# THE DEVELOPMENT OF PROGRAMMES TO COMBAT DIFFUSE SOURCES OF WATER POLLUTION IN RESIDENTIAL AREAS OF DEVELOPING COMMUNITIES

By

GERALDINE SCHOEMAN

of

Afrosearch-Index
P O Box 13540
HATFIELD
0028

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*The development of programmes to combat diffuse sources of water pollution in residential areas of developing communities.*

The Steering Committee responsible for this project consisted of the following persons:

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|---|---|
| Mr H C Chapman | WRC |
| Mr D S van der Merwe | WRC |
| Mr B Jackson | DBSA |
| Mr M L Liebenberg | HSRC |
| Dr H R van Vliet | DWAF |
| Mr F C van Zyl | DWAF |
| Mr C Warren | CSIR |
| Mr A Wright | CSIR |

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# EXECUTIVE SUMMARY

## THE DEVELOPMENT OF PROGRAMMES TO COMBAT DIFFUSE SOURCES OF WATER POLLUTION IN RESIDENTIAL AREAS OF DEVELOPING COMMUNITIES

by

Geraldine Schoeman

Afrosearch-Index
PO Box 13540
HATFIELD, 0028

Supplementary to the WRC Report No K5/519 which is the full report to the Water Research Commission on the Project "The Development of Programmes to Combat Diffuse Sources of Water Pollution in Residential Areas of Developing Communities"

# EXECUTIVE SUMMARY

South Africa's limited ground water resources have been heavily compromised in certain areas of the country. Increasing levels of development, rapid urbanisation and industrialisation are bound to compound this problem. In view of the absence of a formal groundwater management strategy, the Department of Water Affairs and Forestry (DWAF) is presently engaged in the development of strategic objectives and a functional strategy to put such management into place.

While systems for the management of surface water quality have been in place for some years, there is mounting concern about pollution and contamination of this natural resource. Such pollution and contamination result from agricultural practices, industrial activities, urbanisation and, most notably, the impact from the rapid growth in the numbers and size of developing communities in South Africa .

In part, this negative impact has resulted from non-point or diffuse sources of water pollution. This may be directly attributed to activities that have relatively low site-specific impact if seen as isolated pollution incidents (e.g. lack of effective sanitation). However, settlement-wide and cumulative pollution brought about by population growth and the commensurate increase in dense settlements (without effective water, waste and sanitation facilities) is set to produce severe negative environmental and water quality impacts.

Whilst a range of measures is being developed to address point-source contamination, there is international acceptance that diffuse sources of water pollution, by the nature thereof, makes the regulated control thereof virtually impossible. Moreover, there is an increasing realisation that effective mechanisms will need to be developed for involving communities directly in measures to address this problem. This necessitates the promotion of sustainable water resource management programmes at community level, within a framework of integrated regional catchment management.

This report puts forward proposals for the development of programmes to combat diffuse sources of water pollution in developing communities. It draws on recommendations contained in a Human Sciences Research

Council (HSRC) report on the social aspects of water provision, use and preservation.

The following specific objectives had been set for this research project:

- To undertake a national and international overview of multi-disciplinary issues in developing communities related to the development of community-based programmes to combat diffuse sources of water pollution;
- To develop appropriate and sustainable preventive programmes to combat diffuse sources of water pollution in three prototype communities;
- To undertake an in-depth evaluation of the success of the prototype studies;
- To formulate an educational model for the development of programmes to combat diffuse sources of water pollution in developing communities at regional and/or national levels (as long-term goal, based on the results of this project).

A number of distinct areas of focus were identified and incorporated into Action Research phases. These included:

- Data-gathering on a multi-disciplinary, pan-sectoral basis from relevant national and international literature and documented case studies;
- Interviews with persons and organisations with specific expertise and experience of the multi-disciplinary issues related to the development of community-based development programmes;
- Interviews with individuals and groups in developing communities aimed at exploring experiential aspects related to pollution and to determine their understanding of the problem;
- Site-specific investigations in selected areas and communities to identify specific problems and practices that precipitate diffuse sources of water pollution;

- Investigations aimed at identifying specific ameliorative actions that could be utilised to combat diffuse sources of water pollution.

From the literature and interview survey it has become evident that there is disagreement about the exact definition of diffuse sources of water pollution. Two broad approaches to defining the problem have been identified. The first approach, subscribed to by the Department of Environmental Affairs and Tourism, relates to a system whereby any pollution that cannot be traced to (or controlled at) a single pollution point-source is regarded as diffuse. In terms of the second approach, the existence of a single identifiable authority, institution or individual (who can accept responsibility for the pollution) is a central element in determining whether or not pollution will be defined as a point source or diffuse source problem.

Sources of diffuse pollution in developing communities generally result from a lack of adequate infrastructure, management and/or maintenance of water use practices, sanitation, refuse and land-use practices, including agriculture, deforestation and devegetation. Air to water, land to water and water to water pollution paths serve as conduits for diffuse pollution.

The report shows that interventions aimed at containing sources of water pollution in developing communities can be launched by focusing on the promotion of effective, community-based water supply, sanitation and waste management and, where appropriate, environmentally sustainable agricultural practices. It must be noted that, notwithstanding their acceptance of the role of crop production, animal husbandry and other related land use practices in the precipitation of diffuse sources of water pollution, such factors have been excluded from this study by the Water Research Commission. This has been to allow a more focused approach to the project. The decision does not, however, serve to negate the importance of such factors or the fact that land use management should form an essential part of integrated development initiatives in developing communities.

An analysis of seminal work undertaken by a number of national and international organisations, institutions and individuals points to a range of **key substantive issues** that should form the cornerstone for any participative development programme aimed at addressing diffuse sources of water

pollution in developing communities. Whilst these key issues are addressed in detail in the report, a few core considerations are noted here. One of these relates to the importance of rooting participative programmes on pollution in interventions to address priority need areas of developing communities (ie. health, crop production, animal husbandry and sustainable environmental utilisation) and to devise processes aimed at assisting communities to extend development planning to address these needs. This approach essentially cautions against attempts to isolate a specific funded development project from broader development considerations that may exist within in a community in the interests of "getting the job done". Acceptable, integrated management strategies are required that incorporate the underlying values, norms and needs of the community.

Another important consideration is that management designs need to be mindful of environmental problems within the context of developing communities. An analysis of causes of diffuse water pollution in developing communities has shown that pollution is related to basic (first order) development needs and an attempt to address the problem by means of a first-world "Green Agenda" aimed at promoting environmental stewardship is patently illogical and inappropriate. In keeping with the "Brown Agenda", the implementation of sustainable development programmes aimed at meeting human needs on a basis that promotes ecological sustainability is proposed.

It is clear that a programme focusing on the promotion of environmental awareness and a conservation ethos (in the first world sense) is bound to be unsuccessful in combating pollution in developing communities if it ignores this basic needs context. This calls for the implementation of a Primary Environmental Care **(PEC)** approach by which local communities organise themselves and strengthen, enrich and apply their means and capacities for the care of the environment while simultaneously satisfying their needs. A PEC programme design would need to allow for the inclusion of sanitation and waste management practices with water management. It would need to provide for the informed selection of cost-effective and technically appropriate options for the provision of basic services that promote environmental protection. In addition, it would require the incorporation of operational procedures for promoting maximum community empowerment

and community participation in programme planning and implementation.

Other key substantive issues relate to the transfer of technical and non-technical information to the community and the ability of programmes to demonstrate short-, medium- and long-term benefits to obtain and sustain community participation. A learning process approach; capacity building programmes; the utilisation of indigenous skills and resources; the maximisation of the involvement of woman; the introduction of appropriate technologies and the balancing of top-down and bottom-up initiatives should be regarded as key issues.

In addition to the above substantive issues, a number of process-related factors have emerged that play a key role in determining the success or failure of projects. It is deemed essential for these factors be incorporated as guidelines for project implementation. These include a drive towards:

- finding acceptable solutions which can achieve "goodness of fit" between the problem situation (at whatever level) and the intervention;
- devising a framework for programme application that is situationally relevant and capable of adapting to changes in level of intervention on a local, regional or national basis.
- providing appropriate intervention strategies that are developed on the basis of contextual validity, and are appropriate to the level at which the problem manifests itself without losing sight of the interdependence of and interaction between levels.
- devising co-ordinated and integrated multi-disciplinary and multi-sectoral interventions on vertical and horizontal levels to foster an empowerment agenda (i.e. institutional capacity building and participation).

To avoid a situation whereby this study would become a purely academic exercise, the researchers, in consultation with the Water Research Commission (WRC) decided that the initial aim of formulating a conceptual framework should be extended to include the development of guidelines for practical implementation. To this end, a Field Guide was compiled to

serve as a step-by-step practical guide for research and programme development.

A conceptual framework based on the qualitatively analysed information obtained during the various stages of the project was developed. This served as basis for formulating the development approach and implementation strategy for the in-situ implementation, evaluation and adjustment of a comprehensive participative community-based development programme aimed at combating diffuse sources of water pollution.

The proposed approach for the design of the Field Guide (based on the conceptual framework) comprised four basic phases (including strategic objectives) which related to (i) Rapid Assessment and Consultation; (ii) the Development of Sustainable Water, Waste and Sanitation Management Strategies (WWSMS); (iii) the Development of a Community Based Resource Management Plan and (iv) Implementation, Monitoring and Evaluation with a Feedback Approach for adjustment and reorientation.

The Field Guide (based on the conceptual framework) was developed and submitted for extensive peer review. This was used to guide the implementation of prototype programmes for participative water, waste and sanitation interventions in developing communities. Communities willing to act as foci for testing were identified and participative community-based programmes were initiated in each in accordance with the methodology set out in the Field Guide. The Field Guide has been evaluated and adjusted on the basis of the results of these pilot or case studies.

The Field Guide embraces the principle of process oriented research and development aimed at the promotion of **Participatory Appraisal and Training** and **Participative Development Management.** Participation, in terms of the former strives to promote independent community ability to identify, analyse and solve problems and to participate in decision-making, project development and project implementation, thereby enhancing human capacity building. Participative or learner-centred training combines learning about project related matters with capacity building that will initiate and sustain processes of change and empowerment in developing communities. Participative Development Management on the other hand is

a development process that aims to ensure community based co-ordination and integration of planning, implementation, monitoring and evaluation as well as maintenance and control activities relative to existing and future development projects. It is therefore a pro-active, controlled and strategically managed real development process.

It is believed that the Guide, in its current format, is suitable for use by community and project developers and serves to describe the milestones that need to be achieved or incorporated to allow participative project development. However, it should be noted that both the development paradigm and the resultant processes suggested for the Field Guide focus on the building of competencies, the enablement and empowerment of people and the strengthening of community action. General capacity building (including education and training) and information dissemination form an essential component of an empowerment agenda. It is suggested that training in respect of water, waste and sanitation management within communities is structured on pan-sectoral and sector-specific levels. Pan-sectoral training refers to skills that need to be acquired within the context of water-related projects but that are generic in nature. Sector-specific skills tend to be more technical in orientation and are specifically related to the water, waste or sanitation sector. Potential focus-areas for training within the pan-sectoral and sector-specific realms aimed at effective promotion of participative community based water, waste and sanitation project have been set-out in the report.

The pilot projects that had been launched to test the validity of the Field Guide served to evaluate the adequacy of linking the largely pan-sectoral and land-use management training that had been offered by Afrosearch-Index up until that stage, with the technical skills training required to implement effective water, waste and sanitation management (detailed case studies of three of the pilot projects are included in Appendix A). The pilot projects were implemented in different habitats (as per the UN Centre for Human Settlement classification) and included Rural Settlements Upgrading; Rural Growth-Centre Development; Urban Slum Upgrading, Site and Services Schemes and New Urban Community Development.

A range of specific problems were identified in respect of the implementation of the pilot projects:

- In communities with an absence of development initiatives and existing structures, an extensive period of **capacity building** and the promotion of participation needed to be undertaken prior to commencing with large-scale projects such as the provision of community-wide sanitation. Where this has required, small-scale projects (that had a good chance of succeeding despite the immediate lack of capacity) were undertaken to initiate community-based activities;

- While effective **participation** is a core component of successful programmes, project funding for the promotion of this project component is notably absent from funding budgets. Here, for example, the White Paper on Water Supply and Sanitation makes provision for grant funding in respect of training and capacity building of water committees after they have been established and registered! This approach flies in the face of broad-based participatory approaches and promotes a lack of commitment from the members of the committee as well as the communities which they purport to serve. It will favour development in communities were strong community infrastructure and capacity already exists, further marginalising severely disadvantaged communities;

- **Traditional authority structures** provide leadership in non-urban communities on a continuum that ranges from totalitarian to laissez faire. Irrespective of the type of leadership provided, initial entry into such communities will always need to take cognisance of these and other formal structures. Because participative development is based on an empowerment agenda, great care needs to be taken to maximally integrate traditional institutions with the development process without entrenching authoritarian structures or causing division in the community. Ironically, whilst the local elections have promoted democratic governance, they have served to bedevil attempts to find this balance in many communities;

- A **review period** is imperative in order to allow the community to be given enough time and information to allow them to review whether or not they want the project to be initiated. Attempts to force the proposed development are guaranteed to reduce participation in future stages of the process;

- The implementation of project-based **action plans** usually requires extensive involvement of the developer to ensure that the process remains participative at this stage. The danger exists that dynamic or impatient community members may want to move faster than the participative process can allow. This may result in a decline in participation or, alternatively, confrontation between community members during one of the most crucial stages of the project;

- An equitable and generally applicable golden rule regarding the **payment of community members and other participants** has not been identified. However, the most successful means of handling this dilemma has been to assist communities to cost the inputs of strategic workers and to make provision for these expenses within the project budget.

Although none of the above problems have been so serious as to derail the development process totally, more lessons were gleaned from the mistakes then from the successes. Fortunately, the mistakes were made in communities where a climate of trust, mutual respect and mutual learning have served as a buffer to the communities as well as to developers.

A number of conclusions have been drawn from the study and specific recommendations formulated in respect of each. These relate to the following:

- **Education, training and broad-based capacity building**

  *The need for effective education, training and broad-based capacity building in all aspects the development of water, waste and sanitation programmes is an essential prerequisite for sustainable development.*

- **Collaboration and consultation between stakeholders**

  *There is a dire need for the initiation of a process of consultation and the promotion of closer collaboration and co-ordination of activities between all participants and stakeholders on all levels of water, waste and sanitation research, development and programme delivery.*

- **Communication**

  *The promotion of ongoing effective communication between*

*government, communities, developers and funders is fundamental to project success.*

- **Participation**

  *Participation is a key requirement for the development of sustainable programmes at community level. Participation takes time, concerted effort and dedication from developers and communities alike. Funding budgets should reflect this factor.*

- **Community organisational structures**

  *Strong, accountable community organisational structures that build on existing capacity (without duplication) need to be developed as a virtual first step in the development process. There is no other way of ensuring the sustainability of projects without fostering a dependence on external developers.*

- **Local skills and resources**

  *Identification and mobilisation of local skills and resources should be seen as an integral part of the development process. This will increase the multiplier effect of any development actions, promote "buy-in" from the community and serve to maximise development benefits to the community.*

- **Water quality management**

  *There are, at present, no effective guidelines for the implementation of "best management practices" in the context of developing communities. It is necessary that a system be developed whereby the risk of groundwater pollution can be calculated effectively on the basis of what is referred to as "aquifer pollution vulnerability". Notably within restricted project budgets a system that indicates or "flags" areas that have high "aquifer pollution vulnerability" can save time and money and promote "best management practices".*

**Structure of the report**

The report has been structured in the following manner:

**Chapter 1:** This Chapter provides a brief problem statement as background to the project. The specific project objectives as well as a description of the process that was used to obtain and evaluate data for the project are provided.

**Chapter 2 :** The results of the literature and interview studies are presented in Chapter 2. These summarised results are provided under two separate headings:

The first section contains an explanation of the concept of diffuse sources of water pollution and the project-related definition. An overview of factors that have been identified as playing a role in the generation of diffuse sources of water pollution in developing communities as well as the pollution paths are described.

The second section provides information on the key issues that require attention in the development of a model or framework that is designed to promote effective water resource management at community level. In essence, these issues represent a crystallisation of factors that need to be considered in the analysis of and proposed solutions to the problem of diffuse sources of water pollution in developing communities.

**Chapter 3 :** Chapter 3 sets out the conceptual guidelines for the development of a programme to address diffuse sources of water pollution in developing communities based on the key issues and core elements identified and set out in Chapter 2.

It provides a brief overview of the concepts "participative development management" and "participatory appraisal" which form the basis of the approach deemed necessary for programme implementation and sets out criteria (or process milestones) that need to be included in the Field Guide.

Although the Field Guide itself is included with the report as a separate Appendix B, a brief outline of its contents is provided as part of this Chapter.

**Chapter 4 :** Chapter 4 addresses the broad-based capacity building and information requirements within the context of water, waste and sanitation promotion at community level.

Current realities in South Africa are discussed. An analysis of the project based capacity building and information transfer objectives and a number of specific objectives for the development of appropriate training are provided. In addition, suggestions are made regarding training courses for the promotion of participative community based water, waste and

sanitation projects.

**Chapter 5 :** Chapter 5 provides a functional background in respect of the pilot projects that were launched as part of the project. It sets out the focus of the pilot projects, and provides a habitat classification for the projects undertaken by Afrosearch-Index. A brief overview and evaluation of specific problems encountered during the study is also supplied.

**Chapter 6 :** Chapter 6 sets out the conclusions drawn from the study and specific recommendations based thereon.

**APPENDICES**

**Appendix A:**

Appendix A provides an overview of three case studies. These case studies are briefly described and the core problem areas, as well as successes indicated. These case studies do not focus on the "success stories" of the project. They have been chosen to provide an overview of mistakes that have been made and illustrate the different orientations that may be found in various communities. They also serve to indicate the core importance of participation and institutional capacity building in any project that is initiated.

**Appendix B:**

Appendix B comprises the complete Field Guide developed during the community based process. This guide evolved over time and in its final format provides a step-by-step guide on a suggested process to mobilise communities to implement integrated, community-based water and sanitation projects, within the larger ambit of community development.

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# THE DEVELOPMENT OF PROGRAMMES TO COMBAT DIFFUSE SOURCES OF WATER POLLUTION IN RESIDENTIAL AREAS OF DEVELOPING COMMUNITIES

## 1. INTRODUCTION

### 1.1 BACKGROUND

South Africa has limited ground water resources that have been heavily compromised by over-abstraction and contamination in certain areas of the country. Increasing levels of development, rapid urbanisation (and inadequate waste disposal) and industrialisation are bound to compound this problem. While no formal strategy for the management of groundwater quality exists, the Department of Water Affairs and Forestry (DWAF) is presently engaged in the development of strategic objectives and a functional strategy to put such management into place.

Systems for the management of surface water quality, on the other hand, have been well established for a number of years. This includes the relatively recent introduction of measures aimed at pollution control of non-hazardous substances by means of 'Receiving Water Quality Objectives' and the 'Pollution Prevention' approach for the control of hazardous substances. Despite this, pollution and contamination from agricultural practices, industrial activities, urbanisation and, probably most significantly, the impact from the rapid growth in the numbers and size of developing communities in South Africa has had a profoundly negative impact on surface water quality over the past ten to fifteen years.

In part, this negative impact has resulted from non-point or diffuse sources of water pollution, directly related to activities that have relatively low site-specific impact if seen as isolated pollution incidents (e.g. lack of effective

sanitation). However, the settlement-wide cumulative nature of such activities produce severe negative environmental and water quality impacts. It is anticipated that population growth and the commensurate increase in dense settlements that do not have effective water, waste and sanitation facilities will prove to be one of the biggest threats to surface water quality in the next few decades.

It is evident that both ground and surface water quality are being placed under increasing threat from pollution. While statutory and non-statutory measures are being developed to address point-source contamination, it is accepted internationally that diffuse sources of water pollution, by the nature thereof, make the regulation and control thereof virtually impossible. It is further accepted that effective mechanisms will need to be developed for involving communities directly in measures to address this problem. The nature of the problem demands the promotion of sustainable water resource management at community level, *within a framework of integrated regional catchment management.*

On the basis of the above, the Water Research Commission requested the members of Afrosearch to submit a proposal for the development of a programme to combat diffuse sources of water pollution in developing communities during 1992.

It was further requested that recommendations contained in the report by the Human Sciences Research Council (HSRC) entitled ***Social Aspects of Water Provision, Use and Preservation : A Feasibility Study*** be used as a point of departure for further research. The following recommendations appear in the HSRC Report:

- A human-orientated approach is necessary to solve water and sanitation problems;
- There is a need for contextualising a holistic approach on social issues related to water and sanitation problems;
- Target differentiation, communication and negotiation should take place in respect of planning. This implies that the people for whom

the services are intended should be consulted;

- A great need exists for improved communication about water and sanitation;
- Community participation in programmes is regarded as essential;
- A need is expressed for research that is regional and community specific but will, at the same time, lead to an understanding of this complex problem on a national basis;
- Emphasis is placed on the practical and sustainable implementation of research results and the co-ordination thereof;
- A plea is made for inter- and multi-disciplinary research;
- research related to water and sanitation programmes should be seen in the framework of community development in general.

A research project, based on this proposal, was initiated during 1993 and serves as the topic of this report.

## 1.2 SPECIFIC OBJECTIVES OF THE RESEARCH PROJECT

The following specific objectives had been set for this research project:

- To undertake a national and international overview of multi-disciplinary issues in developing communities related to the development of community-based programmes to combat diffuse sources of water pollution. This objective is addressed in Chapter Two of this report.
- To develop appropriate and sustainable preventive programmes to combat diffuse sources of water pollution in three prototype communities. This objective is addressed in Chapter Three of this report.
- To undertake an in-depth evaluation of the success of the prototype studies. This objective has been addressed in Chapter Five of this report as well as Appendix A.

- To develop an educational model for the development of programmes to combat diffuse sources of water pollution in developing communities at regional and/or national levels (as long-term goal, based on the results of this project). This objective has been addressed in part in Chapter Four of this report and the Field Guide that serves as Appendix B.

## 1.3 PROJECT PROCESS

A number of distinct areas of focus were identified for the research project and incorporated into phases of the Action Research model. These areas were:

- Data-gathering from national and international literature as well as from documented case studies, project descriptions and project evaluations related to point and diffuse sources of water pollution on the one hand and water, waste and sanitation-related issues in developing communities on the other hand;

- Data-gathering about pollution (with a focus on diffuse sources of water pollution) and about water, waste and sanitation in developing communities on a multi-disciplinary, pan-sectoral basis from experts and individuals working in the field who could, potentially, provide information relevant to the project;

- Interviews with persons and organisations with specific expertise and experience of the multi-disciplinary issues related to the development of community-based development programmes;

- Interviews with individuals and groups in developing communities to explore experiential aspects related to pollution (including an evaluation of their understanding of the problem) and related to water, waste and sanitation in such communities and to obtain information pertinent to the development of a programme to combat diffuse sources of water pollution;

- Site visits to selected areas and communities to investigate specific

problems that have been experienced and practices that have been identified as precipitators of diffuse sources of water pollution;

- The investigation of specific ameliorative actions that could be utilised to combat diffuse sources of water pollution;
- The development of a conceptual framework (based on the cumulative information obtained during the various stages of the project) to serve as guidelines for the in-situ implementation, evaluation and adjustment of
  - a participative community-based development programme to combat diffuse sources of water pollution
  - requirements for supportive education, training and capacity building;
- The dissemination of the conceptual framework to a large number of role players in order to test the assumptions and conclusions contained therein;
- The development of a Field Guide (a practical implementation manual) based on the conceptual framework that could guide the implementation of prototype programmes for the implementation of effective participative water, waste and sanitation programmes in developing communities;
- Peer review of the Field Guide;
- The development of specific education, training and capacity-building modules that would be required to support effective programme implementation;
- The identification of communities willing to act as development foci for the testing of the participative community-based programme;
- The initiation of participative community-based programmes, in accordance with the process as set out in the Field Guide, aimed at the implementation of the programme in a number of communities;
- The evaluation of the education, training and capacity-building

modules;

- The evaluation and adjustment of the Field Guide based on the case studies;
- The formulation of recommendations.

# 2. RESULTS OF THE LITERATURE AND INTERVIEW SURVEY

## 2.1 INTRODUCTION

### 2.1.1 APPROACH

The literature and interview survey was aimed at obtaining insight into the specific causes of diffuse sources of water pollution in developing communities on the one hand, and the identification of key issues and core elements that would need to be taken into consideration in the development of a programme to address such pollution on the other hand.

Data analysis in respect of the project was based on qualitative techniques. Interviews were conducted on a semi-structured basis and recorded on tape and transcribed or directly recorded in writing. Literature and interview material was read through intensively in order to obtain a general overview of the information contained therein. Thereafter a content analysis was undertaken in respect of each interview and literature source in order to identify and discriminate differing meaning units or categories of response.

The issues identified in this manner were noted, as well as the attitudes expressed in respect of such issues. Finally, the meaning units across all information sources, identified by the content analysis, were synthesised to obtain an integrated statement in respect of each. These served as the basis for identifying 'critical success factors' that needed to be included as part of the conceptual framework and the subsequent development of the Field Guide.

### 2.1.2 DEFINITION

From interviews and literature it is apparent that there is disagreement about the exact definition of diffuse sources of water pollution. Two broad approaches to defining the problem can be identified. The first, subscribed to by the Department of Environment Affairs, relates to a system whereby any pollution that cannot be traced to, or controlled at, a single pollution point-source is regarded as diffuse. In accordance with this definition,

seepage from certain categories of mining and agricultural activities or from a leaking sewer system may, for example, be classified as diffuse pollution.

In accordance with this point of departure, the following definition of diffuse or non-point source of pollution has been set by the Department of Environment Affairs (1990:5):

> *Such a source is not located at a specific point and the result is that pollution occurs over a broad area such as over a whole urban or a rural area. Waste and sewage is therefore being generated over a broad area, from where it finds its way to the water environment. It is not possible to measure and handle the effluent of a diffuse source at one point.*

The second approach places the existence of a single identifiable authority, institution or individual - *who can accept responsibility for the pollution* - as a central element in determining whether or not pollution will be defined as a point source or diffuse source problem. On this basis, seepage from mining activities, agriculture as well as sewer leaks can be traced back to a single responsible institution or individual and must, therefore, be regarded as point source pollution.

The following definition has been set for diffuse sources of water pollution for the purpose of this study:

> *Diffuse sources of water pollution may result from a wide diversity of human actions and activities. Pollutants are generated or deposited at a specific site or spread diffusely but individual accountability cannot be apportioned and no authority or institution acts as source of control. While the effects of diffuse sources of water pollution may not necessarily be major at each point of generation, the cumulative impact thereof may be extensive and severely deleterious to water systems. pollution that result from a wide diversity of human actions and activities*

## 2.2 SPECIFIC CAUSES OF DIFFUSE SOURCES OF WATER POLLUTION IN DEVELOPING COMMUNITIES

### 2.2.1 INTRODUCTION

Within the context of developing communities, diffuse pollution generally results from a lack of adequate infrastructure, management and/or maintenance of the following:

- Water use practices.
- Sanitation.
- Refuse.
- Land-use practices, including crop production, deforestation devegetation and animal husbandry.

### 2.2.2 POLLUTION PATHS

The following pollution paths may be identified:

#### 2.2.2.1 Air to water

Air to water pollution paths include:

- Fuel burning.
- 'Slash and burn' agricultural practices.
- Vehicular emissions.

#### 2.2.2.2 Land to water

Land to water pollution paths include:

- Pesticides and fertilisers used for agricultural purposes.
- Erosion from land use practices, including devegetation and deforestation.
- Run-off pollution from precipitated vehicular emissions.

- ineffective waste disposal.
- inadequate sanitation or an absence of sanitation.
- Animal wastes.

#### 2.2.2.3 Water to water

Water to water pollution paths include:

- Utilisation of rivers and streams for personal ablution and washing of clothes.
- Livestock impact.
- Utilisation of dirty containers to collect water.
- Inadequately treated sewage effluent flows.

### 2.2.3 CONTAINMENT OF DIFFUSE SOURCES OF WATER POLLUTION

From the above it may be seen that significant progress could be made towards the containment of diffuse sources of water pollution in developing communities by focusing on the promotion of effective, community-based water supply, sanitation and waste management and, where appropriate, environmentally sustainable agricultural practices.

While agricultural, animal husbandry and other related land use practices have been identified as specific causative factor in the precipitation of diffuse sources of water pollution, the Water Research Commission requested that the researchers exclude such factors from this study. This does not serve to negate the importance of such factors. Neither does it negate the fact that land use management should form an essential part of integrated development initiatives in developing communities.

## 2.3 KEY ISSUES TO BE CONSIDERED IN THE DEVELOPMENT OF A PROGRAMME TO ADDRESS DIFFUSE SOURCES OF WATER POLLUTION IN DEVELOPING COMMUNITIES

A large number of national and international organisations, institutions and

individuals have undertaken seminal participative development work in the field of water, waste, sanitation and land use management in developing communities.

On international level, the work of UNEP and its EMINWA programme, USAID and its WASH programme, the UNCHS (HABITAT), the Ross Institute of Tropical Hygiene, the World Resources Institute, the International Institute for Environment and Development, the World Bank Water and Sanitation Programme and its International Training Network for Water and Waste Management (ITN) component and the WHO present an extensive information and experience base, inter alia.

In South Africa the work of the DBSA, Umgeni Water, various university departments and institutes, private organisations, such as the Palmer Development Group, government, non-government and quasi non-governmental organisations, such as the IDT and Mvula Trust, have contributed much knowledge and experience towards the development of expertise regarding the South African situation. A study such as this one must, perforce, draw on the national and international lessons learnt and information and experience gained through the successes as well as failures in this field.

An analysis of the work that has already been undertaken has indicated that any model or framework that is designed to promote effective water resource management at community level should address or incorporate the following key issues:

### 2.3.1 INTEGRATED MANAGEMENT STRATEGIES

Effective management of water as resource at community level requires, inter alia, the introduction of integrated water, waste, sanitation and land use management strategies. It is, however, vital to realise that, while the provision of adequate water, sanitation and waste services have proved to be a major identified need in most developing communities, addressing such need will not negate or diminish the importance of other major areas of need in such communities. Neglecting this truism will make it impossible to develop the integrated approaches required to address the inter-linked

problems of people in developing communities.

For truly effective development to take place, communities may require assistance in determining how development planning may be extended to address other areas of need such as, inter alia, health, crop production, animal husbandry and sustainable environmental utilisation. They may also require measures to empower them to address such areas of need.

This point of departure offers a dilemma to funding or donor agents as well as to developers. It is always tempting to attempt to isolate a specific funded development project from the surrounding or broader development context and environment that exists in communities in the interests of "getting the job done". In the long run, however, this (virtually inevitable) approach merely serves to compound the difficulties of integrating externally funded projects into the broad development processes of the community. Because of this, long-term community commitment as well as the potential multiplier effect of projects are significantly diminished.

### 2.3.2 APPROPRIATE ALTERNATIVE MANAGEMENT STRATEGIES

The scope of planning for sustainable resource management on a community participatory basis cannot be addressed effectively by orthodox planning and the utilisation of First World norms and standards. It must be expanded to involve the formulation of alternative, acceptable management options as well as the examination, analysis and express incorporation of the underlying values and norms and needs of the community.

Evaluation clearly demonstrates that many of the problems encountered during implementation and subsequently in terms of project survival and viability, could be avoided through improved participative preparation and appraisal, greater flexibility in design that incorporates situation-specific requirements and timely participative adjustment when short-comings are identified.

### 2.3.3 SUSTAINABLE DEVELOPMENT (OR A "BROWN" VS. A "GREEN" AGENDA)

Although neither simplistic nor easy, the promotion of the effective and sustainable management of water as resource at community level is

possible if designed to address specific multi-disciplinary and multi-sectoral issues and circumstances.

