoek nie. Die gebruik van die omgewingsgesondheid epidemiologiese studieproses kan 'n nuttige ondersoekhulpmiddel wees indien dit toepaslik gebruik word in die bepaling van watergehalte- effekte op menslike gesondheid. Die gids wat uit die studie ontwikkel het, word beskou as voorlopig en word vrygestel vir verdere evaluasie, kommentaar en ontwikkeling.

SUMMARY

One of the more suitable methodologies to follow to assess the impacts of environmental factors on the health of humans would be the epidemiological process. Environmental health practitioners in South Africa are, however, ill equipped to use this process and thereby lose an effective tool in its service abilities. This situation is aggravated by the lack of a suitable guide that can be used to lead such a process.

It was therefore decided to conduct a study that could lay the foundation for developing a guide for using epidemiology in environmental health practice under typical South African conditions. An epidemiological survey was conducted within an extended research programme to study the effects of stored domestic water on the health of the consumers in Section K, Botshabelo, a developing urban settlement in the south-eastern Free State.

In the study area, people used various types of containers to move drinking water from the municipal supply (public standpipes or yard taps) to their individual dwellings to store for daily use. The main aim of this study was to determine whether the people's water-use patterns that had developed around this method of haulage-and-storage had a detrimental effect, specifically diarrhoea, on their health.

The study design entailed an environmental health survey, which provided an opportunity to compile a guide for the application of such an environmental health epidemiological survey. This guide was written based on the experiences gained from conducting the community-based survey.

During the survey, diarrhoea was used as an indicator of the health of the target community. Data were collected by means of a questionnaire designed for household respondents, completed by students. A proportional stratified sample of

300 households was randomly selected from a population of approximately 3326 households. Water provision, water storage, water use, sanitation, and personal hygiene were some of the key variables investigated in the study.

Results indicated that infants (older than 1 year, up to 5 years old) were the age group that were affected most by diarrhoea. Container hygiene, container type (plastic or metal) and storage of water as well as poor sanitation in the area were variables related to the occurrence of diarrhoea. Other practices indicated by the survey as possible causes were unhygienic scooping of water from containers (including scooping-mug hygiene) and the presence of domestic animals in the household.

The study indicated that an epidemiological survey could be appropriately applied to assess environmental health impacts although the results merely pointed towards tendencies. Several other potential variables such as food hygiene, baby-care hygiene as well as other personal and environmental hygiene practices were not investigated in this study. The use of an environmental health epidemiological study process can provide a useful investigative tool if suitably applied for the assessment of water quality effects on the health of humans. The guide developed from this study is seen to be provisional and is released for further evaluation, inputs and development.

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CHAPTER 1

INTRODUCTION

1 INTRODUCTION

Epidemiology is a research tool that can be used to study disease occurrence and relationships between environmental factors and human health. To understand environmental health epidemiology, knowledge of environmental health as well as the epidemiological process is important. In this study water-related environmental heath aspects were investigated by means of an epidemiological community-based survey. This process was then described in a guide for environmental health practitioners.

1.1 EPIDEMIOLOGY

The process of obtaining, interpreting and using health information to promote health and reduce disease is referred to as Epidemiology. According to Lilienfeld and Stolley (1994), epidemiology developed over the span of many centuries, borrowing from other fields of study such as sociology and statistics. Lilienfeld and Stolley (1994) stated that epidemiology is a comparative science where disease occurrence in population groups is related to the presence or absence of risk factors in the population groups. Vaughan and Morrow (1989) defined epidemiology as the study of the distribution, frequency and determinants of health problems and disease in human populations. Epidemiology associates the occurrence of disease and indicators of health in a biological framework to provide insight into the causes and effects of disease. Epidemiology is concerned with the distribution of causes of disease and the risk factors for disease in the population (Bowling, 1997).

If epidemiology is used skilfully and imaginatively, it can help define the pattern of health and disease within populations and groups (Vaughan and Morrow, 1989). Jackson et al. (1989) stated that epidemiology is the study of disease and public health, generally by the use of statistics. Epidemiology can play an important role in identifying risks and preventing disease, even when the aetiological agent is unknown (Craun et al., 1996).

1.2 ENVIRONMENTAL EPIDEMIOLOGY

An important function of Environmental epidemiology is to determine the health effects of environmental factors outside the immediate control of the individual (Briggs et al., 1996). Environmental epidemiology is the understanding of the processes and effects of exposures to physical and chemical pollutants not only in the open environment, but also in areas such as the living and occupational

environments. The spread of infectious agents and disease is generally found to have some influence on human health within certain environments such as the living, occupational, recreational, in-transit, and rehabilitation environments (Jagals, 1996). Epidemiology entails the study of the spread of infectious and other disease agents through environmental media such as air, water and food (Briggs et al., 1996).

Factors in the human living environment influencing the health of humans are often referred to as environmental health aspects that might in turn lead to unhealthy living conditions and disease (World Health Organisation (WHO), 1997).

Von Schirnding (1997) stated that the discipline of Environmental Epidemiology emerged in the 1980's through increasing recognition that efforts at environmental improvement and protection could play a positive role in disease prevention.

The aims of all health-related professions are to prevent disease and to cure or treat the sick, while environmental health becomes the health sector's contribution to ensure a wholesome living environment (Jagals, 1997a). This requires the collaborative efforts of a comprehensive health team, which includes environmental health practitioners (EHP's). The function of EHP's is to facilitate efforts to minimise the risk of negative environmental factors influencing the health of people (Pretorius, 1993).

Because of the contents and nature of their training and experience, the EHP cadre is the ideal group to monitor and assess environmental factors such as water and its impact on health. EHP's are involved in daily activities of identifying, monitoring, evaluating and controlling all factors that may have a negative effect on the health status of the community. An important function of the EHP is to ensure that the population in all the different environments is living safely in conditions that ensure optimum health. Living in a safe healthy environment implies that there is a minimum of negative factors influencing the health of the population living in that specific environment. According to Pretorius (1993), EHP's are in the best position to make a contribution towards managing the environment in such a way that it will support good health and sustainable development.

Specialists in public health can play a key role in public health research because of their research skills and knowledge of epidemiology (Bowling, 1997). According to Von Schirnding (1997), knowledge and application of the epidemiological process is

an important tool for EHP's, who must, apart from other duties, investigate and evaluate the various environments of human life.

At present EHP's are, however, not fulfilling these ideals of environmental health management due to various shortcomings in their environmental management skills training (Jagals, 1997b). Knowledge of and skills in the environmental health epidemiological process were some of the shortcomings identified in the investigation by Jagals (1997b).

Developing epidemiology and research skills at a tertiary institution can strengthen the expertise and skills that are acquired by student EHP's. These EHP's will be better equipped to investigate relationships between environmental factors and the health status of the population.

For environmental epidemiology to be effective, it relies on a multidisciplinary approach which includes epidemiologists, EHP's and laboratory technicians. Vaughan and Morrow (1989) stated that the systematic analysis of data after conducting an epidemiological survey might indicate an environmental source of a disease. This indication may be confirmed by obtaining and analysing samples such as that of food or water in a laboratory. According to Vaughan and Morrow (1989), the presence of toxic chemical or faecal contamination can so be confirmed and linked to the outcomes of the survey to establish the pattern (cause and effect) of the event. This can then lead to further investigation such as the detection and controlling, for example, of breeding sites for vectors such as flies and rodents. This is a good example of multidisciplinary teamwork between the epidemiologist, EHP's and analytic laboratory team.

According to Hunter (1997), after the successful completion of an epidemiological study, the results should be statistically significant to associate environmental factors, disease and risk, as well as the difference in risk between exposed and non-exposed populations.

Skilful application of environmental epidemiology will enable the EHP to collect information about the general environmental health profile of communities and of specific environmental determinants that may influence human health. Environmental health epidemiology can therefore be used to identify environmental, behavioural and other social factors that may influence the health of the community, and provide objective assessments of the impact of various interventions that may

follow (Von Schirnding, 1997).

Environmental health indicators express scientific knowledge about the link or relationship between environment and health. It can therefore contribute to improve health management and help to make more appropriate policy choices (Briggs et al., 1996). An environmental health indicator defined by Briggs et al. (1996), is: "*An expression of the link between environment and health, targeted at an issue of specific policy or management concern and presented in a form which facilitates interpretation for effective decision-making.*"

Skilful application of the epidemiological process includes the use of environmental indicators to point out problems and possible outbreaks of disease (Briggs et al., 1996). Thus, applied environmental epidemiology links environmental determinants or factors to health problems and disease through the use of indicators.

Health assessment is a relatively new field, especially in environmental health. Covello and Merkhofer (1993) defined risk assessment as the process for generating a probability distribution or quantification that can describe uncertainty about timing, magnitudes or the nature of possible health or environmental consequences that are associated with possible exposure to hazardous substances, processes, actions or events. This process includes epidemiology as an assessment tool. The EHP cadre currently does not apply epidemiology as a tool of risk assessment to its full potential.

In environmental epidemiology the application of risk assessment can contribute to identifying specific groups that are at risk of being affected. It is important to realise that just as questionnaires and data sheets are tools to collect data, so is the epidemiological study a tool of risk assessment.

According to the WHO, progress in the methodology of exposure assessment would create opportunities to apply improved exposure assessment methods in epidemiology, some of which are less costly and more suitable for population studies (WHO, 1995b).

According to Hunter (1997), one of the world's most eminent epidemiologists, Bradford-Hill, as well as medical statisticians, suggested in 1965 that epidemiological criteria be used in the assessment of whether environmental factors were associated with human disease.

Epidemiologists are increasingly studying the public use of poor quality water to

determine health risks that may be associated with environmental exposures especially from drinking water. It is therefore important that drinking water professionals become more familiar with epidemiological methods (Craun et al., 1996).

The drinking water professional can be an EHP with a qualification in water quality management or a member of the research team with a relevant degree or strong interest in water quality management.

Appropriate application of the epidemiological process will enable the EHP to collect environmental health data from the population. A database on the environmental health status of the population with built-in indicators and risk factors could be developed and sustained. Environmental factors with the potential to be harmful to health can then be detected and managed before they have an adverse effect on the general health status, and outbreaks of diseases can be dealt with quicker.

Guidelines for using epidemiology in environmental health practice in South Africa could not be found after an intensive search and are presumed not available. Guidelines on epidemiological studies on health-related water quality are especially needed to assist EHP's in the field.

1.3. WATER AND HEALTH

1.3.1 INTRODUCTION

The epidemiological process cannot be piloted in a study format such as this in all of the various human environments (for example work, recreational and living environment) for these are too numerous and also vary in their interaction. Nor can the process be evaluated by using all the media that may potentially carry environmental health influences (for example food and water). To apply the whole process in one study on any permutation of determinants (in a medium) within any of the human environments will be even less achievable. To effectively pilot an epidemiological process one needs to have a relatively simple design of determinant versus human living environment and their possible impact on human health. Therefore this study focused on drinking water and its effect on human health in the living environment based on the occurrence of diarrhoea as an indicator of health.

Water is a natural resource that is essential for life, but can also be detrimental to health under certain conditions. The water people use for their daily needs could become contaminated, serving as the vehicle for disease even in communities with

an apparent safe municipal supply (Jagals et al., 1997; 1999a).

According to Katzenellenbogen et al. (1997), in the chapter on study design, any or a combination of cross-sectional, ecologic, case-control and / or cohort studies can be used to study the link between exposure and outcome. If a community health profile indicates that a significant number of people in the community periodically suffer from diarrhoea (outcome), and because it is known that water can carry disease, an association can be determined if the quality of the water used is known.

The research theme for this study was developed from several current research projects at Technikon Free State, including the effect of environmental health risk assessment and management on water quality. This offered an ideal scenario for designing a water-related environmental health epidemiological guide for use by EHP's.

To improve human health in developing countries through the provision of sanitation systems and water supply has been a goal of health-related agencies for decades (VanDerslice and Briscoe, 1995). According to Payment (1997), epidemiological studies have intensified in America since 1989 to determine if tap water can be a significant source of illness.

Data on a health outcome (the occurrence of diarrhoea), linked to environmental data, can be used to assess (confirm) the exposure-to-effect relationships in the study area. Such information can help quantify the contribution of specific exposures (such as the ingestion of infected water) to total morbidity (Covello and Merkhofer, 1993). This can be done through epidemiology.

However, the epidemiological association of diarrhoea with waterborne transmission would be difficult. Proving the waterborne transmission of diseases is as difficult as proving the reverse, in other words, proving where people with diarrhoea got the disease from (Grabow, 1996). Nevertheless, tendencies are often identified through epidemiological studies that might provide some link or association between environmental factors (variables) and diarrhoea.

It was found in 1995 that two thirds of the African population in South Africa were affected by poor environmental health conditions, such as the lack of clean water and sanitation. Only 20% of African households had a tap inside their homes and 16% of African households did not have a toilet of any kind (Sinclair and Tyson, 1995).

From a study that was completed in the major urban and peri-urban areas of South Africa, risk factors that can cause diarrhoea were identified. These factors included not having an in-house water tap, not having a flush toilet inside the house and not having a refuse container or bin (Von Schirnding et al., 1991).

The provision of safe and adequate water and improved hygiene has been shown to lead to a reduction in diarrhoeal disease morbidity. Peterson et al. (1998) found in the Nyamithuthu refugee camp in Malawi, that the presence of soap in the household was associated with a decrease in diarrhoea incidence. Peterson et al. (1998) and Pinfold (1990) stated that in developing countries, studies have shown a decrease of 14 - 48 % in diarrhoeal disease incidence as the result of hand washing or other hygiene interventions.

Self-contamination in terms of this study is facilitated by poor domestic and personal hygiene. The swallowing of water contaminated by bacteria, viruses and parasites can cause intestinal infection as these organisms can be transmitted via water and dirty, unhygienic surroundings (SALUS, 1993).

In a health profile study in certain communities in KwaZulu Natal, a strong association was found between the availability of water and sanitation and the incidence of acute diseases (Pillay and Terry, 1991). Therefore communities are given access to potable water supply and appropriate sanitation to help minimise disease occurrence.

The Constitution of South Africa (Republic of South Africa, 1996) stated that every person has the right to access an adequate and safe water supply. The short-term aim for "adequate" water is for water management agencies to provide every household with clean safe water, 20-30 litres per person per day within 200 m from the house (Republic of South Africa Constitution, 1996). South African water policies have recently adopted the norm of 25 litres per person per day within 200 m from the house (Republic of South Africa, 1994; 1997a; 1997b). This implies that should a person have less than 25 l per day for purposes of personal hygiene, drinking and food preparation, it could lead to some form of lesser quality of life, which in turn implies a health risk.

To complete an environmental health epidemiological study of this nature, information will be needed on the following aspects:

- The continuous availability of safe water.

- The accessibility of water - including the distance from the nearest tap.
- Water storage methods and container information.
- Information and knowledge on basic health and hygiene concerning the occurrence of diarrhoea (disease).
- The age of, and frequency of disease in, the affected people.

1.3.2 DIARRHOEA AS WATER-RELATED HEALTH INDICATOR

Most of the global burden of diarrhoeal disease occurs in children in developing countries. An estimated 90% of diarrhoeal disease is related to environmental factors such as poor sanitation and lack of access to clean water (WHO, 1997). It was stated by Pegram et al. (1998) that the diarrhoeal incidence rates for children living in areas with poor water supply and sanitation are higher for children under the age of five.

According to Von Schirnding et al. (1991), improvement in social and health services as well as in water accessibility and sanitation facilities results in declines of diarrhoeal disease and other infections.

Because of the public health importance and expected responsiveness to improvements in the water supply and sanitation facilities, diarrhoea has been the focus of many health impact studies (Cousens et al., 1989). Diarrhoea continues to be a major public health problem, usually affecting small children, in most developing countries (Bukenya and Nwokolo, 1991; Gorter et al., 1991; Huttly et al., 1997; Levine et al., 1993; Molbak et al., 1989; Morris et al., 1996; Pegram et al., 1998). Diarrhoea remains one of the most common childhood diseases in South Africa despite all the improvements that have been made in water quality and provision (SALUS, 1993).

Contamination of the environment and contamination of the individual are two environmental factors contributing to diarrhoea. According to Cousens et al. (1989), and Esrey et al. (1991), 1981 – 1990 was declared the international decade for Drinking Water Supply and Sanitation. The object of this was to improve the provision of water supply and sanitation facilities to those people with inadequate water supply and insufficient sanitation facilities. This was hoped to lead to the improvement of the health of those people. Improvements were made to the water supply and sanitation facilities in several areas. Numerous studies, for example

Esrey et al. (1991) and Huttly et al. (1997), were conducted to investigate the provision of water drinking water and sanitation facilities and the improvements on human health.

Because diarrhoeal diseases are a major cause of morbidity and infant mortality in developing countries, water supply and sanitation systems design should include a strategy for preventing faeco-oral disease transmission (Pinfold, 1990). From a community-based study that was undertaken in Durban, South Africa, it was concluded that diarrhoea continues to be a problem among black South African infants. A need was identified for further epidemiological data concerning this disease (Loening et al., 1989).

Epidemics of waterborne diarrhoea can indicate a potential channel of water borne health hazards and should serve as a danger signal to the community (Simchen et al., 1991). The danger signal can be that of a possible outbreak of disease or the indication of the contamination of the water source.

According to WHO (1995a), it is difficult to measure health status related to water. Tools for measuring health status are not efficient and implementation is sometimes influenced by lack of resources. One of the methods to determine health status would be in terms of disease incidence. The number of new cases each year could be used. WHO (1995a) reported that diarrhoea in children is the biggest health problem globally with 1.8 billion episodes per year.

Diarrhoea can indicate the breakdown of social habits. According to Jagals et al. (1997), diarrhoea is often related to the ingestion of contaminated water. It was however also stated by Jagals et al. (1997) that other agents such as poor food and personal hygiene may also contribute to diarrhoea. For diarrhoea to be an effective indicator of the effect of water quality and water use patterns on the health of the population, these other environmental factors should also be investigated when doing an epidemiological survey. Diarrhoea can thus be an indicator of the health of the population linked to social attributes such as their water use patterns as well as environmental factors such as the quality of their domestic water.

According to Henry et al. (1990), it is unclear to what extent diarrhoeal transmission occurs through waterborne transmission as opposed to other routes. It was stated by Henry et al. (1990) that multiple causes and transmission routes exist and some aetiology-specific diarrhoea are more influenced by water and sanitation than

others. For the purpose of this study waterborne diarrhoeal transmission was focused on in general.

Blum and Feachem (1983) reported that for 44 studies that were conducted on relationships between water supply and / or excreta disposal, 11 used diarrhoea (incidence rates of diarrhoea) as health indicator.

For this study, the prevalence of diarrhoea during the past 12 months was used as an indicator of health to determine the health status of the study population. It was decided to interview the respondents on a recall period of 12 months to determine if prevalence of diarrhoea in the area could influence the environmental health status of the community. A twelve months recall period was used to form a general perception of the occurrence of diarrhoea in the area over all four seasons.

This study was not designed to rely on sophisticated assessments of stools and / or microbiological water quality to try and find the aetiological agent causing the diarrhoea in people from the target area. The study was focused on determining the type of stool passed. In order to find some indication of the possible origin of the causing agent the following appearance and structure of diarrhoeic stools were used (Benenson, 1995; SALUS, 1993):

- An enteropathogenic viral infection can generally be identified by watery diarrhoea.
- A bacterial infection (usually from food infecting bacteria) is suspected when the appearance of the diarrhoea is semi-loose.
- Bloody dysenteric type diarrhoea stools generally indicate protozoan infection.

Watery diarrhoea is generally associated with an enteropathogenic viral infection (Grabow et al., 1996). Entropathogenic viruses are readily transmitted by polluted water. A viral infection can result from as little as one virus particle (Grabow, 1996) which means that virus contamination need not be from aggressive pollution. Humans are the reservoir and the faeco-oral route transmits the viruses. Inadequate volumes of water affect the general and personal hygiene of the household. This implies that a virus-infected person in a household can contaminate stored water supplies simply by having contact with the water with unwashed hands. Virus infections are also common where environmental sanitation

is poor (Benenson, 1995). This means that outbreaks can occur because of contaminated food as well. Nevertheless, because of the environmental persistence of enteric viruses in water, these organisms are the prime suspects for waterborne diseases. For the purpose of this study, reported watery stools were associated with viral infection in the infected persons.

A semi-loose stool is usually an indicator of a bacterial infection. Bacterial pathogens such as *Salmonella spp., Shigella* spp., *Vibrio cholerae, Campylobacter jejuni, Campylobacter coli, Yersinia enterolitica* and entero-pathogenic *Escherichia coli* could cause diseases like dysentery, cholera, gastroenteritis and typhoid fever. These organisms can be transmitted via the faeco-oral route by contaminated, poorly treated drinking water but generally need to be ingested in large quantities (Benenson, 1995). This implies a large infectious dose of the pathogen, in other words, heavy pollution or infection of environmental media such as food and water. For the purpose of this study, reported semi-loose stools that were not predominantly watery stools, were associated with bacterial infection of the affected persons unless the stools were clearly described as bloody.

Bloody diarrhoea is an indication of a protozoan infection (Benenson, 1995). Amoebiasis, caused by *Entamoeba histolytica*, is also a protozoan parasite infection that causes diarrhoea in the form of dysentery with fever, chills, and abdominal discomfort with bloody or mucus-containing diarrhoeic stools. It is mostly a disease of young adults, mainly males. It rarely occurs below age five. Generally it is higher in areas with poor sanitation. Protozoan parasites require low infectious doses and are generally transmitted by hand to mouth (faeco-oral route) though food, and occasionally by water (Benenson, 1995). The cysts of *Giardia* spp. and oocysts of *Cryptosporidium* spp. are part of the lifecycle of protozoan parasites that are infective to humans. Occasional outbreaks of giardiasis and cryptosporidiosis are associated with untreated water but also with a breakdown in conventional treatment, or treated water that did not pass through sand filters. The disease takes the form of anorexia, diarrhoea, gastroenteritis and vomiting (Department of Water Affairs and Forestry, 1996). For the purpose of this study, reported bloody dysenteric stools were associated with protozoan infection in the affected persons.

In the past fifteen years several authors (Esrey et al., 1985, 1991; Huttly, 1994 and Huttly et al., 1997; Briscoe, 1987; Peterson et al., 1998) have debated which

intervention is best to reduce the morbidity of diarrhoea:

- Improvement in water supply and sanitation.
- Improvement in water quantity and water quality.

Huttly et al. (1997) identified improvements in water supply and sanitation and the promotion of personal and domestic hygiene as two of four non-vaccine interventions to reduce the prevalence of diarrhoea. They urged that the promotion of hygiene behaviour receive increased attention as a preventative method against diarrhoeal disease when improving water supply infrastructure. These studies confirm that if diarrhoea occurs in an area, the prevalence of the disease could be reduced by improving on the availability, safety and quantity of the water supply as well as by improvements in the provision of sanitation facilities.

If diarrhoea prevalence was found to be high in the study area, the above mentioned improvements could be used to improve the health status of the community.

1.3.3 EPIDEMIOLOGICAL SURVEYING

In the absence of available environmental health data, sample surveys may be the only way to investigate these issues in communities. Community surveys estimate health-related events in the community (Katzenellenbogen, 1997). This survey methodology would include epidemiological studies focusing on environmental health factors related specifically to the water use patterns (availability, accessibility and quality), as well as the prevalence of disease, personal and general hygiene. Friis and Sellers (1996) stated that the problems of health hazards posed by poor water quality require extensive epidemiological study.

The need for information on the health status of communities and the use of health services and environmental factors affecting the community have been recognised since the start of the century by several countries as well as by the WHO. This led to the development of the Health Interview Survey, which was first applied in Hagerstown (USA) in 1926, where interviewers using a questionnaire, interviewed the respondents at their homes (Hoffman et al., 1988). Epidemiological surveys are a form of descriptive studies. Hunter (1997) stated that surveys seek to describe the characteristics of individuals in a population. A portion of the population, a sample, can be interviewed.

According to Hunter (1997) descriptive epidemiological studies strive to describe the pattern of disease in a community. It was stated that although descriptive studies

seldom prove disease associations, it is an essential starting point in the investigation of a possible waterborne disease. In descriptive epidemiological studies information on the occurrence of a disease, or associations among exposures, demographic characteristics, and the disease rate in the population group is available. Descriptive epidemiology is important for summarising the disease information to reveal temporal, demographic, and geographic occurrence patterns to assist with the developing of hypotheses about the risk factors (Craun et al., 1996). The analyses of a descriptive study are, according to Hunter (1997), usually restricted to summarising the data and presenting it in tabular and graphical form.

A sample survey that is based on a representative sample of a population of interest, interviewed at one point in time, is known as a descriptive cross-sectional survey (Bowling, 1997). For this type of epidemiological study the aim is to determine the prevalence of disease and to link it with the services used and associated factors. It was decided to conduct this study by means of a cross-sectional survey.

The population is usually defined geographically, but may also be defined by employment in a certain company or people going to the same clinic or health care facility (Lilienfeld and Stolley, 1994). For the purpose of this study the population was defined geographically. A residential suburb (Section K) in Botshabelo, a developing urban area, was chosen. The sample (300 households) was randomly selected from the population in Section K.

A population is a group of individuals that inhabit a given area at a point in time. A population size can be too large to be studied in depth. Samples of the population is usually drawn. Advantages of sampling over complete coverage of the population include saving on finances, time and human resources, and better quality data are obtained. Statistical sampling is recommended, since the precision of the estimates could be determined from the results (Bowling, 1997). Statistically-calculated sample sizes are important for detection of expected associations. According to Craun et al. (1996), the observed association must be evaluated to determine if systematic and random errors occurred. The researcher must ensure that the sample size as well as the method of collecting the data is designed in such a manner that the information is valid, reliable and representative of the population in the area.

Bowling (1997) said that the selection procedure must be random (a random selection) and that it must depend on chance to be statistically correct. A small sample is likely to be less of an accurate representation of the total population than a large sample. For the purpose of this study a consultant bio-statistician did the sample selection. The statistician selected a sample of 300 households in the study area after considering practical and statistical implications. The 300 households were approximately 10 % of the population households in the area.

Cross-sectional studies are also known as prevalence surveys. This type of study provides information on the frequency of disease in a specific population, which, for this study, were clearly defined. For this study type the sample was selected randomly from the study population at a point (Section K, Botshabelo) in time (past 12 months prior to July 1998). The point in time is specified to identify the selected sample population and to indicate the period in time that was covered by the survey. The 12 month period was chosen to cover the winter of 1997 to the winter of 1998.

In the absence of suitable information sources, questionnaires and observation sheets may be used to determine exposure for environmental epidemiological studies. There should be agreement on the items that need to be covered in questionnaires to assess exposure (WHO, 1995b).

For the data collection of this study, questionnaires were used that were designed for household respondents. A data-capturing sheet that consisted of questions asked by an interviewer to a respondent, as well as noted observations made by the interviewer at the house of the interviewee was used for this survey. According to Blum and Feachem (1983), observational data will be more reliable; especially data on the quantity of water used and questionnaire information should be confirmed by observational data where possible.

