WATER RESEARCH COMMISSION

URBAN SANITATION EVALUATION

SUMMARY REPORT

May 1993

FINAL REPORT TO THE WATER RESEARCH COMMISSION: PROJECT No.385

Technical, socio-economic and environmental evaluation of sanitation systems for developing urban areas in South Africa.

Prepared by:

Palmer Development Group

in association with

University of Cape Town

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PREFACE

The provision of water and sanitation services to the rapidly expanding urban areas in South Africa is a great challenge facing the country. Yet our understanding of the options available for doing this are limited. In order to assist in improving this understanding the Water Research Commission provided funds for a project relating to the provision of sanitation in urban areas. The full title of the project is:

"TECHNICAL SOCIO-ECONOMIC AND ENVIRONMENTAL EVALUATION OF SANITATION FOR DEVELOPING URBAN AREAS IN SOUTH AFRICA"

but, for the sake of brevity, has been abbreviated to "Urban Sanitation Evaluation".

The project, carried out by Palmer Development Group, in association with the Water Research Group at the University of Cape Town, was structured into the following phases:

PHASE I: OVERVIEW

A review of international practice in the field of sanitation.

A review of the current situation with sanitation in South Africa (including the TBVC states). This included, for each region in the country, a survey of urban areas to determine who has got access to adequate sanitation, what types of system are being used and how sanitation systems are funded and managed. Questionnaires and interviews were used as tools to collate the information.

PHASE II: EVALUATION OF SYSTEMS

Various key issues in the implementation of sanitation projects were identified and studied in a series of case studies. The most used sanitation systems were also evaluated in terms of their cost, acceptance by communities, ease of construction and operation, and environmental impact.

PHASE III: GUIDELINES AND KEY AREAS FOR ACTION

The key findings of Phases I and II were summarised in a report and presented to professionals and other interested parties in the sanitation and water sectors at a series of six workshops around the country. On the basis of the work completed and inputs received during the workshops, a draft set of guidelines for the implementation of sanitation projects was developed and key areas for action in the sanitation sector identified.

The project commenced in March 1991 and was completed in April 1993. A list of the outputs from the project is provided overleaf.

LIST OF WORKING PAPERS

All documents headed:

Water Research Commission
Urban Sanitation Evaluation

Working Paper	Title
	Overview documents
A1	Access to sanitation in South Africa - summary
A2	Sanitation and health
A3	Sanitation: Current Institutional arrangements
A4	Technology Options for Sanitation provision to developing communities.
	Case studies
B1	The Mdantsane water-borne system: a case study
B2	Evaluation of 2 VIP latrine programmes in Natal
B3.1	Technical Evaluation of on-site low flush anaerobic digesters in Ivory Park and Duduza
B3.2	Social Survey of user's views on the use of low-flush on-site sanitation systems.
B4	Bucket collection: a case study
B5	Sanitation and the environment: an overview
B5.1	Simple model illustrating the environmental impact of sanitation
B5.2	The Upper Rietspruit - an example of an urbanising catchment
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C1	Region A - Western Cape
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C4	Region D - Eastern Cape and Ciskei and southern and central Transkei
C5	Region E - Natal including KwaZulu and northern part of Transkei
C6	Region F - Eastern Transvaal including KaNgwane
C7	Region G - Northern Transvaal including Lebowa, Gazankulu and Venda
C8	Region H - Pretoria, Witwatersrand, Vaal Triangle including KwaNdebele and part of Bophuthatswana
C9	Region J - Western Transvaal, including parts of Bophuthatswana
	Other
D1	Report on Phase 3 workshops

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The research in this report emanated from a project funded by the Water Research Commission and entitled:

"Technical, socio-economic and environmental evaluation of sanitation systems to developing urban areas in South Africa".

The Steering Committee for this project included the following people:

Mr HC Chapman	Water Research Commission (Chairman)
Dr OO Hart	Water Research Commission
Mr BM Jackson	Development Bank of Southern Africa
Mr A Wilson	Umgeni water
Dr JJ Barnard	Department of Water Affairs
Mr P Solsana	CSIR
Mr G Norris	CSIR
Mr JM Pienaar	Transvaal Provincial Administration
Mr HAC Meintjes	South African Housing Trust
Dr BE la Trobe	

The financing of the project by the Water Research Commission and the contribution of the members of the Steering Committee is gratefully acknowledged.

In carrying out the work for this report an extensive survey was undertaken of organisations involved in the provision of water throughout South Africa. The success of this survey has been due largely to the efforts of the numerous people who responded to it, be they in local authorities, other public authorities, water boards, consulting firms, non-government organisations or community-based organisations. Their assistance and support is also gratefully acknowledged.

The project team for the project was made up of the following members of Palmer Development Group and the Water Research Group at the University of Cape Town:

Rolfe Eberhard
Richard Palmer
Craig Peters
Trevor Hughes
Ian Palmer
Prof G vR Marais

In addition, certain background information was provided by:

Dr YER von Schirnding, Medical Research Council
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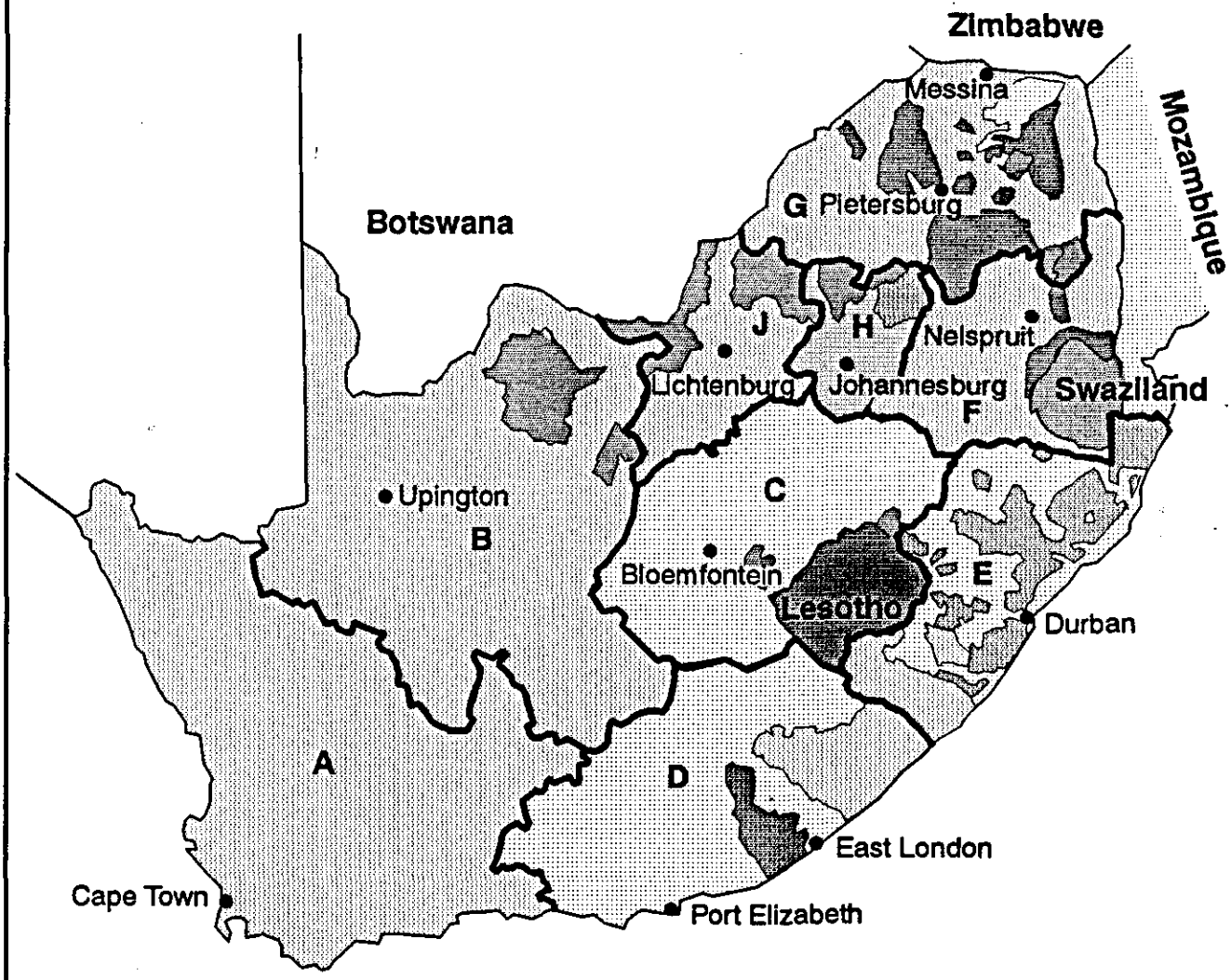
Paul Walker, University of Cape Town

Finally the authors would like to acknowledge the support given to the project by the World Bank and their consultants, particularly in making information available on experience in the field of sanitation worldwide.

Map 1 Development Regions in Southern Africa



1. INTRODUCTION

In many developing countries, significant proportions of the population do not have adequate supplies of safe water and waste disposal facilities. In South Africa (both urban and rural areas) it is estimated that:

- one in every four people (10 million) lack access to a safe water supply[1]
- one in every two people (19 million) lack access to adequate sanitation[2][3]

Diseases related to inadequate water supply and waste disposal are contributory causes of the majority of deaths in infants and also account for a large proportion of morbidity in adults. For example, gastrointestinal infections are the leading cause of death and disability in young children in many developing countries. In addition to the direct negative health impacts that inadequate water supplies and sanitation facilities have on communities, there are also many secondary impacts negatively affecting people's quality of life, productivity and the ability and effectiveness with which they can contribute to the local economy.

Given this situation, it is clear that much needs to be done to effect improvements, from a social, health and economic point of view.

This study provides a technical, socio-economic and environmental overview of the provision of sanitation facilities to the developing urban communities in South Africa (including the TBVC states). The aims of the study were as follows:

- to review the current situation with regard to the provision of sanitation in urban South Africa
- to evaluate the various types of sanitation systems in use in urban South Africa
- to develop strategies for the improvement of sanitation based on input obtained at workshops held around the country and to provide input to a set of guidelines for providing sanitation.

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[1] Sources: Urban - 4.6 million (PDG/UCT, 1993)
Rural - 6 million (Pearson, 1991)

[2] Sources: Urban - 7.7 million (Section 2.3)
Rural - 11.1 million (Pearson, 1991)

[3] Sanitation refers, throughout this document, to human waste (sewage) and does not include refuse removal.

The study was carried out over the period from February 1991 to April 1993.

The work carried out for the study is reported in detail in 24 working papers which are listed at the start of this document. This report represents a summary of the findings of the project as a whole.

2. OVERVIEW OF CURRENT SITUATION

2.1 INTRODUCTION

The project to evaluate the provision of sanitation in the urban areas of South Africa was split into three phases. The first phase of the evaluation comprised of:

- a review of international experience in the provision of sanitation to poor urban communities in developing countries
- a survey of urban areas to assess the current situation with regard to access to adequate sanitation
- an overview of the current institutional and financial arrangements pertaining to the provision of sanitation
- an overview of the relationship between sanitation provision and health
- an overview of the potential environmental impacts of sanitation
- a review of technology options for the provision of sanitation to poor communities

This section summarises the information obtained from the urban survey and institutional and financial overview. In addition, a brief description of sanitation options commonly in use in South Africa is given. Information pertaining to the other overviews may be obtained from the separate working papers. The lessons learnt from international experience are incorporated into the discussion of "sanitation issues" in section 4.

2.2 DESCRIPTION OF SANITATION SYSTEMS

2.2.1 Introduction

In this section brief descriptions of the following systems are given:

- Full waterborne sanitation
- Septic Tank

- Low volume flush, on-site anaerobic digester linked to an on-site soakaway (or "solids-free" reticulation system) (LOFLOS)

- Ventilated Improved Pit latrine (VIP)

- Bucket Collection system

Most of these systems are well known and detailed descriptions of these are therefore not given. The point of describing them, in this case, is to clearly identify the component parts so that the costing evaluation is done on a comparable basis for the different systems.

Only systems that are commonly used or are perceived to have potential for use in South Africa are described in this section.

2.2.2 Full waterborne sanitation

The component parts of a full waterborne sanitation system are:

- pedestal with flush mechanism

  The standard flush volume in South Africa is between 10 and 15 litres per flush. This can be contrasted with the situation in Europe where flush volumes have been reduced to 6 litres per flush.

- toilet structure

  Where formal housing exists, this is usually incorporated into the housing structure. In site-and-service areas, a separate structure must be built. The siting of the structure and the direction in which the door faces are important as they determine the possible incorporation of the structure into a house structure which may be built later.

- on-site sewer connection

  The shorter this connection, the lower the cost, hence the incentive to site the toilet structure to abut either the back or front boundary of the stand.

- internal reticulation

  The sewer reticulation laid within the residential area. The sewers are laid either in the streets or "mid-block" (at the back of the residential properties). Mid-block sewer layouts are cheaper, but local authorities do not like them because access to the sewers for maintenance purposes may be difficult. An alternative layout is the "condominial" system. This system is significantly cheaper, but has distinct maintenance implications for the community. Two alternative configurations are shown in Figure 2.1.

- connector service

  The sewer conveying the sewage from the residential area to the wastewater treatment works (or into the sea). Where gravity flow is not possible, pumping stations are included, with rising mains.

- wastewater treatment works

  The treatment works most commonly used in South Africa are activated sludge, bio-filters and oxidation ponds. Given South Africa's scarce water resources, the issue of nutrient loading of rivers and impoundments is important. Nutrient removal facilities (nitrogen and particularly phosphorous) are therefore required at many treatment works.

In the remainder of the report, the first four components are called "internal services" and are regarded as part of "housing". The last two components are called "bulk services" and are regarded as part of bulk urban infrastructure.