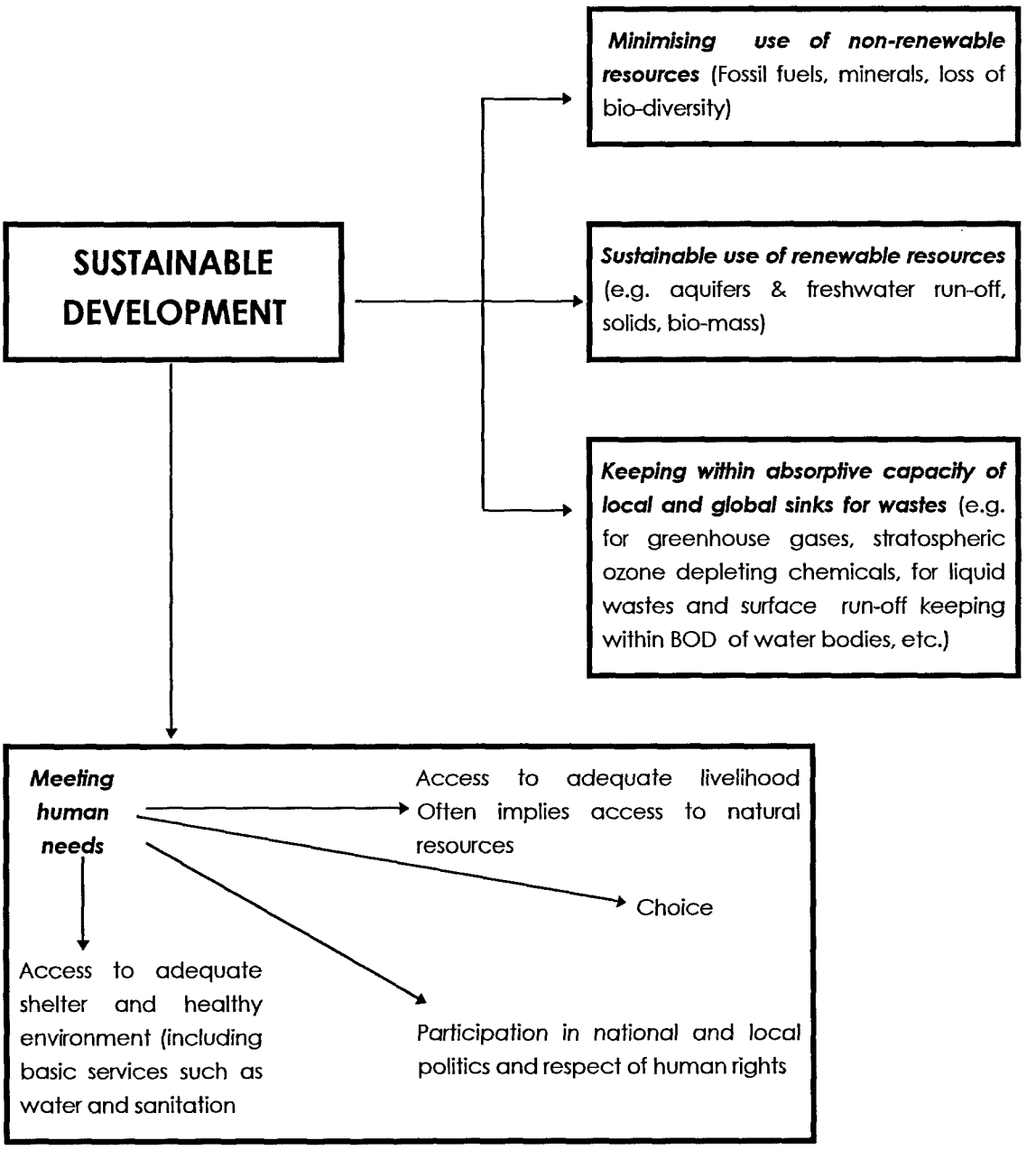
Management designs need to incorporate a focus on what Leitmann, Bartone and Bernstein (1992:132) refer to as the "Brown Agenda" of environmental problems. Issues included as part of this agenda are lack of safe water, inadequate waste and sanitation management, pollution control and land degradation.

The analysis of causes of diffuse water pollution in developing communities shows that such pollution is related to basic or first order development needs. Trying to address the problem by means of a first-world "Green Agenda" that seeks the promotion of environmental stewardship and conservation is patently illogical and inappropriate.

On this basis, the "Brown Agenda" proposes the implementation of sustainable development programmes that integrate the promotion of development aimed at meeting human needs on a basis that promotes ecological sustainability. In terms of a programme to address diffuse sources of water pollution, this approach would imply that the implementation of effective water, waste and sanitation projects at community level would be an essential prerequisite for the management of the problem. In addition, ecological sustainability would need to be promoted as part of the implementation framework.

The following figure provided by Hardoy, Mitlin & Satterthewaite (1992:181) serves to illustrate this concept:

Figure 2.1 Components of sustainable development




### 2.3.4 INFORMED DECISION-MAKING

Participative processes will need to place strong emphasis on the transfer of technical and non-technical information to the community. This will need to be supported by an underlying development philosophy that implicitly accepts the principles of:

- the community's **'right to know'**
- the right to be provided with **choices** about available alternatives, the

cost implications (to themselves as well as external funding agents) as well as the ongoing operations, maintenance and management implications of each. Information on situation specific technological options for problem solving and decision-making is required in a format that allows easy interpretation. Here, for example, algorithms allow information on cost-effective and sustainable options that combine community specific situations and requirements with acceptable planning and implementation guidelines.

- the right to be allowed to make **informed decisions** about available alternatives.

### 2.3.5 IMMEDIATE AND ONGOING BENEFITS

Short-, medium- and long-term initiatives for obtaining and maintaining community participation must be incorporated in the planning, implementation and monitoring phases of projects. Development planning should be based on a phased approach and make provision for interim goals that can be reached within short periods of time. The community must perceive that the project will provide immediate as well as ongoing benefits;

### 2.3.6 ADEQUATE BASELINE DATA

Effective strategies require the establishment of baseline data regarding:

- relevant aspects of the water, sanitation, waste and environmental management and utilisation practices and needs within the community

- relevant socio-cultural aspects of community life. This would need to include information on community health, past and present community participation in projects, social readiness for change, historical cultural traditions, existing institutional, development and social structures within the community, the role and status of women within the broader cultural and narrower community context, etc.

### 2.3.7 BEST MANAGEMENT PRACTICES

Sustainable national management of water resources to reduce the negative impact of developing communities prevent diffuse sources of

water pollution requires the urgent development of guidelines for the practical implementation of the "Best Management Practices". Such guidelines should serve to provide a point of departure in assessing the balance between the potential for degradation of scarce water resources and the need of communities to have reasonable access to adequate, unpolluted water supplies on the one hand and situation-specific requirements for the implementation of acceptable waste and sanitation systems and practices within developing communities on the other hand.

### 2.3.8 WILLINGNESS TO PAY

The sustainability of any development project is essentially dependent on an assessment of the realistic costs of possible development options, the cost-benefit ratios and cost-effectiveness of options that are presented for evaluation, the capacity of the recipient community to afford, understand and meet initial and recurrent costs associated with the project and their willingness to pay such costs. In this regard, unrealistic assessments of recurrent costs and maintenance requirements remain a major problem.

### 2.3.9 LEARNING PROCESS APPROACH

The formulation of any development framework, such as the one proposed in this document, must be regarded as the initiation of a learning process. As such, processes of implementation based on this framework, must be seen as an initial point of departure. These must make provision for ongoing monitoring during implementation as well as feedback into the project to allow relevant and necessary adjustments where and when necessary. Besides process evaluation, it is necessary for the learning process to be extended to include an ongoing evaluation of the conceptual framework on which development actions are based.

### 2.3.10 TRAINING AND CAPACITY BUILDING

Effective community-based water, waste and sanitation development programmes and the management thereof are totally dependent on the provision and implementation of capacity building and skills training to community members. Depending on the needs of any specific community, long-term sustainability through training and education should be aimed at the provision of knowledge and skills to ensure, inter alia, institution building,

basic understanding and competence regarding the technical and technological issues at stake, the requirements of effective operations and maintenance, effective practical utilisation and the provision of ongoing information and communication systems. Education and training should not simply be viewed as supportive adjuncts of development programmes but should be viewed as an integral part of programmes. While this may involve additional expenditure at the start of the project, it should be regarded as part of capital expenditure that will ensure the long–term sustainability of the project.

### 2.3.11 THE ROLE OF WOMEN

It is essential that initial research as well as subsequent programme development should focus on the traditional and existing roles of women within the community and seek to maximise their involvement in all aspects of the development process as well as the benefits that will accrue from the project. Care and sensitivity is, however, required at all stages to avoid the introduction of processes that could lead to conflict within the community. An evaluation of the potential for such conflict can not be based on external appraisal. It can best be grounded in the concrete realities of every-day life through the participation of women in all aspects of planning, implementation, utilisation and maintenance of any development programme.

### 2.3.12 THE ROLE OF CHILDREN

While it has become widely accepted that water is a 'women's issue' no reference is made in the literature (or in practice) to the fact that water is a 'children's issue' in all communities where water supply is not situated in or close to the home. In the majority of instances, children provide the labour for fetching water at source and hauling it home. It would appear that duties such as these are performed irrespective of the need for school-attendance and, at times, take place to the detriment of school attendance. Based on this, the researcher believes that the long-term 'costs' of ineffective or inadequate water supply to children and society as a whole is vastly under-rated. The potential multiplier effect of promoting adequate water provision to developing communities may be significant in

terms of this factor.

### 2.3.13 APPROPRIATE TECHNOLOGY

The introduction of any new technology or the extension of existing technology should be evaluated to ensure that it is appropriate to the situation and circumstances in which the community finds itself and to ensure that it is acceptable and affordable to the people within the community. As far as possible indigenous traditional methods, knowledge, resources and skills should be used or incorporated into development.

Unfortunately, while the choice of technology constitutes an important element in the structuring of projects, progress in this area has been slow.

### 2.3.14 REACTIVE AND PROACTIVE POLLUTION CONTROL

Combating diffuse sources of water pollution at the level of developing communities will require the incorporation of reactive as well as proactive measures into a management framework. Such reactive and proactive measures are necessary in the areas of broad-based production orientated, consumption orientated and organisation orientated intervention to ensure integrated community development.

### 2.3.15 CONSERVATISM VS. APATHY

Development experts frequently note difficulties encountered in motivating apathetic communities to 'become involved in and take responsibility for projects' initiated by developers. It is unfortunate that this approach, in and of itself, indicates a gross lack of understanding of the structures and processes that could promote and facilitate community enablement.

The conservatism towards innovations and strategies often found amongst socio-economically deprived developing communities must not be confused with or regarded as apathy or an inherent lack of motivation. Such conservatism is an expression of a lifestyle that is centred around the day-to-day struggle to meet the essential and basic needs of existence. As such, any development innovation or strategy must prove that it will make a significant contribution to the improvement of life on a daily basis.

Motivation is based on a process of interaction between intrinsic and extrinsic factors. Sustained motivation requires the facilitation of processes that do not create dissonance regarding either of these two dimensions of functioning. Thus, providing conditions that will foster individual and group commitment and participation require combining an enabling environment with a development ideology that the community can fully identify with.

### 2.3.16 BALANCING TOP-DOWN AND BOTTOM-UP INITIATIVES

The initiation of any development programme must be a direct result of the expressed needs of the community and any initiatives launched should be as a direct result of this. This approach implies a 'bottom-up' or grassroots development orientation where external or 'top-down' involvement serves a facilitating and enabling ancillary role. On this basis, ongoing sustainability of programmes and the continued involvement of communities in development is seen as dependent on obtaining a careful balance between the enabling atmosphere of a 'bottom-up' approach and the guiding (yet potentially restrictive and dependence promoting) atmosphere of a 'top-down' development approach.

### 2.3.17 INDIGENOUS SKILLS AND RESOURCES

Each community has a variety of individual and collective resources that can and should be mobilised in the planning and execution of development programmes. It is important that survey, interview and scoping procedures allow for the identification of resources, as well as constraints to such resources, at the outset.

### 2.3.18 PROBLEM-SOLVING APPROACH

Programme implementation will need to take cognisance of the fact that community needs should be met by means of an approach that has a problem-solving orientation. Specific problems may, if viewed creatively, offer solutions to other problems or needs. An example of this approach is found in the harvesting and utilisation of waste as resource.

There are numerous examples of initiatives aimed at addressing the need without solving the problem. These include the extensive use of water-trucks for supply where other alternatives are readily available or the utilisation of

chemical toilets where neither health factors nor contamination potential mandates such use.

### 2.3.19 INTEGRATED ENVIRONMENTAL MANAGEMENT (IEM) FRAMEWORK

Programmes for sustainable management of water in developing communities need to be formulated within a framework of Integrated Environmental Management (IEM) to allow informed decision-making about the potential impact and consequences of proposed development actions. The following principles serve as the basis of IEM in accordance with the Integrated Environmental Management procedure suggested by the Department of Environment Affairs (1992:5):

- "informed decision-making;
- accountability for information on which decisions are taken;
- accountability for decisions taken;
- a broad meaning given to the term environment (i.e. one that includes physical, biological, social, economic, cultural, historical and political components);
- an open, participatory approach in the planning of proposals;
- consultation with interested and affected parties;
- analysis of alternative options;
- an attempt to mitigate negative affects and enhance positive aspects of proposals;
- an attempt to ensure that the 'social costs' of development proposals (those borne by society, rather than the developers) be outweighed by the 'social benefits' (benefits to society as a result of the actions of the developers);
- democratic regard for individual rights and obligations;
- compliance with these principles during all stages of the planning,

implementation and decommissioning of proposals (i.e. from 'cradle to grave'); and

- the opportunity for public and specialist input in the decision-making process."

## 2.4 CORE ELEMENTS OF A PARTICIPATIVE PROGRAMME TO ADDRESS DIFFUSE SOURCES OF WATER POLLUTION

In an analysis of the above issues, a number of process-related[1] factors emerge that appear to play a critical or key role in determining the success or failure of projects. On the basis of this it is deemed essential that the guidelines (Field Guide) for project implementation would need to incorporate these core elements as an essential part of the programme process.

### 2.4.1 ACCEPTABILITY

The drive towards finding acceptable solutions to the problem of pollution (both in terms of the situation and the communities involved) may be seen as one of the major reasons for the development of programmes such as this. The success of interventions are dependent on the extent to which recipients and/or participants can identify with the strategies and processes of such intervention techniques. In essence, the level of acceptability is determined by the extent to which there is a perceived 'goodness of fit' between the problem situation (at whatever level) and the intervention.

### 2.4.2 ACCESSIBILITY

In this context, accessibility is defined on three levels.

- The first relates to the degree and extent to which people may gain access or derive benefit from interventions. The promotion of accessibility to previously marginalised individuals and groups is

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[1] Process-related factors, as set out here, reflect a value system that determines the approach and process to be followed in programme development and implementation.

especially important.

- The participative focus of this project requires that intervention strategies should provide ready access to people on participatory as well as decision-making levels.

- The third aspect of accessibility relates to the drive to promote informed decision-making and participation of individuals and communities. On this basis, access to information and knowledge are seen as key components in promoting the empowerment of people.

### 2.4.3 ADAPTABILITY

Adaptability forms an essential component of change management, based on the interaction and interdependence that exists between individuals from a community and their environment. As this is a dynamic process, the framework within which any programme is applied needs to be situationally relevant and capable of adapting to changes in level of intervention on a local, regional or national basis.

### 2.4.4 APPROPRIATENESS

The quest for the provision of appropriate intervention strategies manifests itself on a number of levels

- the inter-relatedness and interaction between the community and the environment is regarded as the point of departure for intervention. On this basis, intervention strategies are deemed appropriate if they are developed on the basis of contextual validity.

- Societies consist of a number of levels of social organisation that ranges from the individual through to the community. The level of intervention should be appropriate to the level at which the problem manifests itself without losing sight of the interdependence of, and interaction between, levels.

- Research may identify specific interactions of, or relationships between, variables or behaviour characteristics at one level of social organisation. Care should be taken that generalisations of such

findings to other levels of social organisation should be appropriate[2] and relevant.

### 2.4.5 CO-ORDINATION

Problems experienced with the development of successful programmes have placed an emphasises on multi-factorial causality and the inter-relatedness of systems and settings. As such, interventions require co-ordinated and integrated multi-disciplinary and multi-sectoral interventions on vertical and horizontal levels. Due to the dynamic and complex nature of this approach, co-ordination forms an essential requisite for the effective implementation of development-focused programmes.

### 2.4.6 EMPOWERMENT

Development programmes, such as that proposed for this project are essentially based on an empowerment agenda. To be committed to, and consistent with such an agenda in the approach to the programme is to be

> *... committed to identifying, facilitating, or creating contexts in which heretofore silent and isolated people, those who are "outsiders" in various settings, organisations and communities, gain understanding of, voice, and influence over decisions that affect their lives. Empowerment is by definition concerned with many who are (or have been) excluded by the 'majority' society on the basis of their demographic characteristics or other difficulties, experienced either in the past or the present. Such people are often allotted a low ascribed status, and are afforded little opportunity to attain achieved status.* (Sarbin, 1970: 52)

On the basis of this empowerment approach, the proposed programme will need to focus on three essential aspects of empowerment. These are

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2 Borgatta & Jackson (In Heller et al, 1984: 63) refer to this as the "fallacy of the wrong level" or the "ecological fallacy'.

- institutional capacity building
- participation
- the promotion of the formal recognition (legal or otherwise) of the status of the participants as well as the structures they establish.

### 2.4.7 EQUITY

The requirement that any programme that is developed should promote equity comprises a natural and logical component of the empowerment agenda. The principle of equity is accepted as basis for the promotion of social justice and the mobilisation of disadvantaged individuals and groups to participate in, and gain access to, development in accordance with their needs.

### 2.4.8 INDIGENOUS KNOWLEDGE AND LOCAL SKILLS

The programme will need to offer a shift away from a "blaming-centred" orientation to an emphasis that acknowledges and promotes competencies, skills and strengths. Indigenous knowledge and skills have, for a long time, been ignored or marginally considered in human resource programmes and development initiatives. There are two problems inherent in an approach that does not acknowledge the inherent value of indigenous knowledge and skills. The first serves to reduce the capacity building and empowerment potential that development initiatives may offer. The second is that the negation of basic strengths and capabilities increases an individual's belief that he is powerless and actively serves to reduce independence and coping skills.

### 2.4.9 MULTI-DIMENSIONAL

The approach that is being proposed, paradoxically, offers opportunities for oversimplification of problems as well as opportunities for focusing on and escalating their complexities. Both offer the potential for serious errors in inference and intervention. Research and intervention should, at all times, be bedded in an understanding of the multi-dimensional nature of the problem. This approach forces an inevitable realisation that research in this field, as well as the interventions based thereon, can never be regarded as

offering the final answer or the ultimate solution.

For this reason any programme that is developed should strive, at all times, to implement change processes that will enable individuals to responsibly manage their own lives in accordance with their own circumstances and needs. Part of this process must, however, promote individuality and empowerment that respects and accepts the rights and needs of others.

### 2.4.10 PARTICIPATION

A multiplicity of conceptual as well as operational definitions exist for Participation. The majority of these (even where they state the contrary) are synonymous with consultation. In addition, there is frequently a direct contradiction between the conceptual and operational definitions that are set for participation in terms of programme implementation. To be effective, the programme should seek participation on three distinct levels. These levels are

- The active participation and involvement of individuals in the promotion of their own well-being and problem-solving behaviour. On this basis, development is seen as part of individual responsibility and offers a contrast to the usual way of implementing projects where the developer is the active helper and the community the dependent recipient.

- Individual and system-wide (e.g. community) participation and involvement in decision-making processes about the type of broad-based services and programmes that are required in a community. Two specific and essential aims are served by obtaining participation on this level. The first aim relates to the promotion of the accountability and relevance of any institutional structures that are formed within a community. This would, usually, include the establishment (or strengthening) of community-based structures such as development or water committees to promote ongoing involvement and participation. The second aim relates to the involvement and participation of the community in the planning and monitoring of existing services/facilities and the extension or alteration

of such services/facilities.

- The final level of participation seeks the active mobilisation of community resources (human and natural) for the promotion of project objectives. Examples of such 'contributory' participation is the development of community-based appraisal and monitoring teams, the establishment of supportive networks and linkages in the community or any other on-going participative actions deemed necessary by the community.

### 2.4.11 RELEVANT

The contextual understanding of individuals, circumstances and settings should form a central and overarching component of any programme that is developed in order to provide relevance to interventions. In this regard Tolan et al (1990: 213) state that

> *The concept of empowerment, for example, is potentially mischievous if not embedded in the specific goals, values, processes, and definitions of power that have local relevance. Unless grounded in local conditions, empowerment efforts could become another exercise in development imperialism or the imposing of external and potentially alien ideology.*

# 3. CONCEPTUAL FRAMEWORK FOR PROGRAMME DEVELOPMENT

## 3.1 INTRODUCTION

From the information obtained from the literature overview, project evaluations and interviews as set out in Chapter Two it is clear that the development of community-based programmes to combat diffuse sources of water pollution have a number of distinct but inter-linking areas of focus, all of which serve to underscore the multiple basic needs of poorer groups or communities. Programmes focusing on the promotion of environmental awareness and a conservation ethos (in the first world sense) are bound to be unsuccessful in combating pollution in developing communities if it ignores this basic needs context. The aim should be to develop a programme that could promote effective resource management at community level in a manner that satisfies basic development needs as well.

Based on national and international experience in the field of participatory community development in general, and water resource management in developing communities in particular, every indication is provided that no standard development blueprint can effectively be drawn up to address water resource management identically in every community. Not only would such an approach ignore every development caveat that exists but will, in addition, negate the heterogeneous quality of communities, terrains and situations in South Africa.

Despite the above, it is essential that water resource management is addressed in a consistent manner on policy, institutional and user levels and presupposes, at the very least, a conceptual framework that strives to integrate and reconcile social, health, technical, economic and environmental objectives and realities.

The implementation of community-based participative initiatives to satisfy basic needs and promote sustainable environmental practices in accordance with the such objectives and realities has, fairly recently, come to be known as Primary Environmental Care (Pretty & Guijt, 1992). The IUCN

(1994:17) provides the following definition of this approach:

> *Primary Environmental Care (PEC) is a process by which local communities organise themselves and strengthen, enrich and apply their means and capacities for the care of the environment while simultaneously satisfying their needs.*

On the basis of a PEC approach programme design would, firstly, need to allow for the inclusion of sanitation and waste management practices with that of water management. It would, secondly, need to make provision for the informed selection of cost-effective and technically appropriate options for the provision of such basic services in a manner that enhanced environmental protection. It would, in the third instance, require that programme planning and implementation should incorporate operational procedures for promoting maximum community empowerment and community participation.

The researchers believe that the overview of multi-disciplinary issues and the principles of IEM and PEC, discussed above, provide a constructive point conceptual framework to address diffuse sources of water pollution in developing communities on a participative basis.

It was initially intended that these objectives would be met by means of the provision of conceptual guidelines for the development of a programme to address diffuse sources of water pollution, utilising an Action Research Process Approach. The information generated by the study showed that fulfilling these aims, without addressing the practical realities encountered in the field, could result in the study becoming a purely academic exercise.

It became increasingly apparent that a set of practical guidelines was needed that could direct activities aimed at implementing preventive programmes in developing communities. As a result of this the researchers, in consultation with the WRC, decided that the initial aim of formulating a conceptual framework should be extended. The additional tasks comprised the development of guidelines for practical project implementation and the undertaking of pilot projects to test the assumptions of the guidelines.

In order to execute this extended aim, the researchers compiled and tested a Field Guide to serve as a step-by-step practical guide for research and programme development. It is hoped that the Guide will provide developers with the necessary "tools" to develop sustainable, situation specific programmes to address sources of, and problems related to, diffuse sources of water pollution at grassroots level. The balance of this section serves to provide an overview of the approach that serves as basis for the Field Guide.

## 3.2 DEVELOPMENT APPROACH TO THE FIELD GUIDE

Issues identified have served to indicate that the development approach for the compilation of the Field Guide will need to allow the integration of aims that, at times, appear to be contradictory and mutually exclusive. According to these aims the Field Guide should make provision for:

- The development of community-specific, situationally-relevant and applicable programmes;
- Replication under divergent conditions and in different communities;
- Methods that are simple and adaptable;
- Ensuring a goal-directed approach to allow the reaching of project-related targets and objectives (acceptable to communities, developers and funders);
- Provision for an open-ended participatory approach on as broad a basis as possible;
- Promotion of institutional capacity building as part of the process. This is necessary to ensure viable ongoing operations and maintenance of the systems that have been put in place on the one hand and allow the community greater competency to manage their own future development on the other hand;
- Ensuring an ongoing learning-process approach.

This proposed approach for programme development and implementation is not unique or untried. Rather, it provides a strategic basis for integrating knowledge and experience in the field (while attempting to avoid the pitfalls inherent in bringing together the multiplicity of issues that have an impact on effective programme development) with a process oriented approach for research and programme development.

The researchers have been fortunate in that they have been able to draw on the vast practical experience of organisations and individuals and the approaches that they have developed and submitted to extensive testing in developing communities. These include the SARAR approach used by the UNDP-World Bank Water and Sanitation Program for the Promotion of the Role of Women in Water and Environmental Sanitation Services (PROWWESS) as well as the work on Participative Rural Appraisal and Rapid Rural Appraisal by Robert Chambers. The approaches they promote have formed an invaluable basis for the development work that the researchers have been involved in the past number of years. In addition, these approaches have served as tried and tested basis for the development of a Field Guide that incorporates the principles of ongoing **Participatory Appraisal and Training** (such as those ascribed to by Chambers and PROWWESS workers) and extending these to include the promotion of **Participative Development Management** (as ascribed to by community developers such as Afrosearch-Index).

As these two principles form the basis for the Field Guide, the following section of the report provides a working description in respect of each of the approaches.

### 3.2.1 PARTICIPATORY APPRAISAL AND TRAINING

Participatory appraisal and training involves a process that stresses the vital importance of promoting maximum participation of communities at grass-roots level in all aspects of project development. This ranges from the initial discussions and analysis through to the implementation of projects. It is ".. a growing family of approaches and methods to enable local people to share, enhance and analyse their knowledge of life and conditions, to plan and to act." (Chambers, 1993:5)

Participation, in terms of this context, actively strives to promote independent community ability to identify, analyse and solve problems and to participate in decision-making, project development and project implementation. Such participation seeks to maximise human capacity building (as part of the project development process) in order to provide the basis for sustainable present and future development. Participative training (learner-centred training) combines learning about project related matters (such as the functioning of a development or water committee or how to ensure ongoing operations and maintenance of systems) with capacity building that will initiate and sustain processes of change and empowerment in developing communities.

It has become obvious that large numbers of project developers view participation either cynically or dismissively. Large numbers of projects that are implemented address the promotion of community participation on a perfunctory basis if at all or equate consultation with participation. While it is not seen as a panacea, it is firmly believed that effective (and therefore capacity-building and empowering) participation is an essential requisite for project success on an ongoing basis. In this regard, WASH reporting on the results of studies in Indonesia and Togo state that:

> *The community participation process used in developing water supply and sanitation projects has potential benefits extending far beyond those projects. The skills that are transferred, the capability that is developed, and the confidence that results from managing community affairs combine to increase the community's ability to take on other projects and other issues that affect its well-being.*
>
> *The best evidence to date showing the effectiveness of community involvement in water supply projects on participation in subsequent health care activities resulted from a study of 60 villages. Using DPT (diphtheria, pertussis, tetanus) series completion rate as indicator, the WASH study found that, .. where participatory water supply projects had been carried out .. series completion was consistently higher (55 to 60 percent) than in the communities where only non-participatory projects (with facilities developed by external agencies) had been carried out.*

> *The indication is, then, that participation in a water supply project - not just the existence of a project - is the key to the stimulus effect on other health care activities.* (1993:9)

While participative appraisal and training are invaluable for the promotion of community capacity-building and empowerment it is not, in and of itself, automatically synonymous with development.

The techniques of Participative Appraisal and Training allow for "before the fact" and "during the fact" involvement of communities in their own development. While this process does serve to strengthen the capacity of communities and serves to stimulate greater autonomous activity after project implementation, it does not put structures in place for "after the fact" involvement in the management of development.

Because of this, it was believed essential that the Field Guide should incorporate community development measures that will promote on-going development.

### 3.2.2 PARTICIPATORY DEVELOPMENT MANAGEMENT

Participative development Management may be defined as a development process that aims at ensuring co-ordination and integration of planning, implementation, monitoring and evaluation as well as maintenance and control activities relative to existing and future development projects by a community for the community.

Whereas Participatory Appraisal and Training allow for involvement in planning and project-related change, Participatory Development Management seeks to build the capacity of the community to the extent where the members of the community can engage in change management on an ongoing basis.

The key components of such a development model include the following:

- an integrated multi-level, multi-task approach to development;
- capacity building to a management level;

- Ongoing grass-roots participation in planning, decision-making, implementation and control;
- Strong integration and co-ordination of local development within the broader district and regional context;
- Responsible budgeting and financial management of projects devolved to district and local levels;
- Ad hoc application of experts on a cost-effective and issue-related basis;
- Development committees and action groups utilised in a specialised manner to identify, qualify and quantify development issues and proposed solutions.

Participative Development Management may be seen as a pro-active, controlled and strategically managed real development process. This implies that it seeks to enhance the capacity of the people in a community to manage their own development process. The ultimate aim of this process is to ensure that the capacity of the under-developed areas is increased in a manner that will enhance and sustain the development process.

This does not, in any way, imply a desire to shrug off the wider society's responsibility to under-developed communities. It does, however, serve to decrease the dependency of communities on expensive (and frequently inappropriate and ineffectual) external development aid offered by "development tourists[3]". It also serves to assist in increasing their capacity to control their environment and circumstances, in the process not only improving their living standards but also their self-esteem, independence and ultimately, their quality of life.

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[3] A phrase coined by Chambers (1983:10) and amply illustrated by a member of a community in the following statement: "Those white men in their big white cars and black bags were here again. They come here twice a year, spend half an hour looking around and then say that they understand our problems and know all the answers - all the way from out there!"

## 3.3 DESIGN OF THE FIELD GUIDE

The approach that is, therefore, proposed for the design of the Field Guide, comprises four basic phases:

### 3.3.1 PHASE ONE - RAPID ASSESSMENT AND CONSULTATION

Community participation is promoted as first step. A rapid assessment of the key problems relating to water, waste and sanitation within the community is done, based on existing information. Basic data are assembled and analysed, information gaps identified, and a profile of the community is prepared in respect of water, waste as well as sanitation. These profiles are based on information obtained from qualitative data-gathering within the community, quantitative data for the Baseline Data reports and the projections of options derived from decision trees for choosing appropriate technical options (Algorithms).

The strategic objectives of this phase are:

- Provide an acceptable access to the target community.
- An assessment of status within the community regarding each of the fields of water, waste and sanitation;
- The identification of areas of further study should these be found to be necessary;
- The commencement of an increased awareness about water, waste and sanitation across all levels of the community;
- A broad-based "political" commitment amongst all role-players to move forward with the planning process in the form of a project agreement.
- A process of institutional development that ensures capacity building and empowerment of the local participants.

### 3.3.2 PHASE TWO - THE DEVELOPMENT OF SUSTAINABLE WATER, WASTE AND SANITATION MANAGEMENT STRATEGIES (WWSMS)

The water, waste and sanitation management strategies are aimed at establishing sustainable short-, medium- and long-term development goals in a manner that addresses the needs of the community without unduly compromising the environment, and indicates the path to follow in order to reach the goals.

Information gaps identified during the rapid assessment are filled by means of more detailed data collection and analysis, should this be necessary. A detailed diagnosis is made of present WWS (water, waste and sanitation) infrastructure and services, existing development and sector plans, of related environmental risks and impacts, and of possible interventions.

An institutional audit is also done, including policies, regulations and organisations. Using a cost-benefit framework obtained from the first phase, first order estimates are made of the costs of interventions and corresponding impact reductions.

Based on this analysis strategies are formulated, in co-operation with the community, for the development and management of WWS in the community. This analysis process involves one or more strategic planning workshops with the community to provide information about issues such as cost-benefit analysis and intervention alternatives, as well as prioritising development goals and tasks.

The strategic objectives of this phase are:

- Developing appropriate project related baseline data.
- The development of a clear understanding of the core information needs of the Participatory Development Management Process.
- The integration and analysis of data results.
- Ranking of identified issues in order of priority to serve as the basis for developing a Community Resource Management Plan.

- Linking of key project needs with the existing resource base.