Craun et al. (1996) stated that information about exposure from environmental and health factors are usually obtained by questionnaire, sometimes answered by a senior female member of the selected household during an interview. It is difficult to assess exposures that occurred long ago, therefore the quality of the information must be ensured. In the study conducted by Ahmed et al. (1994) it was stated that an adult family member was interviewed about the household and available sanitation facilities of the household. It was further reported that the mothers or caretakers were asked about the health and occurrence of diarrhoea in their

caretakers were asked about the health and occurrence of diarrhoea in their children. In the African culture the mother or wife in a household takes care of the children and the household, therefore the mothers will be able to assist with the collection of the needed information (Pickering, 1985). For this study it was decided that mothers of the household should the responding person wherever possible.

A major problem with surveys is one of bias, especially selection bias. According to Abdool Karim (1997), bias is a deviation from what is true and correct. Therefore when excessive bias occurs, the data could be unreliable and invalid. For household surveys, bias can occur when the target respondents are not at home, are substituted by household members such as the grandmother or older sister. Bias can also occur when a household refuses to take part in the survey and this leads to a response rate of less than 100 % (Joubert and Katzenellenbogen, 1997).

Selection bias occurs when the sampling frame is not complete and if non-random sampling procedures are used. Selection bias can arise in any of three ways. The first is in the identification of the population; the second is when a deviation from the selection rules for selecting a sample occurs, for example when using volunteers instead of a random selection process. The third way is when many of the selected individuals or households could not be traced or would not co-operate (Hunter, 1997). To limit the influences of bias for this study, a complete sampling frame was used (the map indicating the plots) as well as random selection of the sample population (consultant).

1.3.4 SIMILAR STUDIES

Esrey et al. (1991) conducted a study on the effects of improved water supply and sanitation facilities on health (diarrhoeal disease). The study was a review of the impact of water and sanitation interventions on health. From a literature search Esrey et al. (1991) found studies and divided them in two groups:

- Studies that reported statistically significant positive associations between improved water supply and sanitation and improved health.
- Those studies that did not.

Of the studies on diarrhoeal disease that were reviewed, some were conducted in Iran, St Lucia, the West Indies, rural Bangladesh, the Philippines, Malaysia, Lesotho, Nigeria, Gambia and Malawi. Esrey et al. (1991) concluded that reductions achieved in diarrhoeal mortality by improving the sanitation and water

enhancing child survival. From the results of studies published on diarrhoeal disease since 1980, it was concluded that the interventions to improve excreta disposal and water quantity produced greater impacts than improvements in water quality. It was recommended that more attention should be given to safe excreta disposal and proper use of water for personal hygiene. The water supply must be as close as possible to the home. Water supply and health programmes should include education programmes that promote the use of more water for personal and domestic hygiene (Esrey et al., 1991; Jagals et al., 1999a).

Water-related programmes have been implemented to improve health status through the reduction of incidence of waterborne communicable diseases in Malaysia. Lonergan and Vansickle (1991) used a 268 household diarrhoeal morbidity survey to measure the burden of illness and to identify the predictors of morbidity. Interviewer-completed structured questionnaires were used. The interviewer was familiar with health guidelines and required little training. The respondents were asked if they reported each episode of diarrhoea to a health practitioner. Risk factors that were included were water supply, sanitation and child care. Sanitation and children's hygiene were observed by the interviewers. The results of the survey showed that young children (0-4 years) had the highest percentage of episodes of diarrhoea despite representing a small fraction of the population. This suggested that water quality standards and treatment facilities would reduce the health burden of the region, but behavioural and sanitation factors may be more important. Water quality was shown to influence diarrhoeal rates but the impact of water quality programmes alone may be minimal. There are factors in addition to infrastructure that may have a greater influence on diarrhoea, indicating a need to develop parallel programmes to accompany water improvement projects. Hygiene education is an important complement to engineering solutions (Lonergan and Vansickle, 1991).

Mertens et al. (1992) conducted a case-control study in Kurunegala, Sri Lanka. A structured questionnaire was used to collect information on current illness, access to and type of water supply, ownership of a latrine, indicators of socio-economic status and child-feeding practices. Questions were asked to mothers on how they disposed of the childrens' excreta. Results suggested that the limiting effect of the safe disposal of excreta on the occurrence of diarrhoea was greatest amongst households with one or more of the following:

- Households which used more than 40 l of water per person per day.
- Those who reported hand washing before eating.
- Those who lived at an intermediate distance from the clinic.

However, reports from observations indicated that patterns of children's defecation and its regulation by adults vary from place to place, but that children under 5 usually do not use latrines. It was concluded that latrine ownership is necessary for safe excreta disposal. Results showed that diarrhoeal morbidity might only be reduced in Sri Lanka if behavioural changes such as the safe disposal of excreta took place together with construction of sanitation facilities (Mertens et al., 1992).

Peterson et al. (1998) conducted a survey in the Nyamithuthu refugee camp in Malawi. A sample population of 402 households were surveyed for diarrhoeal factors and interviewed for 4 months regarding new diarrhoeal episodes as well as the presence of soap in the household. The questionnaire included demographic factors and questions on a number of potential risk factors for diarrhoea. The sex and age of the household members with diarrhoea were recorded. The diarrhoea risk factors that were evaluated in the study were the number of containers used, the presence of latrines, hand washing, and the number of animals in the household. The major finding of the study was that the presence of soap in households is associated with a decrease in diarrhoeal incidence. It was concluded that the provision of regular and adequate soap rations might reduce diarrhoea in refugee populations despite the low frequencies of hand washing and limited water resources. The availability of soap appeared effective, as this required no behaviour modification or education programme (Peterson et al., 1998). The soap was used automatically with hand washing once it became available.

The promotion of proper infant feeding practices and the improvement of environmental sanitation have been two important strategies in the effort to reduce diarrhoeal morbidity among young children. VanDerslice et al. (1994) conducted such a survey in Cebu City, Philippines. They found that breast-feeding protects infants by decreasing their exposure to water- and foodborne pathogens and by improving their resistance to infection. Some environmental factors that were considered were drinking water quality, access to water, type of excreta disposal facility, presence of excreta in the household's yard, and the sanitation conditions in the household's neighbourhood. The water sources used were identified during a

the household's neighbourhood. The water sources used were identified during a baseline study. The yards were inspected for the presence of faecal material and the respondents were asked if they allowed animals in the house. Results showed that water was readily available to almost all households in the study. The water quality was found to be moderately good to very good at the sources, which indicated that the contamination occurs while water was transported or stored in the containers. It was found that water quality and sanitation were important risk factors for diarrhoea. The consumption of contaminated stored water, lack of a private excreta disposal facility and the presence of faecal material in the yard were associated with the greatest increase in risk. It was concluded by VanDerslice et al. (1994) that an increase in available water volumes and access to excreta disposal facilities could do much to enable families to improve hygiene conditions in the home and to reduce the level of contamination in the community .

These and similar studies were used as background to assist with the development of the data sheet (questionnaire) for this study. The study area chosen for conducting the epidemiological survey was compared to the reviewed studies in relation to water quality and availability, sanitation, standard of living, health status and infrastructure.

1.4 THE STUDY

1.4.1 STUDY OBJECTIVES

The principal aim of this study was to determine the water-related environmental health status of a community in a developing urban area by means of an epidemiological survey based on the occurrence of diarrhoea.

It has been reported that 90% of all diarrhoeal cases could be related to the influence from environmental factors (WHO, 1997). For this study the problem to be investigated was whether the lack of in-house water supply facilities, intermittent water supply as well as inadequate sanitation facilities could be a clear cause of diarrhoea incidences in the community of Section K, Botshabelo, in the Free State Province, South Africa. It was hypothesized that if incidences of diarrhoea in the target population could be detected, a clear tendency could be identified if the other causal variables mentioned above corresponded with the occurrences.

The following objectives were set to meet this primary aim of the study:

- To conduct a community-based cross sectional epidemiological survey.
- To base the study on a survey of a determinant (water quality) versus exposure (absence of in-house water, intermittent water supply as well as inadequate sanitation).
- To determine the possible impact on human health (measured by incidences of diarrhoea).
- To interpret the collected data to find any association between the occurrence of diarrhoea and the water use patterns of the target community.

A similar study by Lonergan and Vansickle (1991) showed that, because of the broad scope of information needed from the household, the use of an interviewer-completed structured questionnaire was required. This required the involvement of fieldworkers and personnel familiar with health guidelines and able to speak the local languages. Interviewers were chosen to eliminate possible biases in interview response that occurs commonly in cross-sectional studies. If the fieldworkers were familiar with the health standards they required little training (Lonergan and Vansickle, 1991).

The interviewers used for this study were students in their final year of obtaining the National Diploma: Environmental Health. They were not members of the target community and also a homogeneous group. Interviewer-bias could therefore be largely excluded.

The questions asked were in the form of a semi-structured questionnaire. It consisted of open-ended questions with possible answers to choose from, as well as provision made for data through observations. Friedman (1994) stated that data relating to social status or exposures to environmental hazards can be successfully obtained in this manner. The same background information that was used on households by Molbak et al. (1997) was used in this study (including information on water supply, sanitation and domestic animals). Although data collection could be done at any venue, for the purpose of this study data was collected at the homes of the interviewers.

As in the studies conducted by Esrey et al. (1991); Mertens et al. (1992); VanDerslice et al. (1994) and Peterson et al. (1998), questions on the number of containers used, availability of latrines, personal hygiene and domestic hygiene as

well as the presence of animals in the household were included in the data sheet. Personal hygiene refers to water used to clean the human body and domestic hygiene refers to water used to keep the house clean (Esrey et al., 1991). For the purpose of this study, nutrition and breast-feeding investigations were not included although reviewed studies did cover this field. VanDerslice et al. (1994) found that full breast-feeding provides protection against diarrhoeal disease for infants during the first 6 months of life. Studies that focused on nutrition as well as food hygiene in Botshabelo have been conducted. Van der Westhuizen (1998) reported that in a nearby section of Botshabelo, food and milk quality were of concern. From an ongoing study on the nutrition status of a community in another nearby section of Botshabelo, it was reported that if the socio-economic status and knowledge of nutrition are poor, the occurrence of malnutrition in the area was high (Walsh, 1999; personal communication). According to Henry et al. (1990), contaminated food and water are regarded as vehicles of diarrhoea transmission.

For most studies a case definition of diarrhoea was included, for example three or more loose stools in a 24 hour period to define the concept to the respondents and fieldworkers for this study. As for the study conducted by Moe et al. (1991) the diarrhoea phenomenon was not defined beforehand in this study. The identification and reporting of diarrhoea cases were left to the discretion of the respondent, usually the mother. Thus for the purpose of this study no formal case definition of diarrhoea was used but it was decided to focus rather on any abnormal stool passed in the past 12 months, namely a loose, semi-loose or bloody stool based on the description of the occurrence by the respondent.

The survey was conducted in the area to pilot the use of the epidemiological process by EHP's as a health assessment tool. This study's secondary aim was, therefore, to design a manual / guide for EHP's to effectively apply an environmental epidemiology survey to assess the effects of water quality on human health, because such a manual / guide for South African EHP's does not exist in South Africa.

The following objectives were set to meet this secondary aim of the study:

- To design a guide / manual that will help the EHP to understand and apply the epidemiological survey process.

- To design the manual in such a way to lead the EHP through the whole survey process by providing more information on:

- Study design
- Sampling
- The questionnaire
- Observations.
- Overall data sheet design
- Analysis and results
- Communication of findings
- Examples on possible errors and how to avoid it

A further purpose of the guide / manual would be to encourage the EHP to complete epidemiological surveys in communities. The guide aims to give information on how to get started (Appendix D). This is thought to assist the EHP to be at ease with epidemiological surveys.

1.4.2 THE STUDY AREA

Botshabelo is a large developing urban community with several low socio-economic suburbs, fifty kilometres east of Bloemfontein in the Free State province. Figure 1.1 indicates the location of Section K in Botshabelo. It is a community of poor infrastructure. A developing area is an area where a disadvantaged or formerly disadvantaged community lives. Waterborne sewage systems have not been installed in most sections of the city. Not everybody in Botshabelo has access to sanitation facilities. In-house water is only available in the sections with flush toilets. In the other sections, including Section K, water is generally available at communal standpipes and in some instances, yard taps.

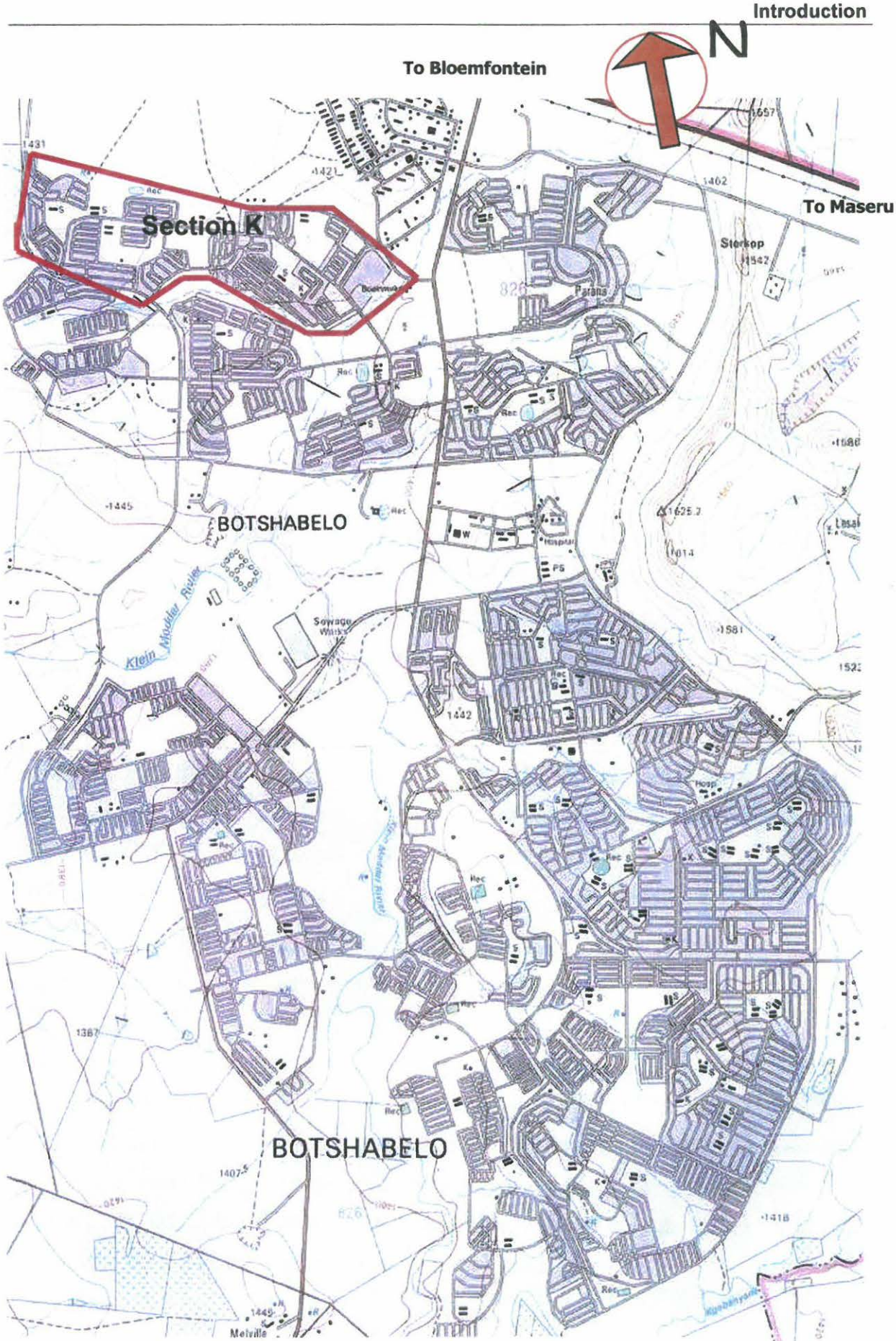

Figure 1.1: Area map of Botshabelo indicating the study area.

Because of other research conducted in nearby sections of Botshabelo, good communication had developed between the research team of Technikon Free State, clinic personnel and the medical doctor who formerly worked in the area. It was decided to conduct this study in Section K because of the relationship that existed between the Technikon and the clinic and medical staff in general but also of this section.

In Section K the people use various types of household containers to move a supply of drinking water from the municipal supply (public standpipes or yard taps) into their individual dwellings to store for daily use (Water Research Commission, 1993; Jagals et al., 1999). Figure 1.2 shows pictures of the study area. A pit latrine, a communal tap (street tap) and one of the methods used to collect water in containers can be seen.

A previous study conducted in Botshabelo indicated that the quality of the bulk water supply that is delivered to the local authority is adequate and safe. Jagals et al. (1997) stated that the water supplied by the local authority via the water reticulation system to the consumers was not faecally contaminated. The total and faecal coliform levels in water sampled from the bulk and network supply, used by diarrhoea affected and non-affected families were below the maximum low risk limits that is proposed by the South African Water Quality Guidelines of 1996 (Bokako, 2000; Jagals et al., 1997; 1999a). The municipal water supply quality in the area posed a negligible risk in terms of the South African Water Quality Guidelines (DWAF, 1996).

It was found by Jagals et al. (1999a), that the quality of the stored water in the containers was not of the same safe quality as the water from the municipal supply. It was concluded by Jagals et al. (1999a) that the water quality in the storage containers of the community of Section K, Botshabelo, is poor. The quality of the stored water was poor because the water was not protected from contamination from the outside environment during fetching and storing. Because of the poor quality of the water in the storage containers as well as the poor hygiene (basic and personal) the risk of being affected by diarrhoeal disease is higher than for those families who do not need to store water in containers.

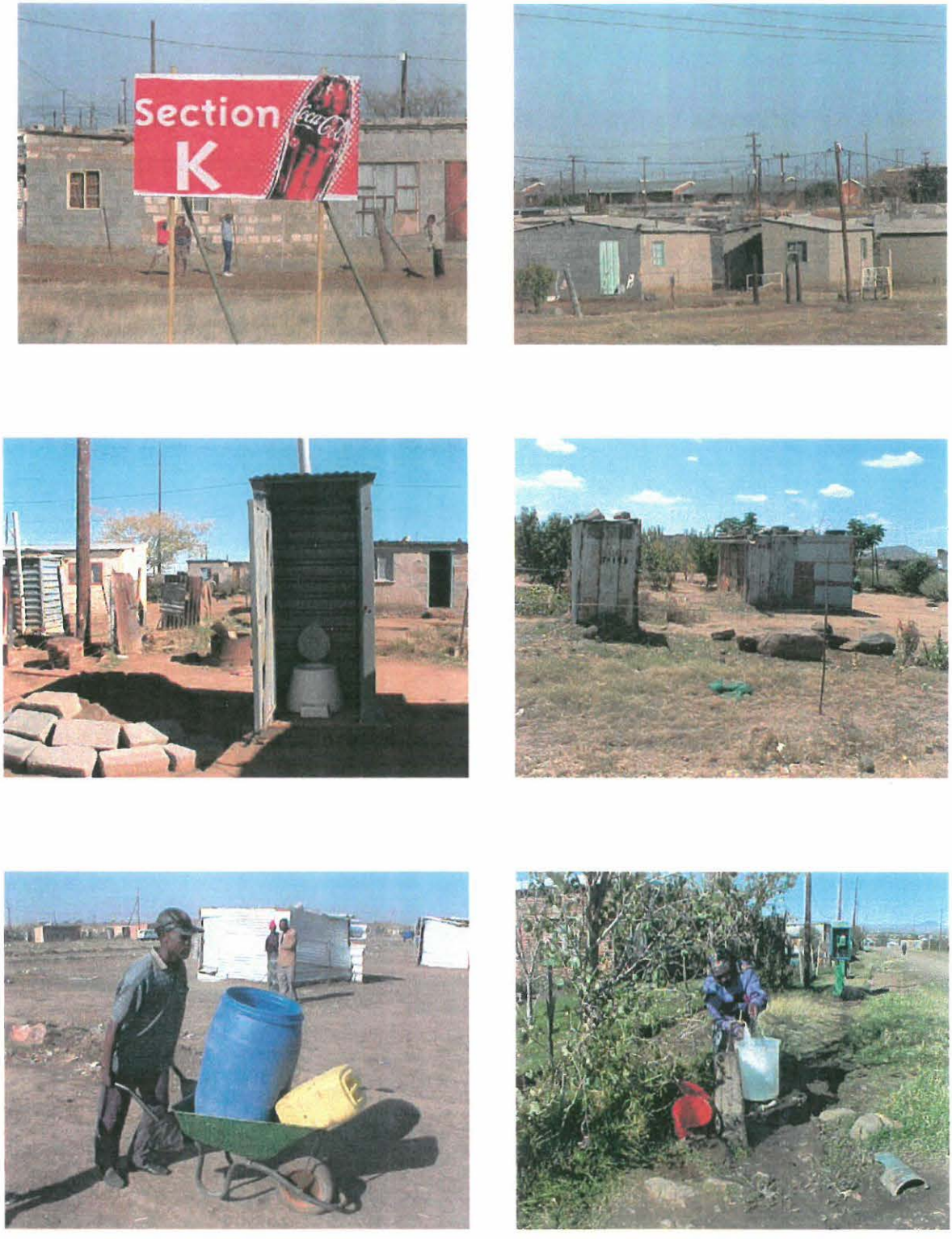

Figure 1.2: Living with water and sanitation in Section K, Botshabelo.

1.4.3 THE RISK FACTORS INVESTIGATED

A representative cross section from the population was selected and interviewed from a questionnaire which made provision for interviewer observations (Appendix A).

The risk factors (exposures) investigated were the availability / unavailability, and accessibility of drinking water and the available sanitation facilities as well as the personal hygiene of the respondents. The disease (outcome) concerned in this study was diarrhoea. The various exposure groups were then compared with the presence of diarrhoea, the outcome, and reported in Chapter 3.

CHAPTER 2

METHODOLOGY

2 METHODS

Figure 2.1 is a flow diagram that presents the methodology of the study. The study methodology will be discussed in this chapter in the order of the diagram.

2.1 SURVEY DESIGN

The aim of the survey was to collect environmental health-related data especially on water-related issues from a sample of a population. Data were needed to determine if the prevalence of diarrhoea in the population was related to water use and water quality.

2.1.1 STUDY TYPE

A descriptive cross-sectional study type was chosen because of the following features:

- A sample of the study population was investigated and data is collected on risk factors (exposures) and disease (outcome) at a point in time.
- The prevalence of risk factors as well as prevalence of disease could be calculated.
- A cross-sectional study of the population allows statistical comparisons between subgroups and may show relationships between exposure and outcome.

2.2 STUDY BASE

The study population consisted of approximately 3362 households within a marginalised residential urban development (Figure 1.1: K Section, Botshabelo). These households live on marked plots in the study area. A substantial number (approximately 300) of households live in informal dwellings on unmarked plots in the study area.

2.2.1 SAMPLE SIZE

On advice from a statistical consultant from the University of the Orange Free State (UOFS) a proportional stratified sample was selected as described by Joubert and Katzenellenbogen (1997). It was decided to interview 300 households (approximately 10% of the population) in the study area. This sample size was chosen, taking practical considerations into account such as time, financial implications and human resources.

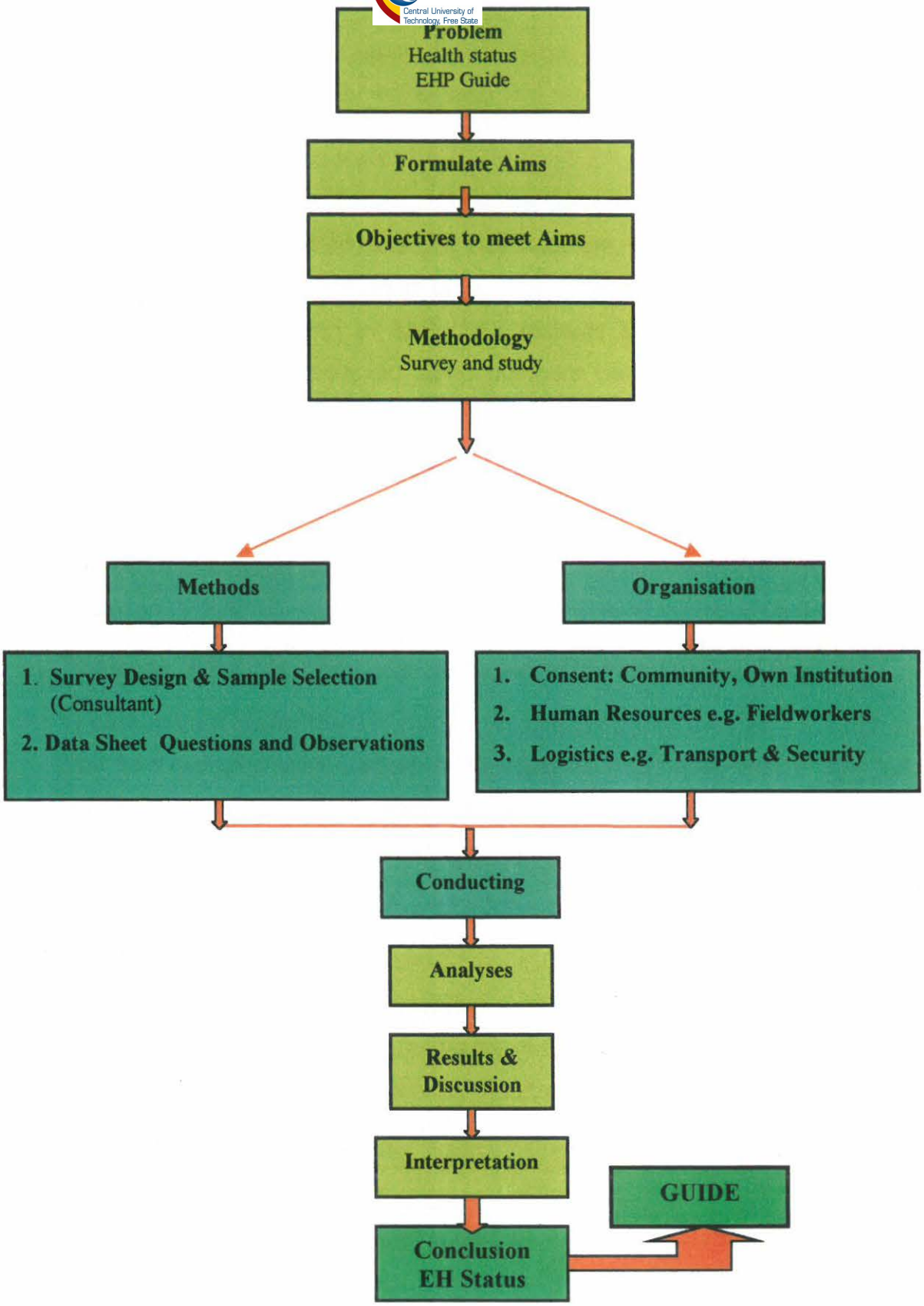

Figure 2.1: Methodological process for conducting the study

The sample consisted of 270 households from the marked plots on the map and 30 from the informal structures not indicated on the map.