2.2.3 Septic Tanks

Septic Tanks are only described here so as to distinguish them from the LOFLOS systems described below. The conventional septic tank comprises:

- a pedestal and full flush mechanism (usually 10 to 15 litres per flush)

- a toilet structure usually incorporated into the house

Figure 2.1 A comparison of two sewer configurations

Figure 1 A: Condominial Sewerage

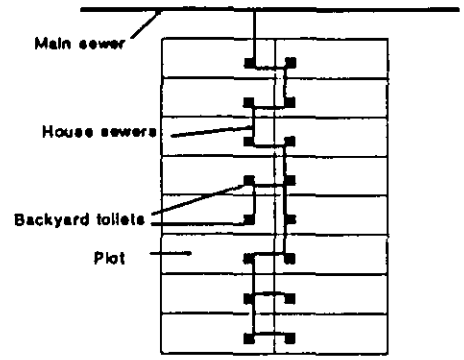


Figure 1 B: Conventional Sewerage

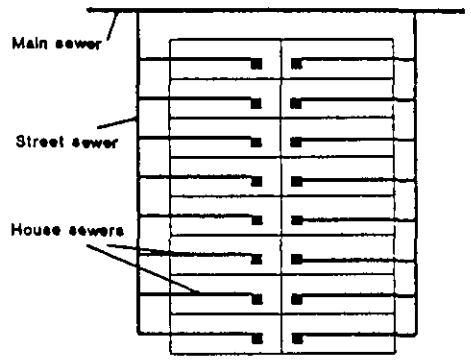


Figure 1A shows the layout of a "condominial" waterborne sewerage system in a "block" in a low-income community. Figure 1B shows the layout in a conventional system.

Technical differences:
. The total length of sewers in the condominial system is significantly less than the length in the conventional system;
. The house sewers in the condominial system can be laid at shallow depths (since there is no need to protect against traffic loads);
. The outfall from the block in the condominial system is, consequently shallower than the outfall in a conventional system, meaning that the main sewers in the condominial system can be laid at shallower depths;

Costs:
. Because of the above technical differences, the capital costs of "condominial" systems are significantly lower than the capital costs of conventional sewers. (Precise figures are not available, but Brazilian authorities report savings of over 60% in capital costs.)
. Because the water and sewerage agency has a much smaller number of manholes, and shorter and shallower sewerage network to manage, and (as is discussed further below) condominial systems are misused much less than conventional systems, operating costs are lower. (Precise figures are not available, but Brazilian authorities again report savings of over 60% in operating costs.)

Community Involvement:

Impressive as the technical innovation of the condominial system is, the sine qua non of the system is the active involvement of the population in choosing their level of service, and in operating and maintaining their portion of the system. (Where such a community dynamic has not accompanied the installation of a condominial system, the systems have often failed.)

Source: J. Briscoe (World Bank, 1991)

- a septic tank and soakaway designed to take flows from the toilet, kitchen and bathroom. The sizing of the tank is usually based on daily flow and a liquid retention time of 24 hours. This design normally ensures a sludge build-up capacity of about 5 to 7 years where the house is continually occupied.

Septic Tank systems are, on average, as expensive as conventional waterborne sanitation systems, although their operating costs are substantially lower. They are generally used in circumstances where conventional waterborne sanitation is not possible or prohibitively expensive, such as where plot sizes are very large and the topography is very steep (eg. Kloof in Durban), or where a community is isolated and the construction of a treatment works is not justified.

2.2.4 Low volume flush, on-site anaerobic digester linked to an on-site soakaway or "solids-free" reticulation system (LOFLOS)

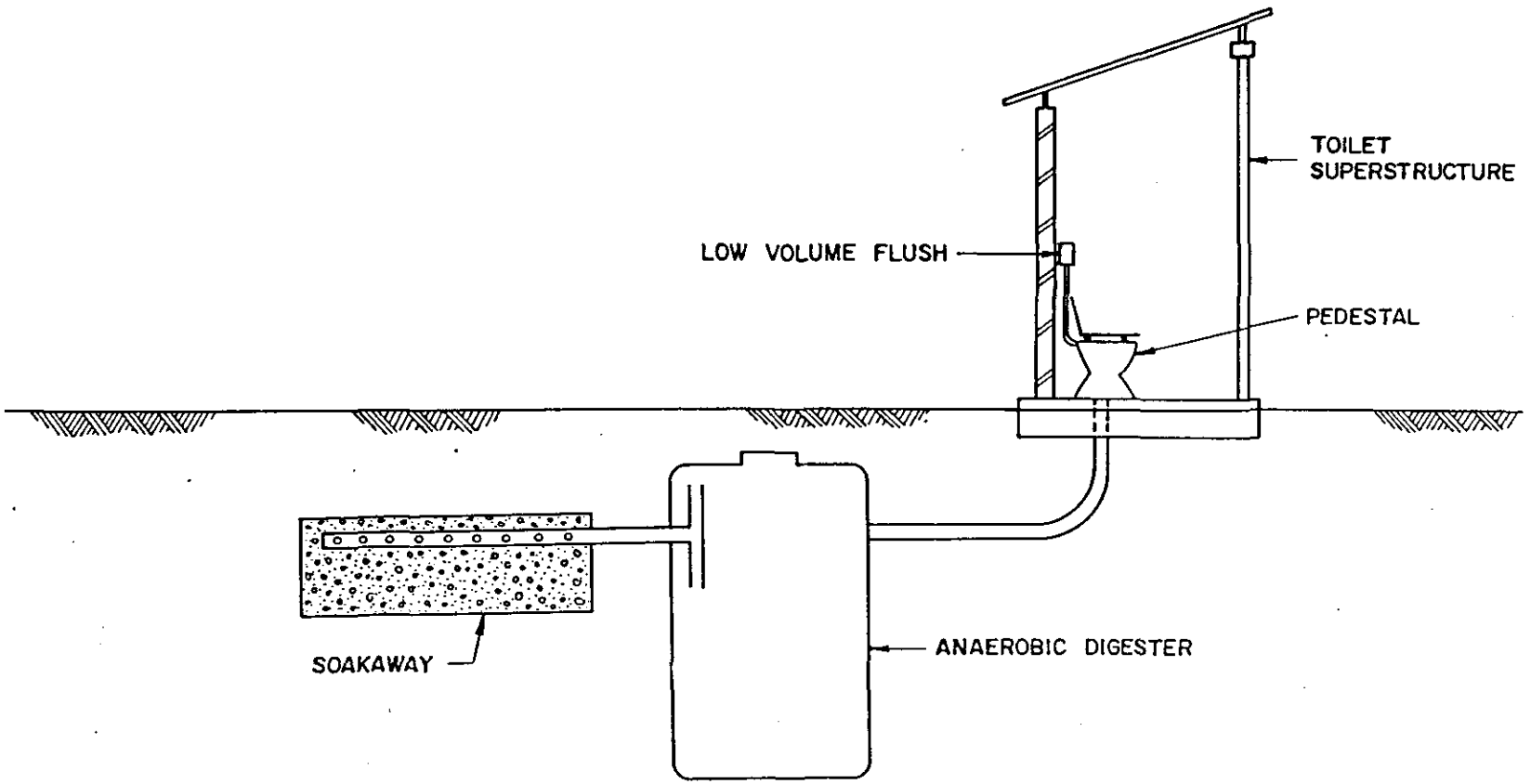
LOFLOS are toilets with low volume flush mechanisms (typically less than 3 litres) discharging to an anaerobic digester (septic tank). The "solids-free" effluent from the digester flows either to an on-site soakaway or a solids-free small bore sewer reticulation system which in turn flows or is pumped to a treatment works.

LOFLOS are often referred to as "aqua-privies" because they are based on the original aqua-privy design developed in the early 1960's. The original aqua-privy is essentially a pedestal with a vertical chute which discharges directly into a septic tank (anaerobic digester). A water seal is maintained by adding small quantities of water. The recently developed systems differ in that a low-volume flush and separate water seal are used (see Figure 2.2).

The use of LOFLOS on any significant scale in South Africa is relatively recent, the oldest systems having been installed 2 to 3 years ago. There are a number of LOFLOS makes currently being installed. They all have certain basic elements:

- A privy (enclosure/building)
- A pedestal with a flushing arrangement typically using about one litre of water per flush.
- A digestion tank mounted adjacent to or under the pedestal. The various makes have a wide range of digester sizes, from 35 to 1 500 litres.

Figure 2.2 Low volume flush, on-site anaerobic digester toilet (LOFLOS) - a generic diagram



- A soakaway for the effluent from the tank. The effluent from the tank may also be linked to a solids-free small-bore reticulation system. However, this arrangement is still relatively uncommon in South Africa at present with only a handful of systems installed.

These units can be supplied and installed through contracts with private companies at competitive prices and in short time frames. However, numerous problems with these units have been experienced. These problems and an evaluation of LOFLOS are discussed in Section 3.5.

2.2.5 Ventilated Improved Pit latrines (VIPs)

VIPs are pit latrines designed in such a way that they are odourless, fly free and safe to use. The key elements of the VIP latrine design are:

- a solid base plate, pit collar and pit lining (if necessary): to prevent pit collapse;
- a sturdy roofed super-structure and pedestal: to ensure relative user comfort and discourage flies; and
- a vent pipe which adequately clears the roof of the super-structure, fitted with a fly screen: to vent odours from the pit and control flies.

VIPs have been extensively used in other countries in Southern Africa, but have only recently introduced in significant numbers into the urban areas in South Africa.

2.2.6 Bucket collection systems

Bucket collection systems, as they are practised in South Africa are not considered an adequate form of sanitation. This is for two reasons: firstly, the bucket collection system does not prevent the spread of disease through flies; and secondly, problems with respect to the proper collection and cleaning of buckets are widespread with the result that unsanitary conditions prevail in many areas where buckets are used. Nevertheless, approximately 2 million people in the urban areas of South Africa are reliant on bucket collection systems for their sanitation. The components of the system are thus described

here and an evaluation of a system was carried out as part of the second phase of the project.

Bucket collection systems comprise the following components:

- a toilet structure in which a bucket is placed

  The toilet structure is often shared by more than one family.

- a collection system

  Buckets are usually collected twice per week (although in some cases only once per week) by the local authority (or other responsible authority in the absence of a local authority). The (full) buckets are either emptied into a truck or trailer and returned dirty, or are replaced with clean buckets with the dirty ones being emptied and cleaned at (say) the treatment works.

- nightsoil treatment

  The nightsoil from the buckets is usually emptied at the head of a treatment works. However, in some cases it is buried, added to solid refuse or treated separately.

2.3 ACCESS TO SANITATION IN THE URBAN AREAS OF SOUTH AFRICA

As part of the study, an extensive survey of urban areas was carried out to ascertain the present position with respect to the provision of sanitation services. The survey differentiated between different sanitation systems as follows:

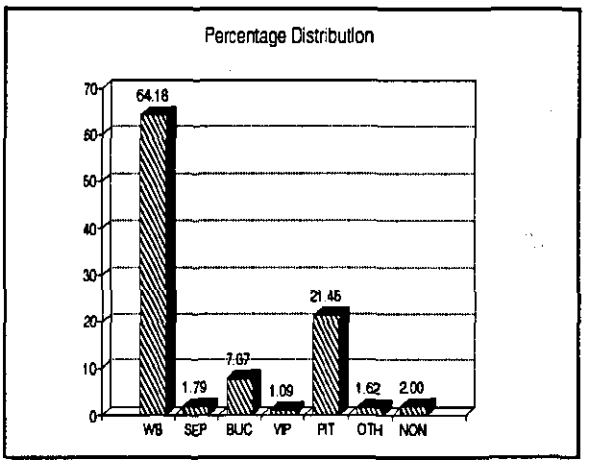
- Full water-borne sewerage
- Septic tanks
- Bucket collection systems
- Unimproved pit latrine
- VIP latrine
- Other (primarily LOFLOS systems)
- None (no access to any sanitation system at place of residence)

Information was collected on a settlement basis and aggregated by region. The urban areas in the TBVC states were included in the survey. The Urban Foundation's demographic model was used as the basis for the urban population figures. The model includes in its definition of urban the "dense settlements"; these settlements are generally situated on the fringes of cities but may be comparatively isolated. However they are densely settled and their primary economic base is the urban economy to which a significant proportion of the population commute on a daily or weekly basis.

All population figures quoted are for 1990.

The results are summarized in the table and figure below:

SANITATION TYPE	POPULATION
Full water-borne	15 718 000
Septic tank	439 000
Bucket	1 926 000
VIP Latrine	266 000
Unimproved Pit	5 253 000
Other	398 000
None	491 000
TOTAL	24 491 000



The survey revealed that at least 7.7 million people (31%) of the 24.5 million people living in urban areas in South Africa do not have access to adequate[4] sanitation. This figure is made up from the number of people who only have access to buckets or unimproved pits, or who have no sanitation facilities at all. The figure is undoubtedly an understatement of the extent of the problem for the following reasons:

- People living in areas which have waterborne sanitation do not always have free access to toilets, particularly if they are living in backyard shacks as tenants.

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[4] "Adequate" sanitation was defined, for the purposes of this report as reasonable access to a sanitation system which provided satisfactory protection from disease associated with human waste. The systems assumed to provide adequate sanitation are: waterborne sanitation, septic tanks, VIPs and other (primarily LOFLOS) systems.

- Some sanitation systems (which although conceptually adequate) are not functioning properly and therefore the sanitation service may be far from satisfactory.

Over 5 million people (21%) living in urban areas use unimproved pit latrines. By comparison, it is estimated that only 0.27 million people use VIP latrines. The distribution of numbers between VIPs and unimproved pit latrines is not accurate as it was difficult to obtain information on whether or not pits had been improved and were VIPs; there is a lack of awareness of the important differences between the two.

2 million people (8%) live in areas where the only sanitation system is a bucket collection service. This is a surprisingly high figure, given the inadequacy of this system.

About 400 000 people use other (predominantly LOFLOS) systems. This represents only 1.6% of the urban population.

There are almost half a million people that do not have access to any sanitation facilities. In most cases this occurs where informal settlements have been recently established and no provision for sanitation has as yet been made. Notwithstanding this, the number is disturbingly large.

The number of people in the urban areas of South Africa who have access to different forms a sanitation are summarised by region in Figure 2.3.

From the figures it is quite clear that extensive regional differences exist with regard to sanitation provision in the urban areas of South Africa. These differences can mostly be attributed to the large variations that exist in wealth, demography and topography between the regions. However, these differences do not account for all of the disparities and policy would seem to play an important role.

A brief description of the regional differences is given below.

Western Cape (Region A)

The Western Cape has the highest percentage (85%) of its population with nominal access to waterborne sanitation of all the regions. This is not surprising due to the fact that the region is one of the wealthiest regions in South Africa and in-migration of people from poor rural areas has been historically restricted. Waterborne sewerage has also been regarded as the only acceptable permanent form of sanitation on the sandy Cape Flats

where a major portion of the urban population in the region resides. There is a noted absence of pit and VIP latrines in the region and little innovation in intermediate (other) sanitation systems. There are a large number of people (280 000) with bucket sanitation and a disturbingly large number of people (119 000) with no sanitation facilities at all, mostly as the result of recent in-migration.