### 3.3.3 PHASE THREE - THE DEVELOPMENT OF A COMMUNITY-BASED RESOURCE MANAGEMENT PLAN

A separate action plan is developed for each of the water, waste and sanitation sectors, with the WWSMS providing the framework for integration and co-ordination to ensure consistency across sectoral strategies. The preparation of each action plan starts with the formulation of the best possible project management options, including preventive and curative measures. Specific action or goal tasks are set within a framework of contributions (including costs and financing) which will be required from the community and external institutions to meet such goals, within the framework of budget constraints and local implementation capacity.

The goal-setting functions of this stage, therefore, result in strategic plans wherein ways of attaining the objectives of the normative model are used to formulate goals that can be achieved given the range of feasible alternatives involved and the optimum allocation of available resources.

In deep rural communities it is envisaged that external institutions will play a facilitating role in providing support in decision-making, implementation and the co-development or selection of appropriate technology as it becomes available. In addition, such institutions will have to undertake a specific education and extension role in organisational and institution building in order to attenuate community knowledge and implementation capacity on a sustainable basis.

Within areas that have a stronger urban link such external involvement may need to make provision for a greater degree of active service delivery to communities depending on viable and sustainable cost-benefit decisions made by the communities involved.

The strategic objectives of this phase are:

- To develop water, waste and sanitation management strategies and commensurate development goals that are socially acceptable to, and affordable for the community;

- The identification and phasing of priority sectoral tasks and actions to reach the goals that have been set;
- The development of needed policies, instruments and institutional development including capacity building components required for management and utilisation.
- A breakdown and allocation of duties (both within the community and in respect of external organisations) based upon goal tasks;
- A breakdown of costs based on goal tasks in respect of each of the sectors of water, waste and sanitation;
- The finalisation of an action plan supported by all role-players to facilitate the scheduling of duties, the execution thereof, report-back procedures and monitoring of progress within a "learning process" approach.

### 3.3.4 PHASE FOUR - IMPLEMENTATION, MONITORING AND EVALUATION WITH A FEEDBACK APPROACH FOR ADJUSTMENT AND REORIENTATION

This stage involves the implementation of the specific action plans in respect of water, waste and sanitation on a basis that makes provision for two levels of ongoing monitoring and evaluation. The first is related to the feasibility and sustainability of the specific tasks that have been set. The second relates back to the initial rationale for undertaking this study, **viz., the management of the incidence and extent of diffuse sources of water pollution.**

The strategic objectives of this phase are:

- The implementation of the specific action plans that have been developed;
- Ongoing monitoring of actions;
- Action plan adjustment by means of participative decision-making, where necessary, based on the results of the monitoring process;
- The introduction of specific extension or support activities, where

necessary, to promote the autonomous functioning of the community in respect of the various projects.

The tasks for the four programme development stages set out above have been used as basis to design a Field Guide that incorporates the aims of Participatory Appraisal and Training and Participative Development Management.

## 3.4 USE OF THE FIELD GUIDE

The Field Guide, in its current format, is believed suitable for use by community and project developers. Some understanding and experience of the development process required to implement water, sanitation or waste projects is required as well as a desire to 'add value' to communities. It provides a solid basis for the implementation of broad-based participative project development in general without pressuming to prescribe "recipes". As such, it serves to describe the milestones that need to be achieved or incorporated to allow participative project development.

It is not suggested that the Field Guide is exhaustive or that it should be regarded as a development 'bible'. The intention is that it should be used in conjunction with the numerous books and manuals on various aspects of Participative Appraisal and Training, development management within underdeveloped contexts as well as guides and manuals on the technical provision of water, waste and sanitation services.

# 4. CAPACITY BUILDING AND INFORMATION REQUIREMENTS

## 4.1 INTRODUCTION

The present situation, as well as the effects of past practices and policies, must be taken into consideration in an evaluation of the capacity building (educational and training) and information needs within the context of water, waste and sanitation at community level.

Marginalisation has left the majority of the population of South Africa with a lack of integrated formal education and training opportunities. This has led to the following realities, amongst others:

- A large percentage of people in South Africa are, at present, either totally or functionally illiterate;
- A large proportion of these people will not be able to access existing formal or vocational (non-formal) education and skills training opportunities;
- At present technical and technological knowledge and training focuses on the promotion of advanced technological initiatives. Although this process is necessary, the emphasis fails to promote a technology that is relevant, appropriate, accessible, affordable and sustainable to meet the basic infrastructural and human needs of our broader society;
- In instances where development projects are initiated, most members of recipient communities lack the necessary skills to participate in the implementation and management thereof and imported expertise is utilised. The applicable skills to promote sustainable utilisation and management are frequently not transferred to these communities, leaving them as disempowered as before the process started.

The restructuring of the existing education and training systems to address issues, such as those set out above, is of the utmost importance. Significant

progress has been made in respect of aligning vocational training into a National Qualifications Framework. However, much remains to be done in the water and sanitation sector. In accordance with this proposed process, it will be necessary to promote training programmes aimed at promoting the establishment of infrastructure that will serve as useful public assets in a manner that would involve the community as a whole and have a marked multiplier effect on the economy. Such programmes would need to be sustainable, include labour-intensive components, promote income generation for the lower socio-economic group, support local enterprise and allowed accredited skills training.

## 4.2 OBJECTIVES OF EDUCATION, TRAINING, CAPACITY BUILDING AND INFORMATION TRANSFER BASED ON THIS PROJECT

Both the development paradigm and the resultant processes suggested for the Field Guide focus on the building of competencies, the enablement and empowerment of people and the strengthening of community action. Based on this point of departure capacity building, including the provision of adult education and training and information dissemination form an essential component of an empowerment agenda.

While the role and value of primary, secondary and tertiary formal education is acknowledged and stressed, it is believed that appropriate training outside the formal system requires urgent attention. Within this context, training is seen as vocational (functional) learning and skills development that form part of the so-called informal and non-formal education system. It sees learning as a life-long process that seeks to impart motivation and skills that will allow the individual a competency base to raise his general standard of living, to improve his quality of life and to find gainful employment.

On this basis, a number of specific objectives are believed to be relevant for the development of appropriate training within the context of water, waste and sanitation related projects. These are:

- Promotion of access to Adult Basic Education and Training (ABET), encompassing skills such as literacy, numeracy and basic life skills to

form the basis for further skills development;

- Development of the necessary accredited training to establish and maintain a viable infrastructure for development projects;
- Ensuring the long-term viability of community development initiatives;
- Structuring training in a manner that will allow wider application in the employment market, thus assisting in addressing unemployment and poverty and promoting the quality of life of individuals and communities;
- Providing training for development managers that will enable them to manage development within their communities in an efficient manner;
- Promoting the transfer of information and informed decision-making at all levels;
- Focusing on courses that can be integrated within a national accreditation system whereby qualifications obtained could, on a cumulative basis, provide access to formal education;
- Actively promoting the development of management and technical support skills on a project or non-project related basis;
- Promoting training that will allow members of the community to fulfil key technical and managerial roles within the community, presently occupied by outside experts;
- Providing education and skills training based on project-related employment requirements;
- Making adequate provision for the training of Trainers;
- Utilising existing, under-utilised educational and training structures and human resources from within the recipient community for the presentation of courses.

## 4.3 STRUCTURING OF COURSES FOR WATER, WASTE AND SANITATION RELATED TRAINING

It is suggested that training in respect of water, waste and sanitation management within communities is structured on two levels, viz., pan-sectoral and sector-specific levels.

Pan-sectoral training refers to skills that need to be acquired within the context of water-related projects but that are generic in nature. These skills include, inter alia, financial management, accounting, communication and management of development and tendering procedures.

Sector-specific skills, on the other hand, tend to be more technical in orientation and are particularly related to the water, waste or sanitation sector. These skills include, inter alia, selection and management of sanitation schemes, design implications of water delivery systems and the proper handling of waste to minimise health risks.

In an analysis and comparison of training on offer as set out by Pearson, Rivett-Carnac & Alcock (1994) on the one hand and Ernst & Greeff (1992) on the other hand, it may be seen that far greater attention has been paid to the development of pan-sectoral skills training courses than to the development of sector specific training on an **appropriate** level.

Available technical training tends to focus on a first world working scenario (e.g. watercare operators and operations managers) rather than on the provision of "enough" skills to ensure effective functioning in a developing community context. Examples of such courses would be the operation and maintenance of different types of water pumps, the building of **effective** soak-aways, etc. This training would need to provide for an in-depth as opposed to a broad-based working knowledge of systems.

In addition to the above, training courses appear to be largely aimed at equipping members of water committees with a broad-based knowledge of the sector on the (mistaken) assumption that committee members will always be the persons responsible for operation and maintenance of infrastructure after project implementation. More frequently, this aspect of

functioning will need to be undertaken by a person who has received specific training in "Community-based Water or Sanitation Operations and Maintenance and who is accountable to the water committee and the community in the first instance and the local authority in the second instance.

## 4.4 POTENTIAL TRAINING COURSES FOR THE EFFECTIVE PROMOTION OF PARTICIPATIVE COMMUNITY BASED WATER, WASTE AND SANITATION PROJECTS

### 4.4.1 PAN-SECTORAL TRAINING

- Institutional (Local Government) Development
- Development management training (including training for participation)
- Portfolio training (aspects related to the effective functioning of committees).
- Formation and implications of legal structures in the community (trusts, companies, voluntary groups, etc.)
- Facilitation and conflict management and resolution skills
- Development of personal skills
- General project management
- Financial planning, budgeting, etc.

### 4.4.2 SECTOR-SPECIFIC TRAINING MODULES

- Development and management of water supply systems, including appropriate technology selection
- Development and management of sanitation systems, including appropriate technology selection
- Technical maintenance and support of water supply systems

- Development of a Community Water Plan
- Development of a Community Sanitation Plan
- Construction of sanitation systems
- Technical maintenance and support of sanitation systems
- Health aspects of water supply and sanitation, hygiene education, water quality monitoring
- Rainwater harvesting and storage
- Waste management, treatment and resource recovery, including appropriate technology for waste collection
- Water, Waste and Sanitation programme monitoring

The above course suggestions are not exhaustive, but serve to provide guidelines on the potential focus and subject-matter of courses.

In accordance with the final aim set for this project, Afrosearch-Index has developed a number of training courses that have been submitted for accreditation. All courses submitted have been extensively tested in the field as part of the development work undertaken by this Organisation.

# 5. PILOT PROJECTS

## 5.1 INTRODUCTION

A number of pilot projects were launched to test the validity of the Field Guide on the one hand and to establish the adequacy of linking the predominantly pan-sectoral and land-use management training that had been offered by Afrosearch-Index up until that stage, with the technical skills training required to implement effective water, waste and sanitation management.

Detailed case studies of three of the pilot projects are offered as separate Appendices to this report. While it was originally intended that only three communities be used, an increasing number of communities have approached Afrosearch-Index over the past two to three years and requested assistance with the implementation of water and sanitation projects specifically. In most instances the communities have requested that these development programmes be linked with agriculture and, where feasible, the establishment of community-based income-generating projects. All communities in which development facilitation in respect of water, waste and sanitation is taking place are however listed in the section of this Chapter dealing with habitat classification. This includes communities where Afrosearch-Index has been contracted by engineering consultants to assist with specific aspects of project development related to the promotion of participative development, training and capacity building,

The balance of this Chapter provides details of the process followed for project implementation as well as a brief overview of the system used for habitat classification. In conclusion, some of the most important problems related to the implementation of the pilot projects and the ongoing maintenance thereof are provided.

## 5.2 FOCUS OF THE PILOT PROJECTS

### 5.2.1 DEVELOPING COMMUNITIES

The focus for all the pilot projects were African developing communities in South Africa and Botswana. Within the literature, developing communities are often referred to as Third World, marginalised or under-developed communities. A large number and variety of definitions have been posited, based on the point of departure or discipline to which the person formulating the definition belongs. All definitions, however, serve to underscore the presence of the following characteristics, inter alia:

- Low socio-economic status;
- Low levels of education;
- Absent or inadequate infrastructure;
- A lack of essential basic services and support structures;
- A high ratio of children under the age of 16;
- Inadequate housing and/or high room densities;
- High levels of unemployment.

For the purpose of this study communities were classified as "developing" if they answered to all seven characteristics set out above.

### 5.2.2 HABITAT CLASSIFICATION

It was initially intended that pilot projects be implemented in different habitats on the basis of an urban, peri-urban and rural habitat continuum. On this basis the following classification of each of these habitats was accepted:

- **Urban areas**

  Urban areas may vary from small to massive agglomerations. On this basis, the United Nations has standardised its data by recognising that all settlements that have more than 20 000 people are 'urban'. 'Cities'

have more than 100 000 people and 'big cities' have more than 5 million people. The arbitrary basis on which these definitions have been set have, however, seldom been adhered to in global tabulations and have been the focus of severe criticism.

As a broad base of departure, an urban area is regarded as any area that has been designated a town or urban area in terms of any proclamation, whether or not such proclamation has subsequently been repealed or replaced. In addition, some form of official local bureaucratic authority exists.

- **Peri-urban areas**

  Peri-urban areas are any areas not actually proclaimed as urban/town areas, but found directly adjacent to proclaimed areas. These areas are diversely referred to as 'high population chieftain areas', 'high density areas', 'informal squatter areas', 'peri-urban areas', 'kapteinsgebiede', 'digbewoonde stamgebiede', etc. within the literature. Such areas may, or may not, depending on manner of formation have some sort of official local bureaucratic authority apart from or in addition to the tribal or community authority.

- **Rural areas**

  A rural area refers to any area, other than the areas designated urban and peri-urban, as set out above. No official local bureaucratic authority is seen to exist. Authority is vested in the tribal or community authority.

As in other countries with a developing community component, great diversity of circumstances, levels of services, infrastructure and population profiles are found in the vast majority of settlement areas in South Africa, irrespective of whether or not these have been designated as Urban, Peri-urban and Rural.

Because of this reality, the United Nations Centre for Human Settlement (HABITAT) has introduced a classification system for human settlements that seeks to avoid the usual (and often inappropriate) disagreement and lack of

consistency in setting adequate definitions regarding 'rural', 'peri-urban', 'urban' and 'urban' parameters. Final classification of projects was based on the classification proposed by the UNCHS. It was believed that this would allow an evaluation of different factors that could influence programme development on an integrated basis.

The following habitat categories may be identified (in each case the settlements selected in terms of such classification is listed below the specific type of habitat):

- Rural Settlements Upgrading:
  - Dinkie 1 and Elandsfontein - Bourke's Luck (Inactive)
  - Middelplaas A - Shongwe
  - Middleplaas Bongani - Shongwe
  - Dinkwanyane - Ohrigstad
  - Retabile - Lewelemagodi
  - Banareng - Lewelemagodi
  - Phiring - Lewelemagodi
  - Moraba - Lewelemagodi
  - Mapareng - Lewelemagodi
  - Malaeneng - Lewelemagodi
  - Makoule - Lewelemagodi
  - Rutseng - Lewelemagodi
  - Nkoane - Lewelemagodi
  - Mabelane - Lewelemagodi
  - Matshekweng - Lewelemagodi

- Makopung - Lewelemagodi
- Makgalane - Lewelemagodi
- Mokotung - Lewelemagodi
- Tswenyane - Lewelemagodi
- Majeje - Phalaborwa
- Mabunda - Phalaborwa
- Mahumani - Phalaborwa
- Mathefila - Phalaborwa

- Rural Growth - Centre Development:
  - Lehroro - Bourke's Luck
  - Ngodini Dam - Clau Clau (Also spelt Hlau-hlau)
  - Spelanayne - Clau Clau
  - Clau Clau A - Clau Clau
  - Clau Clau B - Clau Clau
  - Clau Clau C - Clau Clau
  - Clau Clau F - Clau Clau
  - Buyelani - Clau Clau
  - Nkohlakalo - Clau Clau
  - Dwaleni - Clau Clau
- Urban Slum Upgrading:
  - Setsing - North West
  - Vukuzakhi - South Eastern Transvaal (abandoned)

- eSizameleni - South Eastern Transvaal (abandoned but negotiations for resumption are taking place)

- Site and Services Schemes:
  - Old Naledi - Gaberone
  - Setsing - North West
  - Mabolela - Eastern Free State
- New Urban Community Development:
  - Atteridgeville - Gauteng

## 5.3 PROCESS UTILISED FOR DEVELOPMENT

The Field Guide was used as basis for the approach followed in each of the communities were participative community-based programmes needed to be established.

In some communities, such as Old Naledi, development training for community-based waste managers was done, using the development process as set out in the Field Guide.

## 5.4 SPECIFIC PROBLEMS ENCOUNTERED

### 5.4.1 COMMUNITY CAPACITY

It has been found that, in communities with an absence of development initiatives and existing structures, an extensive period of capacity building and the promotion of participation needed to be undertaken prior to undertaking large-scale projects such as the provision of water supplies or community-wide sanitation. Where this has happened, small-scale projects (that had a good chance of succeeding despite the immediate lack of capacity) were undertaken to initiate community-based activities. Examples of such projects include the promotion of effective agricultural and land use practices or participative management in respect of immediate water supply problems (such as spring protection). While this has, inevitably, served

to slow down the initial process of developing effective community-based water, waste and sanitation programmes it has been demonstrated that this initial "go-slow" has been worth the time, effort and energy in terms of long-term gains and progress.

### 5.4.2 PARTICIPATION

While effective participation has been demonstrated to be the single most important component of successful programmes, project funding for the promotion of this project component is notably absent from funding budgets. Here, for example, the White Paper on Water Supply and Sanitation makes provision for grant funding in respect of training and capacity building of water committees after they have been established and registered! This approach will, inevitably, lead to one of the following two scenarios.

Developers will do the initial training and after the establishment of a legitimate committee will submit an application to funding agents such as the Department of Water Affairs and Forestry requesting funding for training to be undertaken despite the fact that this has already taken place. This provides committees with a perfect example of how to "bend" the rules despite training that should have inculcated a ruthlessly honest approach to financial matters.

The alternative is that developers will resort to putting an "instant" token committee in place that has not been elected on the basis of a participative process and has received very little if any training. Most frequently, such committees will merely serve as a reflection of the elite and serve to further empower the powerful. This approach negates broad-based participation and promotes a lack of commitment from the members of the committee as well as the communities which they purport to serve.

From the above it may be seen that the process will favour development in communities were strong community infrastructure and capacity already exists, further marginalising severely disadvantaged communities.

In an evaluation of the need to build in funding for the development of participative processes, WASH's

> *... work on evaluating five specific A.I.D. - funded projects revealed a general correlation between the amount of money spent for community development and project success in terms of long-term sustainability. This evaluation found that a highly successful project in Togo, for example, had spent about 25 percent of project resources on community participation activities, including health education and training. While no firm percentage can be recommended, it is clear that expenditures for community participation should be substantially more than the frequently cited 1 to 5 percent.* (1993:3)

### 5.4.3 TRADITIONAL AUTHORITY STRUCTURES

Traditional authority structures provide leadership in non-urban communities on a continuum that ranges from totalitarian to laissez faire. Irrespective of the type of leadership provided, initial entry into such communities will always need to be via these formal structures.

Because participative development is based on an empowerment agenda, great care needs to be taken to maximally integrate traditional structures with the development process without entrenching authoritarian structures or causing division in the community.

The coming local elections presently serve to bedevil attempts to find this balance. Traditional authority structures (correctly) foresee that their power-base will be eroded extensively by this process. As such, tribal authorities in a large number of communities are reluctant to promote or support initiatives that may serve to wrest power away from them.

### 5.4.4 IMPORTANCE OF THE REVIEW PERIOD

It is vitally important that the community be given enough time **and** information to allow them to review whether or not they want the project to be initiated. Attempts to bulldoze the community into accepting the proposed development are guaranteed to reduce participation in future stages of the process.

### 5.4.5 IMPLEMENTATION OF ACTION PLANS

The implementation of project action plans usually requires extensive

involvement of the developer to ensure that the process remains participative at this stage. The danger exists that dynamic or impatient community members may want to move faster than the participative process can allow. This can result in a fall-off in participation or confrontation between community members during one of the most crucial stages of the project.

### 5.4.6 PAYMENT OF COMMITTEE MEMBERS AND PARTICIPANTS

The researchers have not found an equitable golden rule that can be applied in making decisions as to whether or not committee members and other participants should be paid for their services in a project.

The most successful means of handling this dilemma has been to assist communities to cost the inputs of strategic workers and to make provision for these expenses within the project budget. There should, however, be an explicit agreement that where necessary, ongoing funding would need to come from the community once project funding ceases. The mechanisms of ongoing funding must be decided on a community-wide basis and adhered to unless there is agreement from all concerned that payment should not or can not be sustained.

## 5.5 EVALUATION

None of the problems that have been encountered have been so serious that they have served to derail the development process totally. There have been frequent "close shaves", severe slowing down of the process, retracing of steps innumerable times and too many mistakes to try and enumerate. We have learnt more from our mistakes than our successes. We have been fortunate to have made them in communities where a climate of trust, mutual respect and mutual learning have served as buffer to the communities as well as to the developers.

A community member described this process of participation and learning as follows:

> *There are days that we feel that nothing that we can do will make a difference but we know that you believe in us and because of this we*

*start to believe in ourselves. There have been many times that we have seen that you have carried us and this is good. Because there have been days and there will be more days were we will carry you.*

*And for everything that we do wrong we do two or more things right and we learn this way. Just like a child who walks for the first time falls down often but then can run and nobody will catch him he is so fast.*

# 6. CONCLUSIONS AND RECOMMENDATIONS

This report has highlighted the fact that sustainable management of diffuse sources of water pollution will need to take place within a context that addresses basic water supply and sanitation needs. Current estimates of the number of people without adequate water supply services are in the region of 12 million, while approximately 22 million lack proper sanitation services. These are spread in some 17 000 communities around the country, the majority being located in the Eastern Cape Province, KwaZulu/Natal, Mpumalanga and the Northern Province.

The Department of Water Affairs and Forestry has prepared comprehensive policies to address this backlog. These have been set out in the White Paper on Community Water Supply and Sanitation Policy and published for comment in November 1994 as well as the Draft White Paper on Sanitation Policy published for comment in 1996. No revisions have yet been made to either White Paper and these must be taken as the definitive documents.

Due to earlier policy inadequacies, an enormous backlog in the delivery of basic water and sanitation services to underprivileged South Africans has built up over the years. This backlog extends to the capacity of the people to control and manage the services they need on a sustainable basis. Based on the research undertaken for this study the following specific conclusions are drawn and recommendations made.

## 6.1 EDUCATION, TRAINING AND CAPACITY BUILDING

The White Paper on Community Water Supply and Sanitation Policy as well as the Draft White Paper on Sanitation Policy regard capacity building (including training) as one of the critical factors that will determine whether or not the Government will succeed in their objectives related to the implementation of reconstruction and development. This is particularly so in the case of water supply and sanitation. Communities will need to be empowered to undertake their own development. This is not possible if the basic skills, which can only be supplied through capacity building and

project-related experience are lacking.

The need for effective capacity building (including education and training) in all aspects of the promotion of water, waste and sanitation programmes is an essential prerequisite for sustainable development. Particular attention will need to be paid to the goals of capacity building. These need to encompass not only the technical skills, but also the development of an understanding of social dynamics. Specific attention should be given to ensure that issues of equity are addressed.

The capacity building that is envisaged covers not only the requirements at community level. Skilled personnel are needed across a broad spectrum. Capacity building categories include:

- general community awareness on water and sanitation including the provision of information packs and teaching aids to schools';
- general community awareness of Primary Health Care (PHC) as related to the fields of water and sanitation;
- general awareness and training about the impact of water and sanitation related issues on the environment in terms of Primary Environmental Care (PEC);
- training of local authorities and local water committees in the principles of democratic governance and public office, a basic understanding of water and public health, administrative skills and necessary technical skills;
- training of community support personnel. Creative solutions are required to produce a cadre of development support workers who are equipped with a balanced set of both community skills and appropriate technical skills; and
- training of specialised water care technicians as well as professional and managerial staff.

Education and training as part of capacity building are seen as fundamental to the process of service provision. The nature of the training and the

accreditation of the training are matters of concern if the skills that are obtained are to be transportable and create wider opportunities for the individuals concerned. A comprehensive plan for the provision of such services needs to be formulated that will promote education and training that:

- Is context-bound and responsive to the needs of the given community in which it is to be implemented;
- Targets **Local Government structures as well as existing community organisations** at local level in order to facilitate a process of swift implementation;
- Will help instil a sense of responsibility and accountability;
- Has tangible and achievable objectives and is directly linked to an implementation plan (i.e. upgrading of water supply infrastructure, implementation of a tariff structure);
- Provides the necessary financial back-up for the established structures to function effectively and efficiently;
- Takes cognisance of the roles and responsibilities of legitimate local government which have been vested in it by the electorate;
- Is cautious of creating parallel structures[4] to local government.
- Includes a focus on managerial training.

DWAF is perceived as a supporting agent in the provision of capacity building. Clarity will need to be obtained about the integrated role to be played by itself and, inter alia, the Departments of Constitutional Affairs, Health, Housing and Local Government and Environment and Tourism.

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4 Without accountability.

## 6.2 COLLABORATION AND CONSULTATION BETWEEN STAKEHOLDERS

The existing institutional framework within which water management policy planning, design and implementation, legislation and law enforcement, political and constitutional visions and strategies as well as operational matters is functioning, is characterised by complexity, diversity of purpose and varying quality of execution. This characterisation can, in turn, be related primarily to historical political and constitutional approaches and inadequacies in integrated planning, design and implementation.

The statutory requirements directed at, relating to or implying water quality control, are distributed over a wide range of laws, regulations, ordinances and by-laws within a plethora of Government departments, Provincial departments, local/regional authorities and statutory bodies. This creates complexity of functional responsibility at the authority level as well as confusion at all levels of service delivery and water management.

There is a dire need for the initiation of a process of consultation and the promotion of closer collaboration and co-ordination of activities between all participants and stakeholders on all levels of water, waste and sanitation research, development and implementation.

Two factors in particular (as related to this study) appear to negate efficient collaboration and consultation between stakeholders in the promotion of co-ordinated service delivery. These relate to policy issues (and resultant strategies) on the one hand and practical implementation of programmes for research, development and implementation in the second instance.

A number of Departments have released one or more policy statements and White Papers. Considerable discrepancy may be found between policy statements issued within the same Department as well as those issued by different Departments. Such inconsistencies allow for deliberate as well as circumstantial misinterpretation as well as significant diffusion of responsibilities. It is urged that the Department of Water Affairs and Forestry peruse its own policies and:

- address apparent discrepancies found within its own policies;

- address apparent discrepancies between its own policy statements and those of other departments.

At practical implementation level, The existence of functional, competent local government is a key factor in the management of unauthorised connections and in terms of sustainable water supply. Aspects that will need to be addressed include:

- Clear "terms of reference";
- Competence (political as well as operational);
- Administrative capacity;
- Accountability;
- Infrastructure (e.g. communication links, etc.);
- Capacity (Ability to manage).

Care will need to be taken that institutional structures do not duplicate functions (Water Boards, Local Government, Water Committees). Functional responsibilities will need to be spelt out clearly. It will be vital to define the roles and responsibilities of community institutions in a manner that will contribute towards long-term sustainability by maximising community involvement and promoting user contributions.

DWAF must assist in programming and implementing the "hand-over" process, and by providing knowledge, guidelines and standards for a sustainable process while also assisting in gaining access to finances for the implementation of the programmes.

## 6.3 COMMUNICATION

The promotion of ongoing effective communication between authorities, communities, developers and funders is fundamental to project success.

Progress is being made with the development of channels for efficient communication at central and provincial level. A large number of local,

regional and national fora further support processes for communication. However, despite this there is still significant lack of relevant information at Local Government and community level. Communication that targets Local Government as well as communities **down to individual household level** will be vital to promote "informed decision making".

## 6.4 PARTICIPATION

Both the RDP and Department of Water Affairs and Forestry have highlighted the role of civil society in the development process. Structures such as Reconstruction and Development Committees (RDC's), and Community Development Forums (CDF's) etc. are expected to harness civil society developmental activity and form a communication conduit with local government.

The above and related structures seem to be evolving in most communities that have been surveyed. Although willing and committed to participate in water management issues, it is evident that these structures have very little capacity and are entangled in endless wrangles regarding legitimacy of representation, resulting in precious little real delivery to constituents.

Participation is a key issue for the development of sustainable programmes at community level. Such participation is not a spontaneous process and takes time, concerted effort and dedication from developers and communities alike. Funding budgets should reflect this factor.

Communities will need to be assisted in the identification of their needs as well as in the development of plans to meet such needs. Local government will need to be built into an effective, efficient and responsive service provider in the meeting of local needs. This approach would be directly in line with, and indeed aid government in putting the "community first - to ensure transfer control to the local level.." (White Paper on Water Supply and Sanitation, 1994: 13).

Identification and mobilisation of local skills and resources should be seen as an integral part of this participative development process. This will increase the multiplier effect of any development actions, promote "buy-in" from the

community and serve to maximise development benefits to the community.

## 6.5 COMMUNITY ORGANISATIONAL STRUCTURES

Strong, accountable community organisational structures need to be developed as a vital first step in the development process. There is no other way of ensuring the sustainability of projects without fostering a dependence on external developers.

The Role and function of Water Committees will need to be clarified. Discussions with role-players appear to support an orientation that promotes a specific role and function for Water Committees. In accordance with this, a Water Committee could:

- Be a non-statutory, voluntary body that represents the interests of the community and serves as communication conduit between individual households within the community and the responsible Local Government;
- Be integrated into the larger RDP community-based structures and/or forums;
- Co-ordinate and integrate issues within the community;
- Accept responsibility for the identification of issues and problems related to operations and maintenance and reporting back to Local Government on these;
- Accept responsibility for monitoring water quality;
- Assist with local level maintenance on a paid agency basis, should it have sufficient skills and resources to do so, under guidance of and with support from Local Government;
- Support and promote capacity building initiatives within the community;
- **not** be sole implementing and maintenance arm but could perform some of these functions on a basis agreed upon between the specific Local Government structure and the individual community (on a

contractual basis);

In accordance with this point of departure, Water Committees would act as a **representative arm** of Local Government and could function as implementing agent on behalf of Local Government.

## 6.6 WATER QUALITY MANAGEMENT

There are, at present, no effective guidelines for the implementation of "best management practices" in the context of developing communities. It is necessary that a system be developed whereby the risk of groundwater pollution can be calculated effectively on the basis of what Foster refers to as "aquifer pollution vulnerability" (1985:120).

The current debate about groundwater pollution sees pragmatists (pollution may be allowed) and purists (no pollution may be allowed) defending their points of view with equal lucidity and logic. Unfortunately this does not provide the uninitiated with generalised guidelines as to how to assess (even if only by approximation) when and where diffuse sources of water pollution will pose a serious threat to ground water quality.

It is not suggested that such guidelines be used as substitute for site specific risk assessment. Within restricted project budgets a system that indicates or "flags" areas that have high "aquifer pollution vulnerability" can save time and money and promote "best management practices".

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# NAVORSING OOR BOORGATE BINNE DIE MUNISIPALE GEBIED VAN PORT ELIZABETH

DIE EIENAAR/HUURDER

## *LEES ASSEBLIEF HIERDIE PAMFLET INDIEN DAAR 'N BOORGAT OP U EIENDOM IS*

Die onlangse langdurige droogte in Oos-Kaapland het tot 'n groot toename in die getal boorgate in Port Elizabeth gelei, met 'n ooreenstemmende toename in grondwateronttrekking. Tensy die situasie professioneel geëvalueer word, kan die voortgesette beskikbaarheid van die grondwater nie gewaarborg word nie.

Die Port Elizabethse Munisipaliteit het tesame met Steffen, Robertson en Kirsten Ing. 'n navorsingsprojek oor grondwateronttrekking van stapel gestuur. Dié projek sal oor twee jaar strek en deur die Waternavorsingskommissie gefinansier word. Die navorsing sal hoofsaaklik die volgende aspekte dek:

* Bepaling van die aantal boorgate in die munisipale gebied;

* Evaluering van die volume grondwater wat onttrek is;

* Monitering van die grondwatergehalte en evaluering van die moontlikheid dat die grondwater deur seewaterindringing en die wegdoening van afvloeistowwe op die oppervlak besmet kan word.

Ten einde inligting oor boorgate in te samel, is 'n sensusvorm hieronder gedruk. Indien daar 'n boorgat op u eiendom is, word u vriendelik versoek om die vorm in te vul en dit saam met die betaling van u maandelikse rekening vir munisipale dienste aan die Departement van die Stadstesourier te stuur of aan die Stadsingenieur, Posbus 7, Port Elizabeth 6000 te pos.