2.2.2 SAMPLING

A map of the study area was obtained from the Botshabelo municipality. This map, which indicates all the marked plots and their numbers, was used for the selection of the 270 households living on marked plots. The 270 households were selected with a computer program written in SAS (SAS Institute Inc., 1990) using a random number generator. The selected stand numbers were verified on the map and marked.

The following procedure were used to select the 30 households from the informal structures:

- The informal housing sections were plotted on the relevant open spaces on the map.
- The areas of the informal houses were divided in 3 sections of similar size.
- In each area a glass bottle was spun on the ground in the centre of the area. The field workers then walked in the direction that the neck of the bottle indicated. The fieldworker team interviewed every eighth informal household that was on the indicated route.
- This procedure was continued until 10 households in each of the three areas were interviewed.

If the household members were unwilling to take part in the study or were not at home, it was decided to interview the family of the house on the left of the selected household when facing the dwelling from the street.

A procedure was decided on if there were more than one structure on any of the selected premises:

- The fieldworkers had small cards numbered 1-3 in a bag.
- If there were more than one structure on the premises, the fieldworkers allocated a number to each structure and then drew a numbered card from the bag.
- The household that was to be interviewed was the house that had the same allocated number as the number on the card.

The fieldworkers had to indicate on their questionnaires when they interviewed a substituted household.

2.2.3 CHOICE OF RESPONDENT

In an attempt to ensure that the information from the household was reliable, it was decided that the respondent should preferably be the mother or grandmother, otherwise a female family member at least 16 years old.

It is generally accepted that adult respondents are best to interview when household information regarding the activities around the house is needed. For health and other information of children, it would be best to interview the mother or caretaker of the child (Pickering, 1985; Ahmed et al., 1994; WRC, 1999).

2.3 THE DATA SHEET

2.3.1 DATA SHEET DESIGN

Data of the households were gathered on data sheets (questionnaires; Appendix A). The data sheet was developed in consultation and collaboration with the statistical consultant. These data sheets contained questions and spaces to tick off respondents' answers. The sheet also provided for observations to be made by the interviewers.

The data sheet for this survey was designed in accordance with the following considerations:

- A list of the variables to be measured. The variables were specific and related to the subject of the study. The variables included the water source, domestic water handling, personal hygiene and available sanitation facilities.
- Questions were formulated with the assistance of experienced EHP's as well as the statistical consultant.
- The research team consisted of the researcher, project study leader and the consultant.
- The research team discussed the detailed practical logistics of each question, before the final format was decided on. This included issues such as interviewer handling and potential interviewee understanding.

The reasons for using certain questions and observations as well as the field experience and problems that arose from the data sheet are explained and

summarised in Appendix C.

After the completion of the data sheets, the data were coded. The coding is usually done on the questionnaire. However, for the purpose of this study it was done on a separate coding form (Appendix B) to facilitate the processing of the data.

2.3.2 DATA SHEET ADMINISTRATION

The questions and observation notes on the data sheet were formulated in English. Each fieldworker group (section 2.5.3) included a trained team member able to communicate in the local ethnic language. This ensured optimal understanding of questions and answers between interviewer and interviewee.

Some of the data needed in the study could be obtained by observation. Fieldworkers were to observe what the situation was or what the facilities were, before noting these down in specially allocated spaces on the data sheet. Fieldworkers could also include additional data potentially useful to the researcher for analyses as well as for a possible follow-up study.

2.4 CONSULTANT

According to Friedman (1994) it would be wise to seek some expert consultation. Knowledgeable persons reviewing the protocol and the proposed research can therefore identify potential problems and anomalies. Epidemiologists and biostatisticians are professionally concerned with these types of study design and data analyses and can therefore provide guidance on these aspects of the study.

As indicated in the Introduction, the research team included an experienced statistical consultant from the Faculty of Health Science from the University of the Free State.

2.5 ORGANISATION

2.5.1 FORMAL CONSENT

Before the data could be gathered, Technikon consent from the Central Research Committee of the Technikon Free State as well as from the people from Section K, Botshabelo had to be obtained. This was done to comply with ethical and professional considerations. Prior to the survey dates, arrangements were made to use Technikon vehicles for transport to the study area.

Verbal consent was obtained from the respondent before a household was interviewed. If the household wished not to be part of the study, the fieldworkers thanked them and went on to the next household. (Section 2.2.2)

2.5.2 LOGISTICS

To ensure the safety of the fieldworkers a special arrangement was made with the station commander of the South African Police Service in Botshabelo. Members of the service patrolled the area and were on standby if a problem would occur. A member of the Technikon Free State security services also accompanied the research group during the conducting of the survey. This was done to ensure the safety of the students and the vehicles. These arrangements were only precautionary because of the possibility of a hijack attempt or theft.

The researcher visited the study area before conducting the survey to discuss the study with the clinic personnel and community workers. A week before conducting the study, the community was informed at a community meeting at K clinic.

2.5.3 HUMAN RESOURCES

Sixteen 3rd year environmental health students of Technikon Free State were used as fieldworkers to conduct the survey in the study area. This was part of the third year practical training in Environmental Epidemiology. The students were to gain practical experience in data sheet (questionnaire) design as well as in the process of conducting an epidemiological survey. The fieldworkers were trained to conduct the survey.

2.5.4 TRAINING OF HUMAN RESOURCES

Training of the fieldworkers comprised three phases:

- Discussion group with the consultant.
  - This included a lecture on data sheet design and surveys.
- Discussion group with project leader.
  - To focus the group, the project leader gave background information on water-related environmental epidemiology.
- The researcher had several discussion sessions with the fieldworkers during which:
  - The aims of the study were explained.

- The questions were explained to the fieldworkers, since it was important that the fieldworkers knew and understood what information was expected from the questions and responses.
- The field workers were informed about conducting observations at each interviewed household. This included the structure and status of the sanitation facility, the distance from the nearest tap and the sizes and volumes of the containers used.
- The procedures to be followed if nobody was at home or if there were more than one structure on the premises were explained to the fieldworkers (Section 2.2.2).

2.6 CONDUCTING THE SURVEY

The survey was conducted between 08:00 and 17:00 each day from July 20-22, 1998.

A total of 31 households were substituted, mainly because there was no one at home. Other reasons were that some selected stand numbers were open fields, schools or parks. The stand numbers were randomly selected from the map; stands with schools and open stands were marked on the map as if there were a house on each stand. The selected numbers that were present on the map were verified but the unused stands were only identified when the survey was conducted.

The researcher was present in the study area during the survey. This was done to address problems that might arise.

To conduct the interviews, the students were divided into 7 teams of two to three members each. To assist the teams to keep to a visiting tempo that would ensure the completion of the survey in 3 days, a schedule was handed to each team. The schedules consisted of the date and the numbers of households and household-stand numbers that had to be interviewed on that day. Copies of the area map were made and handed to each team to assist them in finding the selected households.

The target of 300 interviewed households from the study population within 3 days was reached.

2.7 ANALYSES

The questionnaire information was coded by the researcher onto coding sheets (Appendix B). The data was analysed by the Department of Biostatistics of the

University of the Orange Free State. The SAS system (SAS Institute Inc., 1990) was used for all programming.

After extensive data checking of computerised data by the researcher and statistician, the data were summarised using frequencies and percentages in the case of categorical variables, and medians in the case of numerical variables. Since missing values occurred for some questions, or some questions were not relevant for all respondents, the sample sizes for which percentages and medians calculated were indicated in all tables.

To assess the associations between possible risk factors and diarrhoea occurrence in the households, cross tabulations were constructed. In the case of dichotomous risk factors, relative risks with 95 % confidence intervals were calculated, as well as p-values based on Chi squared or Fisher's exact tests, as appropriate. In the case of categorical risk factors with more than 2 categories, only p-values were calculated. In the case of numerical risk factors, the Mann-Whitney test was performed to compare medians. To identify and investigate possible confounders, stratified analyses were performed.

2.8 GUIDE DEVELOPMENT

After the completion of the study, a basic guide was designed for the use by EHP's in practice (Appendix D). The study and conducting of the survey provided valuable experience and information that were used in the construction of the guide.

CHAPTER 3

RESULTS AND DISCUSSION

3 RESULTS AND DISCUSSION

The results are shown in the following sections and presented in tables. Discussions of the questions as well as the rationale for each question are presented in Appendix C.

3.1 DEMOGRAPHIC INFORMATION

This section included the household information on the number of household members, age group and source of income. This information was necessary to form a general overview of the demographic characteristics of the community. Details about each respondent were also collected.

3.1.1 CHOICE OF RESPONDENT

Other reports indicated that mothers were the appropriate persons to interview when information on household health was needed. Ahmed et al. (1994) interviewed an adult family member and interviewed the mothers or caretakers about the health and occurrence of diarrhoea in their children. Manun'Ebo et al. (1997) interviewed 300 households and 91 % of the interviews were conducted with the mothers. It was reported that for a study conducted in KwaZulu Natal, mainly mothers were interviewed to collect household information (WRC, 1999).

From a national household survey conducted in South Africa it was found that in 93 % of households in the African community, females were the caretakers or the member responsible for the health of households (De Castro and Hirschowitz, 1995). The mother is usually the person with the best knowledge of health matters in the household, as well as the best knowledge about the activities in and around the house of the other household members.

The fieldworkers were trained to interview one respondent per household, preferably the mother. The results in Table 3.1.1.1 show that the fieldworkers interviewed mainly the mother or in her absence, an adult person. In the case were the mothers were not available, a reliable person older than 16 years, preferably a female such as an older daughter or the grandmother, was interviewed instead (Section 2.2.3).

As indicated in Table 3.1.1.1, 73 % of all respondents were females. Mothers comprised 51.7 % of the total respondents. More females were interviewed than males. Of the respondents, 79.6 % were between 21 and 59 years with 10 % of the

respondents younger than 21 years old. This indicated that the fieldworkers were able to find the mother or a female respondent as they were trained to do.

Data indicated that the respondents were of the required sex as well as old enough to give reliable information.

TABLE 3.1.1.1: Respondent details

Status of respondent (n=300)	**n**	**%**
Mother	155	51.7
Father	51	17.0
Daughter	45	15.0
Son	31	10.3
Sister	13	4.3
Grandmother	4	1.3
Brother	1	0.3
Age of respondent (n=299)		
Younger than 21	30	10.0
21 and older, but younger than 60	238	79.6
60 and older	31	10.4
Sex (n=300)		
Male	81	27.0
Female	219	73.0

3.1.2 INFORMATION ON THE HOUSEHOLDS AND THEIR MEMBERS

Data were captured on the number of dwellings per premises. This was done to have a record of the number of the selected premises where a random selection had to be made when more than one dwelling was found by the fieldworkers. Of the 300 households, 90.7 % had one dwelling on the premises, 9 % had two and 0.3 % had three.

There was a total of 1 491 people living in the 300 interviewed households. The

median number of persons per household was 4.9, with a minimum of 1 and a maximum of 14.

The age distribution of the members of the interviewed households is shown in Table 3.1.2.1. This information gave an indication of the age distribution of the population in Section K, especially that which might be related to the occurrence of diarrhoea in the area.

TABLE 3.1.2.1: Age distribution of the sample population

Age groups in the study population (n=1 491)	n	%
Babies: up to a year	50	3.4
Infants: older than 1 year, up to 5 years old	166	11.1
Children: older than 5 years , up to 12 years old	240	16.0
Adolescents: older than 12 years, up to 20 years old	274	18.4
Adults: older than 20 years	761	51.1

There were more adults in the population than people younger than 20 years of age. This age distribution is similar to that found of the ethnic (black) population's age distribution in the Free State province (Central Statistical Service, 1996). Larger households with a larger child to adult ratio is more commonly found in rural and developing areas than in developed urban communities with higher levels of education and income. People living in rural areas that are less educated and poorer, tend to have larger families. This is commonly found among the black families in South Africa (Tshabalala, 1991). People younger than 21 years in the selected study population represented 49 % of the total study population, which indicated a decline in the child to adult ratio. This implied that the level of development in Botshabelo is increasing towards that of a well-established urban area.

The employment status of the main provider's income is summarised in Table 3.1.2.2. Information on the economic status of households could serve to explain possible links between the occurrence of diarrhoea and the level of household poverty, if further investigated. As an example, households with more money available could probably afford more containers as well as soap to improve their

personal and container hygiene.

TABLE 3.1.2.2: Provider and employment status of the main income provider

Main provider (n=300)	**n**	**%**
Father	96	32.1
Mother	64	21.4
Grandfather	1	0.3
Grandmother	13	4.3
Son	15	5.0
Daughter	15	5.0
Mother and father	9.	3.0
More than one person	49	16.4
No income	32	10.7
Other (sources e.g. donations from the church)	5	1.6
Employment status of main provider (n=300)		
Member/s with full-time employment	32	11.0
Member/s with part-time employment	175	58.0
Unemployed	93	31.0

Table 3.1.2.2 indicates that in 69 % of the selected households, household members provided income with full-time or part-time employment. It was found that in 16.4 % of households, more than one person in the household was the main provider and that in 3% of the households, both parents were providers.

The table further shows that 10.7 % of the households had no income and that 31% of the people who provided the income were unemployed. In Botshabelo, employment opportunities are limited. People could find some work at a variety of places provided that posts are available (there are a hospital, clinics and shops to work at). There are also a number of self-employed entrepreneurs in the target area. However, the employed people generally worked in the capital city of Bloemfontein, some 60 km to the west of the target area and therefore commuted

on a daily basis.

Although it was found that some household members worked, the number of unemployed people is high when looked at the main source of income (WRC, 1993; Jagals et al., 1997).

3.2 HEALTH PROFILE

This section on the Health Profile contains the relevant information of the people who reported to be affected by incidences of diarrhoea in the 12 months prior to the survey.

The primary objective of this study was to determine the health (specifically environmental health) status of the community in Section K, Botshabelo, by using diarrhoea as an indicator of health.

Of the 300 households interviewed, 68 (22.6%) reported that someone in the household had suffered from diarrhoea in the preceding 12 months. From these 68 households, 102 people had diarrhoea at one time or other during the reference period.

The number of people reported to be affected for this study, could be a result of over-reporting because a clear definition of diarrhoea was not given to the respondents as a measure or indication of the occurrence of diarrhoea. Therefore the respondents used their personal criteria to determine the prevalence of diarrhoea in the household (see Appendix C).

Table 3.2.1 reports the sex and age distribution of the affected people (the sex and age of 2 affected persons was unknown).

Of the people reported in Table 3.2.1 to have had diarrhoea, it seemed that more females were affected than males. However, this information might not have any meaning because the male to female distribution of the community was not surveyed in this study – a possible oversight to be kept in mind for a similar study elsewhere in future.

It could be that more females were infected simply because there were more females than males in the community in the first place.

The babies and infants together accounted for the highest percentage of people affected despite the fact that they represent a small part of the study population.

TABLE 3.2.1: Sex and age distribution of people who reported diarrhoea

Sex (n=99)	**n**	**%**
Male	46	46.5
Female	53	53.5
Age group (n=100)		
Babies: Younger than 1 year old	4	4.0
Infants: 1 year old, up to 5 years	32	32.0
Children: Older than 5 years, up to 12 years.	22	22.0
Adolescents: Older than 12 years, up to 20 years	6	6.0
Adults: 21 years and older, up to 60 years	28	28.0
People older than 60 years	8	8.0

Table 3.2.2 summarises the percentage of people that reported diarrhoea by age group. (The age for 2 persons was unknown).

The age of affected people was one of the most important risk factors for diarrhoea identified from this study. The babies (younger than 1 year old), infants (1 one year old, up to 5) and the children (older than 5, up to 12 years) had the highest percentages of reported diarrhoea.

The single age group most affected were infants older than 1 year up to 5 years of age. The WHO (1997) stated that children under the age of 5 are at the highest risk to suffer of environmentally related disease such as diarrhoea.

According to Jinadu et al. (1991), diarrhoeal diseases have been associated with poor environmental conditions. Disease profiles amongst children aged 1 up to 5 could be indicative of negative / detrimental environmental influences while children under 1 year of age were still to some extent shielded from environmental factors by the direct care (for example breast feeding versus food and water diets) of their mother. The environmental factors that may cause high rates of diarrhoea among children include poor sanitation, poor hygiene and contaminated drinking water (Bukenya and Nwokolo, 1991). The results of this study confirm findings in similar studies that young children suffer more frequently than members of the other age

groups do. Infant behaviour should be investigated further to establish an explanation why they were more affected by diarrhoea than the other age groups (for example, where they play and what they eat and drink).

The critical age group for this study is therefore seen as the infant group aged 1 up to 5 years.

TABLE 3.2.2: The indicated percentage of diarrhoea of each age group

Age group in years (n=100)	n Interviewed	n Reported	%
Babies: Younger than 1 year old	50	4	8.0
Infants: One year up to 5 years old	166	32	19.3
Children: Older than 5 up to 12 years old	240	22	9.2
Adolescents: Older than 12, up to 20 years old	274	6	2.2
Adults: older than 20, up to 60 years old	761	36	4.7

Of the people 60 years and older, 9 reported diarrhoea. Unfortunately calculation of a rate for this age group was not possible because of an oversight to determine the sample population age percentage of people over 60. It is known that diarrhoeal disease can also be fatal to the frail and elderly (WHO, 1997).

The results from this study could be compared to results found from two similar studies conducted in South Africa and Nigeria. If the occurrence of diarrhoea in infants were compared for the 3 studies, the results are as follows:
From this Botshabelo study, in which 300 households were interviewed, 19.3% of infants reported diarrhoea. No definition of diarrhoea was used, only the respondents' own criteria. Von Schirnding et al. (1991) interviewed 1 500 households from the urban and peri-urban areas of South Africa of which 8.5 % of infants under 5 reported diarrhoea. Diarrhoea was defined as the presence of at least three loose stools in a 24-hour period. Jinadu et al. (1991) interviewed 865 households of which 8.1 % of children 0 - 60 months reported diarrhoea. For that study diarrhoeal information was collected by questionnaire using two-week prevalence of diarrhoea. When comparing the three studies, the study population of Botshabelo was affected more. If these results could be used as an indication of the percentage of infants affected by diarrhoea, it would indicate that the percentage prevalence for Botshabelo is high. Diarrhoea is a disease and the definition of

health includes the absence of disease, thus the prevalence of diarrhoea in this area is not a condition of optimal health and could be seen as an unhealthy condition. It must be noted that different definitions of diarrhoea as well as different time periods could have had an influence on the results of the study.

The frequency of diarrhoea was also determined. This helped to identify those households that were most often affected and in the process also provided a study base for other studies on the quality of the water (Bokako, 2000) used by the affected households in the study area. Affected households and controls were also investigated further by a case-control study (Nala and Jagals, 1999) to identify their specific risk factors.

The absence of in-house water as well as inadequate sanitation facilities were suspected of causing a substantial number of diarrhoea incidences at regular intervals in Section K. Despite the inadequate water supply and sanitation systems used, the occurrences of diarrhoea in the 12 months prior to the survey were predominantly infrequent within the affected households.

Because diarrhoea could be transmitted via food, water and poor personal hygiene, it was difficult to identify a pattern that might imply a single risk factor identifying the cause of the diarrhoea occurrences. It was thought that the structure and appearance of diarrhoeic stool might be important because it may link each diarrhoea-incident to specific causing organisms or a source.

TABLE 3.2.3: Diarrhoea frequency and stool appearance

Frequency (n=101)	**n**	**%**
Weekly	8	7.9
Monthly	21	20.8
Infrequently	72	71.3
Stool Profile (n=101)		
Watery	48	47.5
Bloody	11	10.9
Semi-loose	42	41.6

From Table 3.2.3, it can be noted that most people that were affected (71.3 %) were affected infrequently. Of the affected household members, 7.9 % (eight) had diarrhoea weekly and 20.8 % (twenty-one) suffered monthly.

From Table 3.2.3, it can be seen that 47.5 % of sufferers reported a watery stool, 41.6 % of the affected people had semi-loose stools while 10.9 % of the people reported bloody dysenteric stools.

Watery diarrhoea is generally associated with a viral infection (Grabow et al., 1996). From the results it may be concluded that viruses might have played a role in causing the majority (47.5 %) of the reported incidences. Because viral infections can be caused by a low infectious dose from food and / or water, viral infections may be expected to dominate the diarrhoea profile of the affected persons. This seemed to be the case. Whether this infection could be from the water or food remains to be seen as the other results are analysed and discussed.

Of affected people, 41.6 % reported semi-loose stools indicating bacterial infections. Because bacterial infections are generally associated with a high infectious dose, these reported incidents might be linked to infection from an environment with possibilities of incubation (increasing the numbers in the carrying medium). A typical medium of this nature is the foods stored by the target community. Another medium is biofilm forming on the inside walls of water-carrying vessels such as pipelines and storage containers (Bokako, 2000; Standard Methods, 1998).

From the results it may be postulated that 10.9 % of the affected people were apparently affected by protozoan parasite infections. Because of the low infective dose required, these organisms may come from environments that could be incidentally contaminated without the requirement of increasing growth. These are typically the food and water environments.

The above-mentioned discussion centred on the respondents' perspective of the diarrhoea they themselves thought they or their household members had. The traditional approach of using records from health care centres in the area was not followed. This was because efforts in previous studies to obtain accurate figures on diarrhoea reporting in these areas encountered inadequate record-keeping of diarrhoea occurrences (Jagals et al., 1997). For this study, it was decided to reconfirm this phenomenon as well as building another database on the report rates of the community for future research related to diarrhoea incidence and

environmental health factors, rather that just relying on clinic records.

Households were asked if incidences of diarrhoea were reported at a health-care centre or other traditional health-related facility. Table 3.2.4 shows that of the people that were affected, 61.9 % always reported any incident of diarrhoea at a health-care facility.

TABLE 3.2.4: Frequency of reporting diarrhoea at a health-related facility

Report rate (n=97)	n	%
Always	60	61.8
Sometimes	25	25.8
Never	12	12.4

It is a pity that this percentage is not higher, because clinic records can traditionally serve as an indication of the prevalence of diarrhoea in an area (Briggs et al., 1996).

The information on the age distribution of people that suffer indicated that infants suffered the most (Table 3.2.2). Diarrhoea is a common illness amongst children and the detrimental effects of diarrhoea are generally well known to people. Disease and illness affect small children more easily because their immune systems are still developing. Because diarrhoea and its treatment are generally known to communities, it could be expected that the mothers / caretakers of the affected infants would take them to a health-related facility for medical attention.

It was suspected that adults do not always report diarrhoea but because of the free medical services for small children, more child reports may be expected than adults' reports. It was thought that because diarrhoea was not always reported, only severe cases were reported. Information in this regard was not collected because of an oversight on the questionnaire.

From the results it can be seen that 38.2 % (25.8 % + 12.4 %) of the incidents of diarrhoea in the target area might not be reported. This casts additional doubt on the effectiveness of clinic records to reflect the actual occurrence of diarrhoea in their service areas.

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From the information collected on the report rate, it could be concluded from Table 3.2.5 that the diarrhoea of infants are not reported more regularly than that of other age groups.

TABLE 3.2.5: Percentage of affected people that always reported diarrhoea

Age group (in years)	n Affected	n Reported always	%
Babies: Younger than 1 year old	4	2	50.0
Infants: One year up to 5 years old	32	23	72.0
Children: Older than 5 up to 12 years old	21	8	38.0
Adolescents: Older than 12 up to 20 years old	5	4	80.0
Adults: Older than 20 but younger than 60	35	22	63

For this study, reasonably accurate information on the occurrence of diarrhoea in the target area is now available despite the oversight in the data sheet design. This information would otherwise not be available from the local clinic records.

It was also important to have information on where the people who report diarrhoea incidences, made this report. This would give an indication of the reliability of the existing information at clinics to reflect the levels of diarrhoea in their local areas.

Table 3.2.6 is a summary of the venues where the cases were reported. Respondents could indicate more than one venue. From the table it can be seen that most of the affected people report at the local clinic in Section K, Botshabelo.

Of the 102 people that were affected periodically by diarrhoea, 87.6 % reported the diarrhoea at a health-care facility. Of all the people that reported diarrhoea in Botshabelo, 89.6 % (86 people) reported at Section K clinic. The rest reported at other clinics or at the local hospital or outside Botshabelo.

It was found that 10.4 % of the people reported at a venue outside Botshabelo. This could be either because they work outside Botshabelo and report during working hours or because the people prefer the medical service from a facility outside of Botshabelo.

TABLE 3.2.6: Venue of reporting of cases

Venue (n=96)	**n**	**%**
In Botshabelo	86	89.6
Outside Botshabelo	10	10.4
Botshabelo venues (n=86)		
At K clinic	74	86.0
At other clinic / s	3	3.5
At hospital	7	8.1
Traditional healer	1	1.2
Pharmacy	1	1.2
Venues outside Botshabelo (n=10)		
Clinic	1	10.0
Hospital	7	70.0
Pharmacy	2	20.0

3.3 WATER USAGE

Because in-house water is not available in the study area, the study population collected water in containers from municipal supply points to store at home (Jagals et al., 1997). It has been reported that this practice leads to the minimum volumes of water being fetched and stored at home (Jagals et al., 1999a. This, in turn, leads to poor personal and general household hygiene, which consequently has an impact on health.

3.3.1 ACCESSIBILITY OF WATER

The presence of taps and the distance from the water source measures accessibility (Republic of South Africa, 1994; 1997a; 1997b). This section on accessibility of drinking water shows the results on questions of the source and location of the respondents' domestic water as well as the distance from the source.

This table indicates the number of people that have access to municipal water supply. Only 2.3 % used environmental water. In the target area, environmental

water was water from a borehole or water from urban streams (especially after rainfall), the latter of which people tended to use whenever available during periods of supply cut-offs (Jagals, 1997b).

TABLE 3.3.1.1: Main water source of households in the study area

Water supply (n=300)	n	%
Environmental water	7	2.3
Municipal supply	293	97.7

The main source of water for the people in section K therefore is municipal water. Table 3.3.1.1 shows that 97.6 % of the households reported using municipal water. The tap water supplied to Botshabelo is treated at a water treatment facility where the bacteriological quality of the water is frequently tested. Environmental water quality is not tested. Rains, faecal pollution and chemicals affect the quality of this water (Jagals, 1994).

To determine if the water sources used had an effect on the prevalence of diarrhoea, the association was further investigated as shown in Table 3.3.1.2. A larger percentage of the households using environmental water were affected than households using supplied municipal water. From the Fisher's exact test a p- value of p=0.196 was calculated.

This indicated that there was no statistically significant association. The relative risk of 1.93 was calculated but because of the small number of environmental water users, the risk could be between 0.80 and 4.65 (95 % confidence interval).

TABLE 3.3.1.2: Association between water source used and diarrhoea

Water Used	n Interviewed	n Affected	% Affected
Environmental	7	3	42.9
Municipal supply	292	65	22.3

Since it was found in Table 3.2.1.3 that infants are at higher risk of diarrhoea, it was decided to do a stratified analyses, measuring the association between water source and diarrhoea for households with and without infants separately.