Northern Cape and Orange Free State (Regions B and C)

In the Northern Cape (Region B) only 30% of the urban population have nominal access to waterborne sanitation, 33% use unimproved pits and a further 30% use buckets. This represents a poor situation but Region B has, however, the smallest urban population of all the regions.

Of note in the Orange Free State (Region C) is the large number of people with bucket sanitation: 413 000 people, 24% of the region.

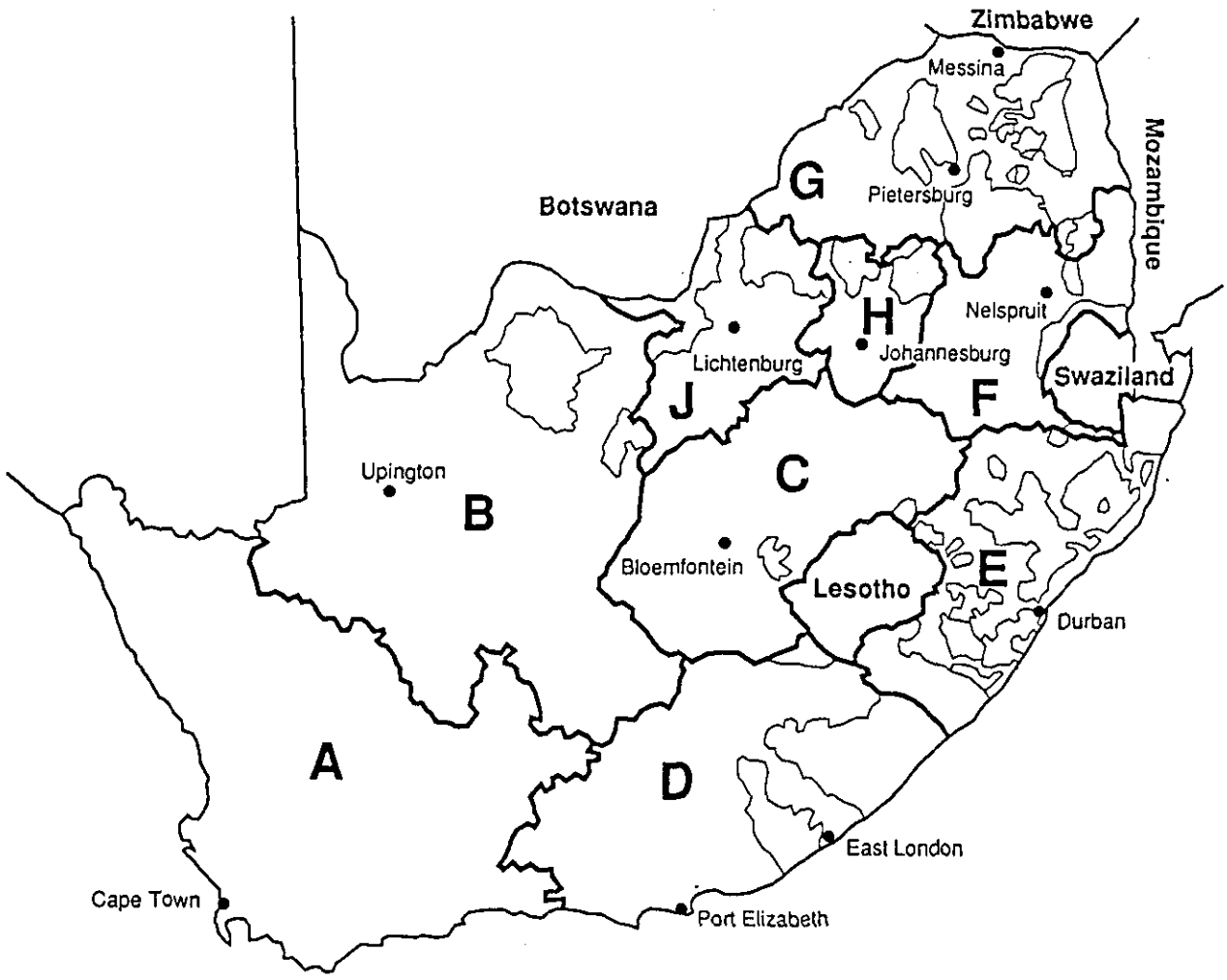
Eastern Cape (Region D)

In Region D, 68% of the population have nominal access to waterborne sanitation. 18% of the population, 450 000 people, have bucket sanitation, of which only half live in the metropolitan areas. Over 200 000 people living in small towns in the Eastern Cape, representing 43% of the total population of these towns, are serviced by buckets. There are also a large number of people (200 000) using unimproved pit latrines.

Natal/KwaZulu (Region E)

In Region E only 58% of the urban population have nominal access to waterborne sanitation and there is a large proportion (33%) of the population which has access only to unimproved pit latrines. This is likely to relate to the demographic and topographic conditions and to the fact that large number of people live on the urban periphery where service provision generally, including sanitation, is poor. Of the 1.5 million people that were reported to use pit latrines, only 7% were using VIP latrines. Clearly a significant improvement in sanitation services can be attained by upgrading the unimproved pits to VIP latrines.

DEVELOPMENT REGIONS OF SOUTH AFRICA



Source: DBSA 1991

Figure 2.3 ACCESS TO SANITATION - SUMMARY

The regions referred to in the tables are the development regions of South Africa and may be identified as follows: (see Map)

A Western Cape
B Northern Cape, including part of Bophuthatswana
C Orange Free State, including QwaQwa and part of Bophuthatswana
D Eastern Cape including Ciskei and most of Transkei
E Natal/Kwazulu, including northern part of Transkei
F Eastern Transvaal, including KaNgwane
G Northern Transvaal, including Lebowa, Venda and Gazankulu
H PWV, including KwaNdebele and part of Bophuthatswana
J Western Transvaal, including part of Bophuthatswana

ACCESS TO SANITATION BY REGION

	WB	SEP	BUC	VIP	PIT	OTH	NON	TOTAL
A	2,706,000	35,000	280,000	3,200	1,500	11,300	119,000	3,156,000
B	211,000	42,000	205,000	4,000	232,000	4,000	8,000	706,000
C	818,000	41,000	413,000	138,000	197,000	1,000	113,000	1,721,000
D	1,694,000	60,000	455,000	4,000	206,000	64,000	13,000	2,496,000
E	2,596,000	150,000	52,700	111,000	1,479,000	17,500	67,500	4,473,700
F	543,000	4,500	115,000	500	234,000	600	14,000	911,600
G	354,500	2,800	600	2,500	949,000	100	0	1,309,500
H	6,306,000	99,000	260,000	0	1,627,000	296,000	156,000	8,744,000
J	489,000	5,000	145,000	3,000	328,000	3,000	0	973,000
Tot	15,717,500	439,300	1,926,300	266,200	5,253,500	397,500	490,500	24,490,800

PERCENTAGE ACCESS BY REGION:

	WB	SEP	BUC	VIP	PIT	OTH	NON	TOTAL
A	85.7	1.1	8.9	0.1	0.0	0.4	3.8	100
B	29.9	5.9	28.0	0.6	32.9	0.6	1.1	100
C	47.7	2.4	24.0	8.0	11.4	0.1	6.6	100
D	67.9	2.4	18.2	0.2	8.3	2.6	0.5	100
E	58.9	3.4	1.2	2.5	33.1	0.4	1.5	100
F	59.6	0.5	12.6	0.1	25.7	0.1	1.5	100
G	27.1	0.2	0	0.2	72.5	0	0	100
H	72.1	1.1	3.0	0.0	18.6	3.4	1.8	100
J	49.4	0.5	15.2	0.3	34.3	0.3	0.0	100
%	64.18%	1.79%	7.87%	1.09%	21.45%	1.62%	2.00%	100%

More detailed information on each region may be found in the separate Regional Profile reports.

Transvaal, excluding PWV (Regions F, G and J)

In the Northern Transvaal (Region G) only 27% of the urban population has nominal access to waterborne sanitation. 72% of the population use unimproved pits. Thus sanitation provision in this region is the worst in the country, a situation likely to be related to the fact that the region is the poorest region in the country and that the urban settlements are mostly small in size making economies of scale difficult to achieve.

The situation is similar, though not quite as severe, in the Eastern and Western Transvaal (Regions F and J) where a large proportion of urban dwellers use unimproved pits. Both regions also have large numbers of people using buckets (115 000 and 145 000 respectively) whereas very few people use buckets in the Northern Transvaal.

PWV (Region H)

The largest concentration of urbanised people is found in the PWV metropolitan complex (Region H). Here 72% of the people have nominal access to waterborne sanitation. Region H also has the highest number of people who use other (mainly LOFLOS) systems. There are a substantial number of people (156 000) who have no sanitation provision at all.

2.4 EXISTING INSTITUTIONAL & FINANCIAL ARRANGEMENTS

In this section the existing arrangements for organising and funding the provision of sanitation in South Africa are reviewed. The chapter outlines the general structure of government bodies, describes the roles of these organisations with respect to sanitation from a sectoral point of view and describes qualitatively how resources for the provision and ongoing maintenance of sanitation systems are allocated.

This section is purely descriptive. The important issues arising from the present structuring and financing of sanitation are discussed in Section 4.

2.4.1 STRUCTURE OF INSTITUTIONS

a) NATIONAL

Although this project deals with South Africa as a single country, it is not presently administered as such and the independent and self governing states have been promoted as separate countries with their governments functioning independently to a large degree, particularly as far as urban services (including sanitation) are concerned.

Further complexity has been introduced with the establishment of the tri-cameral parliament with independent decision making powers over "own affairs" given to each of the three houses which serve white, coloured and asian people. Although sanitation has not specifically been defined as an own affair, in practice it has been treated as such. All matters affecting black people not living in the homelands are treated as a "general" affair and are administered by the departments of the RSA government.

This means that at the level of first tier government there are fourteen authorities responsible for policy regarding sanitation:

- RSA government
- 3 Tri-cameral houses
- 4 Independent states
- 6 Self-governing states

Within each of these "governments" there may be a number of departments which have responsibility for aspects of sanitation provision. For instance, in the RSA government, the following departments play a role in sanitation:

- Department of Water Affairs and Forestry
- Department of National Health and Population Development
- Department of Local Government and National Housing

In the homeland governments there are generally separate departments dealing with local authority and housing affairs and with water affairs. Each have roles in the provision of sanitation.

b) REGIONAL

The governments of the independent and self governing states have been discussed under "national" above and are therefore not dealt with here. There is, however, a view that these governments should be seen as regional authorities.

Based on this classification, there are four regional authorities: the four provincial administrations. These administrations play a major role in the provision of sanitation, particularly for black people. However they do not have a tax base of their own and are subject to control by the RSA government through the Department of Local Government and National Housing.

The provincial administrations control the funding available to the black local authorities and therefore have a substantial say over policy in the areas concerned. They also implement projects and manage certain areas where there is no local authority in place.

The **Water Boards**, which were established primarily to manage bulk water supply to certain areas, could be considered regional authorities, although in some cases their area of jurisdiction is small. At present they play a very limited role in the field of sanitation.

c) LOCAL

For the purposes of this report, local government is assumed to comprise regional services councils (RSCs) and local authorities.

A major function of RSCs is the provision of bulk services (including bulk sewerage infrastructure) in urban areas. However, in some cases (particularly in the larger urban areas) these functions have been retained by the local authority and in other instances RSCs act as local authorities and provide services directly to households. RSCs raise money through levies on commerce and industry and also have the authority to borrow money on the private capital market and from the Development Bank of Southern Africa. However, this facility is seldom used.

Within the RSA, local authorities are organised on racial lines into white and black local authorities. There are a few "coloured" and "indian" local authorities but in the majority of cases the affairs of these "groups" are the responsibility of management committees who delegate the actual physical delivery of services to "white" local authorities. White local authorities (WLAs) usually have a well established financial base and/or have preferential access to regional and national grant and loan finance. Services provision

preferential access to regional and national grant and loan finance. Services provision in these areas is uniformly good. Black local authorities (BLAs), in almost all cases, have a very weak financial base and are heavily reliant on grants and loans from the provincial authorities and RSCs. As a result, the provision of services is poor. An additional problem is that many BLAs have little political support and hence experience problems with regard to the payment of services. The administration in BLAs is generally weak.

The local authority structure in the homelands is often weak and in many cases, particularly dense settlements, no local authorities are established at all. Where local authorities are in existence, they tend to have little autonomy and are substantially influenced by central governments. In many instances local government functions (including sanitation provision) are carried out by regional or even national authorities, either because there is no local authority in existence or because the local authority is not given sufficient power. This does not only occur in homelands, but also in the RSA (for example, Orange Farm, which is administered by the Transvaal Provincial *Administration).*

2.4.2 THE ROLE OF INSTITUTIONS FROM A SECTORAL POINT OF VIEW

Sanitation affects the human & biophysical environments and the economy in many ways and a number of sectors are therefore affected and involved in matters related to sanitation. These sectors are discussed under the headings: urban development, housing, health and environment. The perspective of these sectors on sanitation issues is discussed briefly below:

- **Urban development**

  The main issues pertaining to sanitation from an urban development point of view are:

  - siting of wastewater treatment works
  - location and density of housing
  - planning and financing of bulk infrastructure needs
  - *environmental impact of sanitation systems*
  - health impact related to lack of sanitation

  Urban development planning decisions are taken at the local government level but regional and central authorities often play a role. Conflicts in policy and planning

decisions may exist between regional and local government, between RSCs and local authorities and between adjacent local authorities.

- **Housing**

The main issues pertaining to sanitation from a housing point of view are:

- choice of sanitation technology
- costs of sanitation provision
- financing of sanitation provision (internal services)
- local environmental impact of sanitation
- health impact relating to lack of sanitation

For economic housing developments, that is where the purchaser pays the "full" cost of sanitation provision (comprising the on-site component and the internal reticulation), private developers provide full water-borne sanitation according to standards set by the local authority.

For sub-economic housing development (that is, where households cannot afford the full cost of "conventional" housing), concessionary loan or grant funding may be provided from a number of sources:

National Housing Commission
Houses of Representatives and Delegates (coloured and indian)
Homeland Governments
Provincial Authorities
Local Authorities
Other - eg. Independent Development Trust (IDT)

The institutions that provide the grant or loan finance usually have a large say in the choice of sanitation technology. Historically, authorities have specified that full water-borne sanitation systems should be constructed in almost all urban housing projects (including site-and-service developments).