'n Boorgat verteenwoordig 'n aansienlike belegging. Dit is in u eie belang om u samewerking in dié verband te verleen sodat die langtermynbeskikbaarheid van grondwater vir alle verbruikers verseker kan word. Skakel asseblief onderstaande telefoonnommers indien u enige navrae oor die aangeleentheid het.

*Departement van die Stadsingenieur*
*Wetenskaplikediensteafdeling*
*(041) 5062333*
*Navrae: Mnr G Devey*

*Steffen Robertson en Kirsten Ing.*
*(041) 323705*
*Navrae: Mnr C Langton*

# BOORGATSENSUSVORM

## *LIGGING*

*EIENAAR/HUURDER:*

STRAATADRES: ..... POSADRES: .....

VOORSTAD: ..... VOORSTAD: .....

KODE: ..... KODE: .....

TELEFOONNOMMERS:

HUIS: ..... KANTOOR: ..... ERFNO.: ..... ERFGROOTTE: ..... ($m^2$)

## *BESONDERHEDE VAN BOORGAT*

DATUM GEBOOR: ..... / ..... /19 ..... KONTRAKTEUR: .....

BOORDIEPTE: ..... (m) LENGTE VAN VOERING: ..... (m) TIPE VOERING: PVC: ..... STAAL: ..... BEIDE: .....

VOERING GEPERFOREER: VAN: ..... (m) TOT: ..... (m) RUSWATERVLAK: ..... (m) BOORGATVLOEI: .....

*IS DIE VLOEI VERKRY*

*VAN:* (a) BOORRESULTATE?: JA ☐ NEE ☐ *OF* (b) BEPAAL UIT TOETSPOMPRESULTATE?: JA ☐ NEE ☐

TOETSPOMPKONTRAKTEUR: .....

## *BESONDERHEDE VAN POMP*

*TIPE POMP:* DOMPELPOMP: ..... STRAAL: ..... ANDER: .....

POMPTEMPO: ..... GERAAMDE DAAGLIKSE VERBRUIK: .....

IS 'N VLOEIMETER IN U BOORGAT SE TOEVOERPYP GEÏNSTALLEER? JA ☐ NEE ☐

SAL U INSTEM DAT 'N METER VIR DIE DUUR VAN DIE NAVORSINGSPROJEK KOSTELOOS GEÏNSTALLEER WORD? JA ☐ NEE ☐

## *GRONDWATERGEHALTE*

IS 'N MONSTER VAN U BOORGATWATER VOORGELÊ VIR:

CHEMIESE ONTLEDING: JA ☐ NEE ☐ MIKROBIOLOGIESE ONTLEDING: JA ☐ NEE ☐

MONSTER(S) ONTLEED DEUR: .....

## *ALGEMEEN*

IS U BEREID OM VIR DIE DUUR VAN DIE PROJEK TOEGANG TOT U EIENDOM OP 'N BEHEERDE GRONDSLAG TOE TE LAAT SODAT DIE BOORGAT GEMONITOR KAN WORD?

JA ☐ NEE ☐

# RESEARCH INTO BOREHOLES IN THE PORT ELIZABETH MUNICIPAL AREA

THE OWNER/OCCUPIER

## *PLEASE READ THIS PAMPHLET IF THERE IS A BOREHOLE ON YOUR PROPERTY*

The recent extended drought in the Eastern Cape has resulted in a proliferation of boreholes in Port Elizabeth with a corresponding increase in groundwater abstraction. Unless the situation is professionally assessed, the future integrity of the groundwater resource cannot be guaranteed.

Research into groundwater abstraction in Port Elizabeth has been initiated jointly by the Port Elizabeth Municipality and Steffen, Robertson and Kirsten Inc. in a two year project funded by the Water Research Commission. The research will focus on the following main aspects:

* Determination of the number of boreholes in the municipal area;

* Assessment of the volumes of groundwater abstracted;

* Monitoring of groundwater quality and assessment of the potential for contamination of the groundwater by sea-water intrusion and the disposal of effluents on the surface.

In order to gather information on boreholes a census form has been printed below this letter and, if you have a borehole on your premises, you are kindly requested to complete the form and return it to the City Treasurer's Department with your monthly municipal services payment or to the City Engineer, P.O. Box 7, Port Elizabeth 6000.

A borehole represents a considerable investment. Your co-operation will be in your best interests to ensure that the groundwater resource can be protected in the long term for all users. Any enquiries that you may have in this regard should be directed to the telephone numbers given below.

*City Engineer's Department*
*Scientific Services Division*
*(041) 5062333*
*Enquiries: Mr G Devey*

*Steffen Robertson and Kirsten Inc.*
*(041) 323706*
*Enquiries: Mr C Langton*

---

# BOREHOLE CENSUS FORM

## *LOCALITY*

*OWNER/OCCUPIER:*

STREET ADDRESS: ..... POSTAL ADDRESS: .....

SUBURB: ..... SUBURB: .....

CODE: ..... CODE: .....

TELEPHONE NUMBERS:

RESIDENCE: ..... BUSINESS: ..... ERF NO.: ..... ERF SIZE: ..... ($m^2$)

## *BOREHOLE DETAILS*

DATE DRILLED: ..... / ..... /19 ..... CONTRACTOR: .....

DRILLED DEPTH: ..... (m) LENGTH OF CASING: ..... (m) TYPE OF CASING: PVC: ..... STEEL: ..... BOTH: .....

CASING PERFORATED: FROM: ..... (m) TO: ..... (m) REST WATER LEVEL: ..... (m) BOREHOLE YIELD: .....

*WAS THE YIELD OBTAINED*

*FROM:* (a) DRILLING RESULTS?: YES ☐ NO ☐ *OR* (b) DETERMINED FROM TEST PUMPING?: YES ☐ NO ☐

TEST PUMPING CONTRACTOR: .....

## *PUMPING DETAILS*

*PUMP TYPE:* SUBMERSIBLE: ..... JET: ..... OTHER: .....

PUMPING RATE: ..... ESTIMATED DAILY USAGE: .....

DO YOU HAVE A FLOW METER INSTALLED ON YOUR BOREHOLE DELIVERY LINE? YES ☐ NO ☐

WOULD YOU BE PREPARED TO HAVE A METER INSTALLED AT NO COST TO YOU FOR THE DURATION OF THE RESEARCH? YES ☐ NO ☐

## *GROUNDWATER QUALITY*

HAS A SAMPLE OF YOUR BOREHOLE WATER BEEN SUBMITTED FOR:

CHEMICAL ANALYSIS: YES ☐ NO ☐ MICROBIOLOGICAL ANALYSIS: YES ☐ NO ☐

SAMPLES ANALYSED BY: .....

## *GENERAL*

ARE YOU PREPARED TO PERMIT ACCESS TO YOUR PROPERTY ON A CONTROLLED BASIS FOR BOREHOLE MONITORING DURING THE PROJECT?

YES ☐ NO ☐

**STEFFEN, ROBERTSON AND KIRSTEN**
*Consulting Engineers and Scientists*

402 Douglas Murray House
Rua Vasco da Gama
Foreshore, Cape Town

Box/Bus 6824
Roggebaai, 8012
South Africa

Tel: +27 (21) 21-7182
Fax: +27 (21) 25-4648

191472/4

28 November 1996

K5/515/0/1



Water Research Commission
PO Box 824
**Pretoria**
0001

Dear Sir

**REPORT: RESEARCH INTO GROUNDWATER ABSTRACTION IN THE PORT ELIZABETH MUNICIPAL AREA**

Steffen Robertson and Kirsten are pleased to submit a hard copy and disk copy of the above report, as well as 200 copies of the maps.

We trust that the findings are to your satisfaction and, should you have any queries, please contact us at the above number or Chris Lomberg in Port Elizabeth, at (041)511 911. Thank you.

082 5663769

Yours faithfully

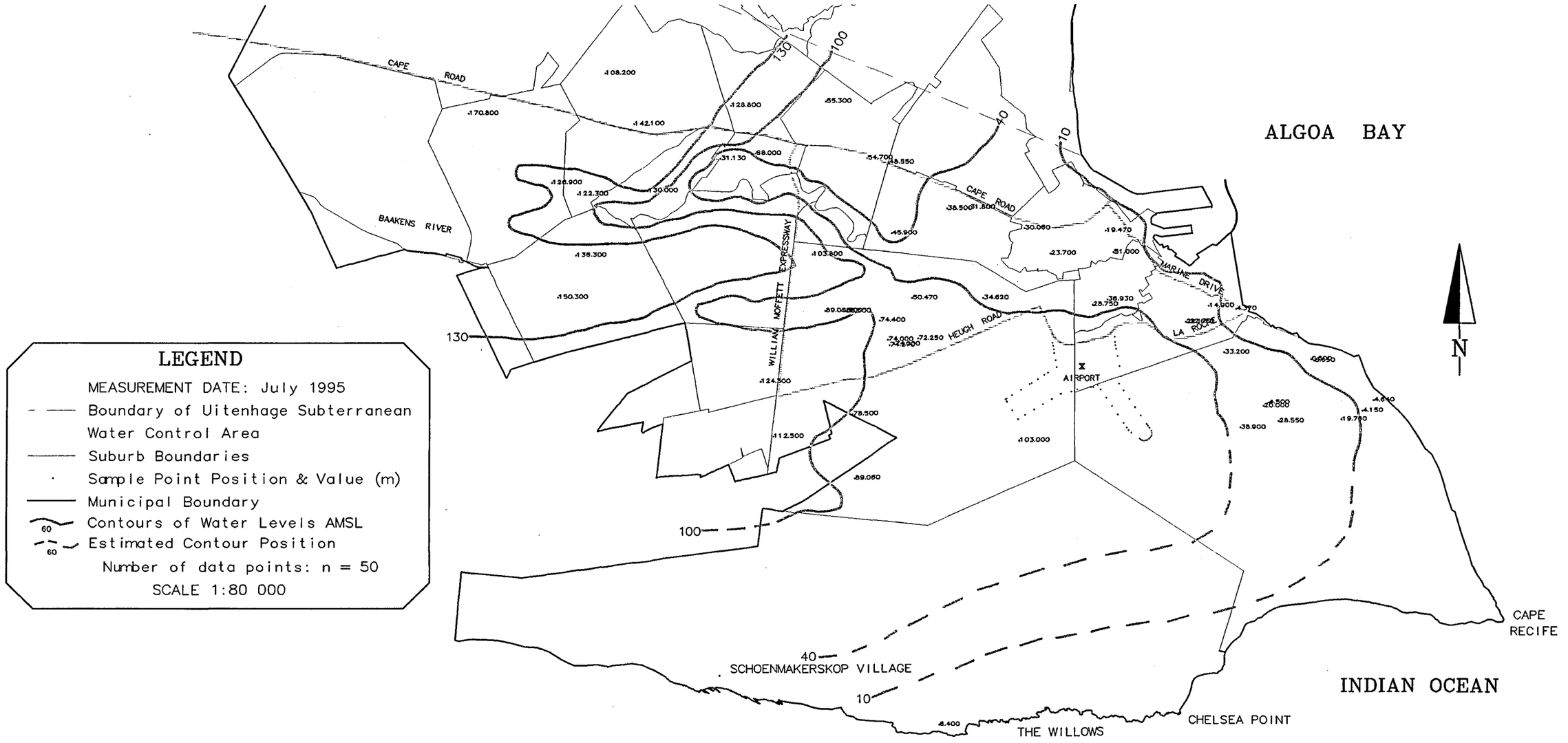
**P N ROSEWARNE Pr Sci Nat**
Steffen Robertson & Kirsten

| Verify's No<br>Refer To | | | |
|---|---|---|---|
| T Reynolds | | | |
| | | | |
| | | | |
| | | | |
| UD-ID | | | |

NOTAS/NOTES

# MUNICIPALITY OF PORT ELIZABETH

## GROUNDWATER LEVELS




## LEGEND

MEASUREMENT DATE: July 1995

- Boundary of Uitenhage Subterranean Water Control Area
- Suburb Boundaries
- Sample Point Position & Value (m)
- Municipal Boundary
- 60 Contours of Water Levels AMSL
- 60 Estimated Contour Position

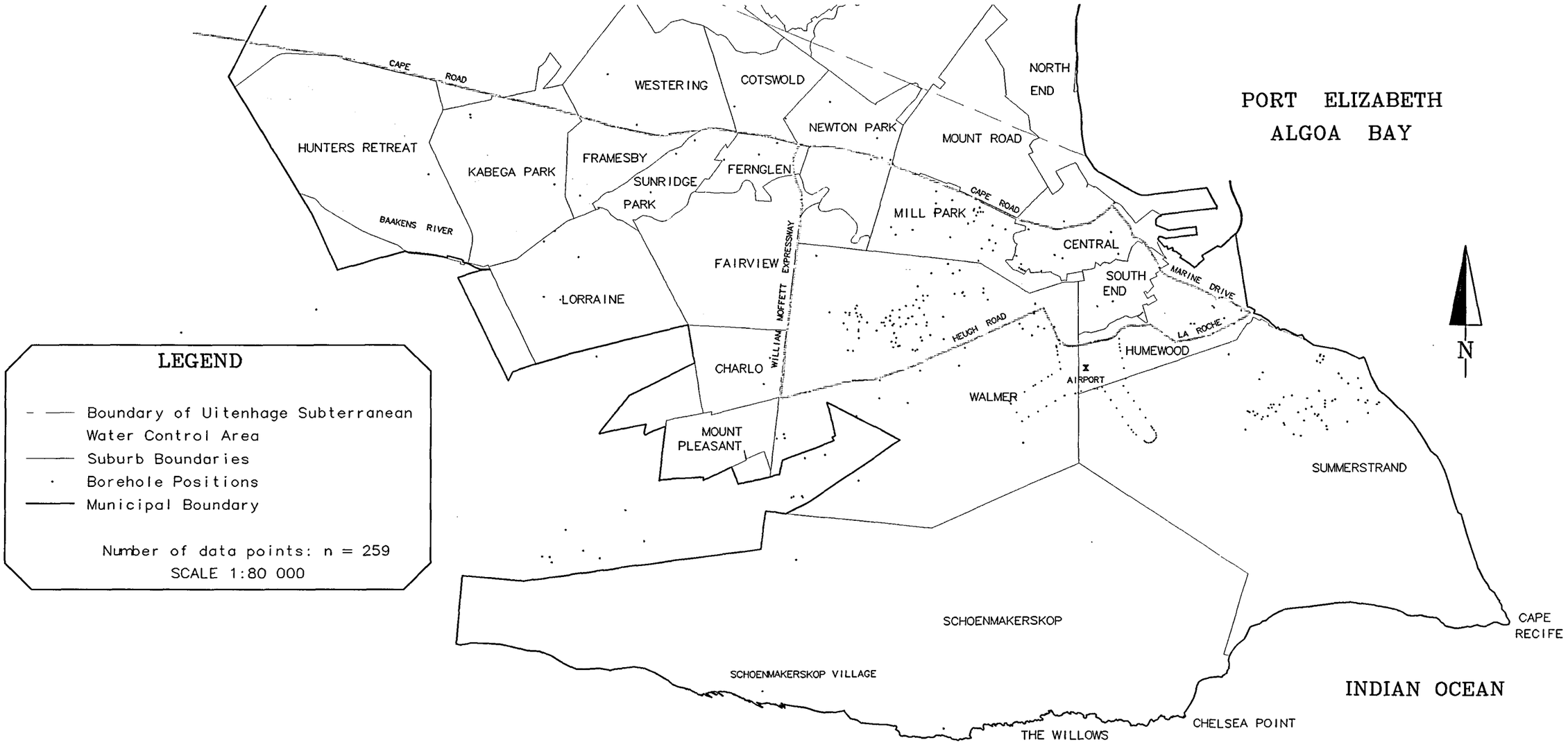
Number of data points: n = 50

SCALE 1:80 000

FIG NO 7

# MUNICIPALITY OF PORT ELIZABETH

## LOCALITY MAP SHOWING BOREHOLE DISTRIBUTION




### LEGEND

- Boundary of Uitenhage Subterranean Water Control Area
- Suburb Boundaries
- Borehole Positions
- Municipal Boundary

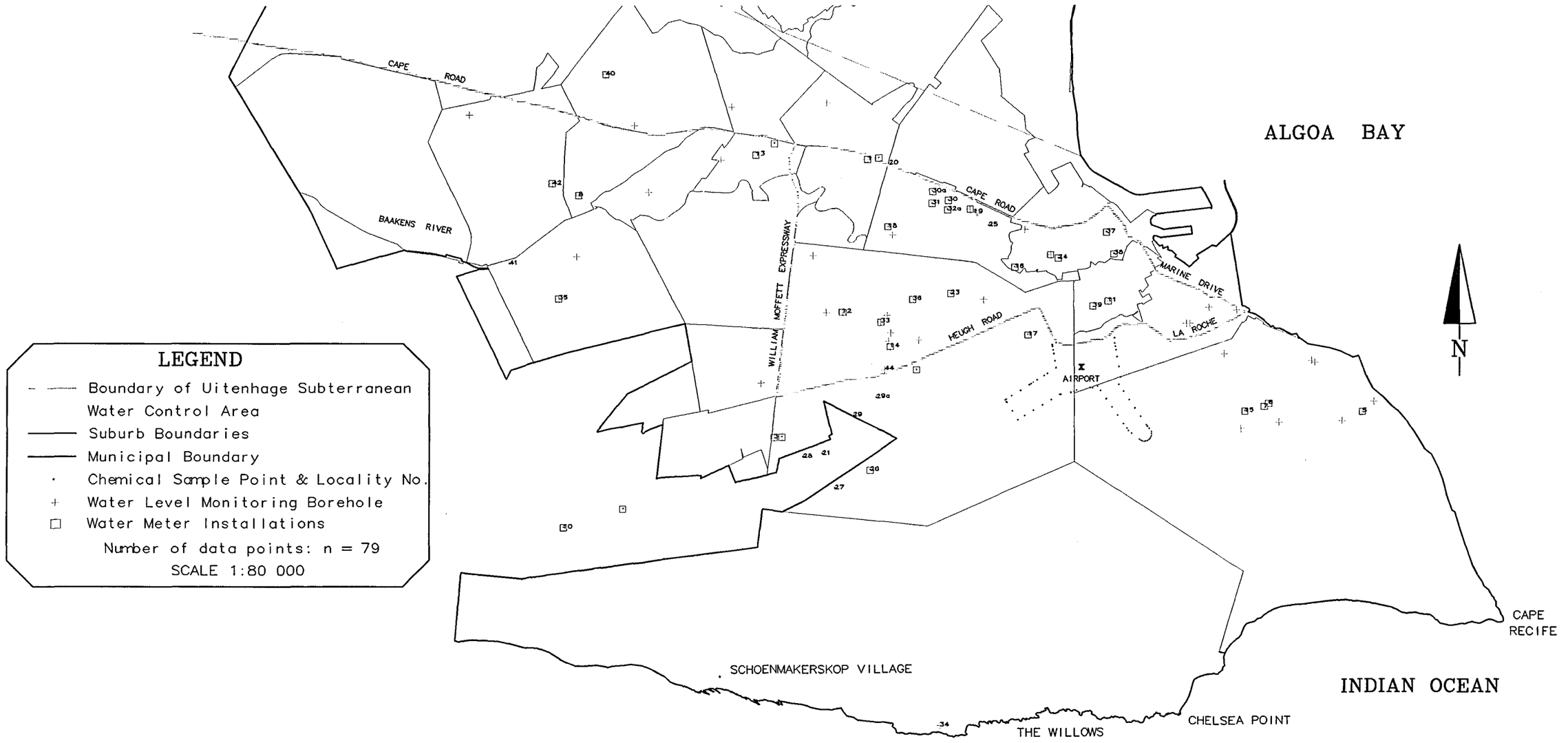
Number of data points: n = 259

SCALE 1:80 000

FIG NO 1

# MUNICIPALITY OF PORT ELIZABETH

## DISTRIBUTION OF MONITORING BOREHOLES




### LEGEND

- Boundary of Uitenhage Subterranean Water Control Area
- Suburb Boundaries
- Municipal Boundary
- Chemical Sample Point & Locality No.
- Water Level Monitoring Borehole
- Water Meter Installations

Number of data points: n = 79

SCALE 1:80 000

FIG NO 2

# MUNICIPALITY OF PORT ELIZABETH

## HYDROCHEMISTRY: ELECTRICAL CONDUCTIVITY

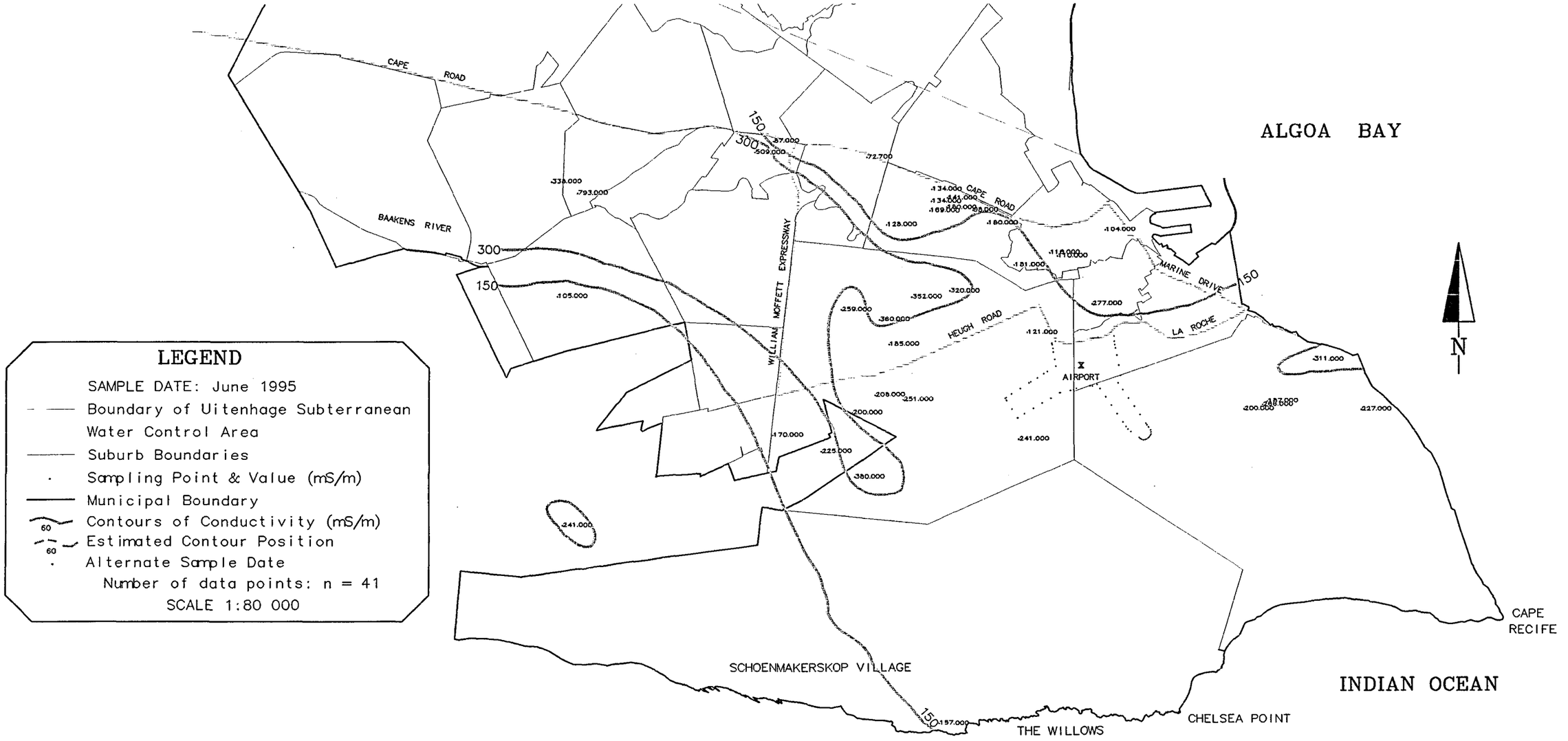
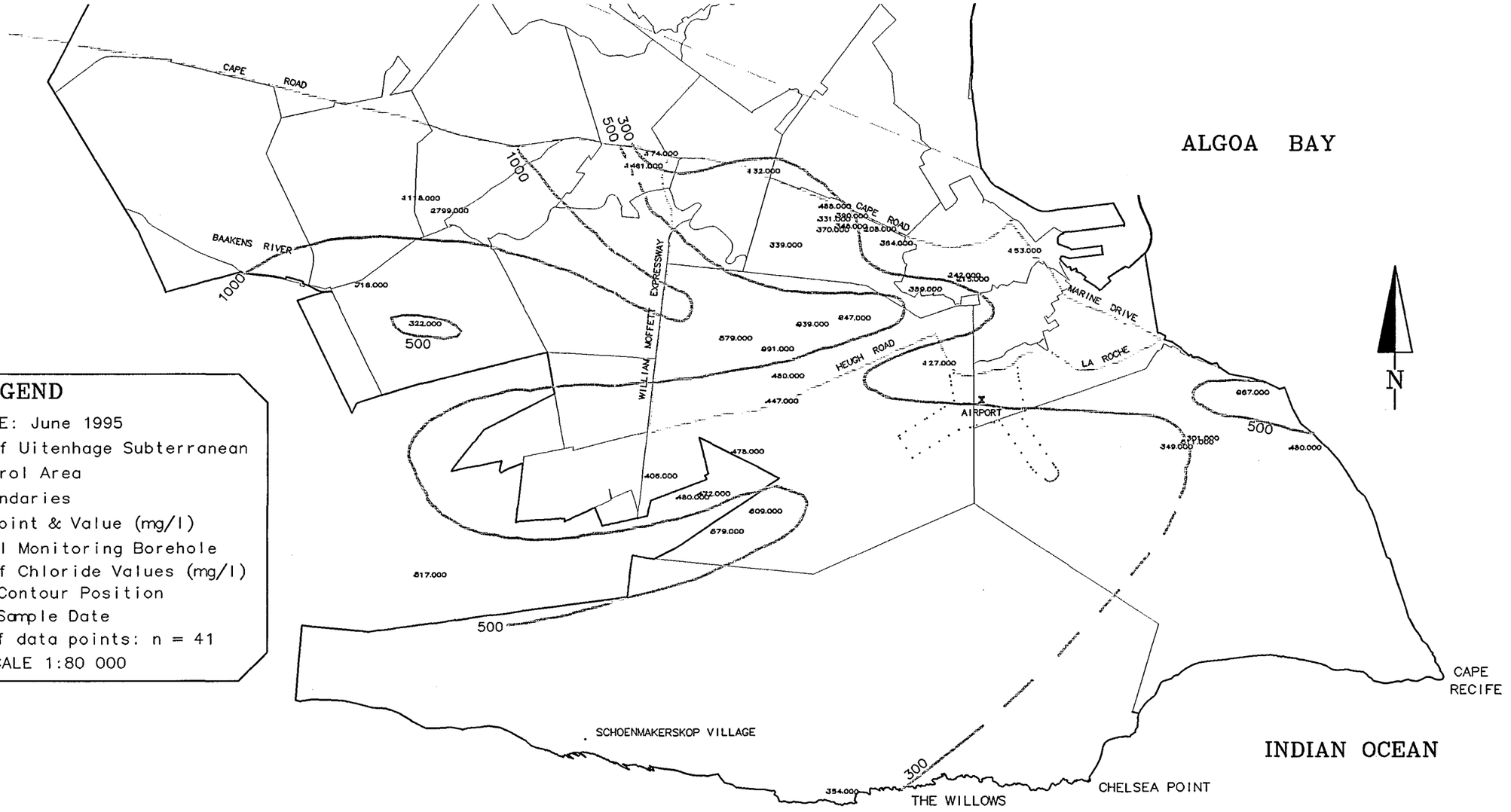



FIG NO
10

# MUNICIPALITY OF PORT ELIZABETH

## HYDROCHEMISTRY: CHLORIDE




### LEGEND

- SAMPLE DATE: June 1995
- Boundary of Uitenhage Subterranean Water Control Area
- Suburb Boundaries
- Sampling Point & Value (mg/l)
- Water Level Monitoring Borehole
- Contours of Chloride Values (mg/l)
- Estimated Contour Position
- Alternate Sample Date

Number of data points: n = 41

SCALE 1:80 000

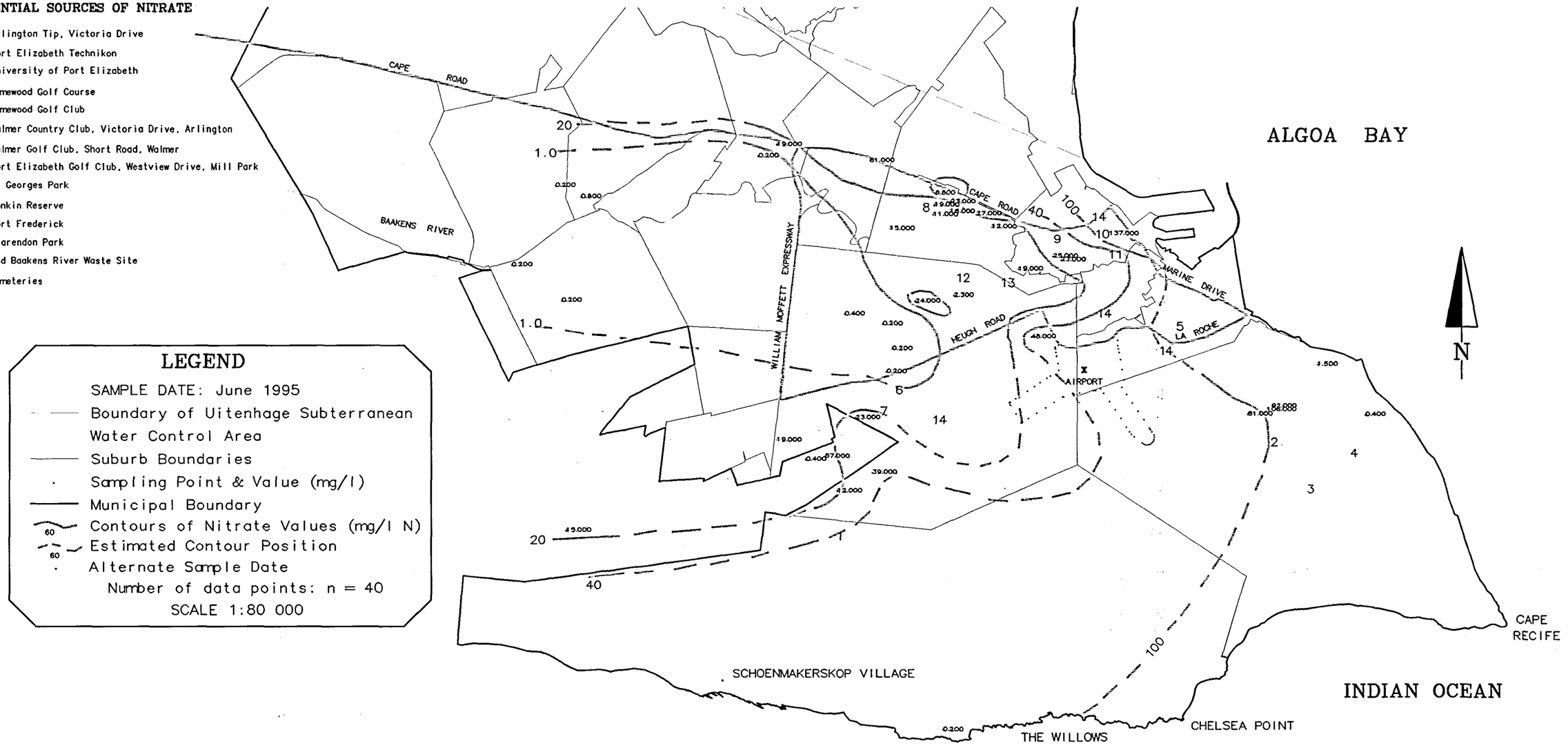
FIG NO 11

# MUNICIPALITY OF PORT ELIZABETH

## HYDROCHEMISTRY: NITRATE

**POTENTIAL SOURCES OF NITRATE**

1 Arlington Tip, Victoria Drive
2 Port Elizabeth Technikon
3 University of Port Elizabeth
4 Humewood Golf Course
5 Humewood Golf Club
6 Walmer Country Club, Victoria Drive, Arlington
7 Walmer Golf Club, Short Road, Walmer
8 Port Elizabeth Golf Club, Westview Drive, Mill Park
9 St Georges Park
10 Donkin Reserve
11 Fort Frederick
12 Clarendon Park
13 Old Baakens River Waste Site
14 Cemeteries