The number of households using environmental water was too small to form a reliable statistical conclusion, but from this data it would seem that the impact of environmental water is highest in households without infants.

Table: 3.3.1.3 Association between diarrhoea, the water source and the presence of infants in the household

Water Used	n Interviewed	n Affected	% Affected
Households without infants (n=170)			
Environmental	3	2	66.67
Municipal	167	26	15.57
Households with infants (n=129)			
Environmental	4	1	25.0
Municipal	125	39	31.2

Municipal water is accessible when it can be collected from taps in yards or from community standpipes. Accessibility has to do with the supply technology as well as the distance to the supply point.

The respondents were asked to indicate the location of their municipal water supply point. The fieldworkers then had to observe and calculate the distance to the indicated supply point by simply measuring it in steps.

Table 3.3.1.4 shows that the water supply points were communal street taps for 69 % of the households. This indicated that households must generally walk some distance to communal street taps with their containers, fill it, and carry / transport the filled containers back to their homes.

Approximately 30 % of the households had a tap located in their yard or lived next to a neighbour that had a tap in that particular yard. These households did not have to walk a long distance to collect water. They used smaller containers and water was not stored in large volumes (Bokako, 2000).

TABLE 3.3.1.4: Municipal supply points

Location of source (n=300)	n	%
Tap inside house	1	0.3
Tap in yard	87	29.0
Communal tap in street	207	69.0
Neighbour	5	1.7

One household indicated that they had a tap in their house. In-house water is not yet available in section K; therefore the tap in the house must be an invention by the household. This was not investigated, but they must somehow have improvised to have water inside the house. The water is probably from a yard tap connected with a pipe to a tap inside the house. This type of intervention could lead to a reduction in the incidence of diarrhoea. With water being available in the house, no fetching or storage of water and no container is needed. The chain from the supply point to the point of use is shortened and there is less time and opportunity (place) for possible contamination from the outside environment (Jagals et al., 1999a).

The water and health sectors in South Africa accepted 200 m from a household to a water supply point as the maximum distance consumers should have to travel for water (Republic of South Africa, 1994; 1997a; 1997b). It could also be argued that, because of the distances travelled to collect water, time is lost. This time could have been used for social issues such as education and quality family time. To get a picture whether distances travelled to supply points as well as the level of accessible supply had any effect on the occurrence of diarrhoea in the study area, fieldworkers had to determine the distance from the nearest tap to the house.

The RDP (ANC, 1994) and legislation (Republic of South Africa, 1994; 1997a; 1997b) stated that peoples' nearest tap or water supply point should not be more than 200 metres from their houses.

In Table 3.3.1.5, it can be seen that the Botshabelo municipality is striving to comply with the governmental policy in this regard (Republic of South Africa, 1994). Only 3% of the interviewed households lived further than 200 meters from their nearest water supply point.

TABLE 3.3.1.5: Distance from water supply points in the target area

Distance (n=299)	n	%.0
Less than 50m	166	55.5
50m and more, less than 100m	79	26.4
100m and more, less than 150m	36	12.0
More than 150m but less than 200	9	3.0
200m and more, less than 250m	3	1.0
250m and more, less than 300m	0	0.0
300m and more	6	2.0

The distance from the supply point to the household was selected as a possible risk factor because it was suspected that as the distance from the supply point increases, the percentage of people affected by diarrhoea will increase.

The association between the distance from the tap to the house and the occurrence of diarrhoea in that household was investigated as indicated in Table 3.3.1.6.

Households between 50 and 150 m from the tap reported a larger percentage of diarrhoea than the other households closer than 50 m or further than 150 m from the tap (supply point).

TABLE 3.3.1.6: Association between supply point distance and diarrhoea

Distance from tap	n Interviewed	n Affected	% Affected
< 50 m	165	33	20.0
50- <100	79	20	25.3
100- <150	36	12	33.3
150- >300	18	3	16.7

From these results, it appears therefore that the distance from the tap does not have an influence on the occurrence of diarrhoea - especially not the 200 m suggested by the various policies (Republic of South Africa, 1994; 1997a; 1997b).

3.3.2 WATER VOLUME PER PERSON PER DAY

To determine the available volume of water to households, information regarding container sizes and numbers as well as frequency of filling of containers was needed. The data collected for this purpose are analysed in the following tables.

A confounding factor was the availability of supplied water at the public or yard standpipes. After calculation of the volume of water per person per day, a discussion will follow on the impact that supply availability can have on the calculated personal water volume.

As in-house water is not available in Section K, the respondents collected water in containers from yard taps or public standpipes in the vicinity.

The number of containers used per household is summarised in Table 3.3.2.1. It was found that the 300 households used a total of 835 containers.

The median number of containers was 3 per household. To calculate the water volumes, numbers of containers used as well as container capacity (volumes) were needed.

TABLE 3.3.2.1: Number of containers used per household

Container (n=300)	n Households	%
1 container	23	7.6
2 containers	116	38.7
3 containers	92	30.6
4 containers	50	16.7
5 containers	12	4.0
6 containers	5	1.7
7 containers	2	0.7

The bigger the container volume, the more water was available to the household. The container capacity can influence the frequency of water collecting. If the container is bulky and difficult to handle / transport, household members tend not to use it that often or to simply leave it at home and fill it up with smaller containers. This practice increases the possibility of contamination of stored water supplies (Jagals et al., 1999).

The recorded container sizes used in Section K are summarised in Table 3.3.2.2. Containers of various sizes were used. The smallest container capacity recorded was 5 l and the largest 250 l. The median capacity was 20 l.

TABLE 3.3.2.2: Number and capacity of household water storage containers

Size (n=833)	n	%
Less than 10 litres	26	3.1
10 l and less than 20 l	272	32.7
20 l up to 30 l	505	60.6
More than 30 litres	30	3.6

From Table 3.3.2.2 it can be seen that approximately 61% of the study population's container capacity was between 20 and 30 litres. The largest of the stationary storage containers were 250 l tanks, rather than containers (only 3). As this phenomenon was unexpected, the data sheet did not provide for storage tanks.

The available water volumes were calculated as if these tanks were always filled to the top although this was not ascertained. This means that for 1 % of the households, the total volume of water stored could be over-estimated.

From literature it is known that the provision of adequate water volumes leads to a reduction in diarrhoeal disease morbidity (Peterson et al., 1998; Huttly et al., 1997). The last component needed in the formula to calculate the volume of water per person per day, is the frequency of water fetching / collection. The distance that the people had to walk to collect water can be the reason for this pattern of filling the container once or twice a day.

A limited volume of water was available for use by each household. To ensure enough water for cooking and drinking purposes, water for washing and personal hygiene needs might have been limited or reduced.

The data regarding water collection frequencies are summarised in Table 3.3.2.3. Table 3.3.2.3 indicates that most containers were filled once per day (52.9 %) while a large number were filled twice per day (34.4 %).

TABLE 3.3.2.3: Frequency of water collection

Frequency (n=826)	n	%
Once per day	437	52.9
Twice per day	284	34.4
3 Times per day	70	8.5
4 Times per day	12	1.5
5 Times per day	1	0.1
3 Times a week	12	1.4
Every 2 days	3	0.4
Every 3 days	2	0.2
After 4 days	5	0.6

The available volumes of water were calculated and summarised in Table 3.3.2.4. It shows that the median volume available per person is less than the recommended 25 l per person (Republic of South Africa, 1994; 1997a; 1997b).

TABLE 3.3.2.4: Water available per person per day

Volume (n=292)	Max l	Median l	Min l
Crude container volume per household	280	50	10
Crude container volume per person	70	10.8	1.4
Total volume per person	77.5	15	4

The crude container volume takes into account the number of containers and their size (volume), but not the frequency of filling, whereas the total volume takes into account the frequencies of filling of the containers as well.

The crude maximum volume of stored water recorded for any household was 280 l, with the minimum volume 10 l per household. The crude median of water theoretically available per household based on this was 50 l.

If the frequencies of filling the containers by 292 households are considered in the

calculation, Table 3.3.2.4 shows that the median volume of water available per person per day, was 15 l. In this case, the maximum volume per person was 77.5 l and the minimum 4 l per day.

The set objective for water availability by the water and health sectors in South Africa to be met by the year 2000 is 25 l per person per day.

Table 3.3.2.5 shows that of 286 households (recorded response), 73.8 % had less than 25 l of water per day available per person.

TABLE 3.3.2.5 Available volume of water per person per day

Volume in l (n= 286)	n	%
Up to 15 l per person	142	49.7
16 to 24 l per person	69	24.1
25 l per person	12	4.2
26 to 30 l per person	22	7.7
31 to 77.5 l per person	41	14.3

From Table 3.3.2.5 it can be seen that only 26.2% of the households in the study population had the recommended 25 litres or more per person per day.

Jagals et al. (1999) found that after providing yard taps to every individual home in some other sections of Botshabelo instead of public standpipes, households used more open containers, used more water as well as replenished the stored stocks more often. With taps closer to the house, supplied water became more accessible and the household members did not need large containers to transport water.

This implied that the available volume of water per person per day could increase. With more water available the hygiene of the household could improve and therefore the number of people affected by diarrhoea could decline.

To assess the impact of water availability in households affected by diarrhoea versus the water availability of unaffected households, the median stored volumes were compared in Table 3.3.2.6. It shows that the median volume of water for unaffected households was larger than the median volume for affected households. Although the difference is minimal, and both medians are still below the target 25 l

per person per day, this could indicate that households with a larger volume of water for each member were less affected by diarrhoea than households with smaller water volumes. However the statistical difference between the two groups was too small to reach a definite conclusion (Mann-Whitney test, p=0.719).

TABLE 3.3.2.6: Water available per household (affected vs. unaffected)

Water per person	n	Median litres
Unaffected households volume	223	16
Affected households volume	62	14.4

From Table 3.3.2.7 it can be seen that the volume of water available per person per day did not influence the occurrence of diarrhoea. After conducting a Chi-squared test (p=0.719) it was found that there was no significant difference between the percentage affected persons in households with less than 25 l of water per person per day and the households where there was more than 25 l per person per day.

TABLE 3.3.2.7: Diarrhoea occurrence and water available per person per day

Volume per person per day	n Interviewed	n Affected	% Affected
Less than 25 l	211	47	22.3
25 l and more	74	15	20.3

Therefore it could not be concluded whether the available volume of water per person per day had an influence on the occurrence of diarrhoea for this study.

It was decided to compare the available water volume per person in households with and without children against the occurrence of diarrhoea (Table 3.3.2.8).

From these it could be concluded that the daily volume of water available per person per day for this study did not have an influence on the occurrence of diarrhoea per household. The results from this table support the results found in Table 3.3.2.6 and 3.3.2.7 that the available volume of water per person does not have a statistically significant influence on the occurrence of diarrhoea in this sample population. Thus the available water volume per household and per person were identified not to be a risk factor for diarrhoea.

TABLE 3.3.2.8 Volume per person compared to occurrence of diarrhoea

Available volume pp pd	n Interviewed	n Affected	% Affected
Households without infants (n=170)			
Persons with less than 25 l	105	16	15.2
Persons with 25 l or more	56	8	14.3
Households with infants (n=129)			
Persons with less than 25 l	106	31	29.6
Persons with 25 l or more	18	7	38.9

3.3.3 AVAILABILITY OF WATER

The local authority intermittently cut off the water supply in the target area because of various social issues that included non-payment of municipal levies. From the section above, it may be seen that water was available at 15 l per person per day when this was based purely on the container capacities and numbers and frequencies of containers filled. This calculation did not consider the times water was actually not available even if the household member went to fill a container.

Because of the method of haulage and storage that is used in the area the availability of water at the supply point was investigated. Very few households reported that water is always available at the water source.

Of the sample population approximately 60 % indicated that the supply water was cut off at least once a week while approximately 42 % indicated that when water was not available, it was usually for a whole day. The local municipality rations the water supply of Botshabelo by making water available to only a few sections at a time and then for a limited period. Some 80% of the respondents reported that this period could last for a few hours to some unquantified days. The information is summarised in Table 3.3.3.1.

TABLE 3.3.3.1: Water availability

How often not available (n=297)	n	%
Every day	29	9.8
Once a week	189	63.6
Once a month	14	4.7
Days	1	0.3
Infrequently	64	21.5
When is water not available (n=298)		
During the morning	75	25.2
Afternoon	82	27.5
During the night	7	2.3
Whole day	126	42.3
Infrequently	8	2.7
Time period out of water (n=299)		
Hours	32	10.7
Days	207	69.2
Weeks	59	19.7
Infrequently	1	0.3

To determine what the community usually did for water under these circumstances, data were collected on the community actions during the times that water was not available or in situations where it was known that the water was going to be cut off and for how long. Table 3.3.3.2 summarises the venues of available water when water was cut off in Section K.

From Table 3.3.3.2, it can be seen that most people, (84.9 %), walked to another section for water. The rest would go to public places like schools or use a neighbour's tap if they lived at the edge of Section K.

TABLE 3.3.3.2: Water source when water is not available at main supply

Water source (n=299)	n	%
Stored extra water	8	2.7
Another section (tap)	254	84.9
Neighbour's tap	10	3.3
Groundwater	8	2.7
Ground water + other section	4	3.1
Other section/ neighbour	3	1.0
Nearby school	12	4.0

Results showed that only a small percentage of the interviewed households indicated that they stored extra water for times that water was not available. Thus, the households apparently did not keep extra water in store to be prepared for the times when water would not be available for more than a day.

Because extra water was not stored, it can only be postulated that the household must ration the available water to share between food preparation, washing, personal hygiene and general hygiene of the house.

According to the WHO (1997), diarrhoea is closely related to poor sanitation and hygiene. However, it could not be determined from the above approach whether the periodic unavailability of water had any detrimental effect on the health of household members.

Poor sanitation, hygiene and diarrhoea can be related to low volumes or simply not enough available water for personal daily purposes, but is it true that with a larger volume of water available, the water volume would have a lesser impact on the health of the people in the study area?

3.4 DOMESTIC WATER STORAGE AND HYGIENE

Issues of water storage and handling are discussed in this section. The way in which people handle fetched water at home can have an impact on the stored water quality. This impact often can render the stored water unsafe for human consumption from a microbiological perspective (Jagals et al., 1999a). This section

endeavours to find associations between the occurrences of diarrhoea and the hygiene-related water-handling practices of households.

The section firstly deals with hygiene issues pertaining to the way water is accessed in or removed from the storage containers. Secondly it deals with hygiene practices related to the storage containers and thirdly with hygiene practices around the utensils used to access the water in the storage containers.

3.4.1 ACCESSING WATER IN STORAGE CONTAINERS

The method of taking water from the container was investigated to determine if contamination could occur and be responsible for the pollution of the safe water from the municipal supply, subsequently stored in the containers.

TABLE 3.4.1.1: Method of accessing water for all containers

Method (n = 826)	n	%
Pour	107	13.0
Scoop	717	86.8
Container with tap	2	0.2

Table 3.4.1.1 shows the methods of accessing water in the containers. This table indicates that water was mainly scooped (86.8 %) from the containers. Of the 835 containers used by the selected households, data on the method of taking water from the container was not available for 9 containers.

When presenting the information by household, the results are as indicated in Table 3.4.1.2, which shows the majority of the households scoop water from some or all their containers.

To access this stored water, mugs of various shapes and sizes were used to scoop water for drinking or other household purposes from the container.

TABLE 3.4.1.2: Method of accessing water in containers per household

Method (n=287)	n	%
Pour from all containers	12	4.2
Scoop from some or all containers	275	95.8

Scooping was commonly found in the area, as the practice is the logical norm for the community to get the water from containers that are predominantly open at the top (Table 3.4.2.3).

Scooping water from storage containers with some form of mug has been identified as a method of possible cross-contamination (Jagals et al., 1997; 1999a). Water could be contaminated with micro-organisms that were spread from the unwashed hands of household members to the water in the container water via the scooping mug.

3.4.2 CONTAINER HYGIENE RELATED TO WATER STORAGE

The hygienic handling of the storage containers by household members was determined by questions in a section on the method of container washing. Table 3.4.2.1 indicates whether the containers were washed and specifies with what they were washed. Of all containers (835) 98 % were reported washed.

TABLE 3.4.2.1: Container wash information

Containers washed before filling (n=829)	**n**	**%**
Yes	815	98.0
No	14	2.0
Method of cleaning (n=814)	**n**	**%**
Soap	331	40.7
Disinfectant soap	301	37.0
Disinfectant	103	12.7
Rinse it	78	9.5
Other method	1	0.1

This information suggested that the container hygiene is generally of an acceptable standard in the area and that the water quality in the filled containers should be the same as the quality from the supply point. From this table it is clear that soap and disinfectant soap was most commonly used.

However, studies by Jagals et al. (1997; 1999a) as well as Bokako (2000) showed that water stored in containers deteriorated from a safe supply to such an extent that

it posed a health risk to the household members. This indicated that the above-mentioned container hygiene information could be misleading.

The following shortcomings were identified in the way the questions were formulated and the observations structured that could have changed the perception that the containers (buckets) were generally kept in a hygienic condition.

- The respondents were not asked to demonstrate how the containers were cleaned and washed to support this information on container hygiene. The cleaning process might not be effective.
- The possibility exists that the information was not reliable. The respondents instinctively knew it was better to wash than not to wash their containers the moment the question was asked. They also knew that hygiene or cleanliness of household utensils were important and thus gave the "correct answer" to the question (to wash).
- The frequency of washing was not included in the questionnaire.

Table 3.4.2.2 shows the association between container hygiene and people affected by diarrhoea.

TABLE 3.4.2.2: The association between container hygiene and diarrhoea

Container hygiene	n	n Affected	% Affected
All containers washed	282	64	22.7
Some containers washed	5	0	0
No containers washed	3	1	33.3

Table 3.4.2.2 suggests that if the containers were not washed, there is a 33% chance of being affected with diarrhoea if water was used from the container. However the number of households, which did not wash their containers, was only 3.

A Chi-square test was done and a p-value of p=0.515 was found which confirms that there was no significant association between container hygiene and the occurrence of diarrhoea.

To determine if containers were stored under conditions that promoted

environmental contamination, container details were investigated and results presented in Table 3.4.2.3.

This table shows whether the containers were covered or not, where the containers were stored (in contact with outside environment or in a cupboard), and how the containers were stored (elevated or on the ground). It shows that the containers were generally kept higher than floor level (away from the ground) (78.5 %) but were still stored in the open environment (84%).

TABLE 3.4.2.3: Container details

Container material type (n=826)	**n**	**%**
Plastic	547	66.2
Metal	279	33.8
Construction (n=822)		
Open, no lid	251	30.5
Open, with lid	531	64.6
Screw top	40	4.9
Storage method (n=828)		
Elevated	650	78.5
On floor	178	21.5
Place of storage (n=825)		
Enclosed in cupboard	133	16
In direct contact with environment	692	84
Container lid closed (n=825)		
Yes	643	77.9
No	182	22.1

Water stored elevated could not be contaminated by child and animal activities in the house. However, even when stored elevated, drinking water in open containers can still be contaminated from the environment and insects, as well as from human

handling (unwashed hands in contact with the stored water).

Table 3.4.2.3 indicates that the containers used were predominantly made of plastic (66 %) and metal (34 %). No other material was indicated.

Table 3.4.2.4 showed the distribution of the type of containers used per household. Most households (42.4 %) used only plastic containers. For the households that indicated using plastic and metal containers it was decided to analyse their container types further.

TABLE 3.4.2.4 Summary of container type used

Container type (n= 290)	n	%
Only plastic	123	42.4
Only metal	58	20.0
Both	109	37.6

The number of plastic and metal containers used by households indicated using both types were calculated and were as follows:

TABLE 3.4.2.5 Type of containers used by households using plastic and metal

Containers material (n= 109)	n	%
More plastic than metal	49	45.0
More metal than plastic	18	16.5
Equal number plastic and metal	42	38.5

From Table 3.4.2.5 it can be seen that more plastic containers were used than metal containers in the households that indicated use of both types.

The type of containers used per household was compared to the occurrence of diarrhoea per household. This was done to determine if a container type could be identified as a possible risk factor. Bokako (2000) investigated whether dirt in a water storage container could adhere to the sidewalls of containers thereby providing cover and harbourage for micro-organisms. The data from this question could provide information to support the Bokako study as well as give an indication if

the material that a container was made of could be identified as a possible risk factor for diarrhoea.

Table 3.4.2.6 shows that a larger percentage of households using plastic containers than metal containers were affected. Households using a mix of the two materials also reported a higher percentage of diarrhoea than households that only used metal containers.

A p-value of p=0.197 was calculated after conducting the Chi-square test. This p-value indicates no statistically significant association between container material and diarrhoea.

TABLE 3.4.2.6: Association between container material and diarrhoea

Containers material (n= 290)	n	n Affected	%
Only plastic	123	29	23.6
Only metal	58	8	13.8
Mixed use: Plastic and metal	109	28	25.7

From a previous study conducted in another section in Botshabelo (Jagals et al., 1997) the container wall surfaces were swabbed. The results showed high bacteriological counts that exceeded the limits posed in regulations used for hygienic food surfaces. These results found by Jagals et al. (1997) could indicate that the high bacteriological counts on the wall surfaces could result from a kind of film forming. From the Bokako (2000) study, it was concluded that some form of biofilm formed on the inside wall surfaces of containers when containers were not cleaned out regularly.

This is potentially useful data and must be evaluated further to investigate whether the biofilm prefers adhering to plastic or metal container sidewalls. Plastic container surfaces can sustain bacteriological life better because of the coarse surfaces of the plastic as opposed to the metal containers with a smooth surface. Film forming in plastic containers can be a possible cause for the difference between the number of people affected by diarrhoea using plastic and metal containers.

The phenomenon of the plastic containers and their hygiene as well as the reported increase of people suffering from diarrhoea when using plastic containers can have various explanations. The Bokako (2000) study indicated that some form of biofilm

formed on the inside wall surfaces of containers when containers were not cleaned out regularly.

Table 3.4.2.7 shows that the households using only metal containers were less affected by diarrhoea for households with and without infants.

TABLE: 3.4.2.7 Association between the type of container used and diarrhoea in the household and presence of infants in the house

Containers	n	n Affected	%
Households without infants (n= 166)			
Only metal	28	3	10.71
Plastic or (plastic and metal)	138	23	16.67
Households with infants (n=124)			
Only metal	30	5	16.67
Plastic or (plastic and metal)	94	34	36.17

If mainly plastic drums are used, it will be difficult to clean the container because of the small opening. It is known that metal is more hygienic to use and easier to clean than plastic. Plastic can be damaged or scratched and those scratched areas can host micro-organisms, whereas metal does not damage as easily as plastic, and metal containers (buckets) usually have wider or bigger openings that permit cleaning of the inside of the container.

From the results in Table 3.4.2.3 it can be seen that most containers were of the open type. The majority of such buckets had lids. The few closed can-type containers had screw-on tops. The containers were generally left uncovered / open despite the fact that the majority of the containers had lids or could be screwed shut.

To see if this habit could have an effect on the occurrences of diarrhoea, the method of container covering during storage was compared to the percentage of households reporting diarrhoea. Table 3.4.2.8 show that some households did not have a fixed habit but could be expected to leave the containers open intermittently.

The percentage of households affected by diarrhoea was highest for those who

cover their containers intermittently (Table 3.4.2.8). A p-value of p=0.394 was calculated with the Chi-square test. Thus, it could be concluded that there is no statistically significant association between container covering and diarrhoea.

TABLE 3.4.2.8: Association between container covering and diarrhoea

Container cover profile (n=287)	n Interviewed	n Affected	% Affected
All containers closed	182	37	20.3
Intermittent covering	67	19	28.4
All containers left open	38	8	21.1

3.4.3 SCOOPING UTENSIL HYGIENE

In a previous section (3.4.1) it was stated that water was scooped from most containers used by the study population. Table 3.4.1.1 showed the methods of accessing water in the containers. This table indicated that water was mainly scooped from the containers with some form of mug. In this following section data collected on hygienic handling of scooping mugs are tabled.

From the 96 % of households that reported scooping from their containers in Table 3.4.1.2, 79.4 % reported to using that same mug for drinking. In most families (74.1 %) that do drink from the scooping mug, the whole family drinks from the same mug. Only 12 households reported to pour water from all their containers into separate vessels used for cooking or drinking. This is the ideal situation as no hands or contaminated mug can contact the stored container water.

Of the other 289, 228 households (78.9%) used the same mug to scoop the water from the container for drinking as well as other purposes such as transferring water to cooking vessels. The rest of the households still scooped from the containers with the mug but at least did not drink the water directly from it. However, in both instances, handling of the mug would bring parts of the human body into contact with the stored container water. Furthermore, the study by Bokako (2000) showed that similar households elsewhere in the study area neither washed nor disinfect these mugs in between uses.

To determine whether the method of taking water from the containers could be

associated with occurrences of diarrhoea within those households that drink from the mug, the data for those households were compared with the occurrence of diarrhoea.

From Table 3.4.3.1 it was found that a larger percentage of households were affected when using the scooping mug for drinking than those that pour from the container. For those who scoop but not drink from the scooping mug, the occurrence of diarrhoea was on the same level as those who poured their water from the containers.

TABLE 3.4.3.1: Association between method of taking water from containers, utensil hygiene and diarrhoea

Water from container (n=287)	n Interviewed	n Affected	%
Pour from all containers	12	2	16.7
Scoop and use mug for drinking	219	54	24.7
Scoop but do not use for drinking	56	9	16.1

In other words, it seemed that using mugs with hand contact with the water was as low a risk ("hygienic") as pouring the water into the drinking mugs. The practice of drinking from the same mug used for the other activities related to the containers seemed to have a larger impact on health. When using the Chi-square test, a p-value of p=0.344 was calculated. Thus, it could be concluded that although it seems that there were more people affected by diarrhoea if water was scooped from the containers, no statistically significant association existed between the profile of taking water from the containers and the occurrence of diarrhoea.

TABLE 3.4.3.2: Mug storage profile

Way of storage (n=288)	n	%
Mug closed (with lid or top)	18	6.3
Mug covered (by cloth or saucer)	43	15.1
Mug unprotected	224	78.6

Jagals et al. (1999) reported that in a similar section in Botshabelo, the scooping

mug was kept next to the container with the stored water. If not covered, these mugs were exposed to the environment and unhygienic conditions such as flies and dust.

The methods of storing the scooping mug are summarised in Table 3.4.3.2. These data were collected to get an overview of how people stored the mug used for decanting or scooping water. Table 3.4.3.2 shows that the highest percentage of households did not cover or close their mugs.

The fact that 78.6 % of the mug-using households do not cover or protect the mug is an indication of poor water hygiene in such households. Unprotected mugs can be contaminated with bacteria and dust which in turn can contaminate the stored water. From a previous study in the area completed in 1997, it is known that the mugs used for drinking were contaminated and that the microbiological quality of the inside mug surfaces indicated poor hygiene (Jagals et al., 1997). Households storing water were at risk of consuming stored water of a poor quality that could result in health effects such as diarrhoea. Handling and contacting of the water with unwashed hands and mugs contaminated stored water. This could be because the personal and general hygiene was poor in the area. Community education is needed to improve hygiene habits and the cleaning methods of the containers. This will reduce the contamination levels of the stored water and that will in turn lead to a reduction in diarrhoea cases.