The shortage of funding together with the high cost of conventional housing with high service levels has meant that a very large housing shortage has developed with the related result that large numbers of poor (especially black) people do not have access to adequate sanitation. Coloured and indian people have been able to lobby through the tri-cameral parliament system for funding and hence their situation is significantly better. It is also notable that the housing subsidy schemes

that have existed until recently have tended to favour middle income people rather than the very poor.

- **Health**

Currently the authorities involved with health at the national and regional level are fragmented on racial and geographic lines and the setting of policy is therefore difficult.

With regard to sanitation, health authorities have confined their role to that of regulation and have little influence over the provision of services. There is, however, an increasing recognition of the importance of primary health care and of the need to integrate this with water and sanitation provision.

- **Environment**

The major environmental impact of sanitation systems is water consumption and nutrient loading of ground and surface waters. The Department of Water Affairs and Forestry in the RSA and various homeland government departments are responsible for setting policy and regulating matters concerning water supply, quality and usage. Once again the fragmentation of responsibility causes difficulties in effectively carrying out these tasks.

There is, however, an increasing recognition of the need to practise integrated river catchment management (see Section 4).

2.4.3 ALLOCATION OF RESOURCES - A QUALITATIVE DESCRIPTION

a) Subsidies from central government

Decisions pertaining to the allocation of resources are generally made at the level where these resources become available:

- the allocation of taxes is decided at the national level
- the allocation of housing finance at the provincial level
- the allocation of RSC levies at the RSC level
- the allocation of municipal funds at local authority level

Decisions which effect the expenditure on sanitation take place at all of these levels, but are usually compartmentalised into housing and bulk services.

In the case of the RSA government, the resource allocation function is not project related. Funds are allocated to the various homelands governments and tri-cameral houses with little constraint on how they are to be used. "General affairs" funding of housing and bulks services is routed through the Department of Local Government and National Housing with the provincial administrations playing a crucial role in deciding how these funds are to be allocated.

The net result is that funds which flow from central government, particularly the RSA government, are allocated in an inequitable way. The amounts available as a subsidy from the state for sanitation provision to a household depend substantially on the race group to which the household belongs and the area where this household lives.

Grant finance in the form of housing subsidies is also available from the Independent Development Trust (IDT). In this case the subsidy is a fixed amount and is applied in a consistent way across the whole country.

b) New approaches to subsidies

The Independent Development Trust's Capital Subsidy Scheme marks a departure from the historical approach in South Africa. Two main principles of the subsidy scheme are:

- equity: the subsidy is uniform and available to poor people (total household income less than R1 000 per month) as widely as is possible given budgetary constraints.

- community participation: communities are given a significant say in the level of service provided within the constraint of the size of the subsidy.

The RSA government has also initiated a review of housing subsidies by setting up a commission under Dr J.H. de Loor to investigate this matter. The two central recommendations of this commission relate to the need for a unified department of housing and the application of capital subsidies. The proposals differentiate the subsidy into four categories:

- Category 1: Very poor, unemployed and newly urbanised. Help in acquiring access to a site with basic services. Security of tenure is guaranteed but ownership may only be obtained at a later stage.

- Category 2: A site with basic services plus a R5 000 five year loan for the erection of a house and technical assistance are provided and the property can be registered in the name of the owner at the end of the 5 year period.

- Category 3+4: One-off capital subsidy (R7 000 and R6 000 respectively) to be used for the acquisition of a site and/or dwelling on an ownership basis, or for purposes of renting a dwelling. The amount of the subsidy is decreased as income increases. Beneficiaries will be required to save 15% and 20% of their annual income and put this towards housing together with the capital subsidy.

Categories 1 and 2 are designed for informal housing, category 3 for transition to formal housing and category 4 for formal housing.

Category 1 is available to households with a maximum cash income of R1 000 per month, and categories 2 to 4 to households with household income between R500 and R3 000 per month.

It should be noted that the de Loor commission recommendations have only recently been tabled and have not been accepted as the basis for. future policy by the government. There are other housing policy initiatives which are not as well advanced. Of particular importance has been the recent establishment of a National Housing Forum, a body with broad representation which is likely to have a major influence over future housing policy.

c) Allocation of resources at a local level

Public funds raised at a local level by RSC's and local authorities are allocated by the RSC's and local authorities. Although this principle is sound, two significant factors prevent equitable and fair distribution of resources in the South African context:

- the inequitable way in which local authority boundaries are drawn. This has a major affect on the rates base of the respective local authorities

- the RSCs representatives are not elected and many of the councils do not adequately represent the people whom they serve.

d) ***Operation and maintenance of facilities***

The operation and maintenance costs of waterborne sanitation systems are subsidised in many local authorities in the RSA and homeland areas. In white municipalities, the running costs are usually subsidised from trading account surpluses (predominantly electricity). In black local authorities, the subsidy arises both from the service being priced below the actual cost of running the service and the failure of the local authority to collect payments for the service (as a result of institutional weakness, lack of political legitimacy and rent and service boycotts). Most of the subsidies for BLA services is paid by the provincial authority in the form of "bridging finance". For example, in Johannesburg, the actual cost of water and sanitation services was R128 per household per month in 1990 compared to the average price charged of R98 per household per month. In Soweto, the actual cost for all services was R330 per household per month whereas the average price charged was R73 per household per month. In 1991 a total of R650 million was spent by the provincial authorities on bridging finance.

2.4.4 ESTIMATE OF GOVERNMENT EXPENDITURE ON HOUSING

This section briefly estimates current government expenditure on housing based on the de Loor Commission's work. Without an extensive and detailed study, it is not possible to estimate how much of this money was spent on sanitation services, however the figures give a clear indication of the order of magnitude spent and the institutions involved in housing expenditure.

The itemised estimates are listed in Table 2.1. These items include loan finance and expenditure that may occur over more than one financial year. The expenditure is consolidated (avoiding double counting and only taking into account expenditure in the financial year 1990/91) to reflect two aggregates: firstly, the annual capital appropriation from the central fiscus for housing and, secondly, housing expenditure of a capital nature by public sector institutions (including housing subsidies).

Appropriations by the central fiscus for housing amounted to R1.6 billion in 1990/91, which accounts for approximately 2.1% of the state budget. The total expenditure on housing was, however, somewhat higher than this when the utilisation of other financial sources are taken into account, and amounted to R2.9 billion in 1990/91.

TABLE 2.1 EXPENDITURE ON HOUSING AND RELATED SERVICES (90/91)

CENTRAL GOVERNMENT

Department of Housing and Local Government (1990/91)	
Acquisition of land for internal services:	R 1m
First-time home buyers subsidy scheme:	R 39m
Loan redemption (National Housing Commission)	R200m
Interest on loans	R135m
Administration (housing related)	R 8m
The department received an ad hoc allocation of R342m from the sale of strategic oil reserves from the 91/92 financial year which was to have been utilised for the upliftment of disadvantaged communities by providing serviced sites.	
Own Affairs Administrations	
Housing finance and administrative support	R 22m
First-time home buyers scheme contribution	R 89m
Slums clearance	R 3.4m
Loan repayments	R 9m
Farm labourers housing subsidies	R 10m
Department of Development Aid (now abolished)	
Contribution to housing in old Trust areas	R 5.6m
Department of Foreign Affairs	
Budgetary allocation normally not project linked, however, expenditure on housing estimated as:	R247m
Department of Water Affairs	
Subsidies for bulk water and bulk water-borne sanitation services:	R 25m
Department of Finance	
Redemption and interest on various housing loans	R 64m
Department of Manpower	
Training subsidies to building contractors	R 38m

CENTRAL GOVERNMENT DEVELOPMENT FUNDS

Housing Development Funds	
Allocation from parliamentary appropriations via respective government departments:	R510m
South African Development Trust Fund	*R277m*
Local Authorities loans fund	
New loans	R103m
Grants	R 4.6m

CENTRAL GOVERNMENT CORPORATE INSTITUTIONS

South African Housing Trust	
Interest free loans from central government to trust	R445m
Development Bank of Southern Africa	
Loans for urban development	R258m
The Independent Development Trust	
One off allocation from Central Government	
Housing Capital Subsidy Scheme	R750m
Housing loan finance	R120m

REGIONAL AND LOCAL INSTITUTIONS

Provincial Administrations	
Four provinces capital expenditure	R 18.9
Housing administration costs	R 4.3m
Transvaal direct expenditure	R 11m
(Bridging finance to BLAs)	(R650m)
Self-governing territories	
Land, internal services, superstructures	R 82m
Bulk infrastructure and community facilities	R 83m
Housing administration costs	R 9m
Local Authorities	
Major portion of finance provided by respective Housing development funds already itemised. They also obtain funds from regional services councils/joint services boards, the Development Bank of South Africa, the Local Authorities loan fund and the private capital market. The last is not significant. All the other funds have already been counted.	
Regional Services Councils	
Direct provision of internal services	R416m
Bulk services	R 84m

Source: de Loor Commission

TABLE 2.2 AGGREGATE FISCAL IMPLICATIONS FOR HOUSING (capital expenditure only) 1990/91

Institution	Appropriations by the Central Fiscus	Expenditure by the public sector
	R m	R m
Central Government Departments	224	224
Housing Funds	510	887
Local Authorities Loans Fund	-	103
South African Development Trust Fund	175	175
Provincial Administrations	30	30
Self-governing territories	145	145
TBVC states	247	247
South African Housing Trust	-	195
Development Bank of SA	258	258
RSCs/JSBs	-	590
TOTAL	1 589	2 854

Notes: 1. Local authorities are included under other institutions.
2. The fiscal impact of IDT housing expenditure and the Strategic Oil Fund ad hoc allocation are not included as their impact will only be reflected in 1992 and 1993.
3. The DBSA amount excludes loans already included under other institutions.

Source: De Loor Commission Report, p174

BUDGETARY IMPLICATIONS OF SANITATION SHORTFALL

The total cost of providing all people living in urban areas in 1990 with full waterborne sanitation is at least R5.1 billion (assuming 6 people per household and an average cost of R4 000 per household).

The total cost of providing for both the backlog and for new households who will be living in urban areas by the year 2000 is at least R11.1 billion (using above assumptions and predicted urban population growths of the Urban Foundation).

The above represents an annual expenditure of R1.38 billion per annum over the next 8 years, or 0.58% of Gross Domestic Product per annum, and would account for approximately half the current total spending on housing of R2.8 billion.

3. EVALUATION OF SANITATION OPTIONS

3.1 INTRODUCTION

The second phase of the report involved an evaluation of the various types of sanitation systems commonly used in the urban South Africa.

As part of the urban survey carried out in the first phase of the project, questions relating to the operation and maintenance of sanitation systems were also asked of practitioners in the field. During the course of the survey of urban areas and a review of current sanitation practise in South Africa, the following points became apparent:

- Inadequately maintained sewer reticulation systems were causing substantial adverse environmental impacts, most often as a result of leaking and blocked sewers, but also sometimes as a result of overloaded or inadequately operated or maintained treatment works and failed pump stations.

- Only a small percentage of the approximately 5.5 million pit latrines were improved VIP latrines. Conversion of existing pit latrines to VIPs could make a significant health and user convenience impact at a relatively low financial and economic cost.

- Approximately 2 million people use bucket sanitation. Problems with the operation of bucket collection systems were frequently reported, giving rise to dissatisfaction amongst users and potential health risks.

- Although increasing numbers of LOFLOS are being installed, concerns as to their acceptance to communities, their capability to function effectively from a technical point of view, the organisational capacity required to manage them and their possible impact on ground water quality were widely expressed.

- It was apparent that there existed a general perception (not necessarily justified) amongst practitioners in the field of sanitation that the negative environmental impact of on-site sanitation systems is much greater than that of full water-borne sanitation systems.

- Providing waterborne sanitation to all urban dwellers by the year 2000 would require an investment of at least R11 billion over the next 8 years. Such an investment would result in a heavy burden on the economy, necessitating the need to examine the costs of sanitation systems.

It was decided to focus on these issues during the second phase of the project and to use a case study approach. The following case studies were thus carried out:

- Investigation into the operation and maintenance of a waterborne system
- Social, technical and economic evaluation of two urban VIP programmes in Natal
- Technical and social evaluation of LOFLOS systems
- Evaluation of the operation of a bucket collection system and its social acceptance
- Comparative evaluation of the relative environmental impact of waterborne, septic tanks (anaerobic digesters) and VIP sanitation systems.
- Comparative evaluation of the costs (capital and operating) of waterborne, VIP, LOFLOS and bucket sanitation systems

These case studies are documented in separate working papers. The main points arising from these evaluations as well as other important insights derived during the project are summarised in this section of the report.

3.2 WATERBORNE SANITATION SYSTEMS: OPERATION AND MAINTENANCE

As part of the questionnaire circulated to all local authorities, the question was asked: "How would you rate the level of problems you experience with the operation and maintenance of your sanitation systems?" The following responses were received:

	Serious Problems	Moderate Problems	Few Problems	No Problems	No Response
Sewer blockages /overflows	28	99	124	37	263
Operation of treatment works	10	40	98	85	318

Of the 288 local authorities who responded to the question relating to sewer blockages / overflows, only 13% had "no problems", whereas 44% had moderate to serious problems. In contrast, only 21% of those who responded had moderate to serious problems with the operation of treatment works. This indicates that the difficulties with waterborne systems are concentrated at the reticulation or user end.

The information obtained from the survey was corroborated by sanitary engineers and consultants working in the field.

The key points that emerge from a consideration of current operation and maintenance practice are:

- It is frequently the case that insufficient resources are committed to the operation and maintenance of sewer reticulation, resulting in a deterioration of the capital asset and increased maintenance requirements and costs.

- In many instances their is a shortage of skilled personnel which has a cumulative effect on maintenance planning with the same results as above.

- Systems are often not treated with adequate care by the users as the result of poverty (toilet paper is often too expensive), inadequate education as to the proper use of the system and/or deliberate mischief. The major factor here is the introduction of a substantial quantity of extraneous materials into the system resulting in more frequent, and sometimes excessive, numbers of blockages.

- There is pressure on design consultants and contractors to reduce system costs due to severe financial constraints. This sometimes results in less robust and / or poorly constructed systems. These factors aggravate the problems arising from system abuse.