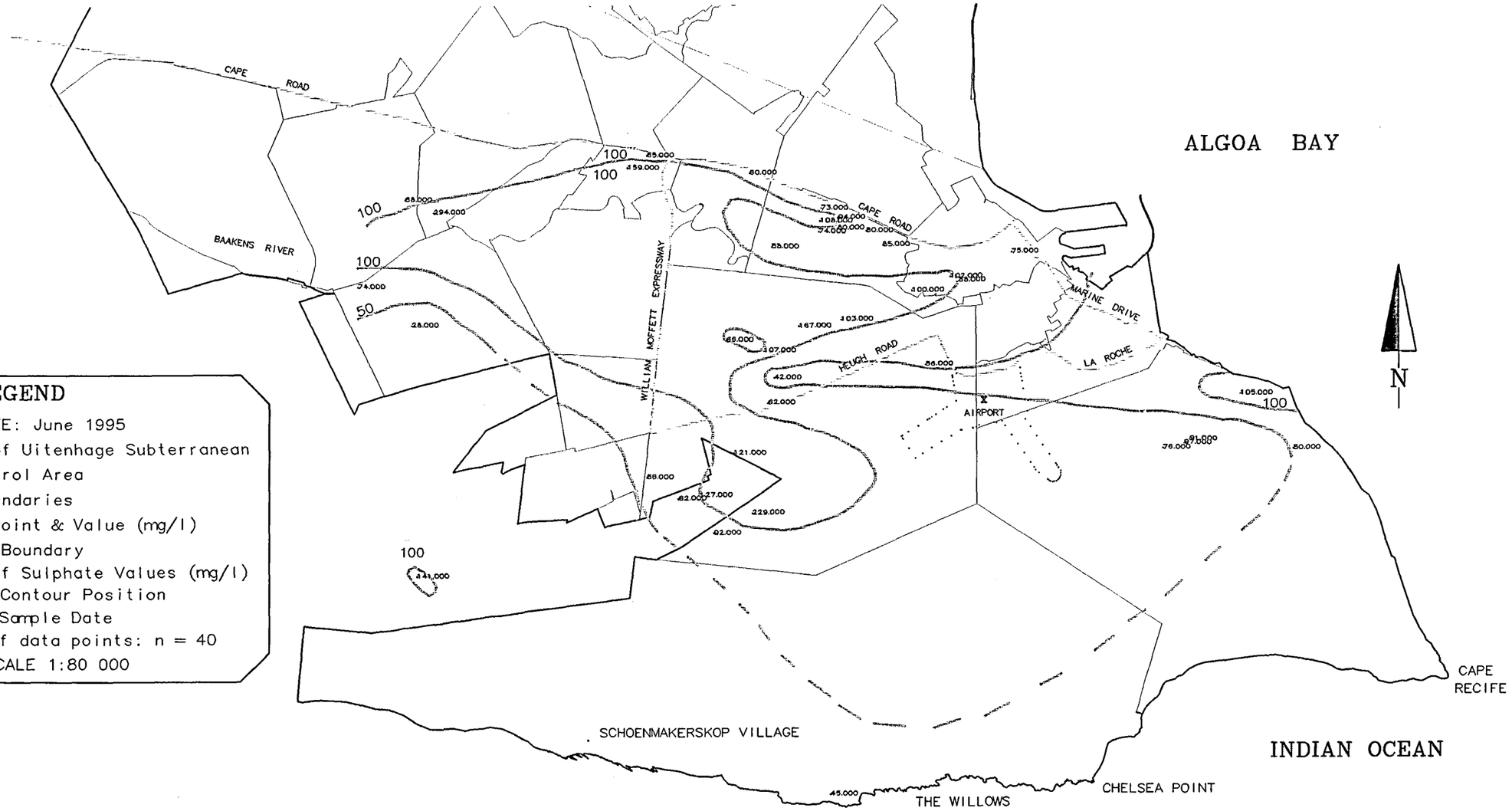

### LEGEND

SAMPLE DATE: June 1995
Boundary of Uitenhage Subterranean Water Control Area
Suburb Boundaries
Sampling Point & Value (mg/l)
Municipal Boundary
Contours of Nitrate Values (mg/l N)
Estimated Contour Position
Alternate Sample Date
Number of data points: n = 40
SCALE 1:80 000

FIG NO 13

# MUNICIPALITY OF PORT ELIZABETH

## HYDROCHEMISTRY: SULPHATE




### LEGEND

- SAMPLE DATE: June 1995
- Boundary of Uitenhage Subterranean Water Control Area
- Suburb Boundaries
- Sampling Point & Value (mg/l)
- Municipal Boundary
- Contours of Sulphate Values (mg/l)
- Estimated Contour Position
- Alternate Sample Date

Number of data points: n = 40

SCALE 1:80 000

FIG NO
12

The hydrochemical monitoring points were planned to cover as large an area as possible with at least four boreholes in each suburb. Unfortunately, borehole distribution is heavily skewed by socio-economic factors, resulting in a clustered distribution across the city. Forty seven boreholes were finally selected for sampling on a regular basis, with the ratio between private, low usage, and "corporate" boreholes designed to be about 50/50 (Figure 2). In addition, borehole drilling and pump installation companies have submitted groundwater samples to the Scientific Services Laboratories for many years and chemical analyses from these samples have been stored in the database maintained by them.

## 2.3 Monitoring programme

Monitoring data to be collected included water consumption (abstraction), water levels and samples for chemical and bacteriological analysis.

Water meters were installed from April 1993 by the Water Installation Workshop of the Port Elizabeth City Engineer's Department. Three sizes of water meter were fitted depending on pump capacity and delivery volume. Due to abnormally high workloads, the PEM staff could only complete the installation programme in August 1993.

Once the water meter installation programme was completed, meters were read on a monthly basis along with water levels where possible. In total, some 700 meter readings were taken from 37 boreholes. During the monitoring period, seven boreholes became non-functional for various reasons and this incidence of borehole failure was taken into account when formulating an estimate of annual abstraction volumes from the aquifer.

Seven hundred and forty four borehole water samples were analysed from the 47 boreholes monitored. To spread the workload on the Scientific Services Division Laboratories, analyses were rotated over a cycle of three months. The aim was to get as many "full" analyses as possible during the project period, with partial indicator analyses in between, and the following schedule was established :

**Month 1 -** Full physical and chemical analysis for the following determinands :
Physical parameters: pH, conductivity, colour, turbidity;
Macro determinands: Total Alkalinity, Total Hardness, Total Dissolved Solids;
Cations: calcium, magnesium, sodium, potassium;

| | |
|---|---|
| Anions: | chloride, bicarbonate, sulphate, nitrate, fluoride; |
| Trace elements: | iron, manganese, copper, lead, zinc; |
| Organics: | total organic carbon. |

**Month 2 -** Partial analysis covering pH, conductivity, Total Dissolved Solids, chloride, sulphate and nitrate.

**Month 3 -** Partial analysis and bacteriological analysis for:
Total coliforms;
Faecal coliforms;
E. coli I;
Total bacterial count.

## 2.4 Database

A data base was developed using DBASE IV which was designed to accommodate information from the census forms. PEM City Engineer's Department maintained a database on Quattro Pro into which monitoring data on borehole water levels and abstraction rates, as well as records of corresponding municipal consumption, were entered. The Scientific Services Division of PEM entered all the results of the hydrochemical analyses on Excel spreadsheets.

The research team was offered a specialised groundwater programme and database, HYDROCOM, which could serve to amalgamate the physical and hydrochemical databases and has the facility to plot relationships between parameters such as water levels, abstraction volumes, rainfall, hydrochemistry and time. Piper and Durov plots can be easily produced to evaluate hydrochemical trends. Because of the amount of data that would have to be re-entered and the incompatibility with other spreadsheets, the research team decided against this option. Instead, all the databases were transformed to the Quattro Pro format which allows easy maintenance, updating, access and manipulation of the data-set for a wide range of interested parties.

The database is maintained in two files:

File 1: This is a physical database which contains 238 entries and lists erf numbers, names and addresses of owners, co-ordinates and information as to borehole depth, yield, abstraction volumes and rates, and water levels. Twenty one other boreholes are recorded but fall outside the perimeter of the study area.

File 2: This is a hydrochemical database with the results of all the analyses for each borehole over the study period. This can be expanded to include the results of all analyses of borehole water ever conducted by the Scientific Services Division.

At the request of PEM, the two parts of the database are correlated by erf numbers.

PEM undertook to perform the plotting and contouring of hydrogeological data on the Genesis GIS system. Borehole positions are plotted according to the erf number, and not co-ordinates, which creates problems when more than one borehole is present on an erf, the erf size is very large or the borehole does not fall on a municipal erf. As a result not all monitoring points could be plotted by the programme. The distribution of data points is clustered but groups are dispersed and large areas have no boreholes. The software was unable to grid and contour the data set and the maps were contoured manually. The extreme variation in hydrochemical values over short distances precluded a standard contour interval being used and contour values were selected to illustrate regional trends.

The complete database in Quattro Pro can be saved in a variety of compatible formats and distributed on 3.5" diskette on request.

## 3 RAINFALL

The rugged mountainous topography resulting from erosion of the resistant TMGS has a strong orographic influence on the rainfall patterns in the Cape Province and particularly the SE Cape coast. Some of the highest annual precipitation in South Africa occurs on these mountain ranges, with up to 2 400 mm/pa on mountain peaks. This rainfall and extensive outcrop ensures a ready supply of recharge in all but the driest years. However, Port Elizabeth's rainfall tends

to be atypical and highly erratic, and references to "drought" years are frequent. The definition of "drought" varies, but is generally accepted a period in which rainfall is half the annual average over any 12 months. More specifically, drought in the Eastern Cape has been defined as rainfall below -0.5 times the standard deviation for more than nine consecutive months over a catchment area (Jury and Levey, 1993). A plot of the standard deviation from the mean monthly rainfall averages (Figure 3) shows that references to monthly and annual averages are less meaningful than the "likelihood of occurrence". The table below shows that over the last 10 years, exceptionally low rainfall has reduced the mean annual average, calculated from the records dating back to 1926, from 672mm to 611mm.

**TABLE 2: SUMMARY OF PORT ELIZABETH RAINFALL STATISTICS**

| | YEAR | RAINFALL mm/a |
|---|---|---|
| **Average** | 1926 - 1982<br>1926 - 1992 | 672<br>611.2 |
| **Minimum** | 1969 | 406.3 |
| **Maximum** | 1968 | 1068.9 |
| **Standard Deviation** | 1926 - 1992 | 139.9 |

## 4 GEOLOGY

The geological succession in the Port Elizabeth area comprises the following:

| | |
|---|---|
| Tertiary to Recent | Aeolian sand<br>Nanaga Formation |
| Uitenhage Group | Sundays River Formation<br>Kirkwood Formation<br>Enon Formation |
| Table Mountain Group | Nardouw Subgroup<br>Peninsula Formation<br>Sardinia Bay Formation |

The Sardinia Bay Formation is a predominantly arenaceous sequence of rocks comprising thin to medium bedded quartzitic sandstone with interbedded shale. The formation outcrops along the coast from west of Skoenmakerskop to about 1.5 km west of the Willows and has a total

# PE ANNUAL RAINFALL STANDARD DEVIATION

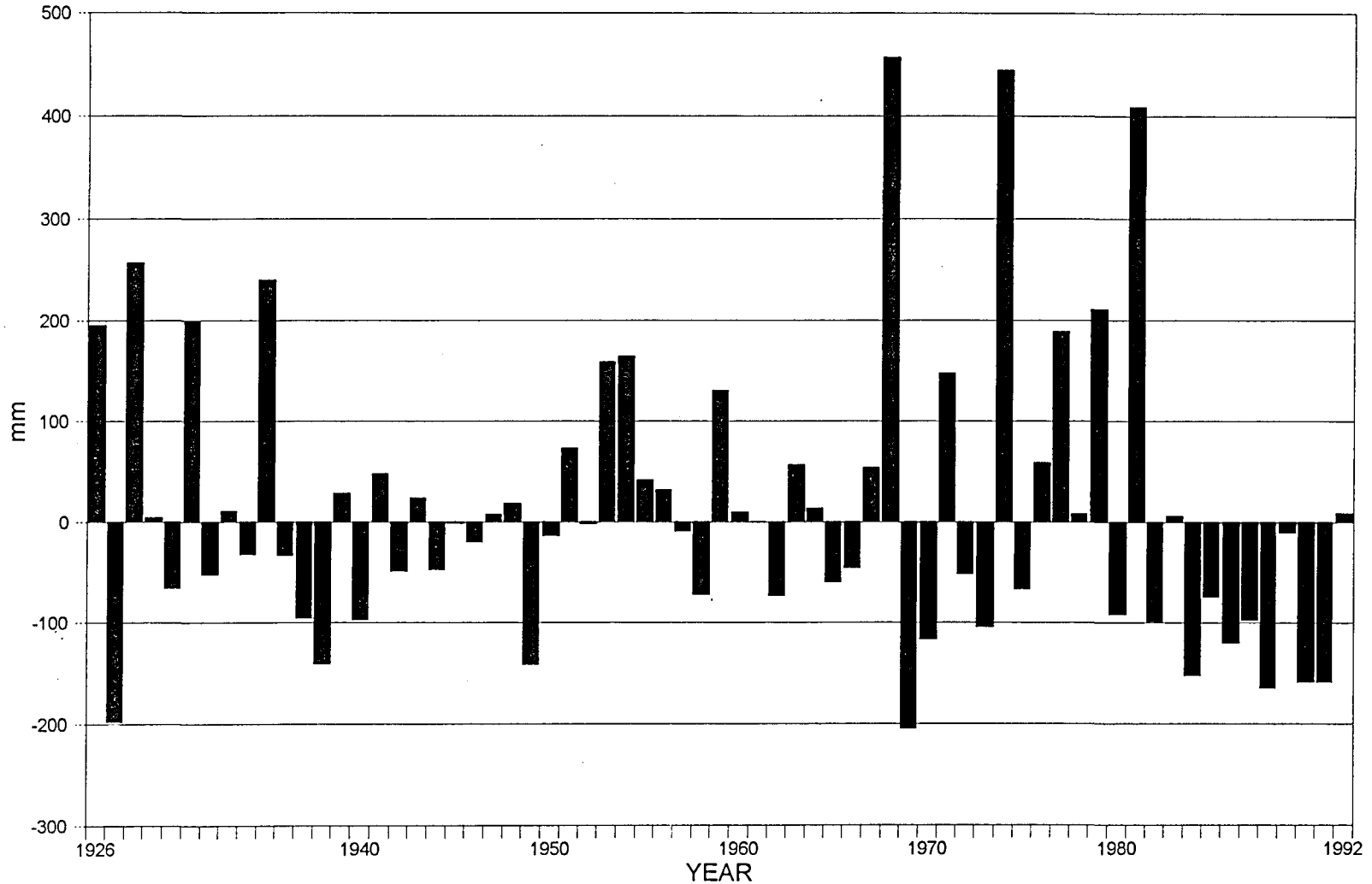



Fig. 3

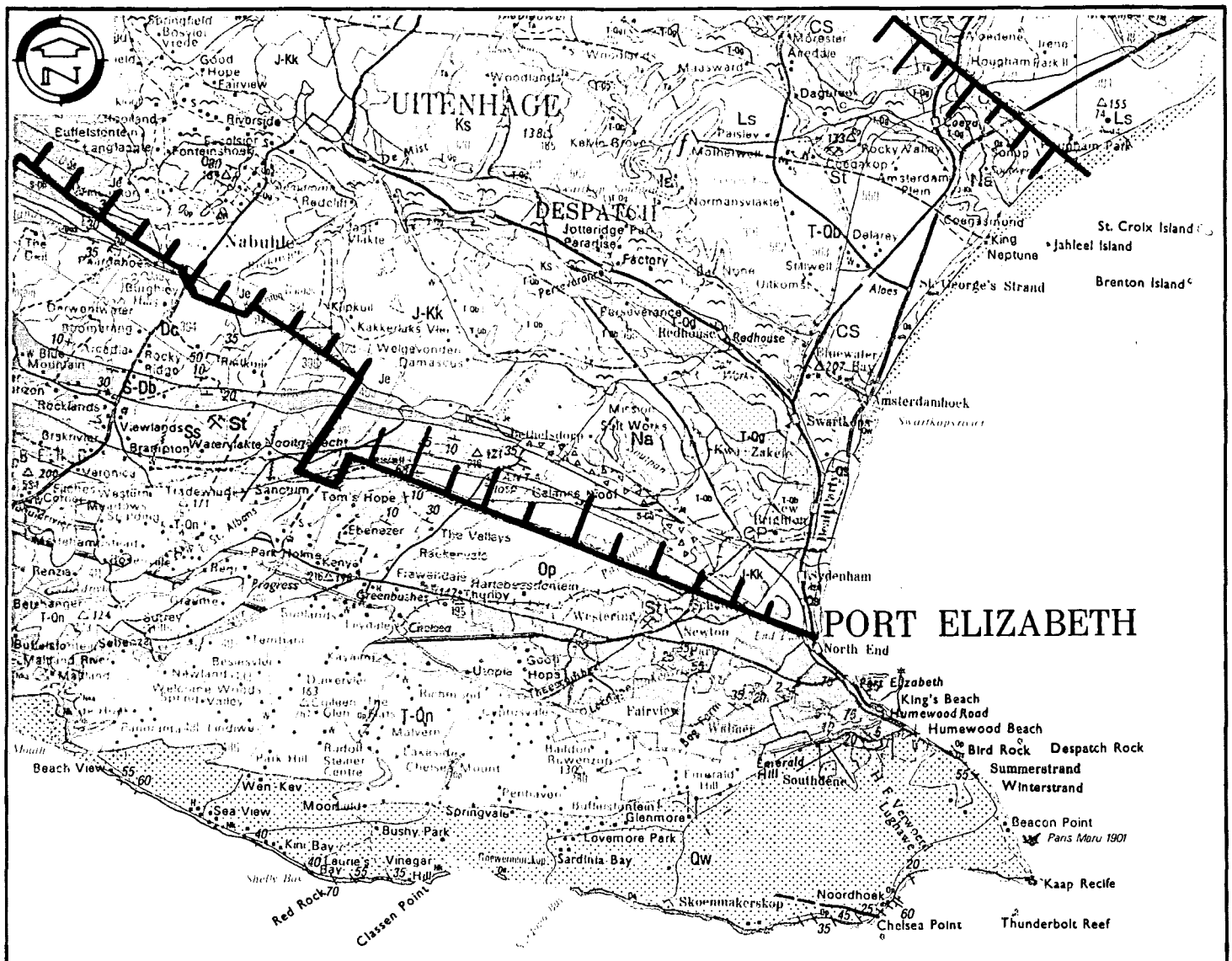
thickness of about 950 m in this area. The boundary with the overlying Peninsula Sandstone Formation is gradational, being taken where shale becomes subordinate in the sequence.

The Peninsula Sandstone Formation (PSF) is aerially, stratigraphically and topographically the most prominent member of the Table Mountain Group (TMG) and consists of medium to coarse grained, generally massive, quartzitic sandstones. The formation is exposed along the coast from the Willows to Cape Recife and in the central and northern areas of Port Elizabeth. In the Willows - Chelsea Point area the sandstones strike in a northwest-southeast direction, dipping at 25° to 45° to the north-east.

The Nardouw Subgroup comprises three sandstone formations which are limited to the northern part of the study area. Along the northern boundary of the study area the resistant sandstones form an escarpment where they dip under Cretaceous formations of the Algoa Basin, while to the south, the sandstones form an elevated wave-cut platform.

The Uitenhage Group rocks consist of mudstones, conglomerates and subordinate sandstones and outcrop to the north of the study area.

Port Elizabeth is situated at the eastern extremity of outcrop of the TMGS on a northwest-southeast trending anticlinal structure, which forms part of the southern limb of the Cape Fold Belt (Figure 4). Booth and Shone (1992) have identified two major fault zones in the TMGS, the Chelsea-Noordhoek Fault in the south and Moregrove Fault in the north. Between these faults they postulate a recumbent fold with numerous thrust planes in a graben structure to account for the excessive thickness of the PSF in the area. The inland extension and trend of the Chelsea-Noordhoek fault, as postulated by Booth and Shone, is based on field observations along the coastal outcrop. A photo-lineament trending west-northwest from the coast, which can be traced for 2 km inland, may be associated with this fault zone (SRK 1993). The Cedarberg Shale Formation, which is normally present between the PSF and Nardouw Subgroup, is absent, probably due to pinching out as a result of thrusting and folding (Shone *op cit*).




| | | |
|---|---|---|
| Recent | Aeolian Sands | Qw |
| | **FORMATION** | |
| Tertiary | Nanaga | T-Qn |
| | Sundays River | Ks |
| Uitenhage Group | Kirkwood | J-Kk |
| | Enon | Je |
| | Baviaanskloof | S-Db |
| Nardouw Subgroup | Skurweberg | Ss |
| | Goudini | Sg |
| Table Mountain Group (TMGS) | Cedarberg | Oc |
| | Peninsula | Op |
| | Sardinia Bay | Os |

Chelsea/Noordhoek fault

Boundary of Uitenhage Artesian Basin

Fig. 4

# GENERAL GEOLOGY

0 5 10km
SCALE

Taken From Geological Survey Sheet 3324 (P.E)

Much of the southern part of the wave-cut platform that forms the Cape Recife headland is covered by a mantle of Tertiary to Recent age deposits. The Nanaga Formation is a consolidated aeolian sand or dune rock, which is calcareous due to the presence of numerous shell fragments. The formation is relatively resistant to weathering and forms topographic highs, e.g. Lovemore and Walmer Heights. Recent unconsolidated aeolian sand forms longitudinal sand dunes with crests trending east-northeast, west-southwest. Calcrete layers are commonly developed within the sand.

# 5 HYDROGEOLOGY

## 5.1 Aquifer definition

The rocks and sediments described above can be classified into two broad aquifer types. The TMGS form secondary aquifers in which groundwater flows and is stored within fractures such as joints, bedding planes and faults. The Tertiary to Recent sands are primary aquifers in which groundwater flows and is stored in interstices within the constituent sand grains. Rocks of the Uitenhage Group are not classed as aquifers within the study area due to their generally low permeability and poor water quality.

- **Primary Aquifer**

The area covered by the Tertiary to Recent deposits is large, but little is known about their thickness or aquifer potential. At St Francis Bay, which is in an equivalent hydrogeological setting, sand thickness varies widely due to the sub-outcrop of more resistant TMGS. Softer formations have been denuded by wave action and the sand cover varies from zero to over 40 m in thickness. Shallow pit profiles at Arlington revealed a soil profile to 3.3m of medium grained aeolian sand with widespread calcrete development. No seepage was observed within these pits.

The coastal sands underlying Summerstrand and Humewood are more recent in age and contain a greater element of shelly beach sand. With a greater coarse grained sand fraction, less calcretisation and compaction, they are likely to have higher aquifer potential.

The Recent sands have high infiltration potential and internal drainage of rainfall takes precedence over surface runoff, thus reducing losses due to evaporation and enhancing recharge volumes. Most of the sand covered area is free of residential development, although the dunes have been stabilised by alien vegetation such as Rooikranz and Port Jackson, increasing losses due to evapotranspiration.

None of the boreholes recorded in the database pump water from the sands in the Walmer, Arlington and Kragga Kamma areas. Reasons for this might be that the sands are unsaturated or it is easier and cheaper to construct a borehole in the TMGS and rely on the upper sands to store groundwater and recharge the fractured rock.

- **Secondary Aquifer**

There are a number of features that contribute to the TMGS being a major aquifer within the context of the generally limited potential of the secondary 'hard rock' aquifers in South Africa. These indicators are:

- Large areal extent and great thickness;
- Extensive fracture development;
- High rainfall and therefore recharge potential;
- Good quality groundwater.

The TMGS outcrop over a large part of the Cape Province and attain great thicknesses, e.g. Peninsula Sandstone Formation 1 550 m, and Nardouw Subgroup 500 m. The TMGS form one of the major secondary aquifers occurring in South Africa and the local towns of Uitenhage, Humansdorp, Jeffrey's Bay and St Francis Bay all use groundwater from this aquifer for domestic purposes, as do other towns such as Ceres, Calitzdorp, Citrusdal and Albertinia. In the Port Elizabeth area these rocks have been intensely folded to form a series of NW-SE trending synclines and anticlines, and associated thrusting has resulted in an increased thickness of the PSF. Consequently, the rock mass is highly bedded and fractured resulting in the development of a network of secondary structural discontinuities. The secondary fractures form the conduits through which groundwater flows and is stored and give the otherwise impermeable rock its favourable aquifer characteristics.

Groundwater contained in the TMGS is usually among the best in quality in South Africa in terms of dissolved salts, as the sandstones mainly comprise silica and contain little in way of soluble salts. Problems can arise with the low pH and unbuffered water corroding steel and concrete, and deposition of iron compounds in pipes.

While groundwater is not a source of municipal water supply to Port Elizabeth at the moment, the TMGS within the surface water supply catchments of Port Elizabeth, which stretch beyond the Humansdorp area, are a strategic regional resource which should be incorporated into the City's water supply planning in the future. It has been proposed to the Municipality that boreholes drilled into TMGS aquifers, where traversed by existing surface water supply pipelines, could prove a cost effective way of augmenting the municipal water supply. Estimates of sustainable delivery of such a system range between 200 and 600 ℓ/sec. Groundwater protection within this area is therefore an important factor in land-use planning.

## 5.2 Present distribution of boreholes

There are two primary controls on the distribution of boreholes, the most important of which appears to be socio-economic status, while geological and hydrogeological factors are of secondary consideration. Although not all boreholes within the study area were located in the census, the borehole distribution and density recorded is considered to be representative of borehole occurrence in the area. Beyond the municipal reticulation network, in areas such as Sardinia Bay, Kragga Kamma Road and Theescombe, rainwater tanks and groundwater are the only supply options. Several boreholes are found in these areas, some of which have been included in the database. Table 3 gives a breakdown of the number of boreholes in the database by suburb.

Walmer and Summerstrand show the highest concentration of boreholes. Together these suburbs account for 65% of boreholes and the distribution drops off dramatically moving away from these areas.

It is apparent from driller's records that new boreholes are sunk primarily in response to drought conditions. Between 1983 and 1992 properties with larger gardens were suffering under both drought conditions and municipal water restrictions and there was a dramatic

increase in the number of private boreholes in PE. With a depressed economic climate and escalating costs of drilling and pumping equipment, it was only the upper socio-economic groups who could afford the installation of a borehole.

**TABLE 3 - BOREHOLE DISTRIBUTION BY SUBURB**

| SUBURB | TOTAL BOREHOLES | PERCENTAGE |
|---|---|---|
| Central | 13 | 5 |
| Fernglen | 3 | 1 |
| Humewood | 8 | 4 |
| Kabega | 3 | 1 |
| Lorraine | 5 | 2 |
| Mill Park | 25 | 11 |
| Newton Park | 7 | 3 |
| Summerstrand | 60 | 25 |
| Sunridge Park | 3 | 1 |
| Walmer | 96 | 41 |
| **Sub Total** | **223** | **94** |
| Others | 15 | 6 |
| **TOTAL** | **238** | **100** |
| Boreholes outside Municipal area | 21 | - |

(Only suburbs with ≥ 3 boreholes are listed.)

Borehole water use is still considered secondary to municipal water use, which is reflected in the number of out of commission or unused boreholes. Expense on maintenance is considered unnecessary until the next drought threat materialises. In many cases, groundwater quality is so poor that people have a negative attitude to groundwater use and the ownership of boreholes is not considered desirable.

Almost all the boreholes in the study area have been drilled by two or three local contractors. However, none are dependent on local work as the demand is neither reliable nor steady. Enquiries with these contractors reveal they have not drilled a private borehole in the municipal area since 1993.

## 5.3 Borehole characteristics

- **Construction**

Borehole construction is usually simple, with casing through the upper sands and weathered rock, and the competent TMGS left uncased. Drilling conditions in steeply dipping TMGS can be very difficult and deep boreholes (>100m) can take weeks to complete. In many boreholes, the casing installed was insufficient resulting in collapse and loss of the borehole and pumping equipment within two years. In others, collapse has resulted from weathering of the wall rock during cycles of oxidation and saturation induced by pumping. The result is that an unacceptably high number of successful boreholes are redundant because of poor construction and collapse.

- **Depth**

Average drilling depths in all areas except Summerstrand tend to be between 60 and 120 m, implying fairly deep water strikes in the fractured rock aquifer. The depth of these water strikes indicates that the boreholes are not supplied from saturated upper sands. The majority of boreholes in the Walmer and western suburbs of the study area record a water level less than 15 m below ground level. In the Summerstrand and Humewood coastal belt, drilling between 30 and 60 m in depth results in average yields of between 1 and 5 $m^3/h$. Figure 5 shows the yield versus depth relationship for 91 boreholes. The minimum drilling depth of a borehole on record along the coastal belt is 20 m and the maximum, is 90 m. Borehole yield characteristics indicate a typical fractured rock distribution despite the mantle of permeable sands.

- **Yields**

In the context of water requirements for garden irrigation and other domestic uses, the success rate of boreholes drilled is high. The high density of functional boreholes in Walmer and Summerstrand indicates that, even without the benefit of geophysical borehole siting techniques, success is guaranteed. Table 4 shows individual borehole yields rarely exceed 12 $m^3/h$ and yields of between 1 and 5 $m^3/h$ are normal. Continuous sustainable yields have been proven up to 8 $m^3/h$ at the PE Golf Club.

TABLE 4 : FREQUENCY OF BOREHOLE YIELDS

| Yield range ($m^3/h$) | < 1 | 1 to 5 | 5 to 10 | > 10 |
|---|---|---|---|---|
| Frequency | 1 | 60 | 27 | 3 |

More than half the boreholes on the depth vs yield plot (Figure 5) are deeper than 80m. The chances of a yield above 5 $m^3/h$ are greatest between 80 and 120 m, although the majority of boreholes only yield between 1 and 4 $m^3/h$. "Dry" boreholes have been reported. To the north-west outside the study area, the incidence of unsuccessful boreholes increases, as do the chances of yields in excess of $10m^3/h$.

The data indicate that the TMGS aquifer in the PEM area is relatively low yielding when compared to TMGS aquifers elsewhere. Boreholes in the adjacent USWCA, which tap the TMGS at depth below the Uitenhage Formation, deliver exceptional yields in the order of 20 to $100m^3/h$. Yields at St Francis Bay, Jeffreys Bay and Humansdorp are in the range 7 to 50 $m^3/h$ from depths of 60 to 90 m, while at Ceres, yields range from 20 to 45 $m^3/h$, from depths of 120 to 150 m. In the latter two examples, the boreholes are tapping the Nardouw Subgroup sandstones, which appear to be more productive than the PSF.

- **Pumping equipment**

Almost all boreholes are equipped with submersible pumps and electric motors. These installations are favoured in urban areas because they can be concealed, make no noise, are entirely automated and are the cheapest to buy, install and run. They require little maintenance but are subject to excessive wear by sand or particulate matter in the water. The relatively high incidence of pump failure is unusual and attests to the indifferent attitude of borehole owners to their groundwater resources.

## 5.4 Groundwater abstraction and use

Much of the groundwater demand is socio-economically controlled, with the water being used for maintaining gardens and other activities where potability is not a criteria. A minor quantity is used for human consumption and only in those areas where municipal water is not available. As a result, abstraction volumes peak in dry weather and particularly when restrictions are imposed by means of tariff penalties for "excessive" municipal consumption.