3.5 PERSONAL HYGIENE

Hygiene information of the community is tabled in this section. The focus of this 7section was the practice of hand washing before contact with the stored container water. This section was included in the questionnaire to give an indication of whether this level of hygiene could have had an impact on the health of the community in Section K in general.

Information was only asked about the practices of the respondents, since they would possibly not be able to report accurately on the practices of the other household members. From Table 3.5.1 it appears that the respondents did not have a habit of washing hands before working with the stored water.

Only 23.2 % of respondents indicated washing their hands always before contact with the stored water. Of the respondents, 53.2 % indicated that they washed their

hands infrequently. It was found that most respondents washed their hands in another bucket (66.5 %) while some indicated that they washed hands at the tap (4.4 %) before contact with the stored water.

TABLE 3.5.1: Respondents hand-washing before contact with container water

Frequency of hand washing (n=297)	**n**	**%**
Always	69	23.2
Sometimes	158	53.2
Never	70	23.6
Where washed (n=227)		
Tap	10	4.4
Other bucket	151	66.5
Washbasin	1	0.4
Tap or bucket	64	28.2
Water from cup / mug	1	0.4

This means that the stored water in these households were constantly threatened by hand contamination. Combined with the "never" response, this was a high percentage of respondents not washing their hands and could be an indication of the poor water hygiene habits of the whole household.

These practices could probably be ascribed to a lack of knowledge about cross-contamination and that they themselves could be responsible for contaminating their drinking water in containers. Household members should be taught to wash their hands habitually. This could be achieved by motivating and being taught the benefits of regular hand washing. An added option could also be that households could keep a separate container for this purpose.

When scooping water from the container, the person that scoops can contaminate the water in the container if hands come into contact with the container water, as well as when the mug used for scooping is not clean or the household members drink from that same mug. Cross-contamination can occur and viruses or bacteria could then cause diarrhoea or illness of the person/s drinking that water. This is

especially a health hazard if hands were not washed after visiting the toilet.

Table 3.5.2 shows a good personal hygiene profile of the respondents with respect to hand washing after visiting the toilet. More that 80 % of the respondents indicated that they always washed their hands after visiting the toilet.

TABLE 3.5.2: Frequency of hand washing after visiting the toilet

Frequency of washing (n=300)	n	%
Always	242	80.7
Sometimes	56	18.7
Never	2	0.7

Pinfold (1990) reported that levels of diarrhoea decreased in communities after introducing the practices of rinsing merely the fingertips of people in a disinfectant before handling water and foods. This was for communities that initially did not have any habit of hand washing after visiting the toilet. In the target community of this study, people washed their hands after visiting the toilet. It can be concluded that whatever contamination took place with hand contact with the stored water, this contamination would not be of faecal origin but rather of an environmental origin. The study by Bokako (2000) seems to confirm this.

This high percentage of people that reported washing their hands could be the result of over-reporting by the respondents. It is known that hands should be washed after visiting the toilet, therefore the respondents could have reported washing their hands regardless of whether they did so or not. From a study conducted in rural Zaire, it was found that a high percentage of respondents reported washing their hands, but these results were not supported by the observations made by field workers (Manun'Ebo et al., 1997). It was concluded that the mothers (respondents) generally over-report on 'desirable' answers (Manun'Ebo et al., 1997).

The household circumstances in this study resembled those in a study conducted by Moe et al. (1991). It was reported that relatively poor personal hygiene and food preparation / storage practices might have contributed to disease transmission. In this study attention was not given to food-related aspects. It is recommended that these aspects should be followed up in future studies that might be conducted in the area.

3.6 SANITATION

Sanitation facilities and related practices are known to have an impact on the prevalence of diarrhoea.

TABLE 3.6.1: Toilet type available

Type (n=300)	n	%
Pit	280	93.3
Bucket	2	0.7
Flush	1	0.3
No toilet	17	5.7

Table 3.6.1 shows that of the 300 interviewed households, only 5.7 % do not have access to their own toilet facilities. Although there was one household indicating that they had a flush toilet, it was not connected to a sewer line, thus it could not have been in use. The sanitation profile and toilet use of this household is unknown.

In the target area it seemed that the domestic environment was reasonably sanitised. Table 3.6.2 shows the association between the availability of toilets and the occurrence of diarrhoea.

TABLE 3.6.2: Association between available sanitation facilities and diarrhoea

Sanitation facilities (n=300)	n Interviewed	n Affected	% Affected
Households without sanitation	17	10	58.8
Households with sanitation	277	58	20.9

From Table 3.6.2 it is clear that the households without sanitation were more affected by diarrhoea than the households with sanitation. Using Fisher's exact test, a p-value of p= 0.001 was calculated. The relative risk of 2.81 has a 95 % CI from 1.78 to 4.45. These results indicate that there is a significant association between sanitation and diarrhoea. The absence of a sanitation facility can therefore be seen as a risk factor for the occurrence of diarrhoea.

The following table represents the availability of sanitation facilities for the selected households with and without infants in the household as well as the percentage of

households affected with diarrhoea.

TABLE: 3.6.3 Association between sanitation facilities, infants in households and the percentage of households affected by diarrhoea

Sanitation facilities	n Interviewed	n Affected	% Affected
Households without infants (n=170)			
Households without sanitation	9	4	44.44
Households with sanitation	161	24	14.91
Households with infants (n=129)			
Households without sanitation	8	6	75.0
Households with sanitation	121	34	28.1

Table 3.6.3 indicates that households without sanitation facilities in all household types were more likely to be affected by diarrhoea than households with sanitation facilities (whether there are infants or not) were more likely to be affected by diarrhoea than households with sanitation facilities.

Since the majority of the people had access to a toilet facility, this community complies with recommendations in water and sanitation policies (Republic of South Africa, 1994), which proposes one sanitation facility per site in the form of a pit latrine or bucket system. A proper sanitation facility complies with the proposed recommendation in the National Water Supply and Sanitation White Paper (Republic of South Africa, 1994) of an available adequate and safe facility.

A basic pit latrine should be of a strong construction, ventilated and fly-proof. Such a facility restricted fly access to the excreta by protecting the toilet opening and screens. The critical hygiene factor for this study is whether or not the facilities were fly-proof. Flies are known to be vehicles of disease (Benenson, 1995). They spread microorganisms that could contaminate food and household utensils. They are not bound by borders and can transmit diseases over a distance. Therefore, flies having access to unprotected excreta relate to poor hygiene and are generally associated with disease.

Table 3.6.4 indicates that most of the toilet facilities were not fly-proof. Because the

local authority supplied the sanitation facilities, it could be assumed that these structures must once have complied with fly-proof criteria.

TABLE 3.6.4: Fly-proof facility

Fly proof (n=283)	Toilet seat (%)	Facility (%)
Yes	32.9	27.6
No	67.1	72.4

The facility must be built in such a manner that flies are discouraged from entering the pit or cannot escape once having entered into the pit. The pit should be ventilated with a high-standing ventilation pipe to prevent build-up of methane gas. The pipe opening must be protected with a screen to prevent insects such as flies having access to or escaping from the pit. If the pit latrine complies with this, it can be accepted as a fly-proof facility (Morgan, 1991; Winblad and Kilama, 1985).

The field workers, who were all student environmental health officers, gathered the fly-proof information by observation.

Although there were adequate toilet facilities in the area, it was found that the facilities were not of the same standard as when they were installed. A few factors could account for this:

- The structures were possibly not well looked after in general and were dilapidated to the point of not being fly-proof anymore.
- A pit latrine has a limited life expectancy. If the facilities were originally well designed, it need not be serviced for many years. However, intensively used pit latrines do fill up and need to be replaced (e.g. a new pit dug). However, in urban areas, space is a problem when considering digging a new pit. Therefore the practice is rather to empty full pits by means of a vacuum tanker by the local service provider. When the latrine is full and not serviced, it generally results in persons (especially the children) starting to use the environment. Further consequences would be overflows or seepage from full pits onto the land surface. More faecal material would then accumulate in yards and attract flies and other insects. Small children could also come into contact with these overflowing materials. This is an unhygienic situation that can result in the spread of diseases like diarrhoea.

Jagals et al. (1997) observed flies at the water line inside unprotected water storage containers. This implies that the more flies attracted to an area by poorly maintained sanitation facilities, the more the stored water could be exposed to these insects and therefore become contaminated by their activities.

The effectiveness of servicing sanitation facilities in the target area was thought to be an indication of the potential of the general household environment contributing to the occurrence of diarrhoea especially with flies as the primary vehicle.

Criteria for an effective pit emptying service were unobtainable. For this study, it was left to the perspective and "feeling" of the respondent to give the suitable answer to this question.

Table 3.6.5 gives information on the effectiveness of servicing of the toilet facility. This information gives more insight into the general hygiene status of the facility.

TABLE 3.6.5: Service effectiveness

Facilities effectively serviced? (n=283)	**n**	**%**
Yes	192	68.0
No	91	32.0

These results would indicate that the sanitation facilities used in the section are generally serviced, which would preclude overflowing and land surface soiling by excreta.

It was reported that the sanitation facilities were serviced effectively. This was further investigated by determining the frequency of service. Tables 3.6.5 and 3.6.6 indicate that the toilet facilities, in this case 93.3% pit latrines, were considered to be serviced effectively and that 90 % of the toilet facilities were serviced at least once a year.

The tabled results for frequency of service are shown in Table 3.6.6. This results indicated that Botshabelo, and specifically this section, has a developed and structured municipal service. Pit latrines that filled up could be emptied and if a problem concerning the sanitation arose, the municipality would react upon a notification of the problem.

TABLE 3.6.6: Frequency of service of those serviced effectively

Frequency of service (n=192)	n households	% of frequency of service
Once a week	3	1.6
Monthly	21	11.1
After being reported	44	23.3
Twice a year	7	3.7
Yearly	83	43.9
Every few months	13	6.9
After a few years	18	9.5

Nevertheless, from the above tables it was concluded that there were some households that experienced toilets that were full, as well as some households that did not even have a toilet. To determine what these households would use / do for latrines, data were collected and are shown in Table 3.6.7 below.

There is a concern about the 28 % that reported their toilet if it was full. From the results it could not be determined where these households go for toilet while they wait for the local service provider to empty the full toilet. This was an oversight in the questionnaire. The previous tables did indicate that the local service provider did not react instantly when a full toilet was reported.

In Table 3.6.7 it can be seen that 1.1 % of the study population used the veldt when their toilet facility filled up or became unusable. There must be a concern about the 5.9 % respondents that indicated that they (and probably the rest of the household) keep using the same toilet if it is full. An unhygienic situation such as the accumulation of faecal material or seepage from the pit to the surface can occur that can result in illness like diarrhoea.

Furthermore, in the study by Jagals (1994), it was observed that infants did not always make use of a pit latrine for various reasons. This could also lead to soiling of the land surrounding the domestic environment with excreta with consequent health implications.

TABLE 3.6.7: Alternative latrine

What alternatives were used? (n=273)	n	%
Neighbour	95	34.8
Environment	3	1.1
Dig hole in ground	23	8.4
Same toilet	16	5.9
Treat it	11	4.0
No problem / never full	48	17.5
Report the situation	77	28.2

To confirm if soiling of the surrounding environment occurred, questions on infant toilet use were asked.

The part related to infant toilet use were poorly answered (families with and without infants answered this question), therefore the results were calculated only for households that had infants in the house (see Appendix C). Of the 129 households with infants (older than 1, up to 5 years), 113 answered the question relating to infant toilet use. Table 3.6.8 shows that in 77% of these households, the infants did not use the toilet.

TABLE 3.6.8: Infants (older than 1 up to 5 years old) use of pit latrines

Infants used the toilet (n=113)	n	%
Yes	26	23.0
No	87	77.0

Mertens et al. (1992) stated that children under the age of 5 years do not use latrines in many parts of the developing world. According to these authors, in some countries children are discouraged from using latrines because they might fall into them. They also reported that in other countries it was reported that children under 7 defecated in or around the house. Table 3.6.9 summarises the reasons why infants in Botshabelo do not use the toilet facilities.

The main reason was that the infants were scared of the toilet facility because the seat was generally too high for them to use and they would need help from an older household member.

The seats were generally of similar height to those found with flush toilets except that the pit is visible through the opening in the seat.

TABLE 3.6.9: Reasons why Botshabelo infants did not use pit latrines

Reason (n=84)	n	%
Fear	50	59.5
Seat too high	11	13.1
Toilet opening too big	12	14.3
Too young	2	2.4
Combination of seat too high and fear	9	10.7

The pit appears to be deep and dark, scaring the infants who were generally also afraid to fall into the dark hole – something which, depending on the size of the infant, was quite possible with the specific construction followed for the pit latrines in Botshabelo.

The question on where the children go for toilet if they do not use the pit latrine was included in the questionnaire to see if the practices used in Section K could be harmful and affect the health of the community. According to VanDerslice and Briscoe (1995) child exposure to faeces and diarrhoeal disease is affected, not only by their own household's excreta disposal practices, but also by the practices of the whole community.

Table 3.6.10 gives the information of where the infants go if they do not use the toilet. It showed that the mothers or persons caring for the infants have some sort of knowledge of environmental health and hygiene. In 95.3 % of the reported households the excreta were picked up, disposed of, or the infant used a potty. The excreta were probably disposed of in the pit latrine or buried in the soil by the mothers.

TABLE 3.6.10: Alternative latrines for infants

Where do infants go? (n=84)	n	%
Potty	15	17.9
In environment and picked up	62	73.8
In environment and disposed of	3	3.6
In surrounding environment	4	4.8

From the 84 respondents only 4 (4.8 %) indicated that they leave the excreta in the surrounding environment.

This information indicated that the mothers or caretakers of the infants generally maintained a high standard of excreta-related infant hygiene. Mertens et al. (1992) stated that children from households where the excreta were disposed of in a latrine were less likely to suffer from diarrhoea than children from households who improperly disposed of excreta.

Myrdal et al. (1994) concluded that improved personal hygiene and how it influences children's health, need to be emphasised, and that the disposal methods of infant faeces must be addressed.

The different ages at which the infants start using the households' toilet are summarised below. This is to get an indication of the age at which potential surface faecal pollution by infants was no longer under the control of their mothers or caretakers. This could help to focus educational programmes on domestic surface sanitation in future.

A previous study by VanDerslice and Briscoe (1995) showed that the provision of private excreta disposal facilities, the improvement of such facilities or their maintenance were expected to reduce childhood diarrhoea by up to 42 %. For households with excreta around the house, the removal of it would lead to a reduction of diarrhoea up to 30 % among these households.

The infants started using the toilet at a median age of 6 (Table 3.6.11). The maximum age at which the infants started using the toilet is 10 years (1.4%) and the minimum age is 1 (1.4 %).

TABLE 3.6.11: Age when infants start using the toilet

Age (n=69)	n	%
One year	1	1.4
Four years	3	4.3
Five years	19	27.5
Six years	17	24.6
Seven years	9	13.0
Eight years	10	14.5
Nine years	9	13.0
Ten years	1	1.4

3.7 ANIMALS

Animals kept in the house or yard can cause household members to have contact with the animals or their faeces. Animals can also contaminate stored water and food. Their faeces can be reservoirs for pathogens to be transmitted by flies to the household environment.

Data regarding the presence of animals in the study area are summarised in this section. Of the 300 households interviewed, only 28% (84) indicated that they kept domestic and or farm animals. A list of the animals kept in the area as well as their numbers are summarised in Table 3.7.1.

The information indicated that dogs were the most popular animals followed by land birds such as chickens and turkeys. It was expected to find more cattle and sheep / goats in the area, because of the traditional affinity of the ethnic Basotho people in the target area towards farming animals (Jagals, 1994; 1997b). They traditionally keep these animals for farming purposes even in urban areas. From the information it can be seen that only 6 households kept cattle (2%), and 4 households had sheep or goats (1.3 %).

Jagals et al. (1999b) found that, of all potential faecal contributors on land surfaces (including humans), dogs contributed the most to the microbiological pathogen load on land surfaces because these animals carry the highest levels of these organisms

in their faeces. This implies that dogs were potentially a big health hazard in these areas if their faecal material is not removed from the direct vicinity of the houses.

TABLE 3.7.1: Animals kept by households

Animals (n= 300)	n Households	n Animals	%
Dogs	68	97	22.7
Land birds	14	124	4.7
Water birds	1	4	0.3
Cattle	6	22	2.0
Sheep/ goats	4	17	1.3
Doves	8	16	2.7
Cats	7	84	2.3

Table 3.7.2 indicates where the households kept their animals during the day and night. The marked areas indicate possible contamination of food and water because of the proximity of the animals.

Because the animals were in the house or yard, household members could have contact with the animals or their faeces and then contaminate the water and food.

It was found that all animals were kept in the yard at some stage of the day. The domestic animals were usually kept either in a cage or around the house in the course of a 24-hour day. This could lead to the accumulation of animal excreta in the yard if the people were not aware of the health implications. The presence of the excreta could provide a reservoir for pathogens and propagated an infestation of flies and other insects. Unhygienic and unhealthy situations could occur.

VanDerslice and Briscoe (1995) used the presence of animals in the house to measure the exposure of the household to pathogens from animal faeces. For this study, it was decided to measure the association between the presence of animals in the house and yard and the occurrence of diarrhoea.

Table 3.7.2 is a profile of the animals that were kept by the community of Section K Botshabelo.

TABLE 3.7.2: Domesticated animal profile

Dogs	n-Day time (n=68)	% Day	n-Night time (n=68)	% Night
House	1	1.5	3	4.4
Field	2	2.9		
Yard	64	94.1	64	94.1
Kennel	1	1.5	1	1.5
Land birds	**(n=14)**		**(n=14)**	
Yard	8	57.1	7	50
Cage	6	42.9	7	50
Water birds	**(n=1)**		**(n=1)**	
Yard	1	100		
Cage			1	100
Cattle	**(n=6)**		**(n=6)**	
Field	5	83.3	1	16.7
Yard	1	16.7	4	66.7
Kraal			1	16.7
Sheep / goats	**(n=4)**		**(n=4)**	
Field	4	100	1	25.0
Yard			1	25.0
Kraal			2	50.0
Doves	**(n=8)**		**(n=8)**	
Yard	3	100	3	100
Cats	**(n=7)**		**(n=7)**	
House	6	50	5	41.7
Yard	6	50	7	58.3

From Table 3.7.3 it can be seen that the percentage of people affected by diarrhoea was highest for households with animals in their houses and yards. A p-value of p= 0.083 was calculated using the Chi-square test. The relative risk was determined as 1.47 with 95 % CI between 0.96 and 2.25. Although the p-value was slightly high, the presence of animals in the house or yard could be seen as a risk factor for the occurrence of diarrhoea.

TABLE 3.7.3: The household presence of animals and diarrhoea

The presence of animals (n=299)	n Interviewed	n Affected	% Affected
Households without yard animals	218	44	20.18
Households with animals in the yard	81	24	29.63

Small children that played around the house and with the animals in the yard could come into contact with the animal excreta and be exposed to diarrhoea-causing microorganisms. This could be a reason why more infants were affected by diarrhoea than any other age group in the study population.

In a study by Moe et al. (1991) it was concluded that households that had domestic animals in the yard might be in direct or indirect contact with animal faecal material. This could result in transmission of diarrhoeal disease to neighbouring households.

TABLE: 3.7.4 Association between the presence of animals, infants in the household and households affected by diarrhoea

The presence of animals in house/ yard	n Interviewed	n Affected	% Affected
Households without infants (n=170)			
Households without animals	84	27	32.14
Households with animals	45	13	28.89
Households with infants (n=129)			
Households without animals	134	17	12.69
Households with animals	36	11	30.56

Table 3.7.4 shows the results from the study area in Botshabelo for families with and without infants in the house and the presence of animals. From Chapter 1(1.3.4) it was found that in similar studies the authors reported that the presence of domestic animals in the yard or home was a risk factor or increased the number of people suffering from diarrhoea.

The presence of the animals was shown not to have an influence on the group

without infants, but in the group with infants the households that had animals in the house or yard had a higher percentage of diarrhoea incidences than households without animals in the house or yard.

3.8 SUMMARY

From the above mentioned results it can be seen that in the study population:

- Mainly the mothers of the households were interviewed and the median number of persons per household was 4.9. The adults (older than 20) were the largest group in the population.
- Infants (older than 1, up to 5 years) suffered more frequently from diarrhoea than any other age group.
- Diarrhoea was generally reported at a health-related facility, usually at Section K clinic.
- Municipal water supply was mainly used (not environmental water), and collected mainly from community standpipes.
- Although most households were within than 150 m from the water supply point, only 26 % of households had 25 l or more available per person per day.
- The distance from the water supply point had no effect on the occurrence of diarrhoea.
- The stored water in the containers was generally scooped from the containers.
- The households used mainly plastic containers.
- The use of containers was a risk factor for diarrhoea.
- No statistically significant association was found between the method of storage of the containers and the occurrence of diarrhoea.
- Mainly pit latrines were used in the area.
- There was a significant association between the absence of a sanitation facility and the occurrence of diarrhoea. The absence of a sanitation facility can be seen as a risk factor for the occurrence of diarrhoea.
- Infants start using the toilet at a median age of 6 years.
- The presence of animals in the house or yard could be seen as a risk factor for

diarrhoea.

The results of the survey indicated that there were certain exposures more closely associated with tendencies in the occurrence of the disease (diarrhoea) amongst the selected households in K Section, Botshabelo. It appeared that age was a confounder that influenced the outcomes of the analyses because the infant age group (older than 1up to 5 years of age) were affected most and could have affected the general results.

The exposure variables identified were:

- Age group.
- Construction material of the containers used.
- Availability of sanitation facilities to individual households.
- Animal kept in the proximity of the household.

From this study it can be concluded that a combination of factors could have a direct influence on the health status of the community, especially on the infants. These factors include:

- Poor hygiene (aggravated by the fact that there is not enough water per person per day available in the household);
- Small children / infants that play around in the house and yard and the presence of animals in the yard;
- Lack of proper sanitation facilities.
- This situation and the combination of poor environmental factors is a sure formula for diarrhoea occurrence and spread of disease.

CHAPTER 4

CONCLUSION

4 CONCLUSION

4.1 INTRODUCTION

Botshabelo is a marginalised urban settlement. It is a developing city in an a under-developed rural area with both formal and informal housing- a kaleidoscope town. Because of the diversity of the area there are a variety of environmental factors that can influence the health of the community. The primary aim of the study was to determine the environmental health status of the community by implementing the epidemiological process in a section of the community. The secondary aim was to develop a guide for environmental health practitioners to assist them in implementing the epidemiological process in practice. The environmental risk factors that were identified included the following variables: age, water source and availability, type of container used, water storage practices, mug hygiene, personal hygiene, sanitation and animals in the yard.

Optimistically stated by Savarino and Bourgeois (1993), the public health and scientific communities have never been better prepared to address the remaining obstacles in diarrhoeal disease control on a global scale. This was ascribed to rapid advances in our understanding of epidemiology and pathogenesis as well as improvements in diagnosis, treatment and prevention in public health.

Added to this, if the EHP's in South Africa could develop their skills in applying the epidemiological and risk assessment processes, the environmental health status of the community can be evaluated more effectively. The environmental factors influencing the health of the community could then be addressed more efficiently and persistent problems like diarrhoeal disease can be dealt with and controlled. EHP's can only be more effective if they acquire the power of knowledge and are prepared to go out in the community and apply the epidemiological process.

4.2 WATER AVAILABILITY AND ACCESSIBILITY

From this study it can be concluded that water availability remains a problem in the area. The water was accessible to the households, but not always available. The community's knowledge on water safety and quality must improve in order to prevent contamination of collected water during the process of haulage and storage. In-house water was not available in the area. The community collected water for daily use at community standpipes and yard taps in a variety of containers. This is a common phenomenon in developing countries.

The small volumes of water available per person per day could have had a direct influence on the household- and personal hygiene of the family. From literature it is known that poor hygiene may lead to diarrhoeal disease.

It was found that the median volume of water available per person per day was 15 l. at the time of the study. This indicated that the families did not collect enough water per day to provide for all their daily needs, especially for personal hygiene. Factors influencing this were:

- Water was not always available and therefore water could not be collected.
- Only a limited volume could be collected at any given time because of the limited number of containers available.
- Water was not always available close by and must be collected at a community standpipe some distance from the house.

The distance from the tap did not have an influence on the occurrence of diarrhoea, therefore it could be concluded for this study and population that distance from the tap has no influence on the occurrence of diarrhoea in the area.

4.3 SANITATION

Sanitation in the study area was problematic. Toilet facilities were generally available. Household waste and animal faecal material could accumulate around the houses and in the area. The waste might attract vectors such as flies that could pose a health risk for the community.

Mainly pit latrines were used (93 %) and most of the informal houses had no toilet facility at all. The absence of a sanitation facility was identified as a risk factor for the occurrence of diarrhoea. Households without available sanitation facilities were at risk to suffer of diarrhoea.

Although the toilet facilities were found to be adequate, most facilities were not fly-proof. The people that lived in informal houses generally did not all have an own sanitation facility. They used a neighbour's toilet facility or they used the veldt or surrounding environment. From this data on sanitation and number of people affected by diarrhoea and the related literature it can be concluded that sanitation facilities must be made available to those families without such facilities. The community must be educated to take responsibility for maintaining their facilities in such a manner that direct influences on health can be minimised.

If economical implications restrict the improvement of the facilities, then the community must act on their own. The implementation of participatory hygiene and sanitation technologies (PHAST) can be a possible solution (WHO, 1996). This program is an educational program where the community learns to help themselves. A group of community workers and members of the community are selected by the community to attend lectures on hygiene and sanitation. After that they identify their own needs and shortcomings in the community and address them as a community. They use their own ideas and resources to improve their community's shortcomings in hygiene and sanitation.

An educated community will prevent disease and unhygienic situations by improvisation and safe disposal of faecal material and improved general and personal hygiene.

4.4 PERSONAL HYGIENE RELATED TO STORED WATER

In the case of personal hygiene there is still much to be learnt by the community. The respondents generally indicated that they washed their hands after visiting the toilet, but a large percentage had contact with the stored water in the container with unwashed hands. Unhygienic practices in taking water from the container needs to be addressed. These practices increased the risk of infection because of the cross-contamination between the stored water (that should be safe) and the hands of the people and the mug that they use to scoop and / or drink from.

It was found in a previous study that improvements in one or more components of water supply and sanitation could lead to the reduction of morbidity rates and severity of diarrhoea (Esrey et al., 1991). In the study area water is readily available, therefore the improvements that can be made include installing more pit latrines, educating the community on general hygiene and sanitation and improving their container hygiene and storage methods.

4.5 FUTURE RESEARCH

- A case–control study in the same area. The case families should include the families that were identified in this study as suffering frequently from diarrhoea. From this case-control study the identified risk factors can be investigated in depth.