- The major effect of inadequately operated and maintained reticulation systems is a high frequency of sewer blockages and spills causing raw sewage to flow into rivers, impoundments and the sea. The potential negative health and environmental impacts arising from this is of great concern.

A case study done on the Mdantsane sewer reticulation system was carried out. The purpose of this study was to illustrate the problems that can typically be experienced in a context of significant resource constraints and a high level of system misuse, and to draw out the lessons that can be learnt from this for policy makers, system design engineers and those involved in the maintenance of water-borne sanitation systems.

Although the basic design of the Mdantsane system was sound, numerous problems have been experienced in effectively operating and maintaining the system, the most important being the numerous sewer blockages which occur and the mechanical failures at the pumping stations and the older Mdantsane wastewater treatment works. For example, an average of 10 blockages were reported per day, widely distributed over the entire reticulation network. The major consequences of these problems are an inconvenience to residents (in cases where raw sewage flows through populated areas) and a significant environmental impact on the Bridle Drift Dam (East London's potable water supply).

The underlying reason for these failures is resource constraint. The direct causes of the failures are: poor construction, as the result of a need to cut costs, and which has resulted in instances of poor pipe laying and negative gradients; the use of (cheaper) pitch-fibre pipes which are susceptible to collapse (for example through inadequate pipe support during pipe laying) and holing (during pipe unblocking) and a high level of system misuse (directly and indirectly related to the poverty of the residents).

The resource constraints can be related to the poor economic position of the residents which is exacerbated by the lack of an economic base for the town of Mdantsane. (Mdantsane was an apartheid creation, artificially situated in the Ciskei and away from the economic centres in the area - East London and King William's Town.)

The high level of system misuse is partly the result of the poverty of the residents (which has had the effect that many of the residents do not use toilet paper resulting in high loads of newspapers, rags, stones and other materials into the system), partly the result of a lack of education and partly from deliberate system abuse (introduction of foreign matter into the sewers)

The poverty of the residents (as well as possible political factors) has meant that the Ciskei Government has not been able to recoup the operation and maintenance costs from the community (cost recovery is approximately 50%). A real constraint on the money available to spend on system maintenance exists and it is possible that maintenance expenditure is only a third of what it should be. This has meant that maintenance has historically been reactive, leading to a deterioration of the capital asset and increased maintenance requirements and costs.

The key lessons that can be learnt from this case study, and which are corroborated by international experience (Yepes, 1990) are:

- In the context of increasing resource constraints in the urban areas of South Africa, the above scenario is likely to repeat itself unless concerted steps are taken to combat the trends described.

- Full waterborne sanitation systems should only be installed where residents are able to afford the full maintenance and operation costs of the system. If this policy is not adopted, the operation and maintenance of these systems will continue to drain fiscal resources with the following consequences:

    - adequate resources will not be made available for proper maintenance which will result in the system not functioning adequately (as described above) and a rapid decline in the value of the assets

    - and/or scarce resources will be diverted from other social investment needs, resulting in a few benefiting at the expense of others.

- Reasonable rates which cover, at the very least, operational and maintenance requirements, should be implemented by all institutions operating and maintaining sanitation systems for the same reasons as outlined above.

- Institutions should develop distinctive organisational cultures, job stability in the mid-management and professional positions so as to attract good quality staff and retain continuity in the achievement of long-term objectives.

- Institutions should develop effective cost accounting systems that allow better financial management.

- The use of private contractors should be considered as a means of increasing staff productivity.

- Monitoring indicators should be used to assess the performance of institutions operating and maintaining sanitation systems. Some useful indicators are:

    - staff per 1000 sewer connections
    - salary cost as a percentage of total operating costs (excluding depreciation)
    - number of sewer blockages per 1000 sewer connections per month
    - response time to sewer blockages

- Cost accounting should reflect total costs and subsidies should be transparent.

3.3 VIP LATRINES IN THE URBAN CONTEXT

3.3.1 Introduction

A detailed evaluation of two urban VIP programmes was carried out as part of this project (see Working Paper B2). The key points arising from this evaluation as well as from other sources are summarised below. This discussion concentrates on social and technical aspects of urban VIP programmes. The cost of VIPs and their environmental impact are discussed in sections 3.6 and 3.7 respectively.

The two VIP implementation programmes chosen for evaluation were: the Umlazi In-fill Scheme and the Bester's Camp In-situ Upgrade Scheme. Both of these projects are in densely settled urban areas in the Durban Functional Region and involve the in-situ upgrading of informal settlements. Both projects are relatively new (less than 2 years) which represents a limitation from the point of view of assessing the viability of pit emptying. However, no long established programmes were found in South Africa which would have suited this purpose.

3.3.2 Key Findings

People will generally aspire to having full water-borne sanitation. VIPs will therefore be regarded as something of a second rate option. However, a significant finding of the investigation was that the community at Bester's Camp were able to accept (in fact, chose) VIPs as an appropriate medium term solution in the light of their present circumstances on the condition that making such a choice would not cut out the possibility of having full water-borne sanitation in the medium to longer term. Furthermore, once the VIPs had been installed, the incidence of complaints and problems experienced was remarkably low in both communities (although it is not clear how the VIPs will perform in the long run). This is particularly striking when compared to the findings of the parallel Low Flush On-site, Anaerobic Digester systems case study (see section 3.5). All the VIPs inspected during site visits were clean, odour free, fly free and well constructed. In both cases the general community response was that the construction of the VIPs had led to a considerable improvement in their living environment and worked satisfactorily.

3.3.3 Applicability

The particular circumstances of each community have undoubtedly contributed to the success of the two projects evaluated. These factors include:

- The VIPs were installed into areas that were already informally settled. The provision of waterborne sanitation would have required the relocation of a significant proportion of the settled community.

- The communities in both areas were settled on steep topography. Sewer provision in these circumstances is particularly expensive.

- In most (although not all) of the areas in both projects, no bulk sewer connectors existed. The cost of water-borne sanitation would therefore have been significantly more expensive because of this.

- Both communities were particularly poor, with high levels of unemployment and low average household incomes.

- Both communities had settled illegally onto the land. They were therefore not in a strong bargaining position with the local authorities.

In summary, the option of water-borne sanitation was effectively ruled out as an appropriate sanitation option.

VIPs were an appropriate alternative in these circumstances because:

- the VIP is the least expensive sanitation option in terms of both capital and operation and maintenance costs

- the operation of VIPs is reliable and relatively problem free based on existing experience in Southern Africa

- local labour could be used in their construction

- the soil conditions were suitable for VIPs

- the possible contamination of ground water was not an issue

- the community accepted (and in the case of Bester's camp, chose) the VIP as an appropriate sanitation option.

3.3.4 Community choice

The method of programme implementation was significantly different in the two projects. At Umlazi, the decision to provide VIPs was made by the KwaZulu Government and communicated to the affected residents. At Bester's Camp, the residents of the informal settlements were consulted by the Urban Foundation right from the start of the upgrade project. At first, the community was adamant that it wanted water-borne sanitation or nothing at all. Given the financial constraints governing the project, this was not possible. It took almost 2 years of negotiation for the community to agree to the installation of VIPs as a medium term solution, and only on the condition that by accepting VIPs they were not cutting off the possibility of obtaining water-borne sanitation in the medium to long term (10 to 15 years). This is an important point: where communities are given a choice of level of service (and it is strongly advocated that they are) it is important that the VIP option be seen as an up-gradable option and that communities be assured that they will not be locked into a certain level of service with no possibility of upgrading.

The involvement of community workers in the decision making process brings substantial advantages especially with regard to communities accepting "ownership", although disadvantages in terms of cost and speed of delivery may be experienced.

3.3.5 Technical Aspects

Influence of status on design

In both projects design was influenced by community perception of the product, rather than on the purely functional requirements of the VIP latrine. At Bester's Camp, the community chose the VIP design from a number of alternatives demonstrated to the community. The VIP design for each project is very similar: a concrete block VIP sub- and super-structure.

The VIP as a washroom

The lack of private space in the small houses within densely settled communities, has resulted in many of the VIP latrines being used as washrooms. The major requirement, from a community point of view, is a larger toilet structure to facilitate it being used for bathing. The second requirement is that the impact of wash water

on the functioning of the pit needs to be assessed and if necessary a separate grey water soakaway provided. A third requirement is that the interior of the VIP be relatively light. (This does not necessarily compromise fly control).

Pit emptying

In both projects insufficient attention has been paid to pit emptying and it is possible that some of the VIPs at both sites will not be able to be accessed by existing pit emptying equipment.

Method of construction

Both projects made use of labour based construction, by training and using local small sub-contractors, who in turn employed people from the community.

3.3.6 Who Pays?

In both projects the capital cost was fully subsidised - by the KwaZulu and RSA government in the case of Umlazi and by the Independent Development Trust in the case of Bester's Camp.

The operation and maintenance costs of services (water, sanitation, refuse removal) are heavily subsidised in Umlazi, whereas at Bester's Camp running costs are fully recovered from the community, although in both cases residents will be expected to bear the pit emptying costs.

While such a subsidy for the provision of urban services for poor people is accepted in South Africa, this is not necessarily sustainable. In other countries it has been demonstrated that adequate sanitation can be provided without a subsidy: a successful urban VIP project in Lesotho practised full cost recovery through making credit available to households and facilitating the households to build their own latrines. (World Bank, 1991).

3.4 BUCKET COLLECTION SYSTEMS

As noted in Section 2, bucket systems, as they are applied in South Africa, are not considered to be an adequate sanitation system. The main reasons for this, which are borne out by the case study, include:

- The fact that flies are not prevented from reaching faeces in the bucket.
- Lack of provision for preventing odour release.
- Risk to the health of workers who need to handle open buckets on a regular basis.

Nevertheless, given the widespread use of this type of sanitation in the country, it was considered necessary to do some investigative work.

3.4.1 Social survey

A case study was carried out in the Silvertown area of Khayelitsha, part of the Cape Town metropolitan area. 100 interviews were carried out with 100 different households, to find out how people experienced the system. The site was also visited on a number of occasions by an engineer carrying out the research and meetings were held with the local authority representatives who were responsible for the system.

The results of the survey indicated widespread dislike of the system. The majority of people complained of odour, fly breeding, and poor service by the workers emptying the buckets. Less common but significant complaints related to the ease with which faeces could be obtained for the purposes of witchcraft directed against the household.

The workers who collect buckets commonly applied their own rules. For example, people were not allowed to urinate into the buckets. If urine was found, the bucket would be tipped onto the doorstep of the house concerned.

It is apparent that the service provided in this area was a particularly bad one, probably due partly to the fact that Silvertown is a transit area and partly to the fact that buckets are shared by two households. This latter situation was the source of regular conflict between neighbours.

3.4.2 Costs

Information provided by Lingulethu West Town Council, the local authority, indicated that the cost per bucket removed was R3,50. This is comparable with costs in other areas but, due to the sharing of buckets gives a comparatively low cost per household.

3.4.3 Conclusion

There is currently little argument to support the ongoing use of the bucket system in South Africa. It offers low protection against disease and low user satisfaction. Also, in relation to other systems which are available it is comparatively expensive.

However, there has also been little innovation in this area and there is scope for improving the way in which bucket collection systems are operated.

3.5 LOFLOS SYSTEMS

3.5.1 Introduction

A case study on a number of different LOFLOS systems (all with on-site soakaways) installed in Ivory Park and Duduza in the Transvaal, including both a technical evaluation and a social survey, was carried out as part of this project. Ivory Park and Duduza were selected because of the variety of LOFLOS systems used and the large number of units that had been installed. In both townships people do not have on-site water supply but have a standpipe a short walking distance from their homes. This is an important consideration because flushing water needs to be carried to the toilets.

The most important issues arising from this study are discussed below. For further detail, see Working Papers B3.1 and B3.2.

3.5.2 Social

In the social survey at Ivory Park and Duduza, 250 interviews were carried out, each at a different house. 74% of people interviewed said there was nothing that they liked about their toilet, with little difference between those using the various makes. The responses to the question "What don't you like about the toilet?" are summarized below:

Flushing arrangement doesn't work properly:	31%
Problems relating to digester and soakaway (filling with sludge, blocking, overflow):	35%
Blockage at pedestal or inlet to digester:	19%
Smells, including "plastic" smell when sun heats up certain of the units:	44%

While the overall dislike for the units was more or less equal, regardless of make, there was considerable variation in the reasons for the dislike shown above. For example, for one make with a very small digester, 66% of users had problems with the digester and/or soakaway. Because there is no backup service offered, people were forced to clear blockages, empty tanks and reconstruct soakaways themselves. The consequence has been that many have excavated pits on their generally small sites, and in some instances this exercise had to be repeated several times within an 18 month period.

Inadequacies with the specific designs are also reflected in the case of the flushing mechanism. For one system 49% of people complained of improper operation of the flushing mechanism in contrast to 13% for another make.

The response of these people to their LOFLOS is obviously strongly related to the specific technical design characteristics of the toilet, digester and soakaway and does not mean that LOFLOS *per se* are unacceptable to communities. However, the results of the survey do show that the development of adequate specifications for LOFLOS, together with proper supervision of construction and an education programme as to the proper use and maintenance of these systems is a prerequisite before these systems will be able to find widespread application in South Africa.

3.5.3 Technical

An on-site investigation and technical evaluation of the LOFLOS systems installed at Ivory Park and Duduza revealed a number of basic problems:

- Inadequate volumes for sludge storage had been provided for, causing sludge carry over into the soakaway within a short period of time after commissioning of the units.

- The infiltration surface of the soakaways and hence their infiltration capacities were too small. The infiltration capacities were also further reduced by sludge carry over from the digester tank.

- Inadequate control over the construction of the systems were exercised, resulting in cases where no soakaway had been dug at all, or where only 2 of 3 stones were placed in a small hole to serve as a soakaway.

- No soil permeability tests had been conducted prior to the installation of the LOFLOS to ascertain the suitability of the site for on-site sanitation systems.

- A high occurrence of failed flushing mechanisms was found (this is corroborated by the social survey)

In the light of these findings, wide ranging discussions with practitioners and relevant authorities have been held and a process has been set in motion to develop a set of guidelines for the design and construction of LOFLOS and soakaways.

3.6 ENVIRONMENTAL IMPACT

3.6.1 Introduction

All sanitation systems have an impact on the bio-physical environment. This section outlines the potential environmental impacts of sanitation systems and compares the relative impacts of on-site and off-site systems on the environment using a simplified mass balance model. The general perception that on-site systems compare unfavourably

with off-site systems in terms of the magnitude and nature of their negative impacts on the environment is shown to be inaccurate.