# DEPTH vs YIELD

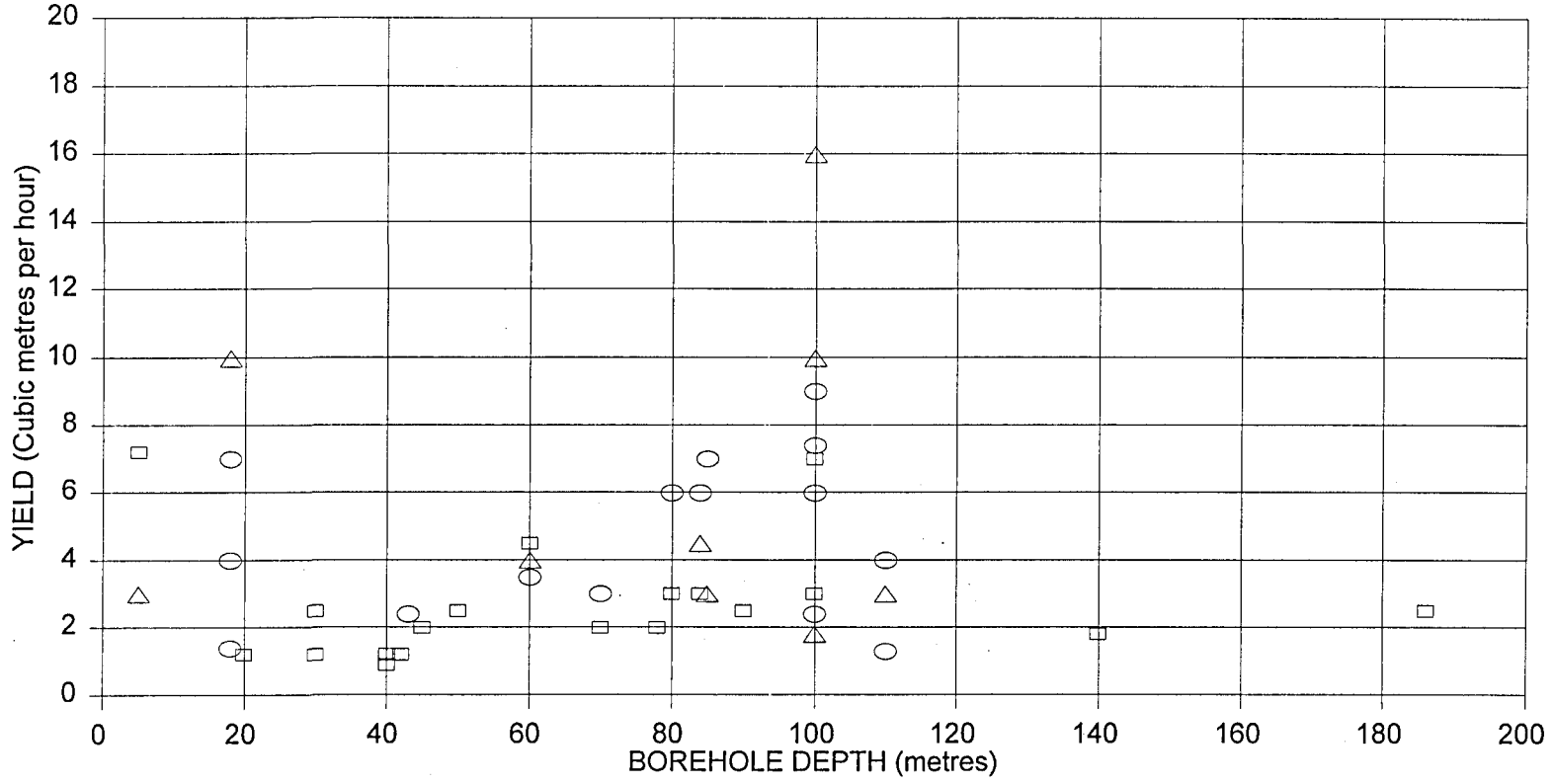



Fig. 5

Water restrictions were first introduced on 22 February 1989. Due to good rains in the catchment areas of the supply dams in November 1989 restrictions were lifted on 22 November 1989. However, the drought continued and restrictions were again introduced on 29 April 1991. High rainfall in October and November resulted in all restrictions being lifted on 2 December 1992. It should be noted that, for this project, the rainfall figures used are those of the gauging station at Port Elizabeth airport and are not the rainfall figures of the catchment areas of the supply dams. It was the available storage capacity in the dams that determined the level of water restrictions which were implemented in stages. An analysis of the situation conducted by consultants after the drought established that it was a one in a two hundred year drought return and was one of the most severe in history.

In the majority of average and above average rainfall months, abstraction is minimal as groundwater quality is considered generally inferior and municipal water relatively cheap. Records show that, for the majority of borehole owners, groundwater is used and considered as an emergency supply source only.

The proliferation of boreholes tapping the aquifer between 1989 and 1992 does not necessarily represent higher sustained abstraction rates but rather the potential for high demand pulses to be imposed on the aquifer. The ability of the TMGS aquifer to cater for this type of demand pattern has been proven, within reason, in the coastal resort towns along the south-west Cape coast, which rely on groundwater for their water supply. Many of these towns specifically manage their groundwater resources to accommodate the skewed water demand imposed by the influx of tourists over the summer season.

- **Private boreholes**

Of the 238 boreholes in the database, 216 are located on private property. Twenty five boreholes were initially metered, but only 20 can be used to assess the representative volume of groundwater abstracted. Table 5 gives a breakdown of abstraction over the study period.

From the 20 boreholes an annual volume of 20486 $m^3$/annum is abstracted. With the 216 private boreholes recorded estimated to represent 85% of private boreholes in the study area, the total volume abstracted annually from private boreholes is calculated by simple proportion as:

$$\frac{216}{0{,}85 \times 20} \times 20\,486\ m^3 = 260\,292\ m^3/\text{annum}$$

**TABLE 5 : METERED ABSTRACTION FROM PRIVATE BOREHOLES**

| Location | Total Abstraction ($m^3$) | Period (days) | Total Annual Abstraction ($m^3$) | Erf Size $m^3$ |
|---|---|---|---|---|
| 98 Verdun Road | 5 547 | 660 | 3068 | 16184 |
| 78 Kabega Road | 26 | 707 | 13 | 1907 |
| 5 Norland Close | 155 | 790 | 72 | 1849 |
| 308 Kragga Kamma Road | data unreliable | | | 3684 |
| 12 West Street | 2 358 | 790 | 1089 | 1606 |
| 47 Wychwood Road | 2 475 | 790 | 1144 | 1190 |
| 8 Hallack road | 4 752 | 783 | 2215 | 4214 |
| 8 Mill Park Road | 3 372 | 781 | 1575 | 2078 |
| 14 Thames Road | 1 126 | 780 | 527 | 1218 |
| 3 Whitney Street | 1 095 | 790 | 506 | 2201 |
| 12 11th Avenue | 1 684 | 408 | 1506 | 2146 |
| 6 Club Road | 1 295 | 761 | 621 | 1983 |
| 64 Short Road | 794 | 765 | 379 | 3780 |
| 10 4th Avenue | 502 | 780 | 235 | 1707 |
| 10 Idlewylde Cresent | 5 519 | 788 | 2556 | 5788 |
| 12 Newcombe Avenue | 4 156 | 790 | 1920 | 14182 |
| *Sardinia Bay (Stone) | 8 333 | 769 | *3955 | - |
| *Sardinia Bay (Danoher) | 30 658 | 829 | *13498 | - |
| 21 Admirality Way | 220 | 765 | 105 | 1740 |
| 10 Bullbring Road | 1 066 | 776 | 501 | 1104 |
| 68 Winchester Road | 2 193 | 776 | 1031 | 1620 |
| 5 Kolbe Cresent | 2 334 | 739 | 1153 | 1700 |
| 74 River Road | not operable | | | 2911 |
| 15 Cosmos Street | 111 | 150 | 270 | 1685 |
| 17 Victoria Park Drive | not operable | | | 765 |
| 20 Boreholes | 40780 $m^3$ | | 20 486$m^3$ | |

* Denotes boreholes not considered for abstraction calculations

Including the percentage of boreholes that became inoperable as being representative of the general incidence of failure in the area, this total is modified as follows:

$$\frac{216}{0{,}85 \times 22} \times 20\,486\ m^3 = 236\,629\ m^3/annum$$

- **Corporate boreholes**

Ten percent of boreholes in the PEM area are classified as corporate. These include business premises, schools, parks, golf courses and the like. Twenty three were identified in the database of which 13 were monitored. Of these, one collapsed, one pump failed and one is disused. This incidence of failure is higher than for private boreholes and is attributed to the lack of a responsible person in charge of borehole maintenance. The sample size is relatively small and 15% is considered to be a more representative figure for incidence of failure. Table 6 overleaf, gives details of groundwater abstraction from corporate boreholes.

From Table 6 it can be seen that an average annual volume of 60 884 $m^3$ was abstracted from the 10 boreholes during the study period. The calculated average abstraction at PE Golf Course is conservative as metering has shown they use about 75 000 $m^3$ per year. Taking this into account, the volume abstracted from the metered boreholes is 92 582 $m^3$. If the total volume abstracted annually from corporate boreholes in the study area is calculated by simple proportion as with the private boreholes, a figure of 213 650 $m^3$ is obtained. This is heavily skewed as, with the exception of PE Golf Club, Telkom, Victoria Park and Crusader Club, the corporate use of groundwater is negligible. Allowing for the two other major corporate users in the area ie. Walmer CC and Arlington Race Course, an order of magnitude figure of total corporate abstraction is estimated to be no more than 150 000 $m^3$/annum.

**TABLE 6: METERED ABSTRACTION FROM CORPORATE BOREHOLES**

| Location | Total Abstraction ($m^3$) | Period (days) | Annual Abstraction ($m^3$) |
|---|---|---|---|
| PE Golf Club | | | |
| No 1 | 38 400 | 763 | 18370 |
| No 2 | 35 167 | 762 | 6845 |
| No 3 | 16 907 | 763 | 8087 |
| No 4 | borehole collapsed | | |
| Telkom | 1 475 | 722 | 746 |
| Clarendon Park School | 337 | 748 | 165 |
| Victoria Park | 24 766 | 746 | 12 085 |
| Fort Frederick | 9 | 760 | 4 |
| Donkin Reserve | 15 | 736 | 7.5 |
| St George's Park | borehole not working | | |
| Crusaders Club | 6 197 | 753 | 3004 |
| King Edward Park | borehole not required | | |
| Fedlife Building | 241 | 56 | 1571 |
| 10 boreholes | 123 514 | 680,9 | 60884 |

Combining figures for corporate and private abstraction, total annual groundwater abstraction in the PE municipal area is estimated to be of the order of 387 000$m^3$.

- **Impact on municipal water use**

From the estimates given above, the annual volume of groundwater that is abstracted is approximately 387 000$m^3$. Table 7 below shows that this volume forms less than 1% of total municipal consumption since recent incorporation of black residential areas.

**TABLE 7: ANNUAL WATER CONSUMPTION**

| Source | 1992/93 | 1993/94 | *1994/95 |
|---|---|---|---|
| Municipal (*Ml*) | 28 915 | 32 336 | 50 114 |
| Groundwater (*Ml*) | 370 | 370 | 370 |
| Percent | 1.3 | 1.1 | 0.74 |

* Includes incorporation of the former Ibhayi, Motherwell, Kwadwesi and Kwamagxaki areas.

This low percentage is due mainly to the small proportion of properties with boreholes compared to those served by municipal reticulation. The percentage of groundwater to municipal water use where a borehole is present appears to be high from the two sites where both sets of data are available. These results are presented in graphical form in Figure 6.

At 5 Kolbe Crescent, Summerstrand, borehole water is used for irrigation and household appliances such as the dishwasher, washing machine and toilet cisterns. Once the borehole was installed in July 1993, municipal consumption dropped dramatically and has remained consistently low, on average only between 10 and 20% of total monthly consumption. A rough calculation indicates a reduction of about R2 000 per annum for this user, excluding borehole installation and running costs.

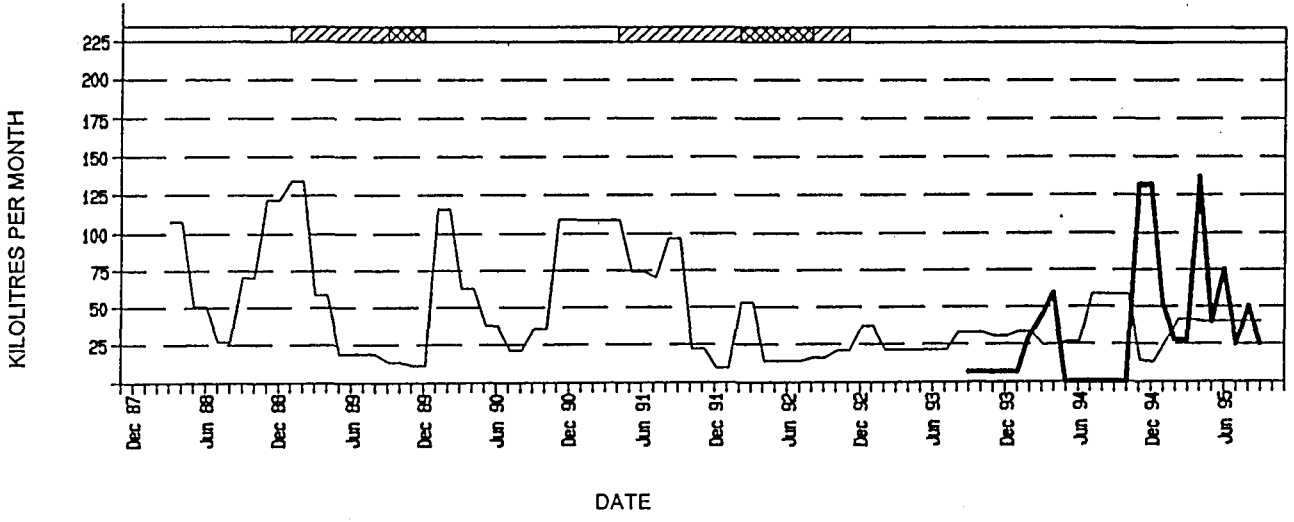
At 64 Short Road Walmer, groundwater is used solely for garden irrigation, partly due to a high iron content making it unsuitable for any household application. As a result, groundwater demand is seasonally driven with typical abstraction peaks in summer. At these times groundwater accounts for up to 75% of total consumption but typically more than 50%.The saving to this user is about R1 200 per annum at current rates but is significantly more during dry years and times of rationing.

Because the borehole distribution is socio-economically controlled, the more affluent people who have the highest per capita daily water demand have the opportunity to make the greatest savings on their water account.

Abstraction volumes have increased since the beginning of the drought in 1983 and peaked in 1992. After the drought and during the monitoring period when "normal" rainfall resumed, many borehole owners allowed their boreholes to fall into disrepair or stopped using them, as the water quality was poor and they are not solely dependent on groundwater. However, many owners do use groundwater as an ongoing part of their consumption, particularly for garden irrigation purposes.

During dry periods additional borehole owners resume abstraction principally to save money. This results in a saving of municipal water which becomes available to other users during times of drought. In this way, boreholes within PEM boundaries that are privately owned are, to a degree, an extension of PEM water resources.

## WATER CONSUMPTION AT 64 SHORT ROAD - WALMER




**NOTES**

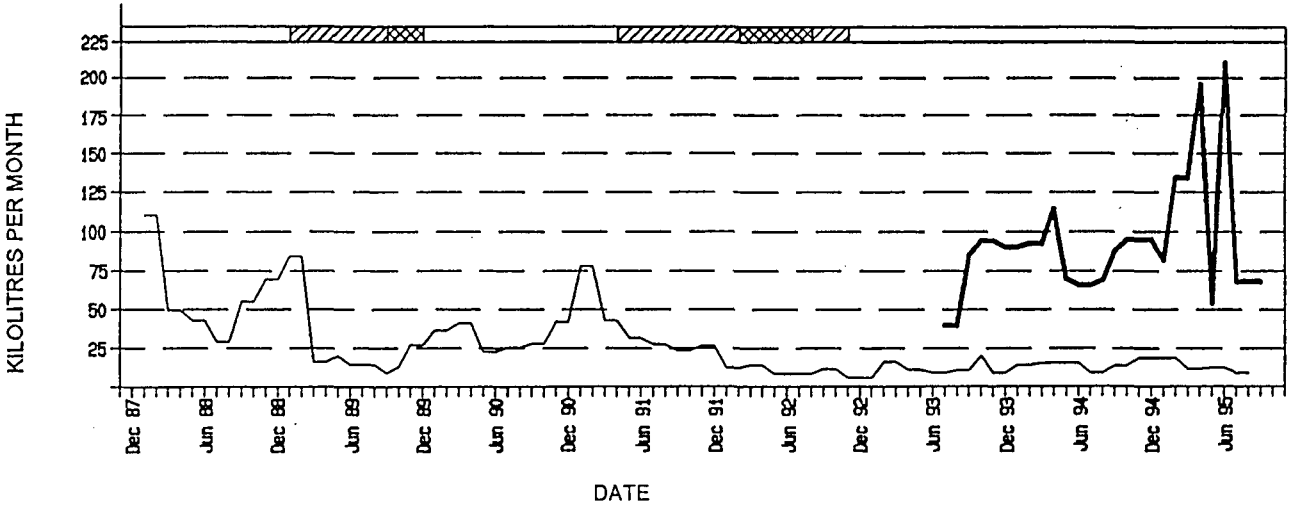
- WATER RESTRICTIONS
- WATER RATIONING
- Municipal consumption
- Borehole consumption

Erf Size : 3780 Square metres

Installed : March 1992

Usage : Irrigation

## WATER CONSUMPTION AT 5 KOLBE CRESCENT - SUMMERSTRAND




**NOTES**

- WATER RESTRICTIONS
- WATER RATIONING
- Municipal consumption
- Borehole consumption

Erf Size : 1700 Square metres

Installed : July 1993

Usage : Irrigation, toilets, washing machine and dishwasher

Fig. 6

Of interest is the effect of municipal water restrictions and water rationing on the user. The Kolbe Crescent site shows that after the lifting of restrictions and rationing, and prior to the installation of a borehole, municipal consumption remained well below the previous average monthly consumption. As soon as the borehole was installed, the total consumption levels increased beyond those previously recorded outside of restriction periods. This indicates that people adapt to conservative water use when restrictions are initially imposed, but as soon as the water is perceived as "free" or strategically unimportant, consumption volumes are unimportant.

The potential impact on municipal water sales can best be illustrated by a large groundwater consumer like PE Golf Club. An annual consumption of 75 000 $m^3$ of groundwater for irrigation replaced a similar volume bought from the municipality. At current rates this saves the golf club about R135 000 per annum but costs approximately R11 000 to pump.

The total cost of groundwater use to the municipality in terms of lost revenue, based on an annual abstraction of 390 000 $m^3$ at R1.80 per $m^3$, is therefore R702 000 at July 1995 prices.

## 5.5 Groundwater levels

A groundwater contour map has been drawn-up from the water levels measured in July 1995 (Figure 7). The contours indicate a natural hydraulic gradient along geological strike from north-west to south-east, towards and across the study area. This reflects the enhanced permeability along strike, with bedding and thrust planes being the principal flow conduits. Exceptionally steep groundwater gradients are maintained across geological strike. This is typical of the TMGS aquifer and mirrors conditions at St Francis Bay and in the Hex River Valley.

The contours indicate that the Baakens River intercepts and drains water from the aquifer and may play an important role in limiting the spread of high conductivity groundwater from the north-west into the Humewood and Summerstrand areas. To the north of the study area, the TMGS is covered by a thick sequence of Tertiary and Cretaceous mudstones. This has generated artesian conditions in the Uitenhage Basin and the groundwater contours indicate that the hydraulic head in this basin pushes groundwater to the south-east and south.

Groundwater levels monitored over the study period show that no significant regional fluctuations of the water table have occurred besides localised drawdown due to pumping. There is no meaningful correlation with rainfall due to the latter's erratic pattern. In general, levels have remained remarkably stable, and without accurate water level data from 1991 and 1992, it is not possible to ascertain the effect of the 'drought' years and increased abstraction on water levels.

The largest monitored user of groundwater is PE Golf Club which uses groundwater for all its irrigation requirements. Three of the four boreholes have been pumped consistently over the last three years. Water levels monitored in the non- pumping borehole indicate that pumping water levels have reached equilibrium at around 58 m below collar and the cone of drawdown is relatively stable. Figure 8 shows water level fluctuations compared to rainfall and abstraction over the study period. Water level measurements were complicated by automated pumping systems and *ad hoc* pumping by major users, which made planning for monitoring difficult.

The presence of the overlying primary aquifer is thought to buffer the effects of both rainfall and pumping on groundwater levels. This is a result of the ability to store and release large volumes of water per unit rise or fall in the water table.

## 5.6 Groundwater chemistry

Groundwater chemistry is firstly discussed in terms of general water types followed by sections on contamination and seawater intrusion.

## 5.7 Overview of groundwater quality

The database contains over 700 chemical analyses presented in Appendix B. To simplify matters, the average analytical values for each constituent over the entire monitoring period have been used for general discussion on water quality characteristics. The average analyses from 47 boreholes representing all suburbs have been plotted on a Piper Diagram, to enable classification of groundwater types and determine evolution patterns, if any.

# RAINFALL vs REST WATER LEVEL

## PE GOLF COURSE

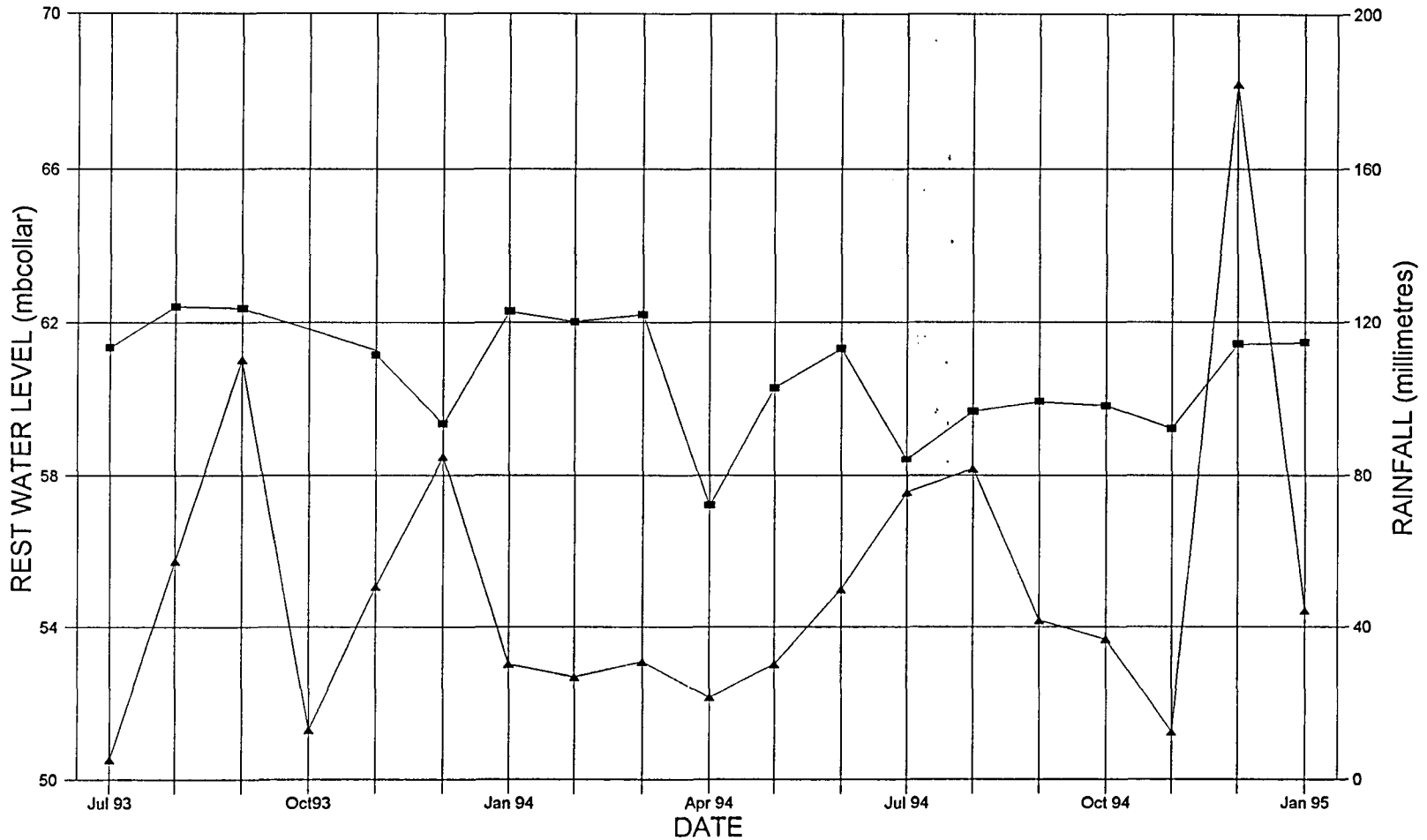



Fig. 8

With reference to the Piper Diagram (Figure 9) it can be seen that groundwater from the central and inland suburbs is all of a sodium chloride type, particularly north of the Baakens River. Groundwater from the Summerstrand area has a greater Ca/Mg $HCO_3$ component, which is due to the influence of the lime rich coastal sands. This could indicate that boreholes are tapping the primary aquifer directly or that a component of the secondary aquifer groundwater is derived by leakage or direct rainfall percolation from/through the sand.

Although water types are consistently within the above two categories, there is a large spatial range in electrical conductivity and individual constituents within the sodium chloride type. This is discussed further in Section 5.7.2.

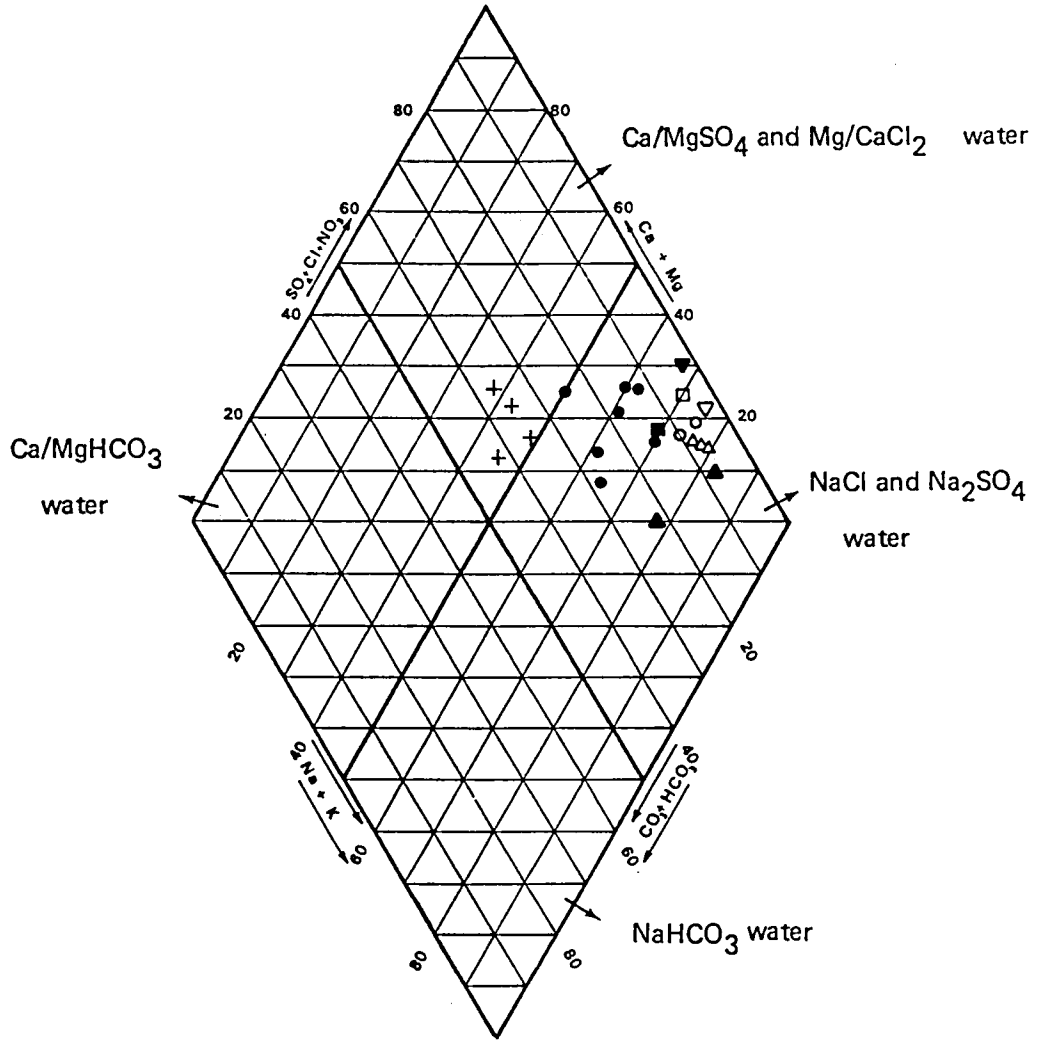
There are also significant time variations in water quality within individual boreholes, as shown by the high values of standard deviation for many constituents, although some are skewed by one analysis, which in many cases was the first of the monitoring period.

The time variations do not appear to be seasonally related, with each borehole having its own pattern. Fluctuations also appear to be above and below a fairly constant level, with concentrations at the start and end of the monitoring period not being significantly different. One exception is the Fedlife borehole, which has shown a continual increase in chloride concentration from 100 mg/ℓ in June 1993 to 500 mg/ℓ in February 1994, although this is based on a small number of samples.

The groundwater generally complies with SABS 241-1984 upper limits for domestic water use, with some exceptions, including chloride, nitrate and iron.

## 5.8 Groundwater contamination

Groundwater from TMGS aquifers in undeveloped mountain catchments ranks among the lowest in electrical conductivity in South Africa. In these recharge areas, conductivity of the "young" groundwater is generally $<20$ mS/m. Examples include the Ceres and Hex Valleys, and the Citrusdal area. In a recent drilling programme at Ceres, groundwater conductivity was $<4$ mS/m . Further along the flow path "older" groundwater quality is influenced by catchment land-use and longer contact with the host rock or rocks, and conductivity tends to




**Borehole localities**

- \+ Summerstrand / Schoenmakerskop
- ● Walmer
- △ Mill Park
- ▲ Newton Park
- o Fernglen
- □ Framesby
- ▽ Kabega
- ▼ Westering
- ■ Lorraine

MODIFIED PIPER DIAGRAM

Fig. 9

Ozalid 87-1735

increase. Examples include St Francis Bay and Gansbaai, both coastal aquifers with similar physiographic and geological features to Port Elizabeth. In the latter aquifers, conductivity ranges between 80 to 150 mS/m. Plots of conductivity and chloride concentration in the St Francis area showed a clear increase in both parameters along the groundwater flow path (SRK 1989), ie towards the coast.

In the study area, however, this chemical evolution of the groundwater is not seen and, in the context of expected TMGS groundwater chemistry, the Port Elizabeth aquifer is atypical. For example, the range in conductivity is 50 to 819 mS/m, and in chloride, 100 to 2 799 mg/ℓ. Furthermore, contour plots of these parameters and sulphate (Figures 10, 11 and 12) appear to indicate that they are decreasing in concentration along the groundwater flow path to the south of the Baakens River. Chemical reactions such as adsorption, precipitation and base exchange can cause natural attenuation and alteration of groundwater chemistry but, in the case of chloride, this explanation is not satisfactory as chloride is a conservative ion. Two quotes from the literature illustrate this fact. Mckee and Wolfe (1963) state that "the chloride ion is probably the best tracer of groundwater flow as it is least affected by absorption-desorption lag or by other physical or chemical phenomena". Hem (1985) states "that chloride ions do not significantly enter into oxidation or reduction reactions, form no important solute complexes with other ions unless the chloride concentration is extremely high, do not form salts of low solubility, are not adsorbed on mineral surfaces and play few vital biochemical roles".

If it is thus accepted that chloride is not being lost from the aquifer system along the flow path, then the only feasible explanation is that it is being diluted. The explanation put forward is that expanding urbanisation in the PEM area (along the outcrop of the TMGS aquifer) has resulted in partial replacement of diffuse recharge through the soil profile by the development of numerous point sources of contamination such as old waste tips, leaking sewers and water mains, septic tanks, fertilizer application and stormwater runoff. For example, Walmer only converted to water-borne sewage in 1968.

This would explain the frequent occurrence of groundwater with radically different chemistry from boreholes a few streets apart. Examples of such conductivity/chloride contrasts are 475mS/m - 1463mg/ℓ and 151mS/m - 390mg/ℓ in Walmer, and 247mS/m - 559mg/ℓ and 652mS/m - 1591mg/ℓ in Walmer Heights. A contributory factor here could be the discrete

nature of the secondary aquifer due to poor hydraulic connection across geological strike. The trend for lower conductivity and concentration of some ions to develop along the flow path is thus a reflection of dilution of contaminated groundwater and its tendency to approximate to background chemistry with time and distance. The main threat to groundwater quality could therefore be from inland sources rather than from seawater intrusion. The reports of 'brackish' water in the Walmer area in the 1920's could also indicate a natural level of salts in the aquifer.