- Experimental / intervention study. A group of families can be selected and be provided with disinfectant soap and brushes. Through research one could then determine if the improved washing of the containers reduces the health risk in the community. Microbiological water quality of the containers can be used as an indicator of health risk.
- Education of the community. As part of an intervention programme, the community workers and community members must be educated in safe hygiene and household practices. The topics that need to be addressed include: haulage and storage practices; scooping from the container; container hygiene; personal and general hygiene as well as proper sanitation habits and the minimum volume of water per person needed each day. A study (field trail) could be done to determine if the environmental health status of the community improved after the education program.
- An epidemiological study on the effects of nutrition, childcare and food handling. Such a study may identify further risk factors that can influence the environmental health of the community. It can be a pilot study for the use of the proposed guide. Diarrhoea can be used as indicator of the health status of the community.
- Investigation of the water quality and formation of organic layers or bio-film forming in plastic containers. This is needed to acquire more data on this subject as well as to determine the possible impact on the health of consumers of water stored in containers with a biofilm on the inside wall surfaces of the container.

CHAPTER 5

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5.1 REFERENCES

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5.2 PERSONAL COMMUNICATION

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APPENDIX A

DATA SHEET

TECHNIKON FREE STATE

DEPARTMENT OF ENVIRONMENTAL SCIENCES

QUESTIONNAIRE – 1998

Number of Questionnaire ☐☐☐

Group number ☐

Date of visit: .....
Section: .....
Stand number: ..... ☐
Status of respondent: .....

Age: ..... ☐☐

Sex: ..... ☐

Mark the relevant block with an x – e.g. Yes [X]

No ☐

Or write the answer in the appropriate space

A. PERSONAL DETAILS

(i) Number of dwelling units on the premises? ☐☐
.....

(ii) How many people are living in the dwelling? ☐☐
.....

(iii) How many are: ☐☐

1. Babies up to 12 months	
2. Infants (up to 5yrs but older than 12 months)	
3. Children (up to 12 yrs but older than 5 yrs)	
4. Adolescents (older than 12 but less than 20)	
5. Adults (20 and older)	

(iv) Who is the main source of income for the family?

1. Father	
2. Mother	
3. Grandfather	
4. Grandmother	
5. Son	
6. Daughter	
7. Other (Specify)	

Other: :.....

(v) Does he/she work?
1. Yes
2. No

(vi) If yes how?
1. Part time
2. Full time

B. HEALTH PROFILE

(i) In the past 12 months, did anyone in the house suffer from diarrhoea?

1. Yes
2. No

(ii) If yes, how many people did?

.....

(iii) Specify sex of each person who had diarrhoea.

Person	1	2	3	4	5	6
1. Male						
2. Female						

(iv) Specify age of person/s who had diarrhoea.

Person	1	2	3	4	5	6

(v) How often does each person(s) suffer?

Person	1	2	3	4	5	6
1. Weekly						
2. Monthly						
3. Infrequent						

(vi) What is the usual appearance of the stool when the person has diarrhoea?

Person	1	2	3	4	5	6
1. Watery						
2. Bloody						
3. Semi loose						

(vii) Were diarrhoea incidences reported at any health centre facilities?

Person	1	2	3	4	5	6
1. Always						
2. Sometimes						
3. Never						

(viii) If sometimes or always, where do you report diarrhoea in Botshabelo?

Person	1	2	3	4	5	6
1. K Clinic						
2. Other clinics						
3. Hospital						
4. Traditional healers						
5. Pharmacy						

If you report, but not in Botshabelo, where else?

Person	1	2	3	4	5	6
1. Clinic near work						
2. Hospital						
3. Traditional healers						
4. Pharmacy						

C. WATER USAGE

Containers

(i) How many containers do you have?

……

(ii) What size is the container?(in l)

Container 1	Container 2	Container 3	Container 4

(iii) How often do you collect water per day?

Container 1	Container 2	Container 3	Container 4

Student calculates water per person per day.

Container Hygiene

(i) What type of container do you use?

Container	1	2	3	4
1. Plastic				
2. Metal				
3. Other (specify)				

Other: ……

(ii) Do you wash your container before filling?

	1	2	3	4
1. Yes				
2. No				

(iii) If yes, what do you use for cleaning the container?

	1	2	3	4
1 Soap				
2 Disinfectant soap				
3 Disinfectant				
4 Rinse it				
5 Other (specify)				

Other:.....

(iv) How do you store the filled container?

	1	2	3	4
1 Elevated (e.g. on a table or shelf)				
2 On the floor				

(v) Where do you store the container?

Container	1	2	3	4
1. Enclosed (in cupboard)				
2. In direct contact with outside environment				

(vi) Describe container construction:

Container	1	2	3	4
1 Open (no lid)				
2 Open (with lid)				
3 Screw top				

(vii) Do you keep the container lid closed or covered?

Container	1	2	3	4
1. Yes				
2. No				

(viii) How do you take water from the container?

Container	1	2	3	4
1. Pour				
2. Scoop				
3. Other (specify)				

Other:.....

Availability

(i) Is water sometimes not available at the water source?

1. Yes
2. No

(ii) If yes, how often is water not available?

1. Every day
2. Once a week
3. Once a month
4. Other (specify)

Other:.....

(iii) If yes, when is the water usually not available?

1. During the morning
2. Afternoon
3. During the night

(iv) How long are you usually out of water (specify periods)?

1. Hours
2. Days
3. Weeks

(v) During that time, where do you get water from?

1. Stored extra water
2. Another section (tap water)
3. Neighbours (tap water)
4. Ground water

Accessibility

(i) What is your main water source?

1. Environmental
2. Municipal

(ii) Where is your main supply?

1. Tap inside house.....
2. Tap in yard.....
3. Communal tap in street..

(iii) Calculate the distance from the tap to the house

1. Less than 50m
2. 50m and more, less than 100m
3. 100m and more, less than 150m
4. More than 150m but less than 200
5. 200m and more, less than 250m
6. 250m and more, less than 300m
7. 300m and more

1
2
3
4
5
6
7

E. MUG HYGIENE

(i) If water is scooped from the container, do you use the same mug for drinking?

1. Yes
2. No

(ii) If yes, how many people drink from that mug?

(iii) How do you store your mug?

1. Covered	
2. Closed	
3. Unprotected	

F. PERSONAL HYGIENE

(i) How often do you wash your hands before contact with the water in the container?

1. Always	2. Sometimes	3. Never

(ii) If always or sometimes, where do you wash your hands?

1. At tap	2. Another bucket	3. Other (specify)

Other: .....

(iii) Do you wash your hands after visiting the toilet?

1. Always	2. Sometimes	3. Never

G. SANITATION

Student observation

(i) What type of toilet is available?

1. Pit latrine	
2. Bucket	
3. Other (specify)	

Other: .....

(ii) Is the toilet seat fly proof?

1. Yes
2. No

(iii) Is the facility fly proof?

1. Yes
2. No

Complete

(iv) Is the toilet facility serviced effectively?

1. Yes ☐
2. No ☐

(v) If yes, how often?

1. Once a week	
2. Twice a week	
3. Weekly	
4. Monthly	
5. Other(Specify)	

Other:……

(vi) If the toilet is full, where do you go for toilet?

1. Neighbour's toilet ☐
2. Environment ☐
3. Other ☐

If other, specify……

(vii) Do the infants (younger than 5 years) use the toilet?

1. Yes ☐
2. No ☐

(viii) If not, why don't they use the toilet?

1. Fear ☐
2. Too high ☐
3. Hole too big ☐
4. Superstition ☐

(ix) If no, where do the infant's go for toilet?

1. In potty and disposed of…… ☐
2. In surrounding environment, picket up by someone ☐
3. In environment and disposed of somehow…… ☐
4. In surrounding environment, and left…… ☐

(x) At what age do infants start using the toilet?

……

H. ANIMALS

(i) Do you have animals? ☐

1. Yes ☐
2. No ☐

(ii) If yes, what kind of animals do you have, and how many?

ANIMALS	HOW MANY	
1. Dogs		☐☐
2. Land birds (chickens, turkeys)		☐☐
3. Water birds (geese)		☐☐
4. Cattle		☐☐
5. Horses		☐☐
6. Sheep/goats		☐☐
7. Other		☐☐

Other: .....

(iii) If yes, where do you keep them during the day and the night?

ANIMALS	Day	Night
1. Dogs		
2. Land birds (chickens, turkeys)		
3. Water birds (geese)		
4. Cattle		
5. Horses		
6. Sheep/goats		
7. Other		

Other: .....

1	IN HOUSE	3	IN YARD
2	IN FIELD	4	OTHER

APPENDIX B

CODING SHEET

Num of Ques

Group no

Date

Status

Age

Sex

PERSONAL DETAILS

(1)

(ii)

(iii)

(iv)

(v)

(vi)

HEALTH PROFILE

(I)

(ii)

(iii)

(iv)

(v)

(vi)

(vii)

(viii)

WATER USAGE

CONTAINERS

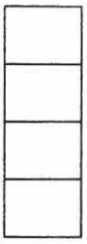
(i)

(ii)

(iii)

CONTAINER HYGIENE

(i) 

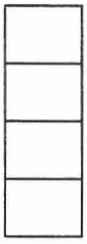
(ii) 

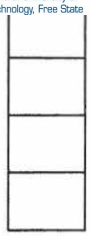
(iii) 

(iv) 

(v) 

(vi) 

(vii) 

(viii) 

AVAILABILITY

(i) 

(ii) 

(iv) 

(vi) 

(vii) 

ACCESSIBILITY

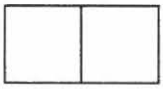
(i) 

(ii) 

(iii 

MUG HYGIENE

(i) 

(ii) 

(iii) 

PERSONAL HYGIENE

(i) 

(ii) 

(iii) 

SANITATION

(i) 

(ii) 

(iii) 

(iv) 

(v) 

(vi) 

(vii) 

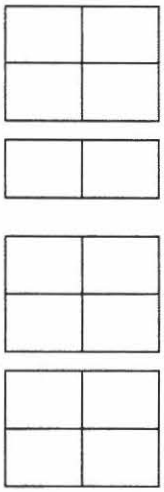
(viii) 

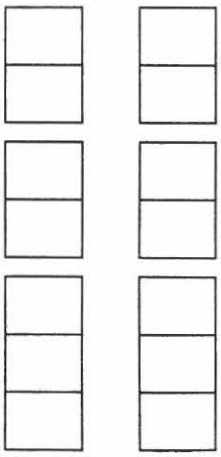
(ix) 

(x) 

ANIMALS

(i) 

(ii) 

(iii) 

APPENDIX C

DISCUSSION OF DATA SHEET

This Appendix discusses and critically evaluates each question that was used as well as the problems identified during the development and use of the data sheet / questionnaire.

The aims of the study determined what information was needed (Chapter 1: 1.4).

The information that was needed from the community determined the structure of questions used to collect the data. The research team predicted possible answers for each question. The possible answers were then used to select for example, options for closed question versus an open question. The respondents had to choose one option from the questionnaire. Partially closed questions were mostly asked with another option -"other"- that the respondent could choose and then answer in her / his own words.

Because of a problem on the questionnaire a separate coding sheet was used. Problems occurred because the researcher was inexperienced and errors occurred with the transcribing of the information to the coding sheet.

For coding purposes it was important that the type of possible answers be considered so that the appropriate number of coding blocks could be drawn. The number of blocks had to correlate with the number of answers that would be completed on the questionnaire.

DEMOGRAPHIC DATA

Each questionnaire had a unique identification number to serve as a record.

The date, address (house or stand number) and number of fieldworker team were included for logistical reasons.

If a problem occurred or if it were necessary to interview the family again later on, the address would be available. The stand number was of particular importance so that the households that indicated suffering more frequently from diarrhoea could be identified. This information could be used in future for a case-control study.

The status, age and sex of the household respondent were noted so that the respondents could be described in the results.

The respondent had to be older than 18 years, and preferably the mother or grandmother of the family.

A: PERSONAL DETAILS

The following personal details were collected to assist in forming a general impression of the household composition of the study population. To be more correct in future, this section could be named: Household Details.

i. Number of dwelling units on the premises

It was considered necessary to determine the number of dwellings on the premises. Only one household (dwelling) per stand number was to be interviewed. If there was more than one dwelling on the premises, one was selected by means of a random selection (Chapter 2: 2.2).

A question on the dwelling size (number of rooms) could have been used to determine whether overcrowding occurred. It was not relevant for this study to have such a question included. Nevertheless, for future environmental health-related surveys a question on the house construction and number of rooms could be included. This type of information could give insight into the environmental health conditions in the house, for example, overcrowding and the possible occurrence of respiratory diseases like Tuberculoses because of poor ventilation.

ii. How many people are living in the dwelling?

This was intended to determine the size of the family.

iii. How many are:

The distribution into age categories gave an indication of the family composition. This classification did not provide a separate category for adults over sixty. It is known that small children and elderly people are more likely to suffer from diarrhoea and other illnesses because of a weaker immune system. There should have been an age group for the elderly (60 years and older) to give a more precisely specified age distribution of the study community. If this age

group could be identified, it could be determined which age group (infants or elderly) was more frequently affected by diarrhoea.

The question was also a check question on the previous question. A check question is one that asks additional information and at the same time verifies the data gathered by another question. By obtaining the ages of the each family member, the number of persons in the household could be verified by checking the number of ages obtained.

The sex of the occupants of the dwelling should have been included in the questionnaire. This could have given more detailed information on the composition of the family and comparisons could have been made between the number of males and females that were affected in the study population.

iv. Who is the main source of income for the family?

This question was asked to form a better demographic profile of the family, as well as to collect socio-economic information on the family. The income could be of a person that has a job (provider) or they could live on the monthly pension from one of the family members. The income level of the family was not asked because respondents are generally uncomfortable when this topic is discussed.

v. Does he/ she work?

This question was asked to determine if there was an income available to the family from a person that worked for an income or if they lived on an individual's pension of the pensioner or from another grant.

vi. If yes, how?

The respondent had to indicate if the provider worked part-time or full-time. All this information was needed to form a profile of the study population.

In retrospect, the last three questions could have been combined as one question for example:

- Who/ what is the main source of income for the family?

1-Full time (job) worker	
2-Part time (job) worker	
3-More than one person that works	
4-Pensioner	
5-Live on interest money/other grant	
6-No one working/ unemployed	
7-Other (specify)	

Other: .....

B: HEALTH PROFILE

The respondent was asked to report on the occurrence of diarrhoea in the family. The questions focussed on diarrhoeal incidences and the family members that were affected. Information obtained from these questions were analysed and profiles of the age, sex, diarrhoeal stool appearance as well as information on the report rate of diarrhoea were formed.

i. In the past 12 months, did anyone suffer from diarrhoea?

This was asked to determine if there was any occurrence of diarrhoea in the household for the past 12 months. The aim of the study was to determine the environmental health status of the community. For this study, the prevalence of diarrhoea was used as an indicator of health.

The term "diarrhoea" was not explained or defined in this study. It was found that in a similar study conducted by Moe et al. (1991) the term was not defined and it was left to the mother's discretion to decide if the person was affected by diarrhoea. For future studies it would be best to define diarrhoea before completing the interview. A clear case definition would assure the quality of the data, over reporting would be minimise because the respondent would know what is meant when asked about diarrhoea. Diarrhoea can be defined as experiencing 3 or more watery loose stools per day (Von Schirnding et al., 1991).

It might be better to ask the question for a shorter time frame than the 12 preceeding months since it is difficult to remember as far back as over a year

- Who/ what is the main source of income for the family?

1-Full time (job) worker	
2-Part time (job) worker	
3-More than one person that works	
4-Pensioner	
5-Live on interest money/other grant	
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Other: .....

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It might be better to ask the question for a shorter time frame than the 12 preceeding months since it is difficult to remember as far back as over a year

with any accuracy. For future studies the recall period must be reduced to a maximum of a few months or a season and the months should be specified to help the respondent to remember: for example, March till end of May or from September till end of November.

ii- iv. If yes, how many people did? Specify the sex and age of the people that had diarrhoea.

These questions were important to identify the people that were affected by diarrhoea.

The age and sex of the people that suffered could help to identify whether there was a relationship between sex, age and diarrhoea.

Data on the sex of the people was important because of the traditional differentiation of work (of responsibilities) according to sex. Western occupations with varying exposures could also have an influence on the different sexes and the occurrence of diarrhoea. As mentioned before, the sex distribution of the sample population was not collected, and sex, as a risk factor could therefore not be investigated.

It was decided to provide answering spaces on the questionnaire for six people per household with diarrhoea. Although the household sizes varied from 1-14 persons per house, the largest number of family members that was affected by diarrhoea that reported, was 7. Interviewers should add the information of any extra people on the questionnaire.

v. How often does that person (s) suffer?

This question was intended to identify the frequency or rate of diarrhoeal illness in the study population.

By indicating whether the person(s) suffered weekly, monthly or infrequently, the households that were affected the most (or the so-called "worst case scenario's") could be detected.

A question on the symptoms and severity of diarrhoea should have been included for this study.

vi. What is the usual appearance of the stool when the person has diarrhoea?

CONTAINERS

i. How many containers do you have?

To know how much water the family consumes daily, data related to the number of containers was needed.

ii. What size is the container?

To help determine the volume of water used and collected daily, information regarding the number and size (volume) of the containers was needed. This was done by observation, because the fieldworkers had to see the containers to determine the size (volume) of the containers used. The fieldworkers were trained to distinguish between 2, 5 and 10 l containers.

On the data sheet there was only space for 4 containers. This appeared not to be enough. Some families had 6 or more containers. Some data about the extra containers were lost because of the lack of allocated answering space. Some interviewers did not collect or complete the information on the extra containers and these households were excluded from the water volume calculations.

From the obtained results it was found that there were a few families that had 250 l containers. It was thought that these containers might be used as storage tanks. It is important to distinguish between containers and storage vessels/ storage tanks. A question should have been included that was specifically related to the storage tank.

- Do you own a storage tank?

1-Yes	
2-No	

If yes, how do you fill your storage tank?	
1-With a plastic container	
2-With metal container	
3-With no specific container	
4-Other (specify)	

Other: .....

- To what extent do you fill the storage tank?

1-100 % full	
2-75 %(¾) filled up	
3-50 %(½) filled up	
4-Other (specify)	

Other: ……

The same type of question could be asked for the containers used by the community.

- How often do you fill the storage tank?

1-Every day	
2-Every second day	
3-Once a week	
4-Other (specify)	

Other: ……

iii. How often do you collect water per day?

If the container volume was known as well as the number of containers and how often water is collected (frequency of water collection), the available water volume per family and per person could be calculated with a simple calculation.

A question should have been included to determine if the containers were always filled to the top. It could be that in the study population at least some of the containers - especially those of 250 l capacity - were not always filled to the top. Because this information was not available, there might be a slight overestimation in the calculated water volume available per person and household per day.

It was found that some families collected water 2 or 3 times a week. These families had bigger storage facilities. In future studies, provision should be made for people that collect water per week and also for people with storage tanks.

A question about a favourite container can be included. It is possible that people could have a favourite container that they used more often or prefer to use. If information on this aspect was available, it could be determined if the household was exposed to a greater risk of diarrhoea because of the type of container used

(plastic or metal) and the filling and hygiene practises of the household regarding this particular container.

A question should be built into this section to collect more specific information regarding this favourite container. It would be more reliable to combine this question with an observation to determine the method of water collection and storage as well as to verify the method of cleaning particular this container. The latter was needed to determine if the container was washed effectively and to obtain container hygiene information.

The question could be constructed as in the following example:

- Do you have a favourite container?

1-Yes	
2-No	

If yes, What type of container?	
1-A plastic container	
2-A metal container	
3-Other (specify)	

Other: ……

- How is water collected and stored?

(Observation by field workers)

Water collection:	**Covered or closed**	
	Yes	**No**
1-Collected in plastic buckets	a	b
2-Collected in plastic containers	a	b
3-Collected in metal containers	a	b
4-Plastic and metal containers used	a	b
4-Other (specify)	a	b

Other: ……

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- Do you have a favourite container?

1-Yes	
2-No	

If yes, What type of container?	
1-A plastic container	
2-A metal container	
3-Other (specify)	

Other: ……

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2-Collected in plastic containers	a	b
3-Collected in metal containers	a	b
4-Plastic and metal containers used	a	b
4-Other (specify)	a	b

Other: ……

- How was water stored?

	CONTAINER NUMBER					
Container storage	**1**	**2**	**3**	**4**	**5**	**6**
1-Container on floor						
2-Container on table						
3-Container in cupboard						
4-Use big storage tank						
5-Other (specify)						

Other: .....

- How is the container washed or cleaned?

Container hygiene:

	CONTAINER NUMBER					
Container cleaning and container number	**1**	**2**	**3**	**4**	**5**	**6**
1-Container rinsed with water.						
2-Container washed with soap						
3-Container washed with soap and brush						
4-Container washed with disinfectant						
5- Container washed with disinfectant and brush						
6-Container not washed						
7-Other (specify)						

Student calculation.

Although there was a block allocated for the calculation by the students, a computer programme was used in the end to determine the available volume per day as well as per person per day. The volumes calculated by the students were not considered during the analysis.

CONTAINER HYGIENE

i. What type of container do you use?

The container profiles were used to determine if the type of container used by the household could be identified as a possible risk factor for diarrhoea occurrence in the household.

The respondent was requested to tell the interviewer what type of containers the family used (plastic, metal, or other). The ideal would be if the interviewer could see the containers. By such observation the interviewer could verify if the previous questions had been answered correctly, and see what type of container was used.

Buckets have wide openings and therefore scooping will occur more commonly from this type of container, which will also be more easily kept clean because of ease of access to the container inside wall and bottom.

Information should have been collected more specifically:

- Describe container construction and profile

Type of container and container number	**1**	**2**	**3**	**4**	**5**	**6**
1-Plastic bucket with no lid						
2-Metal bucket with no lid						
3-Plastic bucket with a lid						
4-Metal bucket with a lid						
5-Plastic drum with no lid						
6-Metal drum with no lid						
7-Plastic drum with lid/ screw top						
8-Metal drum with lid/ screw top						
9-Other (specify)						

Other: .....

The same question should be asked for storage tanks.

ii. Do you wash the container before filling?

This was asked to determine the level (status) of container hygiene.

The same question should be asked for the storage tank.

iii. If yes what do you use for cleaning the container?

The respondent was requested to specify if the family used soap or, disinfectant or, if they merely rinsed the container or used any other method. This question was asked to determine if the containers were washed effectively.

It would have been more appropriate to combine the question with an observation. The interviewer should observe the method of washing and determine if it was effectively cleaned and if a brush was used as well.

iv. How do you store the filled container?

These aspects could give an indication if the stored water could be contaminated by dust and if animals or children could contaminate the water by having contact with the water.

The respondent must state if the container was stored on the floor or on the ground. Stored water in open containers could be contaminated if in direct contact with the open environment.

v. Where do you store the containers?

This was asked to determine if the water was protected from possible contamination from the outside environment.

The intention of questions iv and v was to determine if the water could be contaminated by dust, insect activities or from animal and child contact with it.

The question should have been asked: Show how you keep your stored water

CONTAINER NUMBER

Container storage and container number	1	2	3	4	5	6
1-Container on floor, unprotected.						
2-Container on floor, protected						
3-Container on table, unprotected.						
4-Container on table, protected						
5- Container in cupboard, unprotected						
6-Container in cupboard, protected						
7-Use big storage tank						
8-Other (specify)						

Other: ……

This should be completed for each container.

It was found, in retrospect, that question iv and v could be combined and asked as one question.

vi. Describe container construction

The respondent was requested to indicate if the container could be closed with a lid or screw top. This question and vii could be combined and asked as one question.

vii. Do you keep the container lid closed or covered?

A question should have been included to collect information on how the container opening was covered or what was used to cover the container opening. Possible options that should have been included for covering of the container are screw top/ lid/ cloth/ plate or saucer.

- Describe your storage containers

CONTAINER NUMBER

Type of container	**1**	**2**	**3**	**4**	**5**	**6**
1-Cover container opening with a lid						
2- Cover container opening with screw top						
3- Cover container opening with a cloth						
4- Cover container opening with plate or saucer						
5- Do not cover the container opening						
6-Other (specify)						

Other: ……

viii. How do you take water from the container?

The manner in which the water is taken from the container can have an influence on the quality of the water. If there is contact between the hand and the water while scooping, the water can be contaminated if the hands are not properly washed beforehand.

This question was asked to form a general impression of how water was obtained / accessed from the container.

The questions about mug hygiene should have followed this one. If the mug hygiene questions are asked later (as in the questionnaire), there may be confusion about the way they should be answered. It ensures that the people who indicated that they scooped from their containers could answer them right away. If they are postponed, respondents might not answer the question fully.

AVAILABILITY

i. Is water sometimes not available at the water source?

The volume of available water to a household could have an effect on the household's hygiene. The more water is available, the more frequently it is used. Thus, if water were sometimes not available, this shortage could influence household hygiene and the occurrence of diarrhoea.

ii. If "yes", how often (when) is water not available?

This was asked to determine if there was a pattern with regard to the unavailability of water.

If water were periodically unavailable, this data could indicate if the total volume (crude volume) available to the household were affected by this.

iii. If yes, when is the water usually not available?

Questions were framed to determine if there was a certain time of day when water was usually not available.

It became apparent on the first day of the survey that the given options for this question were not enough and the option "other" was frequently selected and then specified as "daily". Thus, "daily" was included as an additional option.

iv. How long are you usually out of water?

The period that water is not available can influence the time schedule for water collection and the volume of water that the families collect.

Information was needed to determine the pattern of water unavailability. If water was not available for more than a few hours it could have an influence on the volume of water available to the household, as well as influencing the occurrence of diarrhoea.

If the likelihood existed that water would only be unavailable for a relatively short time, extra water would not be stored. The time that water was unavailable could influence the storage practices of the community and have an influence on the water quality in the storage container if it was exposed to environmental contamination.

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v. During that time, where do you get water from?

The other water sources could be the causal factor for the diarrhoea. The quality of the tap water is known, but the quality of the borehole water and the surface water is not. Therefore faecally (for example from animal and human faeces) and chemically (for example by pesticides) contaminated water from dams or the water pools could be used. This contaminated water could be the source of the diarrhoea-causing organisms.

ACCESSIBILITY

i. What is your main water source?

Part of the study was about the water that was available and that the community used. They could use either municipal water from a tap or environmental water. The quality of the municipal water is known, but not the quality of the environmental water sources, as mentioned above.

This question and the rest of the following section were asked to determine if the water could be accessed. This implies that there must be a pump or tap available to access the water and this source must be accessible from the house / dwelling. Thus, the water should be near the house; a water source a few kilometres away must be considered not accessible.

ii. Where is your main supply?

This was asked to determine the location of the water supply point. The two significant elements were whether the family had a nearby tap and to distinguish between the number of yard taps and street taps / community standpipes in the study area.