It should be noted, however, that the discussion is presented here in outline only. For a more thorough discussion on the environmental impact of sanitation, see working papers B5 and B5.1.

3.6.2 Potential environmental impacts (direct and indirect) arising from sanitation systems

Sanitation systems can impact on the (bio-physical) environment in the following ways:

- **on water**, in a quantitative way through increased water use, and in a qualitative way through the passage of organisms and chemicals from the human body into the natural environment. Of particular concern in this regard are the following:

  Nitrates: High levels of nitrates in water can have an effect on health if the water is used for drinking (the risk of methaemoglobinaemia in infants) and also on the ecology of the water body through eutrophication - the excessive growth of algae and larger aquatic plants.

  Phosphates: Phosphates may cause eutrophication of rivers and impoundments. Phosphates are usually the limiting growth nutrient and hence are targeted in water quality control strategies.

  Organics: High concentrations of organics disturb the ecology of water bodies, causing the deoxygenation of the water and the die-off of aquatic life dependent on oxygen. In addition to this there is an associated human health impact through the transmission of organic micro-pollutants by water.

  Micro-organisms: The effect of pathogenic micro-organisms which enter the water environment is also indirect: where such infected water is used by humans, the risk exists of a spread of disease (see Working Paper A2).

- **on soil**, through the application of treated sludge on agricultural land, or, through the saturation of soils in the vicinity of on-site sanitation systems, for example.

- **on air**, in the form of odours and aerosols. In the former case the effect is largely related to the way humans perceive the odours while in the latter it is generally treatment plant operators who risk being infected by aerosol carried pathogens.

3.6.3 Relative environmental impact of different sanitation systems

During the second phase of the study, an investigation into the relative environmental impact of different sanitation systems was carried out. The aim of the investigation was to illustrate quantitatively, in purely theoretical terms using a simplified model, the potential and likely relative environmental impact of different sanitation systems. The results of this investigation are summarised below:

The model traced the pathways of three chemical indicators - Chemical Oxygen Demand (COD), Nitrogen, and Phosphorous - from their source in human waste to their final destination in ground or surface water. Comparative information for the possible environmental impact of stormwater run-off was included for purely illustrative purposes and these figures should therefore be treated with caution.

Three sanitation systems modelled were: Full water-borne sanitation, Septic Tanks (On-site anaerobic digesters with soakaways), and VIP Latrines. Little is known about the environmental impact of LOFLOS with on-site soakaways because of their relatively recent introduction in South Africa and these were therefore not included in the model. Research into this area is currently ongoing, funded by the Water Research Commission.

The model assumes a catchment with the following characteristics: Settlement Population: 100 000; Number of stands: 20 000; Average stand size: 250 m²; average density: 14 stands per hectare; total area: 1400 hectares; no piped stormwater; wastewater is exclusively domestic in origin.

The following assumptions on the daily loads originating from domestic wastes were made:

1. Chemical Oxygen Demand (COD):	100	g/cap/day
2. Total nitrogen (TKN as N):	10	g/cap/day
3. Total Phosphorous:	2.5	g/cap/day
4. Water consumption (full WB and Septic):	114	l/cap/day
5. Water consumption (VIPs and standpipes):	30	l/cap/day
6. COD concentration in domestic effluent:	1 100	mg/l
7. Phosphorous in grey water:	0.88	g/cap/day

The results of the model, depicting the relative impact of the three sanitation systems in absolute terms are summarised graphically in figures 3.1 to 3.3. The graphs show the minimum, maximum and average loadings in kg/annum that can be typically expected.

VIP + GW refers to a VIP system with the sullage (domestic grey water) loading included.

Figure 3.1

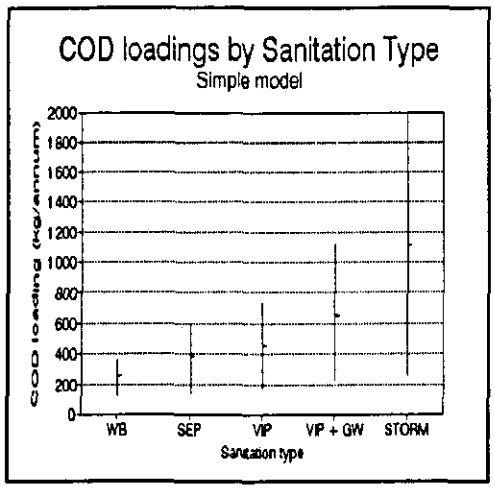


Figure 3.2

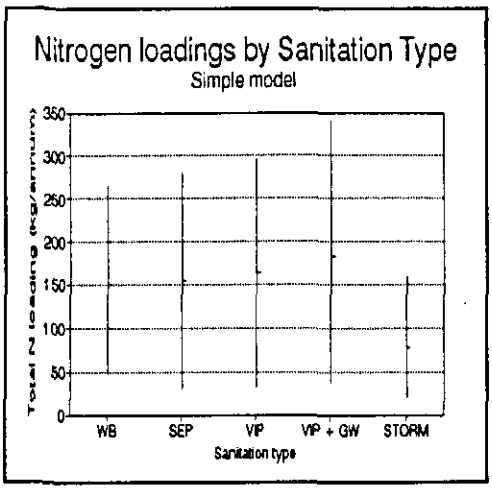
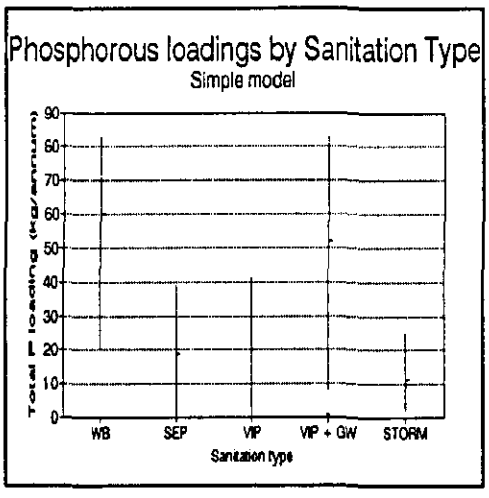


Figure 3.3



COD

Waterborne sanitation systems offer the best COD removal. However, under good conditions the COD removal by septic tanks and VIP latrines will compare favourably with full water-borne systems. However, the total COD contribution of stormwater may greatly exceed the loadings from sanitation systems. The implication of this is that the choice of sanitation technology will not have be a major influence on the total COD loading into the environment although in dry, low run-off conditions it may become important.

Nitrogen

The total load of nitrogen on the environment is system and site dependant and may vary greatly. Where soil conditions are favourable, nitrogen removal from septic tank and VIP systems may compare favourably with water-borne sanitation systems using denitrifying treatment works.

Phosphorous

Unless a treatment works is specifically designed and operated to remove phosphorous, septic tanks and VIP pit latrines will almost always provide greater phosphorous removal than water-borne sanitation.

Microbial pollution

The path of micro-organisms through the various sanitation systems is important because the risk of disease is increased where pathogenic organisms occur. The following points are of note:

- In a water-borne system with no disinfection and no maturation ponds, pathogenic bacteria pass straight through the system (including the waste water treatment works) into the river.

- The application of a disinfectant, usually chlorine, is expensive and also generates secondary environmental impacts (production of chlorine in factories; generation of complex organics in river systems which can be carcinogenic; direct impact of chlorine on river life - fish mortality; and health risks to workers handling chlorine gas).

- Under normal conditions soil acts as a very effective and efficient filter which removes bacteria and viruses from the water migrating through the soil. On-site sanitation systems, if properly designed and used in appropriate soil conditions will therefore generally be effective in removing pathogenic bacteria from the human environment. Where the soil is excessively coarse, the water table is high or conditions exist which might cause short circuiting (for example rock fissures), contamination of ground or (less commonly) surface waters may occur.

3.6.4 The relative impact resulting from system failures

The above results are based on the assumption that the systems have been adequately designed, constructed and maintained. This is, however, not always the case, and it is therefore instructive to outline the relative environmental impacts in the case of system failures.

Full waterborne systems undoubtedly pose the most serious threat to the environment in the case of system failure. In general, failure can occur in three ways: reticulation failure (pipe blockages), pump station failure and treatment works failure (under-capacity, under-maintained, incorrectly operated). In all cases the failures give rise to significant point source pollution with high nutrient and microbial loadings possibly posing a serious health hazard.

Much evidence exists of such system failures in the urban areas of South Africa, indicating that this is a serious problem. However, little research exists to give a quantitative estimate of the extent of the problem and offer solutions to it.

Whereas waterborne system failures almost always give rise to point source pollution with high concentrations and loadings, the converse is true of on-site systems. System failure is almost always restricted to the site itself and therefore the potential for widespread pollution is much reduced. Where failures do occur, these are most commonly associated with poor location of pits and soakaways, resulting in overflows and short circuiting to the surface. In areas with high rainfall and steep terrain, such failures are likely to be more prevalent.

3.7 COSTS

3.7.1 Introduction

A cost comparison of the various sanitation technologies commonly in use in South Africa was carried out as part of the second phase of the study. This section summarises the results. More detail on cost information may be found in Working Paper B6.

It is obvious that sanitation costs are very site specific and depend on a wide range of factors - size of population, density of settlement, green field/in-situ development, design factors, methods of construction, cost of materials, soil conditions, to name but a few. The aim of the exercise was, therefore, not to provide an exhaustive analysis of the costs of sanitation systems, but rather to provide a point of comparison between sanitation systems.

The costing exercise attempted to reflect the costs that might typically be expected in providing sanitation systems for the average urban South African who at the moment does not have adequate sanitation (approximately 7.7 million people). The costs also reflect the range in costs that will be experienced under different circumstances. The wide range of costs indicate the importance of carrying out a cost comparison of appropriate sanitation technologies for each project prior to making a decision as to which technology to opt for.

The capital costs are all-in **construction** costs (including VAT). It should be noted that the **real** cost will be somewhat higher when design, and indirect costs attributed to the developer are included. The costs are reported in 1992 Rands.

3.7.2 Cost summary

The costs are summarised in Tables 3.1 and 3.2.

The costs in Table 1 represent average costs. Net Present Values (NPV) and Annualized costs have been calculated on the basis of these average costs. These have been calculated using an interest rate of 19%, an inflation rate of 15% (ie. a real discount rate of 3.5%) and a 20 year project life.

The range of costs that might typically be experienced for each sanitation system under different conditions is shown in Table 2. NPVs and annualized costs have not been calculated for these ranges because it may be the case that low capital costs are associated with higher operating and maintenance costs.

Table 3.1 Average Costs for Sanitation Systems (1991 Rands)

	WATERBORNE SANITATION	LOFLOS	VIP	BUCKETS
CAPITAL COSTS (per site)				
On Site	1 100	1 200	1 500	600
Reticulation	1 400	-		
Connector Service	*500*	-		
Treatment Works	700	-		
TOTAL (A)	3 700	1 200	1 500	600
O & M COSTS (per site p.a.)				
On Site Maintenance	45	63	27	15
Water	130	9		
Reticulation	80			
Collection/Emptying		20	20	228
Connector Service	15			
Treatment	33	10	10	25
TOTAL (B)	303	102	57	268
Household direct (per month)	R14,60	R6,00	R2,20	R 1,30
Municipality (per month)	R10,70	R2,50	R2,50	R21,10
NET PRESENT VALUE (NPV)				
(A + B x 14,1)	7 970	2 640	2 300	4 380
TOTAL ANNUALIZED COST/HOUSEHOLD (TACH)				
(A x 0,0704 + B)	565	186	163	310
per month	R 47	R 16	R 14	R 26

Calculation of NPV

$$NPV = Capital + (O + M) * \frac{(1+i)^N - 1}{i(i+1)^N}$$

N = *project life* = 20 years

i = *real discount rate* = $(\frac{1+r}{1+f} - 1)$ = 0.035

r = *interest rate* = 0.19

f = *inflation rate* = 0.15

O = *annual operating cost*

M = *annual maintenance cost*

Calculation of TACH

$$TACH = (O + M) + Capital * \frac{i(1+i)^N}{i(i+1)^N - 1}$$

i = *real discount rate* = 0.035

N = *project life* = 20 years

Table 3.2 Cost ranges for Sanitation Systems

	WATERBORNE SANITATION	LOFLOS	VIP	BUCKETS
CAPITAL COSTS: (per site)				
On Site	800 - 2 000	800 - 3 100	600 - 3000	500 - 1 100
Reticulation	600 - 2 500			
Connector Service	*100 - 1 000*			
Treatment Works	300 - 1 500			
TOTAL	1 800 - 7 000	800 - 3 100	600 - 3 000	500 - 1 100
O & M COSTS: (per site p.a.)				
On Site Maintenance	15 - 60	30 - 100	5 - 40	5 - 25
Water	80 - 240	3 - 15		
Reticulation	20 - 120			
Collection/Emptying		10 - 40	10 - 40	160 - 280
Connector Service	1 - 30			
Treatment	13 - 106	5 - 20	5 - 20	10 - 80
TOTAL	129 - 556	48 - 175	20 - 100	175 - 385

3.7.3 Discussion

The Total Annualized Cost per Household (TACH) figures from Table 3.1 are converted to monthly figures and are summarized as follows:

Waterborne sanitation	R47 pm
LOFLOS	R16 pm
VIP	R14 pm
Bucket	R26 pm

These figures represent the amount that a household would need to pay per month at 1992 price levels for the full cost of the sanitation system, including interest and redemption on the capital amount and assuming full cost recovery from the household.

It is clear that waterborne sanitation is substantially more expensive than the other options (three times the cost of on-site systems and twice the cost of a bucket system). However, while it is the most expensive, it also provides the greatest degree of satisfaction from the point of view of the user.

Bucket systems cost twice that of on-site systems and yet are less socially acceptable and less satisfactory from a health point of view.

The on-site systems are the most cost effective. It is indicated that there is little difference in the overall cost of the two basic types - LOFLOS and VIP. VIPs may cost more to construct but cost less to operate and maintain.

The way in which the costs are recovered varies considerably between the four options with the local authority playing a major role in the case of full waterborne sanitation and bucket systems. On-site systems can generally be operated and maintained with input from the local authority limited to education, advice and the provision of a pit/tank emptying service.

4. ISSUES RELATING TO THE FUTURE PROVISION OF SANITATION IN SOUTH AFRICA

The issues discussed in this section are intended to provide background information which will allow strategies to be formulated to improve the provision of adequate sanitation for all South Africans living in urban areas. These "issues" are considered to be key factors influencing sanitation provision.