Nitrate concentrations show an opposite trend to chloride in that concentrations increase along the flow path towards the coastal suburbs. The low iron concentrations in these areas may indicate an increase in redox potentials and a decrease in denitrification potential within the aquifer. This could have long-term implications for groundwater quality, with a continuing build-up of nitrates, given the practice of irrigation with treated sewage effluent in many coastal areas and fertilizer application to gardens, sports fields and parks. Figure 13 shows a trend for a general increase in nitrates in the peripheral coastal areas, which possibly supports the above contention.
In a study of the impacts of urban development on groundwater quality in a coastal aquifer near Perth, Australia (Appleyard 1995), it was concluded that significant changes had occurred. These were mainly manifested in increases in nitrate and sulphate. Chloride did not appear to be affected to the same degree.

Potential souces of contaminants into the aquifer are listed below and shown on Figure 13.

I) **Waste disposal sites**
Arlington, Victoria Drive
Historical sites at Walmer and Baakens River Valley and elsewhere.

ii) **Sites irrigated with reclaimed sewage effluent**
Port Elizabeth Technikon
University of Port Elizabeth
Humewood Golf Course

iii) **Golf courses where nitrogenous fertilizers are used**
Humewood Golf Club
Walmer Country Club
Walmer Golf Club
Port Elizabeth Golf Club, Mill Park

iv) **Other sites where nitrogenous and other fertilizers are used**

Port Elizabeth Municipal Parks
St Georges Park
Donkin Reserve
Fort Frederick
Clarendon Park
Settler's Park
Private and corporate sports clubs

For the purpose of assessment of contamination, the major ground water quality indicators considered were, chlorides, nitrates, iron, total organic carbon and bacteria. These five contaminants are discussed separately as far as the monitoring boreholes are concerned.

- **Chloride**

Most of the boreholes in the Port Elizabeth area have relatively high chloride concentrations, predominantly in the form of sodium chloride. Of the 47 boreholes monitored, 37 had average chloride levels of >250 mg/ℓ; 28 with >400 mg/ℓ and 11 with >600 mg/ℓ. The majority of the borehole waters fall into the medium and medium/high chloride category, i.e., 250 to 600 mg/ℓ.

On the basis of information available, there are not many boreholes in Port Elizabeth where the water is used for domestic/potable purposes, other than for the flushing of toilets, washing down floors and other general uses. The high chlorides have a considerable effect on the use of these waters for irrigation purposes, and in many cases special practices have to be used when irrigating plants. Many of the waters are unsuitable for spray irrigation of plants because of problems resulting from salt build-up on leaves. Certain of the boreholes are virtually unusable for irrigation purposes because of the very high total salt content. None of the very highly saline boreholes are close to the sea.

- **Nitrate**

Out of the 47 borehole waters analysed, 21 have nitrate levels >4,0 mg/ℓ as N, with 11 being >10,0 mg/ℓ. The high nitrate boreholes are contained in a triangle from

Newton Park towards the sea, with Central and Summerstrand being the outer corners of the triangle.

In a study by Tredoux (1993) on nitrates in groundwater in South Africa, it was found that out of a data base of 18827 complete analyses, the median nitrate value (as N) was 4,5 mg/ℓ. The majority of this sample base was representative of inland aquifers, with few coastal aquifers apart from the west coast. In this context, nitrate values in the study area are not excessive, although in the context of TMGS aquifers, they are excessive.

Sources of nitrate include areas irrigated with treated sewage effluent eg PE Technikon, UPE and Humewood Golf Course, irrigated parks and golf clubs where nitrogenous fertilizers are used, eg Walmer Country Club, Walmer and PE Golf Clubs, municipal parks.

Nitrate contamination is not seen as being a serious problem with the Port Elizabeth boreholes as the water is used for irrigation purposes rather than drinking water.

- **Iron**

Iron has only been found in significant levels, i.e., >1 mg/ℓ, at 10 sites, of which four were >5,0 mg/ℓ. The Walmer/Walmer Heights area seems to have a particular iron problem and this also applies to the Framesby, Lorraine and Kragga Kamma areas. Very high iron levels of >20 mg/ℓ were found on occasions, particularly in Walmer. High iron concentrations are typical of TMGS groundwater, being derived from oxidation of pyrite, but levels > 5 mg/ℓ are probably more indicative of borehole condition, ie casing corrosion.

- **Organics**

The Total Organic Carbon test was used to evaluate the possible organic pollution of borehole waters. Only in seven out of the 47 boreholes monitored were the levels of organic carbon considered significant, i.e., >6,0 mg/ℓ as C. Of these sites, three are situated in the Arlington area and three in Summerstrand, but others in the same areas did not have significant organic carbon levels. There may be some possible connection between the boreholes and the situation of the City's largest domestic waste disposal site at Arlington, but this cannot be proved from the relatively few boreholes studied in the

area.

- **Bacteria**

  Some samples recorded faecal bacteria during the period of study, but most of these can be attributed to bad sampling. One site had significant E. coli I counts on several occasions. This borehole is situated on a smallholding and there are several labourer's cottages with "toilets" in the vicinity of the borehole, and this is the likely cause of the contamination. After due modifications to the facilities the problem was resolved. One borehole in Walmer also had faecal contamination on the several occasions that it was sampled, but these were not significant.

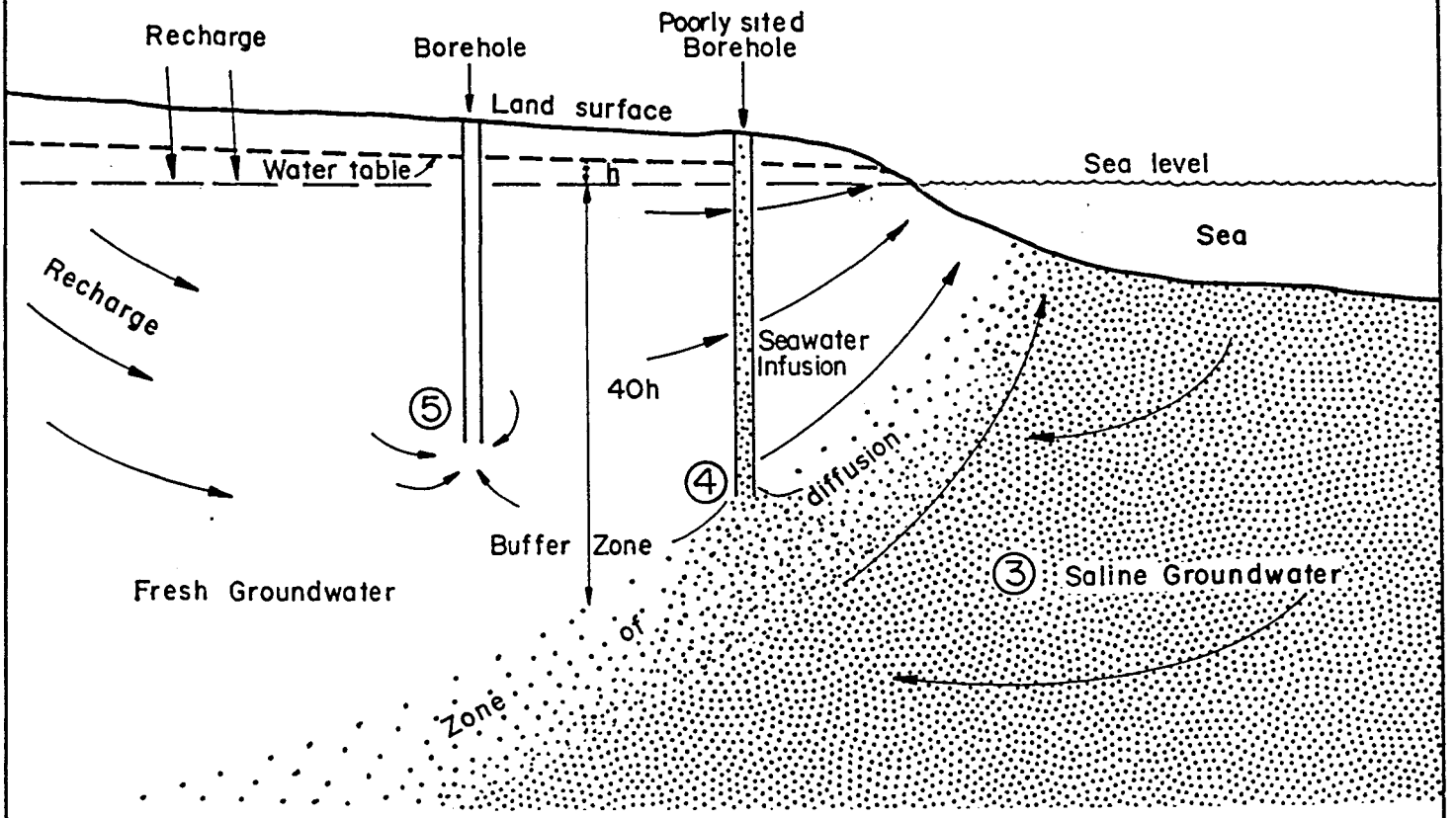
  On the basis of this study bacterial contamination of borehole water is not a problem in the Port Elizabeth area. Even the situation of a low income suburb with informal housing in part of Walmer does not appear to result in pollution of the groundwater, as yet.

## 5.9 Sea water intrusion

The main area of concern with regard to sea water intrusion is the suburb of Summerstrand and, to a lesser extent, Humewood. The other coastal areas are either undeveloped or bordered by office or industrial areas. Inspection of the results from the four monitoring boreholes in Summerstrand shows no sign of any problem relating to sea water intrusion. Of all the boreholes investigated for this project, the Summerstrand boreholes were some of the most consistent in terms of water quality. Water levels are about 4 mamsl within 100m of the sea. This positive hydraulic head will maintain the current fresh/sea water interface position. On the basis of these results sea water intrusion would not be seen as a problem. However, the drought ended shortly before the commencement of this project, and the boreholes have not been used as much as they would during drought conditions.

Recent information has come to light on boreholes in Summerstrand, very close to the sea, which change from fresh water to saline water very quickly during pumping . The owners report that when the borehole is next pumped, fresh water is again obtained initially. These boreholes are within 200 m of the beach, whereas the four monitoring boreholes are at least 400 m from the fresh/salt water interface. A diagram illustrating the mechanics of pulsed sea water intrusion in a secondary aquifer is shown in Figure 14.

# CONCEPTUAL MODEL OF FRESH WATER AND SALINE GROUNDWATER IN AN UNCONFINED COASTAL AQUIFER




## GHYBEN-HERZBERG RELATION

AT A GIVEN LOCATION, THE DEPTH OF FRESH WATER ABOVE THE MEAN SEA LEVEL (h), IS 1 METRE FOR EVERY 40 METRES (40h) OF FRESH WATER BELOW SEA LEVEL.

Fig. 14

Under drought conditions, with all boreholes being used on a regular basis, there is a risk that this transient, short-lived intrusion of saline water could be drawn further into the aquifer at Summerstrand. This is especially true under the likely scenario of borehole use, with pumping frequently taking place at relatively high rates for short periods of time. Turbulence in fractures is a prime cause of expansion of the brackish water diffusion zone between fresh and sea water. With the NW-SE structural trend of the TMGS, there is potential for direct connection between the aquifer and the sea. Ideally, boreholes close to the sea should be pumped continuously at a relatively low rate to minimize turbulence.

## 5.10 Overview of aquifer potential

On the basis of the yield and water quality characteristics described in the preceeding sections, it can be concluded that the TMGS aquifer in the PEM area does not have potential for municipal water supply, unless more productive aquifers exist at depths greater than those exploited so far. The economics of a network of low yielding boreholes delivering variable but generally poor quality water into the system are not feasible.

It is possible that many boreholes are not being used to full capacity and the yields are generally underestimated. It appears that some areas, like Port Elizabeth Golf Club, are more favourable and the aquifer can support fairly high sustained yields of suitable quality groundwater in these areas.

The clustering of boreholes in selected areas means large parts of the aquifer remain unassessed. The extreme variability in groundwater quality is consistent over the sample areas and on this basis further reduces the aquifer potential for larger scale exploitation.

On a more regional scale, the aquifer beyond the western boundary of the study area improves in both water quality and yield potential. Boreholes forming part of the AEC/WRC investigation and drilled in the Bushy Park area on a large fault, yield between 18 and 55$m^3$/h of potable quality water. Smallholdings in the Kragga Kamma area use groundwater for all domestic purposes, as do the landowners stretching back toward the Lady Slipper and Van Stadens area.

The linear TMGS aquifers formed by the E - W trending folds of the Cape Fold Belt extend for hundreds of kilometers into the Western Cape. Large outcrops form the mountains of the West and South East Cape and high rainfall over the area ensures significant recharge to the aquifer. Three major parallel aquifer systems traverse the catchment feeding Port Elizabeth's

water supply dams. These aquifers are being exploited on a small scale locally, but show high potential for further development for regional objectives.

Within this regional hydrogeological framework, the portion of the aquifer forming the Port Elizabeth Peninsula is atypical in terms of both groundwater quality and yield.

It appears from water level data that recharge exceeds abstraction and there is little doubt the aquifer can cope with greater abstraction volumes if they are spread over a wider area. The aquifer is suitable for the type and nature of the demand it currently fulfills and has the ability to cope with the pulses of increased abstraction in dry years.

# 6 LEGAL ASPECTS

## 6.1 The international situation

Broadly speaking, international water law can be classified into two main systems, which are often referred to as the common law and civil law systems. The common law system is the body of law built up by the courts through successive judgments, whereas civil law is codified law developed by Parliament or its equivalent in the country concerned.

Both systems had their origin in Roman Water Law, the common law system developing into the riparian system primarily found in England and in countries across the world with historical ties to England. The civil law system is found in European countries where the Napoleonic Code of 1804 applied and in other countries in Africa and the East with historical ties to the European states of France, Germany, Belgium and others.

In the United States of America, most of the eastern states have accepted the riparian system while in the more arid western states the appropriation system developed, which at the same time protects the rights of people who had prior rights to water. A common factor in the national systems of most countries is a tendency towards greater State control. Even in regions where water availability is not the primary issue, State intervention in order to safeguard the quality of water resources appears to be the order of the day. Some examples of the international situation are:

- **Botswana**: Water is publicly owned and anyone who drills a borehole must apply for

a water abstraction right. All boreholes have to be registered and such registration can be refused if the information supplied is inadequate;

- **Germany**: Water belongs to the community of citizens of a state, who are represented by a government which is responsible for protection and fair distribution of the resource. Some of the basic tenets of the German Federal Water Balance Act are, no water use without a permit, which is limited in time and quantity, and protection of wells and springs for public water supply;

- **Russia**: Water is an exclusive state property and is made available only for use. It is neither bought nor sold and cannot be separated from the state property.

With the above summary of international water law as a background, section 7.1 focuses on the situation within South Africa.

## 6.2 South African Water Law

South Africa's water law is contained primarily in the Water Act of 1956 but is also scattered in 33 other Acts. Most of the legislation is based on the legal system of the countries from which the European settlers came from.

The Roman-Dutch Law was introduced by the first Dutch settlers in the Cape in 1652 and it was soon found to be necessary to control the use of water from rivers near the original settlement. As the Cape settlement was extended and more water was used for irrigation, disputes arose which were dealt with by the "Landdrost en Heemraden" until their abolition in 1827. These bodies, when dealing with water disputes, in effect performed the State's traditional role of regulating water use and resolving disputes. The abolition left a vacuum which could only be filled by the Cape Supreme Court. By the end of the 19th Century, however, it became clear that laws were needed to regulate competing demands on water resources and consuquently laws were developed in the Cape Colony, Natal and the Transvaal. After Union in 1910, water law was rationalised under a single Act - the Irrigation and Conservation of Waters Act, 1912. This Act largely contained the existing common law position as developed by the Courts. Because the courts dealt mainly with irrigation disputes, the Act was largely aimed at compiling these irrigation rules. After the Second World War, when industrial development was on the increase, it became necessary to update the law, which

resulted in the substitution of the 1912 Act with the Water Act, 1956.

South Africa is one of the few countries in the world that has no legal way to restrict the use of groundwater, save through emergency regulation by the minister of Water Affairs. The Water Act of 1956 vests in the owner of land the exclusive right to use groundwater occurring on his land, with only some prohibitions on transfer of such water across boundaries of the land. The declaration of Subterranean Government Water Control Areas (SGWCA's) is the only way within the present Act (Section 26) to regulate development and use of groundwater. As of 1993, only 13 SGWCA's have been declared, covering a total area of about 5000 $km^2$, including the Uitenhage Artesian Basin.

The Water Act distinguishes between two types of groundwater, namely *subterranean water* and *underground water*. The former is defined by the Act as ,"such water naturally existing underground...as is contained within the areas proclaimed by the State President to be subterranean water control areas". It is presumed to exist or flow in defined channels. The latter category of water is not defined in the Act but it can be assumed to refer to water that also exists naturally underground but is not included in a subterranean water control area (Visser 1987).

On 17 January 1986 a proposed Water Amendment Bill was published in the *Government Gazette*, the main purpose of the bill being to, vest in the minister the powers to control and exploit water in subterranean sources in certain areas in the public interest." The bill does not alter the existing state of groundwater law and only confers wider powers concerning public management and use of subterranean water found in a SGWCA. The best policy, however drastic, would be to define all groundwater as public water and to deal with such water as is presently proposed for water found inside a SGWCA.

South Africa's water legislation is unsuited to an essentially dry country and is being reviewed. It is based on Roman law which was developed in a totally different climate where water shortages were not of major concern. The shortfalls in current SA water law with regard to groundwater are recognised by the DWA&F and a draft white paper is being drawn-up in consultation with experts from the private sector, and there seems little doubt but that the status of groundwater will change from private to public water in the near future.

In this respect, the Department of Water Affairs and Forestry has published a booklet "You and Your Water Rights - South African Water Law Review - a call for public response". The following is an extract from the section of the booklet dealing with the process of reviewing South Africa's water law and the call for public response:

"It is planned to undertake the review in three phases:

* The first phase will be to make sure that as wide a cross-section of South African society as possible has the opportunity to comment on the law and express what is important to their community. The objective is to avoid the "tyranny of the articulate". Workshops will be encouraged throughout the country, particularly in rural and poor communities.

* The second phase will be the consideration of the public's response by a monitoring team to be set up by the Minister of Water Affairs and Forestry. This committee will consist of experts in various fields disciplines to the water field, including community representatives, who will recommend to the Minister the principles that should provide the basis for a new legal structure. These principles will then be published in a White Paper giving further opportunity for public involvement.

* After the Government has made a decision in principle, the third phase will be the actual drafting of new legislation under the supervision of a second monitoring committee consisting of legal experts, whereupon once again draft legislation will be widely published for comment.

Contributions, comments, recommendations and submissions concerning the review of any aspect of the present water law were invited from individuals and interested parties, to be submitted by 19 May 1995."

From the above it can be assumed that far reaching changes can be expected in South African water law in the near future.

## 6.3 Municipal by-law formulation

The current legal framework for local government in South Africa comprises National Statutes, provincial ordinances and municipal by-laws. Municipal by-laws are generally in accordance with the provisions of the relevant provincial ordinance. The PEM Water Supply by-laws were promulgated in The Province of the Cape of Good Hope Gazette No. 4672, November 1990, and contain the following clauses on water installations that can be related to borehole use;

- Chapter I - Section 13

  The clause provides for the right of entry to premises to request information regarding the water installation, or to inspect, examine or operate any water fitting of the water installation on the premises.

- Chapter IV - Section 52: "Persons permitted to do installation and other work".

  This clause states that only plumbers registered with the Council may carry out work on pipes and fittings on any premises.

- Chapter VI - Section 68: "Use of pipes and water fittings to be authorised by Engineer".

  Only pipes and fittings included in the Schedule of Accepted Pipes and Water Fittings, shall be installed. The schedule is drawn up by JASWIC, the Joint Acceptance Scheme for Water Installation components whose members are representatives from the municipalities of Port Elizabeth, Cape Town, Durban, Johannesburg, Pretoria, East London and Kimberley as well as the Water Research Commission and the South African Bureau of Standards.

- Chapter VI - Section 74(8): "Installation of pipes".

  The Engineer may require that different water installations on premises bear an acceptable means of identification such as colour coding.

- Chapter VIII - Section 99(4)(b): "Protection of water installation".

  The owner is to ensure that no cross connection is made between the municipal supply and an alternative supply, for example, a borehole.

- Chapter IX - Section 102: "Use of water from sources other than the water supply system".

  No person shall use an alternative source of water for domestic, industrial or commercial purposes unless the water quality conforms to the specifications of SABS 241-1984: Water for Domestic Supplies. Also, if borehole water used on a premises is discharged to the municipal sewerage system, the Engineer may install a water meter at the source of the borehole supply.

- Chapter IX - Section 103: "Notification of boreholes".

  The Engineer may, by public notice, require that owners with boreholes on their premises notify the Engineer of the boreholes and that owners intending to sink boreholes advise the Engineer of their intentions.

  The owner of a premises within a municipal area is obliged to comply with the promulgated by-laws of that authority (in this case PEM). The municipality can, by enforcing by-laws and publishing of public notices, regulate the use of groundwater in terms of installation standards , health aspects related to water quality, discharge of effluent groundwater and the registration of existing and future boreholes.

In terms of the existing Water Act and the by-laws outlined in the previous section, PEM cannot regulate the volumes of groundwater pumped from the aquifer and thereby assess the impact of abstraction on the resource in terms of available storage and groundwater quality. This highlights the need for public awarness through education as well as a need for self control.

Further potential problems that may occur and ultimately involve the municipality, include the following:

- Well interference - this can occur when a cone of drawdown formed during pumping from one borehole extends to other boreholes situated nearby. The water levels in surrounding boreholes can decline to the extent that the neighbouring boreholes cannot be used simultaneously;

- Over-pumping from an aquifer - which will occur if the total volume of water pumped from an aquifer exceeds the rate of recharge to the aquifer, resulting in a nett decrease in storage and a consequent decline in water levels;

- Groundwater pollution - Indiscriminate disposal of effluents on surface areas and the application of fertilizers can, in time, result in pollution of an aquifer and degradation of groundwater supplies in areas adjacent to the source of the contamination;

- Sea water intrusion - Port Elizabeth occupies a peninsula bounded by the ocean to the east and south. Summerstrand is a suburb situated on the coastal plain and a major proportion of the boreholes identified in Port Elizabeth are concentrated in this area. A potential exists for saline intrusion to occur if pumping in the area exceeds recharge. This potential will be aggravated by high rate, short duration, pumping and in times of drought, when recharge is diminished;

- Sub-standard borehole construction - During the drought, some owners in the city sought quick solutions and did not specify borehole construction to the drilling contractor with the result that, in some instances, borehole owners have paid dearly for remedial work to boreholes that were poorly constructed.

Other municipalities with known private groundwater use were contacted to obtain further insight into the *status quo* in respect of legislation. Most have no provision for control or even notification of groundwater use, eg. Somerset West, Hermanus and Graaff Reinet. Beaufort West has no general by-law concerning groundwater/boreholes but further drilling is prohibited in one particular suburb because of the large number of existing boreholes. The most detailed examples of a by-law that the researchers came across is that of Johannesburg, relevant sections of which are as follows:

**Wells and excavations**:

33.(1) Every well or excavation shall be and be kept adequately covered or fenced and everything shall be done which is necessary to prevent its being in any way dangerous to life or limb.

**Construction of wells and boreholes:**

35.(1) No well, tube well or borehole may be sunk or constructed, nor shall any person cause, permit or suffer it to be sunk or constructed, unless fourteen clear days' notice has first been given to the Council of the intention to carry out such work, which notice shall also state the proposed position and nature of the work and the purpose for which the water to be derived therefrom is to be used.

The Council may, in any case in which the medical officer of health deems it necessary for the protection or otherwise in the interests of the public health, to do so, by notice in writing to the owner of the premises -

(a) prohibit the use of any well, tube well or borehole permanently or for such period as he may specify in the notice;

(b) require modifications of or alterations to, including a change in the position of any well, tube well or borehole and prohibit the use thereof until such modifications or alterations have been completed and approved by the medical officer of health;

(c) prohibit the carrying out of any work the subject of a notice given to it in terms of sub-section (1) or give such directions as the medical officer of health may deem necessary with regard to the carrying out of such work.

**Water supply:**

No person shall use or cause, permit or suffer to be used the water from any well, tube well, borehole, spring, dam, river or other source, not being the Council's water main, for human consumption or for any other domestic purpose or for the preparation or manufacture of food or drink for human consumption or in the cleansing of vessels, utensils or appliances used in the preparation or manufacture of the aforesaid unless and until the Council's Medical Officer of Health has given a certificate under his hand stating that such water is suitable for the use which is to be made of it.

Aspects that should be addressed in any by-law promulgated by PEM include:

- Compulsory employment of drilling contractors affiliated to the Borehole Water Association to assist the borehole owner to achieve a satisfactory standard of construction;

- Compulsory submission of copies of borehole completion certificates to the municipality by the owners;

- Right of access for inspection of borehole installations, groundwater sampling, installation of flow metres and measurement of water levels;

- Compulsory submission of one water sample per year for chemical and bacterial analysis;

- The imposition of restrictions on groundwater use should declining water levels become evident or changing water chemistry indicate pollution, sea water intrusion or should well interference be proven and a dispute between borehole owners arise;

- Possible ban on borehole use within an exclusion zone adjacent to the sea;

- Provision for restriction of use of groundwater unfit for domestic consumption;

- Education and self controll.

The aim of PEM should not be just to regulate groundwater use and possibly alienate borehole owners, but also to generate an interest, awareness and self control in the public of the need to protect the resource. In parts of the USA, signposts inform the public that they are entering a protected aquifer area. Such signs placed at strategic points along main thoroughfares would create an awareness among the public and possibly generate interest and enquires.

In the light of the fairly limited use of groundwater as a percentage of municipal consumption, the low yields and moderate to poor water quality, the need for a by-law containing all of the above provisions may need to be reconsidered. It may also be prudent to wait for indications from the DWA&F as to the status of groundwater in the new water laws soon to be formulated.

# 7. CONCLUSIONS AND RECOMMENDATIONS

The main conclusions to be drawn from this study are listed below and follow the same order as the research objectives:

- Number and distribution of boreholes;
  There are an estimated 300 boreholes in the PEM area, of which 241 have been located on the ground;

- Volume of groundwater abstracted;

- Annual groundwater abstraction is estimated at 370 000 $m^3$;

- Legal aspects;
  There are very few municipalities who have promulgated by-laws to control private groundwater use. Aspects that should be included in a by-law for PEM are:
  - employment of an affiliated drilling contractor;
  - submission of borehole completion certificates;
  - right of access for inspection and monitoring;
  - regular submission of water samples for quality analysis;
  - restrictions on groundwater use in areas with declining water levels or quality, or where mutual interference occurs;
  - restriction on groundwater use in an exclusion zone adjacent to the sea;
  - create public awareness on groundwater issues.

- Groundwater Quality
  Over most of the study area the groundwater is a sodium chloride type. The only exception is Summerstrand where the groundwater has a greater Ca/Mg $HCO_3$ component;

  Groundwater quality in the PEM area is generally atypical of TMGS aquifers elsewhere in the Eastern and Western Cape;

  There is extreme spatial variation in groundwater quality, often over very short distances in the same suburb;

Seasonal variation in groundwater quality is not seen as the rainfall patterns are so irregular. There is no 'winter' or 'summer' period of high or low rainfall as in Cape Town, for example;

- Sea water intrusion
  There is sporadic and short-lived intrusion of sea water in boreholes closest to the sea in the Summerstrand area. This is a local and non-permanent phenomenon at the moment but there is potential for a deeper incursion of saline water into the aquifer under higher pumping stress should drought conditions return;

- Groundwater pollution
  There is evidence of groundwater contamination in many areas on the basis of conductivity, chloride and nitrate levels, especially in the context of groundwater quality in TMGS aquifers elsewhere. The contamination is attributed to urbanisation and specifically waste dumps, fertilizer application, leaking sewers and stormwater runoff;

- Effect of groundwater use
  Groundwater use has had a negligible effect on municipal consumption in respect of homeowners but in the case of the main corporate user, PE Golf Club,
  75 000 $m^3$/annum of groundwater is used. This costs the municipality about R135 000 per annum in lost revenue from sales;

- Groundwater potential
  In terms of yield and water quality, the TMGS aquifer in the PEM area is not a potential source of municipal supply, unless untapped aquifers exist at greater depths than so far exploited.

The following recommendations are made for further attention:

- The database should be maintained, expanded and constantly updated to include all boreholes drilled into the Port Elizabeth TMGS aquifers as far as Van Stadens River;

- A reduced monitoring borehole network should be maintained in representative areas of the aquifer. These include upgradient (Kabega Park), central (Arlington), northern (Newton Park) and coastal (Summerstrand) areas. This would equate to about six boreholes, including Arlington waste site, which will be monitored as part of a separate project;
- A more detailed study of the boreholes within the coastal rim of

Summerstrand/Humewood, where sea water intrusion has been periodically reported, should be made to quantify the threat or occurrence of sea water intrusion;

- There is a vast amount of chemical data in the database which has only been qualitatively assessed in this study. More rigorous statistical and graphical analysis should be carried out to provide further insight into the atypical hydrogeochemistry of the TMGS aquifer in Port Elizabeth;

- The upgradient limits of the poor quality groundwater should be delineated to ensure that the potential groundwater resources in the TMGS to the west of Port Elizabeth remain unpolluted.

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# RESEARCH INTO BOREHOLES IN THE PORT ELIZABETH MUNICIPAL AREA

THE OWNER/OCCUPIER

## *PLEASE READ THIS PAMPHLET IF THERE IS A BOREHOLE ON YOUR PROPERTY*

The recent extended drought in the Eastern Cape has resulted in a proliferation of boreholes in Port Elizabeth with a corresponding increase in groundwater abstraction. Unless the situation is professionally assessed, the future integrity of the groundwater resource cannot be guaranteed.

Research into groundwater abstraction in Port Elizabeth has been initiated jointly by the Port Elizabeth Municipality and Steffen, Robertson and Kirsten Inc. in a two year project funded by the Water Research Commission. The research will focus on the following main aspects:

* Determination of the number of boreholes in the municipal area;

* Assessment of the volumes of groundwater abstracted;

* Monitoring of groundwater quality and assessment of the potential for contamination of the groundwater by sea-water intrusion and the disposal of effluents on the surface.

In order to gather information on boreholes a census form has been printed below this letter and, if you have a borehole on your premises, you are kindly requested to complete the form and return it to the City Treasurer's Department with your monthly municipal services payment or to the City Engineer, P.O. Box 7, Port Elizabeth 6000.

A borehole represents a considerable investment. Your co-operation will be in your best interests to ensure that the groundwater resource can be protected in the long term for all users. Any enquiries that you may have in this regard should be directed to the telephone numbers given below.

*City Engineer's Department*
*Scientific Services Division*
*(041) 5062333*
*Enquiries: Mr G Devey*

*Steffen Robertson and Kirsten Inc.*
*(041) 323706*
*Enquiries: Mr C Langton*

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# BOREHOLE CENSUS FORM

## *LOCALITY*

*OWNER/OCCUPIER:*

STREET ADDRESS: ..... POSTAL ADDRESS: .....

SUBURB: ..... SUBURB: .....

CODE: ..... CODE: .....

TELEPHONE NUMBERS:

RESIDENCE: ..... BUSINESS: ..... ERF NO.: ..... ERF SIZE: ..... ($m^2$)

## *BOREHOLE DETAILS*

DATE DRILLED: ..... / ..... /19 ..... CONTRACTOR: .....

DRILLED DEPTH: ..... (m) LENGTH OF CASING: ..... (m) TYPE OF CASING: PVC: ..... STEEL: ..... BOTH: .....

CASING PERFORATED: FROM: ..... (m) TO: ..... (m) REST WATER LEVEL: ..... (m) BOREHOLE YIELD: .....

*WAS THE YIELD OBTAINED*

*FROM:* (a) DRILLING RESULTS?: YES ☐ NO ☐ *OR* (b) DETERMINED FROM TEST PUMPING?: YES ☐ NO ☐

TEST PUMPING CONTRACTOR: .....