The question should have been: "If main supply is municipal water, where is your preferred main supply point (tap)?" And then various options were given for the respondent to choose from. The option of collecting water from a neighbour's yard tap should have been included.

iii. Calculate the distance from the tap to the house.

This was done as an observation by the interviewer. The interviewer had to ask the respondent to indicate the tap the household used, and then the distance was established roughly by stepping it off.

It is proposed that no person should be living further than 200m from a tap. Legislation also requires that a household should not be further than 200 m from the water supply point.

This question was asked to verify if the distance to the supply points were within the 200 m range and to determine if the distance from the supply point had an influence on the occurrence of diarrhoea.

E: MUG HYGIENE

As previously indicated, this section should have followed immediately upon the section on the containers, or could have been incorporated in that section.

i. If water is scooped from the container, do you use the same mug for drinking?

This was asked to establish whether the mug used could be a cross-contaminating agent.

This question should be asked for each container.

ii. If "yes", how many people drink from that mug?

If they drink from the mug, it could indicate that the stored water in the container could be contaminated by unwashed hands having contact with the water and by the use of the same drinking mug by the whole family. The stored water could thus be cross-contaminated from the infected person to the stored water that could in turn infect the rest of the family.

iii. How do you store your mug?

If the mug were stored unprotected, it could have been contaminated by environmental factors such as dust and flies. The contaminated mug would contaminate the stored water if in contact with it.

In addition questions should be asked about mug cleaning (hygiene).

- If you drink from the mug, do you wash your mug? Yes/ No

- If yes, how often?

1-Before using	
2-Few times a day	
3-Once a day	
4-Other (specify)	

Other: ……

- How do you store the mug?

1-Unprotected	
2-Turned upside-down	
3-Covered with saucer	
4-Covered with plate	
5-Covered with cloth	
6-Other (specify)	

Other: ……

This data was important to help determine if the people who drank from the mug were at risk of getting sick because of possible cross contamination.

F: PERSONAL HYGIENE

This particular section was included to obtain information on the hygiene habits in the study area. The personal hygiene was determined by hand washing of the respondent.

i. How often do you wash your hands before contact with water in container?

If it was known that the family members always washed their hands, then it was probable that the act of scooping did not contaminate the water.

If the family members had contact with the water in the container, and they did not wash their hands, the water could become contaminated.

ii. If "always" or "sometimes", where do you wash your hands?

This question was asked to determine where hands were washed. It would be meaningless if the person washed hands but the water used for washing was that in the container. Then direct contamination would take place. The option of using the storage container should have been included.

Information should have been gathered to identify what other containers were used by the respondents to wash their hands before using or having contact with the stored water.

iii. Do you wash your hands after visiting the toilet?

The responses to this question were used to form an impression of the personal hygiene of the community. Washing hands after visiting the toilet is commonly accepted as good hygiene.

If the response to this question was "never" or "sometimes", poor hygiene could be the reason for diarrhoea in those families.

It is important to realise that the respondents know which answer is expected of one or what it should be. Their answers may be framed to provide the "correct" answer rather than the actual facts of the situation. Some studies have collected information in this regard by observation; it is very time-consuming, as the observations should be done without the sample population being aware of it.

G: SANITATION

Sanitation data was used to determine the number of households without an own toilet as well as to determine what the standards of the available facilities were (fly proof and effectiveness of service). The infant toilet use was also profiled. The first three questions were observations. The respondents were not trained and would not know what was meant with the facility being fly proof.

i. What type of toilet is available?

ii. Is the toilet seat fly proof?

iii. Is the facility fly proof?

The fieldworkers had to go and see what type of toilet was available as well as to assess the hygiene status of the facility.

If there was a facility and if was fly proof, and the hygiene was in order (adequate), the potential for the spread of disease by flies and insects was minimal.

Training of the fieldworkers is important; they must all know what the meaning of "fly-proof" is.

iv. Is the toilet facility serviced effectively?

This was asked to determine the level of service in the area as well as to determine what the perspective of the community was on the service. No criteria were given to the respondents; answers were formulated from their own perspective.

Full and overflowing pit latrines can lead to unhygienic and unsafe conditions that can lead to the outbreak of disease.

This question's answers should be based on an observation as well.

A question regarding the status of the toilet facility should have been added.

- What is the status of the toilet facility?

1-Not full	
2-Full	
3-Overflow and/ or seepage	
4-Other (specify)	

Other: .....

v. If yes, how often is the facility serviced?

If the facility is serviced regularly, it will be accessible to the household. A pit latrine does not have to be serviced as often as a bucket; thus the type of toilet determines the frequency of service needed.

vi. If the toilet is full, where do you go for toilet?

If the person goes to the neighbour then there is no problem, but if that person goes into the environment, faecal contamination of the surrounding environment

takes place. Faecal material in the yard or near the house is unhygienic, and it attracts flies and other insects that can spread disease.

vii. Do the infants (children up to 5 years) use the toilet?

Pit latrines are not very user-friendly, especially to small children.

If the children did not use the toilet, it was important to know where they went or what happens with the faecal material.

The questions on infant toilet use were poorly answered. It was found that not all respondents answered them, and that in some cases people who did answer did not have infants in the house. To ensure reliability in future questionnaires, only families who have children and infants in the house should be asked to answer these questions. This should be clearly specified beforehand.

viii. If not, why don't they use the toilet?

Small children are usually scared of a pit latrine. This question was asked to determine the reasons for children not using the toilet.

ix. If they do not use the toilet, where do they go for toilet?

This was asked to achieve some estimate of the faecal pollution of the area. If faecal material ends in the toilet, it is good. If it is dropped in the environment and disposed of in some way it is still safe. However, if the faecal material is left in the environment, it could contribute to an unhygienic situation and also attract insects and flies.

x. At what age do the infants start using the toilet?

The age that the children / infants started using the toilet could provide an indication of how much faecal pollution might be expected in the living environment of the study population. This question and the previous one should not be interpreted separately.

This question was poorly answered as stated above. It would have been better if only the respondents with small children in the household were asked to complete question vii-x.

Those without small children should skip the questions on infant toilet use. A construction like this with clear indications will ensure that all the questions that are relevant to a household will be answered.

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H: ANIMALS

Information on the presence of animals in the area could be used to link animal faeces in the yard with the household and in the surrounding environment of the household. For the purpose of this study the focus was on animals that were in the house or yard at any stage during a 24-hour period.

i. Do you have animals?

This question was asked to determine if the household kept any animals.

ii. If yes, what kind of animals and how many?

This question was asked to determine how many animals live in the study area. The kind and number of animals could indicate the degree of faecal pollution caused by animals in the area.

Poor hygiene and sanitation create the risk of being affected by diarrhoea. Children and infants play around the house and could be exposed to disease-causing organisms from animal faeces in the surrounding environment.

Observations could be used to assess the level of faecal pollution in the yard.

iii. If "yes", where do you keep your animals during the day and the night?

Where the animals were kept could indicate if there might be a sanitation or hygiene problem near the dwelling. Especially animals allowed to go into and out of the house might influence the hygiene of that household.

Animals and their faecal material attract flies that can increases the potential of the spread of disease and insects that can lead to contamination of the water.

APPENDIX D

GUIDE FOR CONDUCTING AN EPIDEMIOLOGICAL SURVEY

TABLE OF CONTENTS

1 INTRODUCTION

Epidemiology is a tool that can be used for health assessment by all health practitioners. To apply the epidemiological process as an assessment tool, a survey could be used. The aim of epidemiology may be describe in three parts:

A: To describe the size and distribution of disease problems in a human population,

B: To identify the etiological factors in the pathogenesis of disease,

C: To provide the data that is needed for the management, evaluation and planning of activities for the prevention, control and treatment of disease.

From practical experience while conducting an epidemiological survey, a guideline was formulated to assist environmental health practitioners in the field in conducting an epidemiological survey. This is meant to offer guidance in the application of epidemiology and how the process can be used in practice to determine the status of environmental health in a community.

This document provides information on the epidemiological survey process, the different phases of the process and how the study should be structured and conducted. The formulation of the aim and objectives of the study as discussed, will help the researcher to achieve tangible results. The objectives must be specific and closely related to the specific survey as well as the community. Objectives of a study can be seen as stepping-stones to reach a specific goal (aim), therefore the objectives must be very specific and related to the problem at hand.

The study design is decided on after the research problem is identified. The design can be seen as the research strategy that will be followed to address and solve the identified research problem.

The data collection process (questionnaires and observations) is discussed. Important aspects such as sampling and sample size are addressed.

Further aspects that are included in the guide are the involvement of a research team, fieldworkers, contact with the community where consent and information regarding the survey is addressed. Data analyses and reporting of the findings as well as feed back to the community and implementing of the results in the field of practice follow after the completion of the survey.

It is important to review relevant and related scientific literature as well as examining relevant routine data. Before addressing the problem or planning the study design, a thorough literature search must be completed and the literature obtained and reviewed.

2 THE RESEARCH PROCESS

The epidemiology survey process as the research process has a specific sequence (Figure D.1). This sequence assists the researcher with the project, it gives guidance to what should be done and the order in which it should be done.

There are five main stages involved in an environmental health epidemiological investigation (survey):

- Clarification of the need for the study and statement of objectives.
- Determination of the sample and methods.
- Organisation and implementation of the study.
- Analyses, interpretation and presentation of findings and recommendations.
- Use of findings in environmental health planning and disease control.

Figure D.1 is a flow diagram of the research process. (Adapted from Vaughan and Morrow, 1989.)

2.1 PROTOCOL

Before any research project can be approved or begin, a protocol must be compiled. The protocol is an explanatory document that summarises the research project one wants to conduct as well as stating the planned procedures, the aims and objectives set to be achieved as well as a literature overview of relevant articles and books. For funding purposes it is important to include a well-planned and well-constructed protocol with the funding application. Some funding organisations prescribe a certain format or have requirements for research protocols, thus it is necessary to find out beforehand if an organisation have a prescribed protocol format or not.

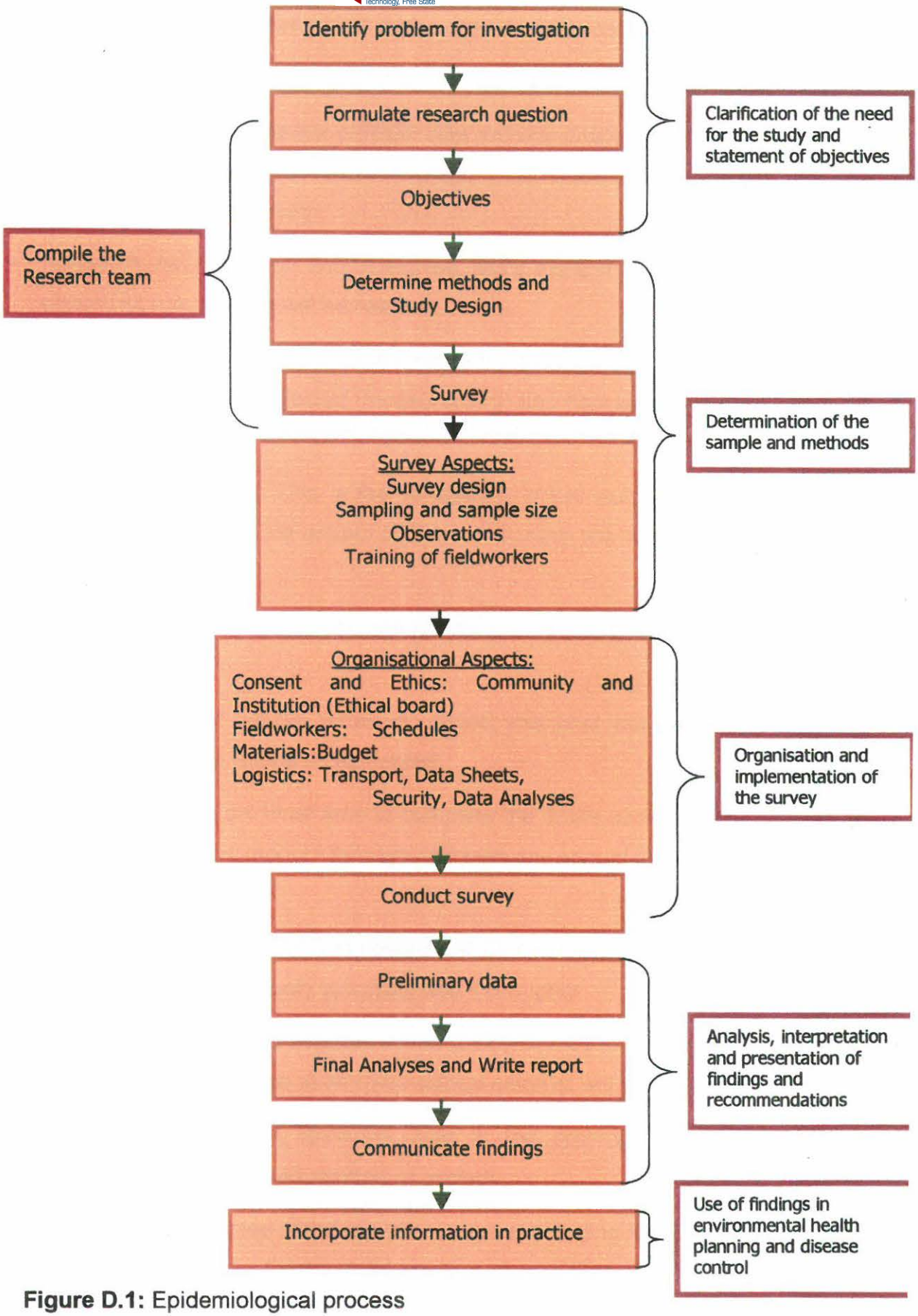

Figure D.1: Epidemiological process

The components of a protocol are similar to those of a research project, therefore only the components will be listed:

- Title: must be descriptive of the study, easy to read and not too long.
- Researchers or contributors to the study must be listed: a CV can be included.
- Introduction: Formulate the problem and include a literature review, state what has been published from related studies, what needs to be done and motivate why this study is important.
- Research aim / question and objectives: State the aim clearly and indicate with objectives how the aim will be reached.
- Methodology: This section should include the study design, method of sampling, how the data will be collected (measurement) and how validity and reliability will be ensured.
- Pilot study / pre test: This is the conducting of the study on a small scale. It serves as a test for the project before conducting the whole study in a target area.
- Analysis of data: How and who will handle the data and in what format will it be presented.
- Implementation of results: What you expect and what you will conclude as well as how the results will be implemented.
- Time schedule: a set timeframe to complete the entire project. Although it is an estimate, it must be thought through and then one should aim to keep to the time schedule.
- Budget: All the expenses and costs must be calculated. The whole budgeting process must be done very precisely and thoroughly.
- Consideration of ethical aspects: An ethics committee should approve the study. In the protocol it must be stated how ethical conduct will be ensured.
- List of references: All literature used in the protocol must be referenced according to a recognised method or system.
- Appendices: Examples of the questionnaires and coding forms must be included as well as any other forms or information sheets that will be used during the study.

3 RESEARCH TEAM

The study topic will determine what background the team members should have.

The research team should consist of the following: environmental health practitioners (EHP) with practical experience, consultants (epidemiologist with statistical knowledge), as well as health and community workers from the area. Community members could be included to facilitate the acceptability of the project to the community.

If the study is related to, for example food or the vending of food and food hygiene, the team should include members with knowledge of food science and food microbiology.

A multidisciplinary team will ensure that the study is relevant to the subject and will give background information that is important when designing the study, identifying possible questions and developing the answer options. Possible beneficiaries can be identified and co-opted on the research team. This will ensure that the results will be used. As the study process develops and further needs are identified, more persons of specific expertise could be included in the research team.

Seek advice from someone, who is familiar with research and epidemiological process, if such a person is not part of the team. Decide who will be responsible for the statistical analyses of the data and include this person in the team, or at least consult this person in the planning phase.

Visit the area and introduce the researchers to the health workers at the clinic.

Speak to persons, like doctors, community workers and managers of the clinic and involve them in the study, possibly as team members.

Collect general information of the study population from the health workers and investigate the area to get familiar with the environment.

Tell the health workers what your motives are and what you plan to do. Obtain collaboration from the health workers and community workers: listen to them and get input from them.

4 CLARIFICATION OF THE NEED FOR THE STUDY

In each research project it is important to state what the researcher / research team wants to do and what the research team wants to achieve with the study. Before

one can start planning the study or a survey, the research problem or question must be formulated and stated clearly. To formulate the research question to be answered by the study, the following steps must be taken:

1 Identify the problem at hand.

2 Formulate aim of the study.

3 Study specific objectives.

4.1 IDENTIFY THE PROBLEM

An occurring environmental health problem can lead to a research project to solve it. By exploring the subject thoroughly the researcher will be able to identify a suitable topic or research problem, which should be broken down systematically into components to enable the researcher to view it critically.

To finalise the study problem or problem statement, the research team can use a "brain storming" exercise to narrow it down. This can be done by writing all the possible causes down as well as all the contributing factors. Sometimes more than one study will be needed to investigate all the contributing factors or possible causes, thus the research team must take time and other resources in account and decide on one study that can be conducted by the research team.

Explore the problem thoroughly and investigate all the possibilities, then the suitable or correct research topic/ question can be identified.

Example: In an urban area there are high incidences of diarrhoea and mortality of children.

The problem should be broken down systematically into components, so the researcher can identify the actual problem.

Example: What is the reason for the high incidence and mortality rate for diarrhoea?
What is the standard of hygiene in the area?

Is water available?

Is water accessible and safe?

What is the quality of the food and milk that is consumed daily?

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Is water available?

Is water accessible and safe?

What is the quality of the food and milk that is consumed daily?

Thus: water quality, availability and accessibility, hygiene, sanitation, food and milk hygiene; reporting rate of diarrhoea and other contributing factors can be identified. These factors can be investigated in the study and be used as variables.

The research question / problem should be no longer than one sentence and focus on one problem or single theme. It is better to do a few separate, smaller studies, each with a clear question to be answered, than develop a research problem with multiple questions and too wide an aim.

It is important for the researcher to develop certain skills, like critical thinking and creativity, which enable one to look at a problem without preconceptions. Issues are then not considered at face value, but from all angles. This process of breaking down the problem at hand will enable the researcher to have a better understanding and a clearer idea of which aspects of it should be tackled initially.

4.2 AIM OF THE STUDY

Defining the aim of the study is the most important aspect in planning it. If the problem is identified, the focus or topic of the study needs to be stated and described in an aim statement.

The statement of purpose or aim is usually not longer than a single sentence, but it must be clear and state precisely what the contribution of the study will be. The aim statement serves as a reference point by which the relevance of the research objectives will be measured.

The aim may be in the form of sentences with action verbs, or formulated as a question. It is important that this aim statement should be as specific as possible.

Example: To determine the health status of a community living in an urban area.

4.3 SPECIFIC OBJECTIVES

The aim of the study should be broken down into clear and mutually exclusive objectives that are logically connected.

Specific objectives indicate the specific information that will be generated from the study and the research questions that must be answered. If the objectives are clearly stated and the results will serve a definite purpose, it will ensure co-operation from the study population and decision-makers.

Example: To develop a data sheet to collect household information from a sample.

To use an epidemiological survey to collect data on the water use patterns of the community.

To determine the health status of the community by using occurrence of diarrhoea as health indicator.

5 STUDY DESIGN

This refers to the research strategy that the researcher plans to follow.

The main study types are:

- **OBSERVATIONAL STUDIES**
- **EXPERIMENTAL STUDIES**

Observational studies comprise of two types: Descriptive studies and Analytic studies.

The former describes the situation and is used to quantify the extent of the problem in the study population. Descriptive studies can not investigate the relationship between exposures and outcomes.

A survey is usually descriptive in nature. Advantages of a survey include the ability to cover gaps in the items in routine data-collection systems. Surveys often permit the collection of information not readily catered for in routine returns. Additional information that is not available from the routine health information or other surveillance systems could be collected by a survey. Surveys are not suitable for identifying the reasons for specific actions.

Surveys are used for periodic surveillance of certain conditions.

Surveys are commonly used to:

- Estimate the prevalence or incidence of disease.
- Screening of populations.
- Provide household information regarding the household members and household environmental health aspects.
- Collect information about culture and local beliefs and habits and customs.
- Evaluate health and environmental health services.

Analytic studies, by comparing groups, can investigate the relationship between exposures and outcomes. There are three types of analytic studies as shown in Table D.1.

Experimental studies are used to evaluate an intervention made in the study population. They can not be used to investigate risk factors because the participants can not be exposed to risk. This study type is usually not conducted by the EHP.

Ecologic studies, which can be experimental or observational, differ from the other study types, since they focus on a population or group and not the individuals in the population. To conduct a study like this, the researcher needs information for each of the groups being investigated. For example, percentage of residents with sanitation in an area and the percentage of diarrhoea cases reported in an area can be used to determine whether communities with a higher percentage of sanitation have a lower percentage of diarrhoea reported.

Table D.1 Analytic study types

Cross-sectional study	Case control study	Cohort study
• A sample of the study population is investigated and information is collected on risk factors (exposures) and disease (outcome) at a point in time.	• Cases are compared to appropriately selected controls to determine whether they differ with respect to exposure	• Also known as follow-up studies. With a group that shares the same characteristics Example: people working in the same place, an exposed group and non-exposed group is studied and followed up. At end of follow-up period the outcome of the two groups are compared.
• Can calculate the prevalence of risk factors and disease.	• Cannot be used to calculate the prevalence of disease.	• Can be used to calculate incidence of outcome.
• Many risk factors (exposures) and many diseases (outcomes) can be studied.	• Only one disease (outcome), but many risk factors (exposures), can be investigated at a time.	• Often only one exposure is studied, but many outcomes.
	• Is used to study rare disease	• Is used to study rare risk factors
	• Definition of study base is important – ensure that cases and controls are selected from the same study base.	
• Cross-classification allows statistical comparisons between subgroups, may show relationship between exposure and outcome but cannot conclude that the one causes the other.	• Recall bias can occur. This study type is vulnerable to selection bias	• Disadvantages are time and cost considerations due to follow-up time needed.

6 THE SAMPLE

The people being investigated are called the reference population. If the whole reference population were to be studied it would need much time, money and manpower. A selection of the population is usually investigated, and this is called a sample. The sample should be selected in such a way that every person in the reference population has an equal chance of being selected and included in the sample. If the sample is selected like that, it will prevent sampling bias and ensure that the sample is representative of the reference population.

It is important to define the study population clearly in terms of place and time, and other factors relevant to the study.

Example: Residents of Section K, Botshabelo, June 1999.

For each study it is important to have a sampling frame to work from. A sampling frame is a list or representation of each person if individuals have to be selected or households if households have to be selected. It is important that all the sampling units (individuals for persons or households for households) are included in the sampling frame. A representative sample can only be selected if the sampling frame is complete.

A sampling frame can be a map that indicates all the houses in the area for the purpose of a household survey. A member of the research team can draw a map if one is not available (for example a squatter camp or informal housing area). All houses must be indicated on the map. Lists of people living in a specific area could be obtained through governmental offices such as from the Department of Internal Affairs.

The local municipality can provide a recent map, or aerial photograph. One should visit the area and get familiar with the area and verify that all the plots / houses are indicated on the map.

The research team must decide beforehand how many samples will be needed. For example: if water samples are taken only for one season, it must be decided if sampling should be done weekly, or after every tow weeks.

7 SAMPLE SELECTION

7.1 SAMPLING TYPES

7.1.1 SIMPLE RANDOM SAMPLING

The main steps for drawing a simple random sample:

- Firstly the unit of sampling must be selected.

When sampling individuals the sampling unit refers to an individual and each individual in the population has an equal chance of being selected.

- A sampling frame is needed. This is a list or map that represents the study population. It is important that the sampling frame contains all the individuals in the study population.
- The researcher must draw up a list of the study population and each individual has to be given a unique number.
- When selecting the sample, the researcher has to draw random numbers by using a table of random numbers, generating random numbers on a computer, or simply using a hat filled with numbers and then drawing a sample these without being able to identify the numbers beforehand.

Example: In a survey where household respondents were interviewed, a map of the area, obtained from the local municipality, indicated the plots. The map was used as the sampling frame. The total plots were counted and each given a unique number. The sample of 270 households was selected by means of a table with random numbers.

7.1.2 STRATIFIED RANDOM SAMPLING

If sub groups are expected in the target population, then the population should be divided into these subgroups (strata). These strata must be mutually exclusive (no one should be able to fit into more than one stratum) and exhaustive (each individual should fit into one).

Simple random sampling can be used to select the individuals of each stratum. To collect stratified random samples, the researcher must have a full list (complete sampling frame) of all individuals in each stratum. The strata should be selected in such a manner that there is small difference between the characteristics within the subgroup (stratum), and large differences between the subgroups (strata).

The number of individuals selected from each stratum is sometimes proportional to its size relative to the study population; this is called proportional stratified sampling. But equal numbers can be chosen from each stratum to facilitate comparisons between strata. Typical strata include age groups, geographical areas and occupation or social class categories.

Example: If workers in a large industry are studied, they can be divided into a group for mechanical work, one for workers exposed to fumes and gases and one for people who do loading and transportation of goods. The sampling frame is the

list of workers in the specific groups, and can be obtained from the administration or management section of the industry. For a community study the community can be divided into different socio-economic groups.

7.1.3 CLUSTER SAMPLING

This is done when the study population is divided into groups or clusters, which are selected randomly instead of individuals. Examples of clusters are schools or villages.

After the clusters are randomly selected, all the individuals or a random sample of individuals in selected clusters are included in the sample.

In an area the researcher can decide to select randomly a number of villages, and from the selected villages to select randomly a number of households.

Advantages of cluster sampling:

- A simple sampling frame is needed, e.g. the number of villages in the area. (complete list of clusters)
- It is an easy and fast method because the people are grouped together.

Cluster sampling is liable to cause errors if the disease or the variables being studied are clustered in the population. It can happen by chance that the people studied in the villages chosen, have different problems or symptoms than the people from the other villages. To avoid such difficulties or increase the validity of the survey, it is necessary to carry out an initial survey and to establish the degree of clustering before taking cluster samples.

If the area is a large geographical area and consists of villages or small towns, cluster sampling could be used.

Example: To conduct a study in Botshabelo on food and milk hygiene and quality, cluster sampling can be used. A municipal map of the area shows that the area is divided into sections. The sections are used as clusters and a number of sections (clusters) are randomly selected. On a map, plots can be grouped into clusters. From the selected clusters, a number of randomly selected households is interviewed and samples taken from their food and milk.

7.1.4 SYSTEMATIC SAMPLING

In this method a list of the people from which the sample is drawn is not initially needed. The selection of the sample can be done by deciding on a number from a table of random numbers, and every nth person or name is then selected there after. This aspect of systematic sampling gives it a practical advantage over a simple random sample.

If the researcher has decided on every fourth person, a random procedure must be used to determine which person on the list can be used as the first one to start with.

Example: If a route can be taken in the community, passing each household, every fourth household on the left can be selected for the sample. A complete sampling frame is available, because the route leads past every house in the target population.