4.1 BACKGROUND: SANITATION AS PART OF HOUSING AND BULK SERVICES

Sanitation provision in urban areas can generally not be separated from the provision of a "package" of services which includes water supply, refuse removal and access roadways as a *minimum*. This package of services (excluding their bulk components) is generally funded and managed in the same way.

From the point of view of funding, this package of services can be considered as part of "housing". There is a large body of opinion, supported by the findings of this study, which holds that the capital cost of providing internal services should be included as part of the purchase or rental price of a housing package, whether this includes a house or just a serviced stand. The issue of subsidies is separate and does not change this principle.

The above points are important because it means that many of the decisions regarding sanitation are decisions which relate to housing provision.

Where "off-site" sanitation systems are used, the bulk service component - comprising the connector service (outfall sewer) and treatment works - is often dealt with separately from the point of view of funding and management. Although this creates some difficulties, there are sound reasons for this.

4.2 NEW INITIATIVES

In August 1991 a broadly representative National Standing Committee on Water and Sanitation was established for the purpose of promoting the development of a coherent and coordinated approach to the formulation of water supply and sanitation policy and strategy. This Committee marks an important start to the formulation of policy which strives to address the current situation meaningfully and which has the support of a wide range of community, professional, institutional and political bodies.

Also, late in 1992, the National Housing Forum was established. This is a broadly participative body looking at long term housing policy in South Africa. Such policies will have an impact on the possibilities for sanitation provision.

4.3 NATIONAL ISSUES

4.3.1 Rationalisation of institutions

Probably the most fundamental difficulty in providing adequate sanitation for all relates to the geographical and racial subdivision of the country, with 14 government departments setting policy. The "re-unification" of South Africa is now likely and what is needed is sensible interim arrangements which facilitate the move towards a common policy.

4.3.2 Overall objectives

The second fundamental difficulty relates to the setting of a national objective and making provision for the funding, implementation and regulation of activities aimed at achieving this objective.

The national objective with regard to the provision of sanitation should recognise the aspirations of people to have a high level of service but take into account the ability of the economy to sustain the provision of such a service.

Currently there is no nationally recognized objective regarding sanitation provision. However, reference is made to sewage (sanitation) in the ANC's proposed bill of rights which states:

> "The State shall take steps to ensure that energy, access to clean water and appropriate sewage [sanitation] and waste disposal are available to every home"

This could possibly be used as the starting point for the formulation of a national objective.

4.3.3 "Some for all rather than all for some"

There are at least 7 million people in urban areas in South Africa who do not have access

to adequate sanitation. The vast majority of these people are poor. International experience indicates that the initial objective should be to focus primarily on the provision of a basic level of service to these people. If the level of service is too high, and thus too costly, the likely result is that a few will get access to this service and the majority will remain with nothing.

4.3.4 Equitable national subsidy for housing

Internationally it is becoming accepted that, where a subsidy is provided by the state for housing, this should be on the basis of a "one-off" capital amount. This subsidy arrangement is gaining acceptance in South Africa. It is already being applied by the Independent Development Trust (IDT) and has been recommended by the de Loor "Housing Commission" report for improving the provision of housing in South Africa to poor people. It is also the basis of the current housing finance debate at the National Housing Forum.

This subsidy arrangement has the advantage that everyone can be provided for equally and that people will take decisions regarding level of services on the basis of economic principles.

The amount of the subsidy is a matter of debate which centres on the capacity of the economy to facilitate large public expenditure on housing. The investment in housing must be viewed in the context of other public investments in health care and education amongst others. There is general agreement among economists that the economy can afford to provide for at least a basic level of service for all poor people in South Africa. Additional expenditure required for a higher level of service and better housing would, in this case, be borne wholly by the individual household.

The corollary of the one-off capital subsidy scheme is that the full operation and maintenance costs of sanitation (and other) services should be borne by the user.

4.3.5 Bulk services subsidy (from the state)

If a subsidy for bulk services (outfall sewers and treatment works) is provided by the state, a bias is introduced which favours a high level of service: full waterborne sanitation. This is difficult to justify, particularly given the difficulty most people will have in paying for the ongoing cost of this service.

The present Department of Water Affairs and Forestry (DWA) subsidy for water and sewage works should therefore be questioned, not only on the above grounds, but also because it is focused only on smaller towns. The emphasis in smaller towns should rather be towards the provision of simpler systems.

4.3.6 Access to loan finance

Local authorities need access to loans both to upgrade internal services where communities can afford this and to provide bulk services. This should be the function of a national body such as the Development Bank of Southern Africa. Keeping the loan function outside of central government has the advantage that hidden subsidies can more easily be prevented from occurring.

Individual households also need access to loan finance in order to improve on their standard of housing. The banking and finance sector in South Africa has not been able to provide home loan finance (less than R30 000 and especially less than R12 000) on a significant scale to poor people. This needs to be addressed at a national level.

4.3.7 Regulatory functions

Regulations pertaining to sanitation should be made at a national level concerning two basic issues:

- the appropriate safeguarding of present and future water resources (both surface and ground);

- the maintenance of a certain minimum level of sanitation service (based on health criteria, not on convenience) to be provided by local authorities and the parallel application of primary health care provision.

Unless a new environmental protection agency is introduced, the first function will remain as a "water affair". The second function will remain a health issue. However, in both instances the current situation is untenable, given the fragmentation of policy making bodies in the country.

4.4 REGIONAL ISSUES

4.4.1 Role of regional authorities

At present the provincial administrations (and homeland governments in the sense that they are regional authorities) play a substantial role in sanitation provision. However, they do this primarily where local authorities are either non-existent or too weak. When local authorities are rationalised, the role of regional authorities in the provision of sanitation services should largely fall away.

In a context of a uniform national housing subsidy and a strong central government, the regional authorities would not have a strong role to play in the provision of sanitation services in urban areas, as this would take place at the local level. The situation may be somewhat different in the rural areas - here regional bodies may well have a part to play.

In a federal model of government, the regional authorities could exercise some of the regulatory functions relating to sanitation that would have been exercised at the central government level. However, subsidy arrangements should still be made at a national level.

4.4.2 River catchment management

Sanitation has an impact on the water environment. The most effective means of managing water resources is integrated catchment management which should include the regulation of water quality in the catchment. In the case of larger catchments particularly, this can be seen as a regional function.

4.5 LOCAL ISSUES

4.5.1 Restructuring of local government

The inadequate provision of urban services to poor people in urban areas in South Africa is largely related to the way in which local authorities have been structured, resulting in the perpetuation of authorities which lack political support and are not economically viable. It is now widely accepted that local authorities will need to be restructured and rationalised across racial lines. Until this is done, interim measures are needed to improve co-operation between authorities.

4.5.2 Metropolitan areas

The situation in the metropolitan areas is complex. It is however likely that a metropolitan authority will be formed in each metropolitan area. In this case, it is probable that the provision and operation of bulk sanitation infrastructure will be the responsibility of the metropolitan government. Such an authority will have the resources (both financial and personnel) to adequately operate and maintain the bulk infrastructure. If a second tier of local authorities is established or maintained, these would have responsibility for providing sanitation services at the household level.

4.5.3 Established towns

In established towns, once they are unified, local authorities could adequately provide for and maintain sanitation services in most cases. The sanitation service provided would be at a level that was sustainable by the community with the one-off housing capital subsidy contributing towards the initial capital cost of the sanitation service. The bulk services provided would be funded by the local authority (through loans) and recovered from the users of the service through rates.

4.5.4 Dense settlements

Dense settlements have been defined as areas, mostly in homelands, where people have settled in large numbers in locations where there is little economic base and little infrastructure. Often these areas are functionally part of a metropolitan area, such as the Inanda complex in the Durban Functional Region, but they may also be separate, which is the case with many settlements in KaNgwane, Gazankulu and Lebowa. In the former case the government of these settlements can be dealt with by incorporation into the metropolitan area. However, in the latter case lack of organisational structures and economic base make it difficult for local government to be established. However, local decision-making structures must be promoted, with regional government playing an interim role in managing these areas. Services need to be provided at a basic level, in order to maintain health standards.

4.5.5 Private sector involvement

The private sector has a role to play primarily in five areas:

- As designer, project manager and contractor involved in the process of service delivery
- As a manufacturer of components of sanitation systems.
- As a developer of housing and serviced land.
- As a provider of loan finance for housing.
- As a contractor in the operation and maintenance of facilities.

The role of the private sector is well established in the first two areas. Private companies have also been functioning effectively as property developers and financiers serving the middle and upper income market. With regard to the low income end of the market, the involvement of these firms will depend on the way subsidies are made available and collateral provided by the public sector. In this regard there is a contrast between the IDT approach to capital subsidies, which is private sector orientated, and the previous approach which has been public sector driven.

In providing housing finances at the bottom end of the market, sanitation is also being funded, as it is part of the housing package. However, finance houses do not currently make finance available to this market where loans of less than R15 000 would be the norm. New finance mechanisms are therefore needed.

The private sector has been increasingly active in the field of operation and maintenance of facilities, particularly treatment works. Their role in this area of activity is likely to depend on how efficient and cost effective their service will be in comparison to that delivered by public sector bodies.

Finally, a private sector approach provides scope for the involvement of small-scale enterprises in the process of services delivery.

4.5.6 Socio-economic aspects

Poor people have great difficulty in paying for services and yet it must be recognised that payment is necessary if the provision of such services is to be sustained. The financial support of the public sector is necessary but should be confined to the provision of capital subsidies as already discussed. This means that the full operating and maintenance costs (including capital redemption for bulk services) should be borne by the users.

As background to the issue of affordability, it is informative to note that, in 1990, there were 3,7 million black households in urban areas in South Africa. 2.5 million of these households (67% of the total) earned less than R1 000 per month (Urban Foundation, 1990).

The amount which households can afford and are willing to pay should be determined early in the planning process, through surveys and discussions with the community to be served. There is insufficient work done on this issue but, in order to put figures into perspective, the following is put forward: it could be argued that poor households cannot afford to spend much more than 15 - 20% of household income on "housing", including the rates bill (excluding the purchase of electricity). The rates bill should therefore not be greater than 5-7% of household income. This implies that only one third of black urban families can afford a rates bill (electricity excluded) of greater than R60 per month. In contrast to this the actual cost of urban services (including electricity) provided to Soweto residents in 1990 was R330 per household per month (van Ryneveld, 1992: pers comm.).

The above argument emphasizes that, in deciding on the level of service to be provided, the arrangement of on-site components and the payments associated with the service, it is vital that the people who are to receive this service be involved in the decision-making process.

4.5.7 Financial arrangements - capital expenditure

The role of the state in providing a housing subsidy has been discussed. This would generally be sufficient to provide the capital for internal services at a basic level.

Capital for bulk services is currently available in some areas as a grant from sources such as Regional Services Councils, National Housing Commission, homeland governments and tri-cameral departments. This needs to be rationalised and it is suggested that grant finance should <u>not</u> be made available at a national or regional level for sanitation bulk

services, especially since levels of capital investment are probably not sustainable.

However, at a local level the option for raising capital from the local rates base for bulk services is important. This represents a form of cross subsidisation and is currently being practised through the Regional Services Councils. The way in which this is done in the future will depend on the way in which local authorities are restructured and the strength of the rates base (overtaxing needs to be avoided).

If capital is not available for bulk services from the local rates base, then the funds will need to be borrowed from a source such as the Development Bank.

The net result of this is that areas with greater economic strength will have greater opportunity to fund a higher level of service (waterborne sanitation).

4.5.8 Financial arrangements -recurrent expenditure

It is assumed that recurrent expenditure will not be subsidised by the state and therefore needs to be funded from the local rates base. It is important that people pay the full recurrent cost of the service they receive. This should be done equitably for local authority areas so that people who receive the same level of service pay the same amount.

4.5.9 Technology choice

It is important that the technology applicable to sanitation provision be viewed as a spectrum of options. An example of a possible spectrum, ordered roughly in terms of technological complexity and cost, is shown below. It should be noted that this hierarchy is not necessarily in order of user acceptability.

- VIP latrines
- Aquaprivy with flush only to maintain water seal
- LOFLOS with flush mechanism, on-site anaerobic digester (septic tank) and soakaway.
- LOFLOS with flush mechanism, on-site anaerobic digester (septic tank) and solids-free sewer reticulation.

- Low flush toilet with conventional sewer reticulation.

- Full flush toilet with conventional sewer reticulation.

The transition from on-site to off-site treatment will depend on local conditions: soil type, topography, groundwater conditions and so on.

Similarly, the quantity of water used in a flush will depend on how much people can afford, the availability of suitable bulk supply, whether water can be delivered to each site and the capacity for the sanitation systems to dispose of the water. Also, in deciding on water volumes it is not necessarily the case that increasing quantities of water give a higher level of service from the users' point of view.

The choice of a technology option should not necessarily be long term. Sanitation systems should be designed for upgrading so that, should income levels in an area improve, service levels can also be improved.

It should be noted that not all of the options in the range of technologies used in South Africa have a positive track record and work needs to be done in pilot projects to evaluate these options.

All of the technology options should be considered by local authorities, consultants and communities at the project feasibility stage. The decision on which technology to opt for should be based on a holistic consideration of all the relevant factors. It should also take into consideration the possibilities for upgrading the service, which would generally imply improved user satisfaction but at an increased cost.

4.5.10 Orientation towards user

Sanitation systems are designed by engineers who, too often, focus their attention on what is underground: the reticulation, how it functions and how much it costs the authorities who employ them. In higher income areas an orientation towards the user was seldom important as it is taken for granted that full waterborne sanitation will be provided and that the households can pay the applicable costs. The users in low income areas, on the other hand, are substantially affected by on-site considerations and what the service costs. The issues from their point of view could look something like this:

- Status associated with unit, incorporating pedestal, flush system (where used) and building.

- Size of privy and building materials used.
- Comfort of pedestal, odours and ease with which unit can be kept clean and hygienic.
- Ongoing cost of system, both rates and costs paid directly by household.
- Siting of toilet inside or outside the house, recognizing that in-house toilets must be fail-safe.

In order for communities to make choices it is essential that sufficient information is made available to them regarding the options available.

Introducing community choice is central to the re-orientation of sanitation provision in South Africa. However, benefits of introducing such choice can only be fully realized if:

- Costs are not distorted.
- Users are informed.
- Users are free to choose.
- Charges are collected.