7.1.5 NON-RANDOM SAMPLING

When non-random sampling is used, consecutive subjects can be selected until the required number of sampling units is obtained. A quota system can be used, for example by dividing the population into age groups and then including the first few subjects found in each age group. The researcher decides beforehand how many people must be included in each group.

Such a sample is usually not representative of the study population and is not recommended.

7.2 SAMPLING BIAS

Sampling bias occurs when the sample is not representative of the study population, which is when the individuals selected in the sample differ systematically from the study population.

Bias can occur even if random sampling is used. If the sampling frame is incomplete the researcher may obtain biased results. Even if the researcher has a complete list of the study population, it may be difficult to locate the people for interviewing. Some people have day jobs and others work night shifts, but this does not mean that the individual can be excluded from the sample because that person is not home at the time of the interviewer's visit.

People may refuse to participate in the study. If this happens or if there are more than one house structure on the premises, one must have a clear strategy on how to replace the household.

Example: In the community some adults work and the children are at school and can not be interviewed. If this household is not interviewed or simply replaced by the first household that is found to be at home by the fieldworker, the sample would no longer be random. To ensure random sampling, the fieldworker must go back at another time to interview the household.

7.3 SAMPLE SIZE

Observations are made on a sample to generalise the results from the sample to the entire study population. When the sample is too small the results will be neither useful nor conclusive and money and time will be wasted. A sample that is unnecessarily large will lead to waste of resources.

The sample size must be big enough to be representative of the whole section or community. Formulae exist for calculating the appropriate sample size needed, but information from the researcher will be needed before the formulae can be applied.

The sample size is determined by balancing the high level of precision from a larger sample against the extra time and cost required by such a sample. The dominant considerations in choosing a sample size are practical ones such as time available, financial and human resources and considering sampling errors.

8 FIELDWORKERS

8.1 SELECTION OF FIELDWORKERS

There are advantages and disadvantages in using people from the same community as fieldworkers. The community could prefer to give personal and household information only to strangers who do not know them, but the opposite situation could also prevail, where they would rather give this information to people from their own community. Before deciding on fieldworkers, the community workers and representatives of the study community could be of assistance.

Advantages of fieldworkers from the same or a similar community includes:

- They know the local language and local words used for certain conditions.

- They understand the community and their customs and beliefs.
- They know what is considered a stigma and how to address sensitive issues.

The people that will be used as fieldworkers should be acceptable to the study population, must be neutral towards both the study and the community, literate and presentable.

Fieldworkers can be used as interviewers to complete a data sheet, they can be observers that observe certain aspects of the study population or do measurements, for example, collecting water samples or taking anthropometry measurements from children for a nutrition study.

It is important to give recognition to the fieldworkers after the study is completed.

8.2 TRAINING OF FIELDWORKERS

Training includes the following steps:

- Discuss the questions in the questionnaire and explain the aim of the project to the field workers.
- Discuss the contents of the questions and what information is needed from each.
- Explain how to complete the questionnaire and how the observations must be done.
- Learn how to ask the questions correctly and not to ask the questions in a leading manner.

The fieldworkers and the method they use or how they work must be checked to find ways to improve the work or method.

9 DATA COLLECTION

The study design, the research problem, the target population as well as the type of field workers determine the data collection strategies to be used. Data can be collected by means of analytical instruments for the purpose of collecting occupational health and safety data such as air quality monitors and dust sampling pumps. For collecting data on water and food quality a number of samples is taken and microbiologically and chemically analysed in a laboratory.

Interviewer-based questionnaires can collect data on health and environmental health aspects. For the purpose of this guideline questionnaires will be discussed as instruments to collect the data.

9.1 QUESTIONNAIRE DESIGN

A standardised data-sheet or questionnaire should be used in order to increase the accuracy of the recorded data and to facilitate the processing.

The following questions should be answered by the researcher when designing the questionnaire:

- Are questions enough or do we need other techniques like observations?
- To whom will we put the questions and what techniques will we use?
- Are the respondents mainly literate or illiterate?
- How large is the sample that will be interviewed?

The questionnaire can be designed on a computer programme EPIINFO V6: 04 (see page 31), but the questionnaire that is used in the field and to be completed by the respondents should rather be typed in a Word document. A Microsoft Word document facilitates the completing of the answers and coding of the information better because of the facility to include coding blocks. The data of the coded questionnaires can then be typed into the questionnaire on the EPIINFO program.

Design the questionnaire as complete as possible and as short as possible. Do not leave important questions out, try to exclude unnecessary questions and keep the questions and instructions simple.

9.2 STEPS IN DESIGNING A QUESTIONNAIRE

9.2.1 CONTENT

The objectives and identified variables will give an indication as to what information is needed. If it is known what information is needed and what variables are identified, the researcher can develop questions that will result in the necessary information being obtained.

9.2.2 FORMULATING QUESTIONS

The design and formulating of the data sheet is the epidemiologist's equivalent of a scientist's laboratory methods. It is necessary to specify the wording of each question in advance to achieve uniformity in the measurement done by the various fieldworkers.

The researcher must consider the beliefs, ethics and general culture of the study community. This will ensure that the respondents are not offended by the questions put to them.

In practice, a questionnaire usually has a combination of open-ended and closed questions, arranged in such a way that the questions follow in a logical sequence and as naturally as possible. Partially closed questions can be used where answering options is provided with a last option "other" that can be chosen and completed by the respondent.

Example: How do you keep your stored water?

	CONTAINERS					
METHOD OF STORAGE	**1**	**2**	**3**	**4**	**5**	**6**
1-Container on floor, unprotected.						
2-Container on floor, protected						
3-Container on table, unprotected.						
4-Container on table, protected						
5- Container in cupboard, unprotected						
6-Container in cupboard, protected						
7-Use big storage tank						
8-Other (specify)						

Other: .....

Formulate at least one, perhaps more questions to provide the information needed for each variable.

Example: To determine the total daily volume of water available per person in a community, more than one question is required. The questions needed for information to calculate the available water volume per person per day, will include:

- How many people are there in the household?

- How many containers do you use?
- What is the size (volume) of each container used?
- How often do you fill your containers? This must be asked for each container.

One should avoid leading questions. The question should never suggest an answer or that a particular answer is "correct".

Example: Rooibos tea is good to drink, isn't it?

Design the questionnaire to be "consumer friendly". This means that the interviewer as well as the interviewee must be able to follow the instructions and understand what is expected of them.

The questions must be in simple easy-to-understand language. This can be tested in the pilot study.

Check whether each question asked measures one variable at a time.

The questions should be appropriate to the study population (example, do not ask female-related questions to male respondents).

One should also take the community's level of education and literacy into account when formulating the questions.

9.2.3 SEQUENCING OF QUESTIONS

The questions must be in a logical order. Those under the same heading must relate to the topic / heading. The next heading must follow logically upon the previous section of the questionnaire.

The more personal type questions are usually asked at the end of the questionnaire, when the respondents are more as ease with the interviewer. The interviewer must assure the respondent that all information will be handled as confidential.

9.2.4 LANGUAGE AND TRANSLATION

The questions on the questionnaire should be asked in the local language of the community. The questionnaire itself may be in a different language but the field workers must be well trained and fluent in the local language to ensure data quality and validity.

It is not essential to translate the questionnaire but it is helpful. The fieldworkers can also help in translating. They can translate the questions if the respondents do not understand the questions or can describe key words of the question by using words of the local language.

10 PRE-TEST / PILOT STUDY

This is a test of the questionnaire and fieldworkers. A pilot study is necessary to:

- Determine the feasibility of the study.
- Detect errors in the questionnaire and the protocol.
- Ensure the field workers' understanding and ability to get the questionnaires completed correctly.
- Test the respondents' understanding of the questions.

Have 5-20 questionnaires completed as a pre test. Ask the questions of people with a background similar to that of the people in the community that will be surveyed.

Ensure that the fieldworkers understand the process of surveying and method of asking the questions. They must include all the information and complete all the questions. Extra information or answers not included in the options must be recorded.

Correct errors and edit the questionnaire. The edited questionnaire must be discussed and reviewed with the fieldworkers before conducting the survey.

11 TIME SCHEDULE

A time schedule / time frame assists the researcher to plan and structure the study.

When developing the time schedule, it is important to be realistic in terms of time needed to complete the different stages in the research process.

The schedule must be used from the beginning and time must be allocated from the survey and questionnaire design to the presentation of findings and report writing. The coding, analysis and checking of data is time-consuming, therefore enough time must be allocated for these sections. For a household survey it is important to be realistic in the amount of time spent per interview or household. The number of dwellings that can be covered by an interviewer is limited. The

researcher must take into consideration the time used to find non-responders and locate houses with no one at home and to find substitute households.

Co-workers and workloads must be kept in mind when finalising the time schedule. It is important to set deadlines and to keep to the schedule.

12 ETHICS AND CONSENT

Ethics committees exist at most tertiary institutions. Such an ethics committee should first approve the research protocol, before the study can be conducted. The project can be funded by the local authorities or employers, after approval of the study proposal.

If possible, arrange with clinic personnel and community workers to organise a community meeting to inform the community about the project.

Inform the community of the project and of the specific dates that the fieldworkers will be working in the community. Explain briefly what information is needed and that all the information will be handled as confidential.

If a community meeting is not possible then the project must be advertised. This can be done with posters and informing children at schools. Direct advertising using microphones or megaphones can be used to inform the community while riding in an identifiable vehicle.

Hand out pamphlets in English and the language of that community, which informs the people about the survey.

The respondents must know that they have the right to refuse their co-operation.

13 LOGISTICS OF SURVEY

Arrange for transport to and from the study population for the research team as well as the fieldworkers.

Copies of the questionnaires and of area maps must be distributed to the fieldworkers.

It is important that one person in each interviewer team should be able to speak the local language if the questions are not framed in the local language.

The researcher should escort the fieldworkers to be available for questions and to help with any problems. The researcher must check the questionnaires during the

survey to pick up possible problems. If problems occur, the error must be corrected and the fieldworkers notified.

14 BUDGET

During the planning phase, the researcher as well as the research team must decide what logistical as well as analytical aids, instruments and equipment will be needed to complete the project. A complete budget must be drawn up, from stationery, telephone bills and the training of the fieldworkers to the fuel that will be used. If a consultant is used, remember to budget for consulting hours as well as the analysis of the data.

Funding organisations must be contacted in advance; local and provincial governments could be of assistance. Research organisations local and overseas could be approached. Possible research funding institutions include the Council for Scientific and Industrial Research, National Research Foundation, Medical Research Council, Health Systems Trust, as well as from local tertiary institutions, especially if that institution can be involved with the research project.

Applications for funding must be accompanied by a research proposal or protocol.

15 CODING OF QUESTIONNAIRES

Each question must be coded on the questionnaire or on a separate coding form. The coding process is applied according to the decided plan and coding structure. This ensures that the questionnaires are coded uniformly.

Usually coding blocks are drawn on the right hand side of the questionnaire and can only be filled in after the questionnaire is completed. Coding is done in this way to order the information and to simplify the punching of the codes into a computer. The answers for the open questions or option "other" must be grouped and coded as well.

Coding can be demonstrated by the following example:

Example: If water is scooped from the container, do you use the same mug for drinking?

Yes [X]
No [ ]

[/]

If yes, how many people drink from that mug? 06

6

1

(iii) How do you store your mug?

1.Covered	X
2.Closed	
3.Unprotected	

16 ANALYSIS OF DATA

A freely available computer programme that can assist the researcher as well as supplying helpful examples and hints is EPIINFO. This program is available through the Internet and can be downloaded to your computer. This program is user friendly and can be learned on your own, although there are teaching programmes and consultants to assist, available.

The EPIINFO programme can be accessed by the following Internet address: http://www.cdc.gov/epo/epi/epiinfo.htm. By making use of the program the whole study can be done, from designing the questionnaire to the analyses and presenting the results in graphs and tables.

It is important to check the data on the computer before any analysis can be done. Be on the lookout for obvious errors, as well as information that does not make sense or is inconsistent. Check this information by referring back to the completed questionnaires. It is important to keep the questionnaires in numerical order for this purpose. If the information on the questionnaire is clearly incorrect, one cannot guess what the correct answer is, but should handle the information as missing information.

After the coded data is read into the questionnaire the researcher can start with the analyses of the information. The variables can be compared in tables and graphs. The results can be presented in graphs, this can assist in interpretation of the results. After the completion of the analyses and presenting of the results the researcher can write a report or conclude on the conducted study. The findings can then be communicated to the community and incorporated in practice.

The results as well as variables that are found to be important can indicate future studies or research that can be done.

Example: Compare the number of people in the house to the number of people in

the house reporting diarrhoea.

17 COMMUNICATE FINDINGS AND USE IN PRACTICE

The role players and community leaders involved in the study must receive a copy of the final report after completion of the study. Possible recommendations should also be presented.

The final analyses and conclusions should be reported to the research team and local health workers; the survey population and their leaders; scientific journals, ministries and interested bodies.

The lessons learned through completing the study as well as the final findings must be incorporated in practice. The results and findings to be addressed must become part of the EHP's daily activities.

Example: It was found that the community lacks knowledge of basic hygiene principles. Community education will be the next aim or programme to be implemented by the EHP in that community.

18 EXAMPLE BOTSHABELO STUDY

18.1 THE RESEARCH TEAM

The study was designed and the questionnaires developed by the research team.

For this study, the research team consisted of an experienced environmental health practitioner, a statistician, student environmental health officers and the researcher who is a qualified environmental health officer. The clinic personnel as well as the doctor working in the area were consulted before the study design was completed.

18.2 AIM OF THE STUDY

The aim of the survey was to collect environmental health-related information especially water-related, from a sample of a population. This data was needed to determine if the incidence of diarrhoea in the population was related to water use and water quality.

18.2.1 OBJECTIVES

The following objectives were set to meet the aim of the study:

I. To initially design an epidemiological study based on a survey of determinant (water quality) vs. environment and its possible impact on human health

(water quality) vs. environment and its possible impact on human health (diarrhoea).

II. To apply a cross-sectional analytic study design (during the initiation phase) in the marginalised urban are.

III. To implement the study within a Technikon research theme focussing on health risks posed by adverse drinking water quality.

IV. To collect the required data on questionnaires relating to the problem of diarrhoea and a possible link to water use.

V. To gather and analyse further data on the exposures (use of water) vs. the outcomes (diarrhoea) from the study and control group during other studies in the same area characterising levels of actual risk during water use (water quality vs. the uses).

VI. To gather the additional data on specially adapted questionnaires designed from this proposed study.

VII. To interpret results on the above-mentioned water quality study involving dividing the study population in 2 groups: the cases and controls.

VIII. To assess the initial data (gathered on questionnaire during the initial survey) for being appropriate.

IX. To draft a provisional process in a manual / guide based the re-aligned approaches.

X. To provide EHP's with a practical environmental health epidemiological process description (in the form of a guideline set) for use in an environmental management skills toolkit.

18.3 STUDY DESIGN

A descriptive cross-sectional study type was chosen because of the following features:

- A sample of the study population was investigated and data collected on risk factors (exposures) and disease (outcome) at a point in time.
- One can calculate the prevalence of risk factors as well as prevalence of disease.

- Cross-classification of the population allows statistical comparisons between subgroups, and may show relationships between exposure and outcome.

18.4 SAMPLE

18.4.1 STUDY POPULATION

The study population consisted of approximately 3362 households within a marginalised residential urban development. In this area people used various types of containers to move a supply of household drinking water from the municipal supply (public standpipes or yard taps) to their individual dwellings to store for daily use. These households lived on marked plots in the study area. Approximately 300 of households live in informal dwellings on unmarked plots in the study area.

18.4.2 SAMPLE SIZE

On advice from a statistical consultant from the University of the Orange Free State (UOFS),it was decided to interview 300 households in the study area, 270 from the marked plots and 30 from the informal structures. Thus, a proportional stratified sample was selected. This sample size was chosen taking practical considerations into account such as time, financial implications and human resources.

18.4.3 SAMPLE SELECTION

A map of the study area was obtained from the Botshabelo municipality, which indicates all the marked plots and their numbers. It was used for the selection of the 270 households living on marked plots by means of a computer program written in SAS (SAS Inc., 1990) using a random number generator. The stand numbers were verified on the map and marked and the informal housing sections were plotted on the map by the researcher.

The following procedure was used to select the 30 households from the informal structures:

The informal housing area was divided into three sections of similar size. In each area a bottle was spun on the ground in the centre of the area. The field workers walked in the direction that the neck of the bottle indicated. The bottle was made of glass; it was spun at the centre of the informal settlements, one south of the road and two north of it.

- The fieldworker team interviewed every eighth informal household on the indicated route.
- This procedure was continued until 10 households of each of the three areas had been interviewed.

The fieldworkers had to indicate on the questionnaires if they interviewed a substituted household.

If a household was unwilling to take part in the study or were not at home, it was decided to interview the family of the house to the left of the selected one, when facing the dwelling from the street.

A procedure was decided on if there was more than one structure on the premises:

- The fieldworkers had small cards or pieces of paper with number 1-3 on in a bag.
- If there was more than one structure on the premises, the fieldworkers allocated a number to each one and then drew a numbered piece of paper from the pocket or bag to pick one for interviewing.
- The household that was to be interviewed was the house that had the same allocated number, as the number on the card.

The field workers had to indicate on their questionnaires when they interviewed a substituted household.

18.5 FIELDWORKERS

Sixteen third year environmental health students of Technikon Free State were used as fieldworkers to conduct the survey. This was part of their practical training in Environmental Epidemiology. The students were to gain practical experience in data sheet (questionnaire) design as well as in the process of conducting an epidemiological survey.

They had to be trained before conducting the survey.

The training comprised three phases:

- Discussion group with consultant.
- The consultant giving a lecture on data sheet design and surveys.
- Discussion group with senior lecturer.

To focus the group the lecturer gave background information on water-related environmental epidemiology.

The researcher had a discussion session with the fieldworkers. The aim of the study was formulated and the researcher informed the fieldworkers what the study was meant to achieve. The contents of the questions were explained to the fieldworkers, for it was important that they knew and understood what information was expected.

The discussion and explanation of the questions ensured that the fieldworkers understood the questions and knew how to deal with responses.

Explanations how to complete the questionnaire and what to do if nobody was home or if there were more than one structure on the premises were given to the fieldworkers.

18.6 THE DATA COLLECTION

18.6.1 DATA SHEET DESIGN

Data on the households were gathered on data sheets (questionnaires). They contained questions and spaces to tick off respondents' answers. The sheet made provision for observations to be made by the interviewers.

The data sheet for this survey was designed based on the following considerations:

- A list of the variables to be measured. The variables were specific and related to the subject of the study.
- Questions were formulated with the assistance of experienced EHP's as well as a statistical consultant specialising in epidemiology.
- The research team discussed the detailed practical logistics of each question before the final format was decided on. This included issues such as interviewer handling and potential interviewee understanding.

18.6.2 DATA SHEET ADMINISTRATION

The questions on the data sheet were formulated in English. Each fieldworker group included a trained team member able to communicate in the local ethnic language. This ensured optimal understanding of questions and answers between interviewer and interviewee.

Some of the data needed in the study could be obtained by observation. Fieldworkers were to observe what the situation was or what the facilities were before making notes in specially allocated answering spaces on the data sheet. Fieldworkers could also include additional information that potentially useful to the researcher in the analysis phase as well as for a possible follow-up study.

18.7 PILOT STUDY

The fieldworkers (students) checked the questionnaire for errors before conducting the survey. A pilot study was not carried out.

18.8 CONSENT

Before the actual data could be gathered, consent from the Technikon as well as the people from Section K Botshabelo was be obtained. A week before conducting the study, the community was informed of the specific dates that the survey would take place, at a community meeting at K clinic.

Before a household was interviewed, verbal consent was obtained from the respondent. If the household wished not to be part of the study, the fieldworkers thanked them and then went on to the next household.

18.9 TIME SCHEDULE

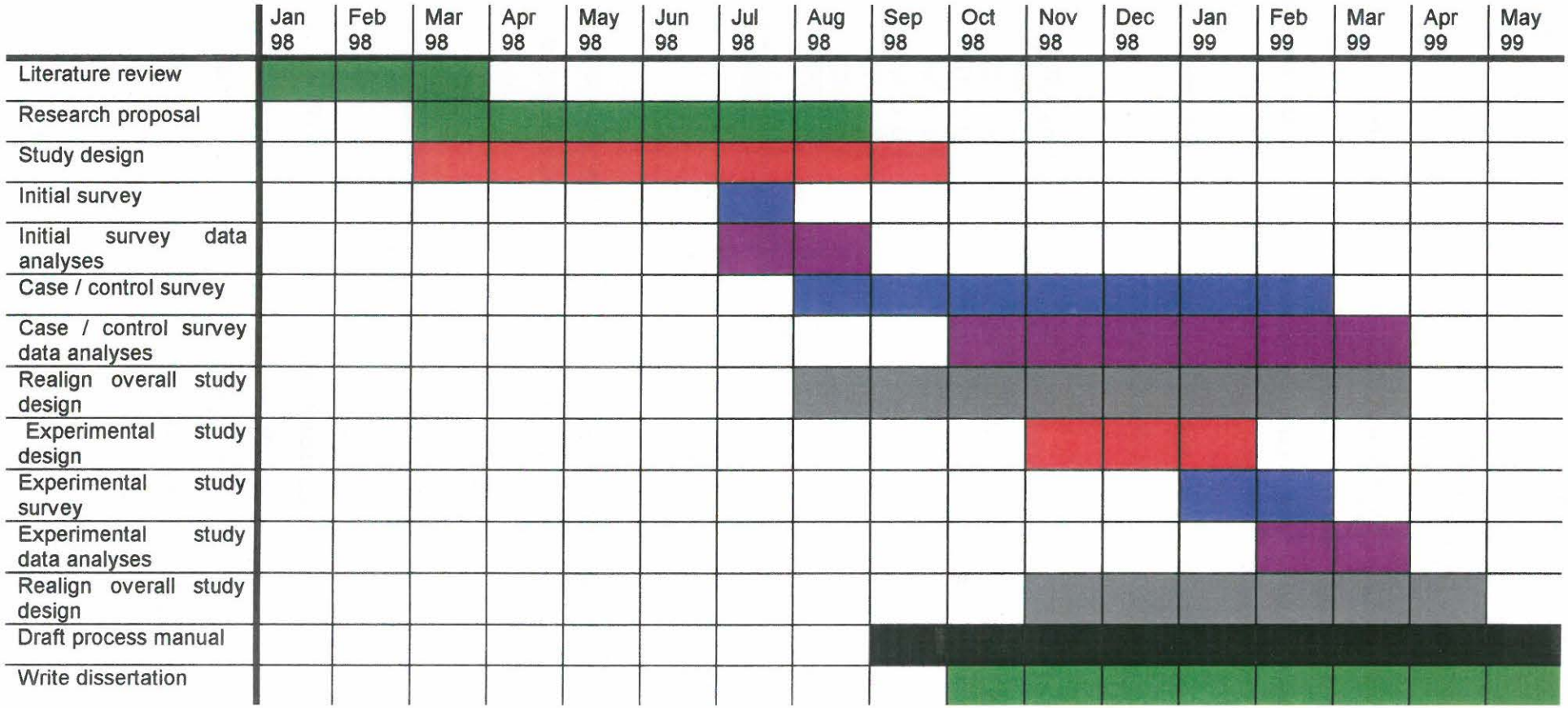
The researcher and the experienced EHP drew up a time schedule.

It started at January 1998 and time was allocated for the study up to October 1999.

- Time was allocated for the literature review and writing of the research proposal.
- The study design, training of the fieldworkers and conducting of the survey.
- Coding of the questionnaires and checking of the data as well as the analysis of the data.
- Completion of the results, writing of the dissertation and time taken for the attendance of a conference.

The time schedule was constructed in the form of a table and included in the research proposal. The time schedule for the Botshabelo study was included in Table D:1 as an example.

TABLE D:1 EXAMPLE OF A TIME SCHEDULE



The researcher was present in the study area during the conducting of the survey. This was done to ensure that if problems arose, the researcher could assist the fieldworkers immediately or address the problem at hand.

The students were divided into 7 teams of two to three members each to conduct the interviews. To help them to finish in 3 days, a schedule was handed out to them. The schedules consisted of the date and the number of households and household-standnumber that must be interviewed on that day. Copies of the area map were made and handed to each team to assist the team in finding the selected households.

The target of 300 interviewed households from the study population was reached.

18.10 BUDGET

The budget was completed after all the expenses of the study were calculated. This document was included in the research proposal. Funding was obtained from the National Research Foundation (NRF).

An example of a budget for this project could be as follows:

EXPENSES	**AMOUNT**
Survey costs	
Travelling expenditure	R 2 000
Photocopies	R 500
Contingencies	R 2 500
Data analyses costs	R 5 000
Consultant costs	R 5 000
Assistant costs	R 2 500
Administration costs (Telephone, Stationery)	R 1 000
Study literature	R 1 000
Total expenditure	**R19 500**

18.11 CODING

The researcher carried out the coding after the questionnaires were completed in the study population.

Because of a problem on the questionnaire, a separate coding sheet was used. The use of a separate coding sheet is not unusual, but errors are likely to occur when the data is transferred from the questionnaire to the coding sheet.

18.12 ANALYSIS OF DATA

Data was analysed by the Department of Biostatistics of the University of the Orange Free State.

After extensive data checking of computerised data by the researcher and statistician, data was summarised using frequencies and percentages in the case of categorical variables, and medians in the case of numerical variables. Since missing values occurred for some questions, or some questions were not relevant for all respondents, the sample size for which percentages and medians were calculated, were indicated in all tables.

To assess the associations between the various variables, results were cross-tabulated. Tables were made to compare the percentage people that were affected with diarrhoea in various subgroups.

18.13 COMMUNICATE FINDINGS

The community was informed about the results during a community meeting that the researcher attended. Other researchers, who planned to conduct an educational project where the community would be educated on personal, mug and container hygiene practices as well as to improve the general hygiene in the area, held this meeting.

A conference paper was delivered on the findings of this study. A research article will be sent for publication to an accredited journal.

19 CONCLUSION

This document is a guide to assist with the planning and conducting of an epidemiological study. It should be used together with other notes or books on epidemiology to achieve the best results.

This guide is a draft copy and is released for further evaluation, inputs and refinement.

Books that are be recommended for further reading:

- Baker DJP and Hall AJ. 1991. **Practical epidemiology: Medicine in the tropics**. 4th ed. London. Churchill Livingstone.
- Bowling A. 1997. **Research Methods in Health: Investigating Health and Health services**. Buckingham: Open University Press.

- Joubert G, Bam RH and Cronjé HS. 1999. **How to write a protocol: A manual for beginner researchers**. Bloemfontein: UOFS.
- Katzenellenbogen JM, Joubert G, and Abdool Karim SS. 1997. **Epidemiology: A manual for South Africa.** Cape Town: Oxford University Press.
- Lilienfeld ED and Stolley PD. 1994. **Foundations of Epidemiology**. 3erd ed. New York. Oxford University Press.
- Vaughan JP and Morrow RH. 1989. **Manual of Epidemiology for District Health Management**. Geneva: World Health Organisation.