4.5.11 Project implementation

From an engineering point of view South Africa has a well developed capacity for implementing projects. However, more involvement by the non-government sector is needed in initiating projects and in responding to community needs.

It is particularly important for the social aspects referred to above to be integrated with physical implementation. Support programmes need to be set up to educate and assist individual households in operating new systems. These programmes should be community based and funds should be provided from within the project budget for this purpose. Support systems would also support individual upgrading.

4.5.12 Management of sanitation systems

With the restructuring of local government, the management of systems presently under black local authorities will improve. However, the areas where sanitation provision is worst are the dense settlements and metropolitan fringe areas where there is currently no effective local authority. Interim arrangements are needed for improving the management of urban services (including sanitation) in these areas.

The management of sanitation systems should incorporate user education and strive to build and maintain community support, both of these functions following on from community participation in the project implementation phase.

Where upgrading of the level of service is possible, a support system for users should be established, as part of the management arrangements.

4.5.13 Economies of scale

International experience has shown that important economies of scale can exist in the operation of water and sanitation systems. In metropolitan areas, it would in most cases be more efficient to have one institution (either the metropolitan authority or a specialised public sector [water and] sanitation institution) manage and operate the bulk service components of sanitation. But this could bring loss of accountability.

Outside of the metropolitan areas the ability of local authorities to manage sanitation systems depends on their size and income. Medium to large towns are likely to be able to manage their own systems. But in the case of small towns, or towns with low incomes, greater efficiency may be achieved by setting up small regional technical support teams which could provide management and technical support to a number of local authorities in the area, each of which might not have been able to support the necessary high level technical and management personnel.

5. KEY AREAS FOR ACTION

5.1 SCOPE

This section represents a summary of the key areas where action is needed to improve the provision of sanitation services to all people in South Africa. These areas have been identified partly through the research work which is reported in the earlier sections of this document and partly through inter-action with numerous people working in the water and sanitation sector. In order to structure this inter-action under this project, workshops were held with 400 practitioners in the field of sanitation, in six different centres in South Africa.

The orientation of the project has been on technical, socio-economic and environmental aspects. However, it has not been possible to ignore financial and institutional aspects as they have such a fundamental influence on the provision of sanitation services. Therefore they are dealt with here, but in a preliminary way. In order to address these latter aspects more completely, the Water Research Commission is funding further research into this area.

If action is to be taken, it is essential that this be identified with the particular organisations who would be in a position to take such action. For this reason the key areas for action are grouped here in relation to the type of organisations who would need to implement them.

5.2 CENTRAL GOVERNMENT

Setting of national objectives: National objectives for the provision of sanitation need to be set. This should be referred to the National Standing Committee on Water Supply and Sanitation.

Financial policy: Currently the most fundamental problem with sanitation in South Africa is the lack of a consistent funding policy at government level. This policy should be orientated towards the provision of a basic level of service for all, and should be demand driven. While it may not be possible for long term policy to be set until an interim government is in place, it is necessary for interim arrangements to be made.

Cooperation between departments: The departments of Water Affairs, Health and National Housing in the RSA government need to have greater inter-action. Also homeland governments need to be drawn into a process of inter-action: it is often in homelands where the situation with respect to sanitation is worst.

Supporting private and NGO sector: The policies for facilitating the provision of sanitation to urban communities should be orientated towards the involvement of the private and non-government sector. The way in which subsidies are arranged is particularly important in this respect.

Regulation: There are two issues of importance:

- The SABS applies standards to water closets which prevent the use of lower flush volumes. This standard needs to be withdrawn urgently and reworked, if necessary.

- The approach to regulating the use of on-site sanitation is poorly developed with the result that conflicting views are expressed by different departments and different offices. A common guideline is needed.

Local authority restructuring: In restructuring local government it is necessary that services provision is taken into consideration

Dense settlements: For the purpose of this document dense settlements can be considered as urban areas which are not proclaimed and therefore have no local authority. The sanitation situation in such settlements is generally poor and a particular focus on such areas is necessary.

5.3 LOCAL AUTHORITIES

Policy of RSCs and JSBs: Regional Services Councils and Joint Services Boards are playing an increasing role in the funding of sanitation services. Yet they are almost always doing this without a policy. This often leads to a situation where a high level of service is provided for a few while many have no service or an inadequate one. It is therefore essential that RSCs and JSBs who have sanitation (sewerage) as a delegated function develop a policy for funding of this service.

Policy of local authorities: Local authorities are in a process of transition with increasing understanding of the way integration is going to take place. This will substantially effect services provision generally and sanitation in particular. As this transition takes place it is important for policy regarding services provision, including sanitation, to be developed, along the following lines:

- An assessment of what financial resources could reasonably be expected from central government.

- An assessment of what rates and levies could reasonably be generated locally.

- An assessment of the demand for services (where demand is what people want and are prepared to pay for).

- Based on the above, an assessment of what level of service is viable taking subsidies into consideration.

Urban planning: In carrying out urban planning, sanitation provision must be kept in mind and particularly the need to provide for a range of options, including on-site sanitation. In parallel with this environmental assessment is important.

Guidelines: Local authorities need to have guidelines for the provision of sanitation services. It is intended that the guidelines prepared as part of this study could serve this purpose and could be modified by the local authority where necessary.

Delegation of responsibility to developers: Where development of new urban areas is planned, the local authority should clearly delegate responsibility to developers to apply proper procedures with regard to project planning and implementation. The guidelines are set up partly to define responsibility.

Local authority as developer: Where the local authority acts as the developer, proper procedure needs to be followed, as suggested in the guidelines. In particular a range of technology options needs to be assessed, taking social, economic, urban planning and environmental factors into consideration.

Ongoing management: Before a project is implemented, local authorities need to ensure that they have the necessary resources, both financial and human resources, to manage the services in the long term. In managing the sanitation service, user support and primary health education should be incorporated.

5.4 DEVELOPER

Involvement of private and community sector: Private developers and community based organisations need to become more involved in the process of property development for low income people particularly. It needs to be recognized, however, that this can only be done where there is an appropriate subsidy environment.

Responsibility of developer: The developer should take responsibility for the planning and implementation of projects and should carry the risk associated with such projects and should proceed only with proper community involvement in the process. Where necessary, the developer should delegate functions to other bodies such as consultants and non-government organisations.

User orientation: Projects should be planned and implemented with the primary orientation towards the user.

Project procedure: Proper procedure should be followed in the planning and implementation of projects. The draft guideline prepared as part of this project sets out such procedure. Particular aspects which require attention are:

- Environmental assessment: procedures need to be followed to ensure that the environmental impact of the project is acceptable.

- Socio-economic assessment: the developer needs to understand the social and economic issues associated with the project and plan the project in such a way that users needs are satisfied while, at the same time, the project is economically viable.

On-going management: Developers need to take more of a role in on-going management, particularly during the early period of use of the service when there is a need to educate and support users.

5.5 COMMUNITY

Awareness of options: Communities need to be made aware of the options available for the sanitation provision, and the advantages and disadvantages of these options.

Shared responsibility: The responsibility for the successful implementation of a project needs to be taken jointly by communities, in partnership with developers.

Affordability issues: The issue of what can be afforded should be central to negotiations over the level of sanitation service. In the long term if reliance is made on subsidies which are unsustainable, the service is likely to deteriorate.

Community and management: Communities need to be involved in the process of managing the sanitation service, both to allow them to understand the process and so that individuals can be trained to assist with the work required.

5.6 ENGINEER

Planning: Engineers play a leading role in the design and construction of sanitation services. Yet they take little responsibility for the planning of these services in the broadest sense where planning includes social, economic and environmental assessment. Engineers need to improve their knowledge of this area and accept a greater role in planning.

Application of technology: Over recent years poor decisions have been made in applying sanitation technology, leading to hardship amongst people who have had to use failed services. In general an engineer has been involved in the process at some point and should have taken greater responsibility in applying the technology correctly. It is therefore important for engineers to gain a better understanding of sanitation technology options and of how to apply these options.

Environmental impact: Engineers need to improve their understanding of the environmental impact of sanitation systems, particularly the relative impact of off-site and on-site systems.

Design: In designing sanitation services, orientation towards the user is essential, particularly regarding the on-site services. In contrast to the below-ground services, there has been a tendency to design what is least expensive and easiest to construct without considering the user's perspective.

Employment creation: There is a need for projects to be structured in such a way that labour can be used extensively and also that opportunities for locally-based small-scale contractors (entrepreneurs) can be created.

5.7 CONTRACTOR - PACKAGE UNITS

Responsibility: The recent history of provision of package units for sanitation has been characterized by lack of understanding of the technology and neglect of proper procedure in designing and installing such units. The result is that people have often been provided with an unsatisfactory service. Contractors have used two arguments to protect themselves from responsibility:

- That they provided what was specified, even if the specification was seriously lacking.

- That users do not know how to use the system.

If package units are to have a future in South Africa, contractors will have to take more responsibility for delivering a quality product which can be used without problems by unsophisticated users.

6. CONCLUSION

This summary report represents the outcome of two years of work on the urban sanitation evaluation project. During these two years a literature review and questionnaire survey were carried out, case studies were undertaken, workshops were held throughout the country and the results of all this work was written up in 24 working papers.

The report itself represents a summary of the situation, with conclusions drawn in sections 4 and 5 of the report. In this final section the report is concluded by relating the project outcomes to on-going initiatives to improve sanitation services to the poorly served.

Draft guidelines

Based on the findings of this project the need for guidelines to improve the provision of sanitation services was recognized. Therefore, as part of this project, a draft set of guidelines has been prepared which are aimed at improving the situation with sanitation in South Africa. These guidelines have the emphasis on proper planning procedures and proper delegation of responsibility. They deal with sanitation in a holistic way, including socio-economic, financial and environmental aspects.

The draft guidelines are not included with the project documentation set as they need to be worked into final form by a suitable authority or organisation who would be in a position to "own" such a document.

Further work funded by the Water Research Commission

The Water Research Commission is funding further work in the field of water and sanitation provision to developing communities. Of particular note is a project titled:

"Water supply and sanitation in urban areas: financial and institutional review".

This project, which is being carried out by Palmer Development Group, represents a follow-on from this urban sanitation evaluation project in that it deals with the policy aspects identified as a key area for action.

Sanitation and new sector-based national forums

It has been noted in this report that there are two sector-based initiatives which are working on future policy:

- The National Standing Committee on Water and Sanitation (SCOWSAS).
- The National Housing Forum (NHF).

There is also a new initiative to look at local government restructuring:

- The Local Government Forum.

At the time of completion of this report (May 1993), these initiatives have been particularly active and the proposals emanating from them will have a substantial impact on the way services are provided.

As far as possible the findings of this project will be referred as input to these forums.

Other organisations active in the sanitation field

It is important for a wide range of organisations to review their roles in the field of sanitation provision. In this regard the key areas for action identified here are intended to promote such a review.

This process of review and re-orientation is an essential step to be taken in working towards the improvement of services and hence the improvement in the quality of life of those who are presently poorly served.

GLOSSARY OF TERMS

Adequate sanitation: A sanitation arrangement which provides an adequate barrier against disease.

BLA: "Black" local authority.

Bulk services: The pipelines, sewers and pumping stations required to deliver flow from the site to a treatment works or discharge point, and the treatment works itself.

COD: Chemical Oxygen Demand. A measure of organic content and biological load placed on an ecological system.

Community: The group of individuals who will use the service being provided once such service is complete.

CSIR: Council for Scientific and Industrial Research.

DBSA: Development Bank of Southern Africa.

Demand: In the context of services provision this is the level of service a community both wants and is willing to pay for.

Dense settlements: Generally situated on the fringe of cities, but may be comparatively isolated. Their primary economic base is the urban economy to which a significant proportion of the population commute on a daily basis. Local institutions are usually non-existent or very weak.

Developer: The organisation responsible for implementing the project to service stands and sell or rent the properties concerned. This may be an authority, a community based organisation which has legal status, or a private property developer.

Development Region: Development Region as defined by the Development Bank of Southern Africa. See Map on page 14

DWA: Department of Water Affairs.

Grey water: The waste water generated from household washing and cooking activities. That is, water from kitchen sinks, showers etc.

GW: See Grey water.

IDT: Independent Development Trust.

Implementation: The design, tendering, contractual arrangements and construction of the project.

Internal services: The reticulation required to deliver flow from each stand to the boundary of the immediate residential area where it is connected to the bulk service.

JSB: Joint Services Board. Natal equivalent of RSC.

Local Authority: The statutory body responsible for the management of an urban area, generally through an elected Council. In certain cases the Local Authority may also act as a developer in that they would implement a project to service stands and sell or rent the properties. (see "Developer").

LOFLOS: A Low Flow, On-site Sanitation system using a low volume flush, an anaerobic digester to treat the flow, and a soakaway. These are generally sold as package units.

mg: milligram.

NGO: Non-government Organisation.

NHC: National Housing Commission.

NHF: *National Housing Forum.*

NPV: Net Present Value.

O&M: Operating and maintenance.

pa: per annum.

Package unit: A unit which is provided to receive and treat or partially treat human wastes on the stand and which is made off-site and provided by the a manufacturer as a package.

PDG: Palmer Development Group.

Project: The activity of providing a package of services, which includes sanitation, for a defined number of stands or number of people, where construction will take place at one time.

pm: per month.

PWV: Pretoria, Witwatersrand, Vereeniging metropolitan area.

Region: See Development Region.

RSA: Republic of South Africa (excluding TBVC states).

RSC: Regional Services Council.

Sanitation: The treatment and safe disposal of wastes from the human body. Solid waste (refuse) disposal is not included. Grey water disposal may or may not be included depending on the sanitation technology.

SCOWSAS: Standing Committee on Water Supply and Sanitation.

SEP: Septic tank. *See page 5 for description.*

TACH: Total Annualized Cost per Household. See page 46.

TBVC: Transkei, Bophuthatswana, Venda, Ciskei.

UCT: University of Cape Town.

Urban: As defined by the Urban Foundation Demographic Model (1991) including "dense settlements".

VIP: Ventilated Improved Pit latrine. See page 9 for description.

WB: Water-borne sewage.

WLA: "White" local authority.

WRC: Water Research Commission

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Note:

The References and Bibliography presented here represent a selected list of literature consulted and referenced during the course of the project. Comprehensive reference lists are provided for each of the Working Papers produced as part of this project. The more important references from these papers have been included here as well as a selection of the literature reviewed during the course of the research.

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