## *PUMPING DETAILS*

*PUMP TYPE:* SUBMERSIBLE: ..... JET: ..... OTHER: .....

PUMPING RATE: ..... ESTIMATED DAILY USAGE: .....

DO YOU HAVE A FLOW METER INSTALLED ON YOUR BOREHOLE DELIVERY LINE? YES ☐ NO ☐

WOULD YOU BE PREPARED TO HAVE A METER INSTALLED AT NO COST TO YOU FOR THE DURATION OF THE RESEARCH? YES ☐ NO ☐

## *GROUNDWATER QUALITY*

HAS A SAMPLE OF YOUR BOREHOLE WATER BEEN SUBMITTED FOR:

CHEMICAL ANALYSIS: YES ☐ NO ☐ MICROBIOLOGICAL ANALYSIS: YES ☐ NO ☐

SAMPLES ANALYSED BY: .....

## *GENERAL*

ARE YOU PREPARED TO PERMIT ACCESS TO YOUR PROPERTY ON A CONTROLLED BASIS FOR BOREHOLE MONITORING DURING THE PROJECT?

YES ☐ NO ☐

# NAVORSING OOR BOORGATE BINNE DIE MUNISIPALE GEBIED VAN PORT ELIZABETH

DIE EIENAAR/HUURDER

## *LEES ASSEBLIEF HIERDIE PAMFLET INDIEN DAAR 'N BOORGAT OP U EIENDOM IS*

Die onlangse langdurige droogte in Oos-Kaapland het tot 'n groot toename in die getal boorgate in Port Elizabeth gelei, met 'n ooreenstemmende toename in grondwateronttrekking. Tensy die situasie professioneel geëvalueer word, kan die voortgesette beskikbaarheid van die grondwater nie gewaarborg word nie.

Die Port Elizabethse Munisipaliteit het tesame met Steffen, Robertson en Kirsten Ing. 'n navorsingsprojek oor grondwateronttrekking van stapel gestuur. Dié projek sal oor twee jaar strek en deur die Waternavorsingskommissie gefinansier word. Die navorsing sal hoofsaaklik die volgende aspekte dek:

* Bepaling van die aantal boorgate in die munisipale gebied;

* Evaluering van die volume grondwater wat onttrek is;

* Monitering van die grondwatergehalte en evaluering van die moontlikheid dat die grondwater deur seewaterindringing en die wegdoening van afvloeistowwe op die oppervlak besmet kan word.

Ten einde inligting oor boorgate in te samel, is 'n sensusvorm hieronder gedruk. Indien daar 'n boorgat op u eiendom is, word u vriendelik versoek om die vorm in te vul en dit saam met die betaling van u maandelikse rekening vir munisipale dienste aan die Departement van die Stadstesourier te stuur of aan die Stadsingenieur, Posbus 7, Port Elizabeth 6000 te pos.

'n Boorgat verteenwoordig 'n aansienlike belegging. Dit is in u eie belang om u samewerking in dié verband te verleen sodat die langtermynbeskikbaarheid van grondwater vir alle verbruikers verseker kan word. Skakel asseblief onderstaande telefoonnommers indien u enige navrae oor die aangeleentheid het.

*Departement van die Stadsingenieur*
*Wetenskaplikediensteafdeling*
*(041) 5062333*
*Navrae: Mnr G Devey*

*Steffen Robertson en Kirsten Ing.*
*(041) 323706*
*Navrae: Mnr C Langton*

# BOORGATSENSUSVORM

## *LIGGING*

*EIENAAR/HUURDER:*

STRAATADRES: ..... POSADRES: .....

VOORSTAD: ..... VOORSTAD: .....

KODE: ..... KODE: .....

TELEFOONNOMMERS:

HUIS: ..... KANTOOR: ..... ERFNO.: ..... ERFGROOTTE: ..... ($m^2$)

## *BESONDERHEDE VAN BOORGAT*

DATUM GEBOOR: ..... / ..... /19 ..... KONTRAKTEUR: .....

BOORDIEPTE: ..... (m) LENGTE VAN VOERING: ..... (m) TIPE VOERING: PVC: ..... STAAL: ..... BEIDE: .....

VOERING GEPERFOREER: VAN: ..... (m) TOT: ..... (m) RUSWATERVLAK: ..... (m) BOORGATVLOEI: .....

*IS DIE VLOEI VERKRY*

*VAN:* (a) BOORRESULTATE?: JA ☐ NEE ☐ *OF* (b) BEPAAL UIT TOETSPOMPRESULTATE?: JA ☐ NEE ☐

TOETSPOMPKONTRAKTEUR: .....

## *BESONDERHEDE VAN POMP*

*TIPE POMP:* DOMPELPOMP: ..... STRAAL: ..... ANDER: .....

POMPTEMPO: ..... GERAAMDE DAAGLIKSE VERBRUIK: .....

IS 'N VLOEIMETER IN U BOORGAT SE TOEVOERPYP GEÏNSTALLEER? JA ☐ NEE ☐

SAL U INSTEM DAT 'N METER VIR DIE DUUR VAN DIE NAVORSINGSPROJEK KOSTELOOS GEÏNSTALLEER WORD? JA ☐ NEE ☐

## *GRONDWATERGEHALTE*

IS 'N MONSTER VAN U BOORGATWATER VOORGELÊ VIR:

CHEMIESE ONTLEDING: JA ☐ NEE ☐ MIKROBIOLOGIESE ONTLEDING: JA ☐ NEE ☐

MONSTER(S) ONTLEED DEUR: .....

## *ALGEMEEN*

IS U BEREID OM VIR DIE DUUR VAN DIE PROJEK TOEGANG TOT U EIENDOM OP 'N BEHEERDE GRONDSLAG TOE TE LAAT SODAT DIE BOORGAT GEMONITOR KAN WORD?

JA ☐ NEE ☐

| ERFNO | NAME OF OWNER | STREET ADDRESS | SUBURB | -Y CO-ORD | X CO-ORD |
|---|---|---|---|---|---|
| 14001480000 | PE GOLF CLUB NO.1 | WESTVIEW DRIVE | MILL PARK | 54285.000 | 3758980.000 |
| 14001480000 | PE GOLF CLUB NO. 2 | WESTVIEW DRIVE | MILL PARK | 53965.000 | 3759040.000 |
| 14001480000 | PE GOLF CLUB NO.3 | WESTVIEW DRIVE | MILL PARK | 53995.000 | 3758865.000 |
| 14001480000 | PE GOLF CLUB NO.4 | WESTVIEW DRIVE | MILL PARK | 54000.000 | 3758635.000 |
| 17030090000 | METROPOLITAN LIFE LTD | 281 CAPE ROAD | NEWTON PARK | 52965.350 | 3757956.920 |
| 04031820000 | PE MUNICIPALITY | CRUSADERS CLUB | CENTRAL | 56380.000 | 3759900.000 |
| 32019350000 | PE MUNICIPALITY | KING EDWARD PARK | WALMER | 53690.810 | 3762029.400 |
| 32019480000 | TELKOM CLUB | VICTORIA DRIVE | WALMER | 52540.000 | 3764120.000 |
| 32000470000 | CLARENDON PARK SCHOOL | 50 SEVENTH AVENUE | WALMER | 54350.000 | 3760570.000 |
| 22005270000 | VICTORIA PARK SCHOOL | VICTORIA PARK DRIVE | CENTRAL | 57035.000 | 3760815.000 |
| 04035960000 | PE MUNICIPALITY | FORT FREDERICK | CENTRAL | 57435.000 | 3759820.000 |
| 04019000000 | PE MUNICIPALITY | DONKIN | CENTRAL | 57290.000 | 3759405.000 |
| 04031820000 | PE MUNICIPALITY | ST GEORGES PARK | CENTRAL | 56240.000 | 3759375.000 |
| 22006240000 | BUYS, ISC | 17 VICTORIA PARK DRIVE | SOUTH END | 57326.570 | 3760716.770 |
| 32026390000 | KEMP, ES | 10 4TH AVENUE | WALMER | 55800.000 | 3761360.000 |
| 32001790000 | EXLEY, FR | 12 11TH AVENUE | WALMER | 53190.000 | 3761589.000 |
| 32025500000 | VAN DER WALT, A | 74 RIVER ROAD | WALMER | 53623.000 | 3760684.000 |
| 32004980000 | CORNISH, C | 64SHORT ROAD | WALMER | 53010.000 | 3761117.000 |
| 32028810000 | MILLER, P | 6 CLUB ROAD | WALMER | 52288.000 | 3760925.000 |
| 14002420000 | DEWAR, BN | 8 MILL PARK ROAD | MILL PARK | 54785.000 | 3759026.000 |
| 04034050000 | DASHWOOD, HA | 8 HALLACK ROAD | CENTRAL | 55569.000 | 3760077.000 |
| 14009890000 | LAPINER | 47 WYCHWOOD AVENUE | MILL PARK | 53145.000 | 3759304.000 |
| 17016790000 | LANDMAN | 12 WEST STREET | NEWTON PARK | 52765.000 | 3758016.000 |
| 06000560000 | ENGELBRECHT | 3 WHITNEY STREET | FERNGLEN | 50952.464 | 3757754.59 |
| 36000930000 | DU TOIT, LM | 98 VERDUN ROAD | LORRAINE | 46923.000 | 3760663.000 |
| 06002980000 | LOFTIE-EATON, GA | 14 THAMES ROAD | FERNGLEN | 50660.000 | 3757926.000 |
| 12000720000 | MICHEALS | 78 KABEGA ROAD | KABEGA | 46808.230 | 3758480.000 |
| 32019810000 | HARTY, JP | 12 NEWCOMBE AVENUE | WALMER | 50109.560 | 3763293.540 |
| 07008590000 | LANGER | 5 NORLAND CLOSE | FRAMESBY | 47300.000 | 3758698.000 |
| 27006880000 | PEINKE | 15 COSMOS STREET | WESTERING | 47812.790 | 3756403.070 |
| 32040170000 | PEDERSEN, C | 10 IDYLWYLDE CRESCENT | WALMER HEIGHTS | 51150.000 | 3763310.000 |
| 99003510000 | DANHOER | SCOTSAM | LOVEMORE PARK | 47018.087 | 3765034.779 |
| 99007400000 | STONE, TC | STONE'S THROW | LOVEMORE PARK | 48140.731 | 3764679.926 |
| 23006160000 | GRAHAM, RC | 21 ADMIRALTY WAY | SUMMERSTRAND | 62141.000 | 3762843.000 |
| 23014100000 | CHURCH, KA | 5 KOLBE CRESCENT | SUMMERSTRAND | 60364.000 | 3762682.000 |
| 23017360000 | BOSCH, JK | 68 WINCHESTER ROAD | SUMMERSTRAND | 60270.000 | 3762750.000 |
| 23016930000 | VAN RENSBERG | 10 BULBRING ROAD | SUMMERSTRAND | 59912.000 | 3762833.000 |

# APPENDIX B

# PHYSICAL DATA BASE

# CHEMICAL DATA BASE

| No. | ERFNO | NAME | STREET ADDRESS | SUBURB | -Y CO-ORD | X CO-ORD | ELEVATION(m) | BH_DEPTH(m) | YIELD(m3/hr) | WLMBGL(m) | WLAMSL(m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 04005270000 | VICTORIA PARK SCHOOL | VICTORIA PARK DRIVE | CENTRAL | 57035.000 | 3760815.000 | 61.500 | | | 33.25 | 28.75 |
| 2 | 04019000000 | PE MUNICIPALITY | DONKIN | CENTRAL | 57290.000 | 3759405.000 | 56.000 | | | 36.53 | 19.47 |
| 3 | 04028630000 | PE MUNICIPALITY | OVAL TRACK | CENTRAL | 56410.000 | 3759200.000 | 71.500 | | | | |
| 4 | 04031820000 | PE MUNICIPALITY | ST GEORGES PARK | CENTRAL | 56240.000 | 3759375.000 | 71.500 | | | 46.65 | 26.35 |
| 5 | 04031820000 | PE MUNICIPALITY | CRUSADERS CLUB | CENTRAL | 56380.000 | 3759900.000 | 72.500 | 100.0 | 6.0 | | |
| 6 | 04032120000 | NAZARETH HOUSE | 10 PARK LANE | CENTRAL | 55749.000 | 3759355.000 | 84.000 | 100.0 | 7.4 | 53.94 | 30.06 |
| 7 | 04034020000 | TRUSTEES OF HALLACK RD. | 2 HALLACK ROAD | CENTRAL | 55679.000 | 3760135.000 | 72.000 | | | | |
| 8 | 04034030000 | DALLA-VECCHIA, E | 4 HALLACK ROAD | CENTRAL | 55641.000 | 3760116.000 | 76.000 | | | | |
| 9 | 04034040000 | POUROULLIS, AI | 6 HALLACK ROAD | CENTRAL | 55607.000 | 3760096.000 | 76.000 | | | | |
| 10 | 04034050000 | DASHWOOD, HA | 8 HALLACK ROAD | CENTRAL | 55569.000 | 3760077.000 | 76.000 | | | 52.3 | 23.7 |
| 11 | 04034300000 | VAN DER SPUY, S | 1 BRIAN CLOSE | CENTRAL | 55622.000 | 3759857.000 | 76.500 | | | | |
| 12 | 04034370000 | GREYLING, JGB | 11 HALLACK ROAD | CENTRAL | 55609.000 | 3760003.000 | 76.000 | | | | |
| 13 | 04035960000 | PE MUNICIPALITY | FORT FREDERICK | CENTRAL | 57435.000 | 3759820.000 | 57.000 | 100 | 6 | 27.7 | 51 |
| 14 | 05004000000 | FERREIRA, TIR | 8 LEWERKIESTRAAT | COTSWOLD | 50189.000 | 3757019.000 | 131.000 | 5.0 | | 2.2 | 128.8 |
| 15 | 06000560000 | ENGELBRECHT | 3 WHITNEY STREET | FERNGLEN | 50952.464 | 3757754.590 | 116.000 | | | | |
| 16 | 06002720000 | STRECKER, H | 32 STELLA LONDT DRIVE | FERNGLEN | 49993.000 | 3758026.000 | 118.000 | 100.0 | 6.0 | 58.87 | 31.13 |
| 17 | 06002980000 | LOFTIE-EATON, GA | 14 THAMES ROAD | FERNGLEN | 50660.000 | 3757926.000 | 113.000 | 110.0 | 1.3 | 45 | 68 |
| 18 | 07008590000 | LANGER | 5 NORLAND CLOSE | FRAMESBY | 47300.000 | 3758698.000 | 125.000 | | | 2.7 | 122.3 |
| 19 | 09000750000 | VAN DER VYWER | 15 GLENGARRY CRESCENT | HUMEWOOD | 58795.000 | 3761150.000 | 43.500 | 84.0 | 2.4 | 21.33 | 22.17 |
| 20 | 09001160000 | LEVINTHAL | 13 KILLARNEY ROAD | HUMEWOOD | 59206.000 | 3760809.000 | 23.500 | | | | |
| 21 | 09001170000 | DE BEER,AS | 15 KILLARNEY ROAD | HUMEWOOD | 59234.000 | 3760841.000 | 22.000 | | | 22 | 14.9 |
| 22 | 09001540000 | MUKHEIBER, E | 14 GLENGARRY CRESCENT | HUMEWOOD | 58850.000 | 3766115.000 | 43.000 | 80.0 | 1.5 | 20.35 | 22.65 |
| 23 | 09001780000 | BRITO, MM | 27 MARSHALL ROAD | HUMEWOOD | 59428.000 | 3761039.000 | 35.000 | | | | |
| 24 | 09003920000 | HUMEWOOD HOTEL | 33 BEACH ROAD | HUMEWOOD | 59751.000 | 3760896.000 | 8.500 | 60.0 | 3.0 | 4.13 | 4.37 |
| 25 | 09004830000 | CROSS, JH | 8 LA ROCHE DRIVE | HUMEWOOD | 59617.390 | 3761160.000 | 31.000 | 43.0 | 1.4 | | |
| 26 | 09012560000 | PE MUNICIPALITY | HAPPY VALLEY | HUMEWOOD | 59405.000 | 3761695.000 | 40.000 | | | | |
| 27 | 10020470000 | GOLIGHTLY, GA | 10 KLEINEMOND STREET | HUNTERS RETREAT | 44426.000 | 3758285.000 | 160.000 | | | | |
| 28 | 12000720000 | MICHEALS | 78 KABEGA ROAD | KABEGA | 46808.230 | 3758480.000 | 132.000 | | | 5.1 | 126.9 |
| 29 | 12009620000 | LOURENS | 21 TULBAGH STREET | KABEGA | 45220.660 | 3757160.000 | 174.000 | | | 3.2 | 170.8 |
| 30 | 12009920000 | STRYDOM | 18 TULBACH STREET | KABEGA | 45224.640 | 3757214.270 | 171.000 | | | | |
| 31 | 14001480000 | PE GOLF CLUB NO. 2 | WESTVIEW DRIVE | MILL PARK | 53965.000 | 3759040.000 | 95.000 | | | 62.31 | 35.69 |
| 32 | 14001480000 | PE GOLF CLUB NO.1 | WESTVIEW DRIVE | MILL PARK | 54285.000 | 3758980.000 | 93.000 | 150 | 7.0 | 62.95 | 35.05 |
| 33 | 14001480000 | PE GOLF CLUB NO.3 | WESTVIEW DRIVE | MILL PARK | 53995.000 | 3758865.000 | 95.000 | | | | |
| 34 | 14001480000 | PE GOLF CLUB NO.4 | WESTVIEW DRIVE | MILL PARK | 54000.000 | 3758635.000 | 97.000 | COLLAPSED | | | |
| 35 | 14001480000 | PE GOLF CLUB NO.5 | WESTVIEW DRIVE | MILL PARK | 54300.000 | 3758800.000 | 98.000 | | | | |
| 36 | 14002240000 | SIMPSON, KA | 25 MILL PARK ROAD | MILL PARK | 54602.000 | 3759238.000 | 88.000 | 110.0 | 4.5 | | |
| 37 | 14002310000 | MEYBURG, JM | 11 MILL PARK ROAD | MILL PARK | 54705.000 | 3758991.000 | 90.600 | 104.0 | 9.0 | | |
| 38 | 14002320000 | MOORCROFT, CF | 9 MILL PARK ROAD | MILL PARK | 54717.000 | 3758963.000 | 91.500 | | | 60.2 | 31.3 |
| 39 | 14002370000 | ROUX,VJ | 2 MILL PARK ROAD | MILL PARK | 54821.000 | 3758940.000 | 91.600 | | | | |
| 40 | 14002400000 | ALAN ORCHARD FAMILY TRUST | 5 MC LEAN ROAD | MILL PARK | 54855.000 | 3759023.000 | 90.000 | | | 65 | 25.5 |
| 41 | 14002400000 | ORCHARD, NA | 3 MCLEAN ROAD | MILL PARK | 54840.000 | 3759020.000 | 90.500 | 96.0 | 3.5 | | |
| 42 | 14002420000 | DEWAR, BN | 8 MILL PARK ROAD | MILL PARK | 54785.000 | 3759026.000 | 91.000 | | | | |
| 43 | 14002450000 | JONES, IA | 10 MILL PARK ROAD | MILL PARK | 54757.000 | 3759087.000 | 91.000 | 110.0 | 4.0 | | |
| 44 | 14002600000 | VAN ZYL RUDD & ASS, PTY,LTD | 18 MILL PARK ROAD | MILL PARK | 54716.000 | 3759191.000 | 90.000 | | | | |
| 45 | 14002650000 | EDUCATIONAL TRUSTEES | GREY HIGH SCHOOL | MILL PARK | 55080.000 | 3759275.000 | 86.000 | 125.0 | 6.0 | | |
| 46 | 14003560000 | MCCALL, I | 10 SALISBURY AVENUE | MILL PARK | 55312.790 | 3759343.680 | 81.000 | 110.0 | 3.0 | | |
| 47 | 14003690000 | HOPEWELL, EC | 5 WAVERLEY DRIVE | MILL PARK | 55128.000 | 3759609.000 | 76.000 | 80.0 | 2.4 | | |
| 48 | 14004410000 | FORSDICK, AE | 1 YOUNG LANE | MILL PARK | 54797.000 | 3759947.000 | 70.000 | | | | |
| 49 | 14005300000 | GOWAR, GB | 11 REITZ ROAD | MILL PARK | 54862.000 | 3759715.000 | 80.000 | 100.0 | 3.0 | | |
| 50 | 14005610000 | OLIVETO | 1 LINTON ROAD | MILL PARK | 55009.000 | 3759552.000 | 78.000 | | | | |
| 51 | 14006200000 | GREYVENSTEIN PRIMARY TRUS | 2 WOODVILLE ROAD | MILL PARK | 55079.000 | 3759750.000 | 79.000 | | | | |
| 52 | 14009680000 | VIANELLO | 10 FAIRFORD AVENUE | MILL PARK | 54250.000 | 3759520.000 | 80.000 | 60.0 | 2.2 | | |
| 53 | 14009890000 | LAPINER | 47 WYCHWOOD AVENUE | MILL PARK | 53145.000 | 3759304.000 | 87.000 | 100.0 | 4.5 | | |
| 54 | 14010030000 | MORIS, DH | 21 WYCHWOOD AVENUE | MILL PARK | 53549.000 | 3759356.000 | 92.000 | | 6.0 | | |
| 55 | 14010260000 | MEYER, G | 4 CAMDEN ROAD | MILL PARK | 53230.000 | 3759452.000 | 80.000 | | 2.6 | 34.1 | 45.9 |
| 56 | 17001500000 | MARAIS | 52 KING EDWARD STREET | NEWTON PARK | 51991.000 | 3756937.000 | 106.000 | 80.0 | 2.0 | 50.7 | 55.3 |
| 57 | 17002840000 | ERASMUS, LB | 92 PICKERING STREET | NEWTON PARK | 51165.910 | 3757250.193 | 122.000 | 70.0 | | | |
| 58 | 17008720000 | FEDLIFE | GREENACRES | NEWTON PARK | 53170.000 | 3758100.000 | 106.000 | 140.0 | 7.4 | 57.45 | 48.55 |
| 59 | 17016790000 | LANDMAN | 12 WEST STREET | NEWTON PARK | 52765.000 | 3758016.000 | 108.000 | 126.0 | 3.0 | 56.48 | 54.7 |

| No. | ERFNO | NAME | STREET ADDRESS | SUBURB | -Y CO-ORD | X CO-ORD | ELEVATION(m) | BH_DEPTH(m) | YIELD(m3/hr) | WLMBGL(m) | WLAMSL(m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 60 | 17017220000 | BRERETON, DN | 20 MANGOLD STREET | NEWTON PARK | 52880.000 | 3757619.000 | 106.000 | 100.0 | 2.4 | | |
| 61 | 17030090000 | METROPOLITAN LIFE LTD | 281 CAPE ROAD | NEWTON PARK | 52965.350 | 3757956.920 | 107.000 | | | | |
| 62 | *17030500000* | *OLD MUTUAL* | *GREENACRES* | *NEWTON PARK* | *53130.000* | *3758030.000* | *106.000* | | 3.0 | | |
| 63 | 21000690000 | SHEPHERD, SB | 108 MARINE DRIVE | SCHOENMAKERSKOP | 59727.000 | 3768115.000 | 19.000 | | | | |
| 64 | 21001090000 | ALGOA REGIONAL SERVICES | "VITAL LINK" FAITH MISSION | SCHOENMAKERSKOP | 54150.000 | 3768830.000 | 11.000 | 30.0 | 1.8 | 4.6 | 6.4 |
| 65 | 22006240000 | BUYS, ISC | 17 VICTORIA PARK DRIVE | SOUTH END | 57326.570 | 3760716.770 | 59.000 | | | 22.07 | 36.93 |
| 66 | 23000250000 | | 8 BRIGHTON DRIVE | SUMMERSTRAND | 61229.000 | 3761888.000 | 9.000 | | | | |
| 67 | 23000160000 | MOOLMAN, CH | 1 3RD AVENUE | SUMMERSTRAND | 61242.000 | 3761731.000 | 6.000 | | | 1.85 | 4.15 |
| 68 | 23000170000 | BLUMBERG, JM | 3 3RD AVENUE | SUMMERSTRAND | 61233.000 | 3761757.000 | 7.000 | | | | |
| 69 | 23000230000 | ZONIA PROPERTY TRUST | 4 3RD AVENUE | SUMMERSTRAND | 61306.000 | 3761763.000 | 6.000 | | | | |
| 70 | 23000250000 | WEPENER, EP | 8 3RD AVENUE | SUMMERSTRAND | 61285.000 | 3761826.000 | 7.000 | 30.0 | 10.0 | | |
| 71 | 23000450000 | HARTZENBERG, FA | 8 2ND AVENUE | SUMMERSTRAND | 61170.000 | 3761857.000 | 10.000 | | | 3.4 | 6.6 |
| 72 | 23000470000 | ALBERTYN, ML | 7 BRIGHTON DRIVE | SUMMERSTRAND | 61229.470 | 3761888.090 | 9.000 | 13.0 | 10.0 | 2.35 | 6.65 |
| 73 | 23001310000 | VAN HEERDEN, PS | 34 BRIGHTON DRIVE | SUMMERSTRAND | 61637.000 | 3762184.000 | 10.000 | 45.0 | 4.0 | | |
| 74 | 23001480000 | ROTHERAY, B | 7 9TH AVENUE | SUMMERSTRAND | 61953.000 | 3762182.000 | 6.000 | | | | |
| 75 | 23001610000 | HUISAMEN, GG | 2 BOGNOR STREET | SUMMERSTRAND | 61767.000 | 3762285.000 | 12.000 | | | | |
| 76 | 23001980000 | KRUGER, M | 17 SCARBOROUGH STREET | SUMMERSTRAND | 62015.000 | 3762370.000 | 6.000 | 40.0 | | | |
| 77 | 23002220000 | SPIES, AJ | 70 BRIGHTON DRIVE | SUMMERSTRAND | 62139.000 | 3762602.000 | 7.000 | | | | |
| 78 | 23002330000 | DEMAY, JRC | 77 BRIGHTON DRIVE | SUMMERSTRAND | 62096.000 | 3762648.000 | 8.000 | | | | |
| 79 | 23002500000 | LONGWORTHY, T | 5 ADMIRALITY WAY | SUMMERSTRAND | 62356.000 | 3762640.000 | 5.300 | 16.0 | 4.0 | 0.66 | 4.64 |
| 80 | 23002530000 | BYRAM, AG | 9 ADMIRALTY ROAD | SUMMERSTRAND | 62314.000 | 3762675.000 | 6.000 | 20.0 | 3.0 | | |
| 81 | 23005060000 | FOURIE, AB | 22 BOGNOR ROAD | SUMMERSTRAND | 61468.000 | 3762614.000 | 20.000 | 40.0 | 3.0 | | |
| 82 | 23005080000 | EDWARDS, JP | 18 BOGNOR STREET | SUMMERSTRAND | 61520.000 | 3762584.000 | 19.000 | | | | |
| 83 | 23005290000 | KOORTS, EM | 19 NOBBS STREET | SUMMERSTRAND | 61328.110 | 3762723.210 | 23.000 | | | | |
| 84 | 23005310000 | READ, M | 28 7TH AVENUE | SUMMERSTRAND | 61326.000 | 3762660.000 | 23.000 | 26.0 | | | |
| 85 | 23005330000 | REEDERS, AJ | 24 7TH AVENUE | SUMMERSTRAND | 61332.000 | 3762602.000 | 22.000 | | | | |
| 86 | 23005400000 | PLACKETT, CK | 15 JENVEY STREET | SUMMERSTRAND | 61964.000 | 3762597.000 | 10.000 | | | | |
| 87 | 23005790000 | CONNACHER, KH | 21 BRADLEY ROAD | SUMMERSTRAND | 61749.000 | 3763009.000 | 21.800 | 32.0 | 4.5 | 2.04 | 19.76 |
| 88 | 23006160000 | GRAHAM, RC | 21 ADMIRALTY WAY | SUMMERSTRAND | 62141.000 | 3762843.000 | 11.000 | | | | |
| 89 | 23006930000 | DITSHOFF, IT | 8 ERASMUS AVENUE | SUMMERSTRAND | 61353.000 | 3763092.000 | 27.000 | | | | |
| 90 | 23006950000 | SCHONEGEVEL,NC | 4 ERASMUS AVENUE | SUMMERSTRAND | 61368.000 | 3763154.000 | 28.000 | | | | |
| 91 | 23007650000 | BEETTIGER, MA | 8 SHERINGHAM STREET | SUMMERSTRAND | 61213.000 | 3762422.000 | 22.000 | 30.0 | 7.0 | | |
| 92 | 23007840000 | LUDERS, FW | 41 ERASMUS AVENUE | SUMMERSTRAND | 61072.000 | 3762723.000 | 26.000 | 43.0 | | | |
| 93 | 23007890000 | TRUSTEES OF MARCLA TRUST | 44 ERASMUS AVENUE | SUMMERSTRAND | 60957.000 | 3762768.000 | 28.000 | | | | |
| 94 | 23008120000 | MICHAEL, H | 33 SOUTH PORT ROAD | SUMMERSTRAND | 61000.000 | 3762555.000 | 27.000 | | | | |
| 95 | 23008620000 | PELLE, PJW | 13 AVONMOUTH CRESCENT | SUMMERSTRAND | 60704.000 | 3762512.000 | 30.000 | | | | |
| 96 | 23008840000 | CHERRY, HT | 30 AVONMOUTH CRESCENT | SUMMERSTRAND | 60555.000 | 3762544.000 | 30.000 | | | | |
| 97 | 23012710000 | GOUDBERG, VE | 11 7TH AVENUE | SUMMERSTRAND | 61575.630 | 3762095.170 | 8.000 | 30.0 | | | |
| 98 | 23014100000 | CHURCH, KA | 5 KOLBE CRESCENT | SUMMERSTRAND | 60364.000 | 3762682.000 | 32.000 | | | 27.5 | 4.5 |
| 99 | 23014160000 | SCHNETLER, ES | 17 KOLBE CRESCENT | SUMMERSTRAND | 60403.000 | 3762815.000 | 34.000 | 50.0 | 16.0 | | |
| 100 | 23014350000 | BRADSHAW, JH | 64 WINCHESTER WAY | SUMMERSTRAND | 60310.000 | 3762684.000 | 38.000 | 32.0 | 8.0 | | |
| 101 | 23014400000 | SCEMMER, F | 31 KOLBE CRESCENT | SUMMERSTRAND | 60474.000 | 3762683.000 | 32.000 | | | | |
| 102 | 23014550000 | GROBLER, LC | 14 LOUIS BOTHA CRESCEN | SUMMERSTRAND | 60817.000 | 3762831.000 | 30.000 | | | | |
| 103 | 23014660000 | DELPORT, HJ | 1 BURGER STREET | SUMMERSTRAND | 61200.000 | 3762861.000 | 26.000 | 40.0 | 3.0 | | |
| 104 | 23014670000 | HOLANI, AP | 3 BURGER STREET | SUMMERSTRAND | 61180.000 | 3762897.000 | 26.500 | 40.0 | 3.0 | | |
| 105 | 23014690000 | HATTINGH, DJH | 34 LOUIS BOTHA CRESCEN | SUMMERSTRAND | 61131.000 | 3762864.000 | 26.500 | | | | |
| 106 | 23014720000 | BLUMBERG, AV | 44 LOUIS BOTHA CRESCEN | SUMMERSTRAND | 61260.000 | 3762983.000 | 28.000 | | | | |
| 107 | 23015000000 | TUTTON, CW | 2 MARITZ STREET | SUMMERSTRAND | 60553.000 | 3763040.000 | 34.000 | | | 5.45 | 28.55 |
| 108 | 23015010000 | ROBEY, BD | 23 BEYERS ROAD | SUMMERSTRAND | 60567.000 | 3763075.000 | 34.000 | 78.0 | 16.0 | | |
| 109 | 23015100000 | DIPPENAAR, MJ | 90 LOUIS BOTHA AVENUE | SUMMERSTRAND | 60735.420 | 3763254.540 | 33.000 | | | | |
| 110 | 23015190000 | MARSHALL, A | 89 ADMIRALTY ROAD | SUMMERSTRAND | 60867.000 | 3763276.000 | 31.500 | 30.0 | 4.8 | | |
| 111 | 23015680000 | SNYDERS, PJ | 10 HATTINGH ROAD | SUMMERSTRAND | 60925.000 | 3762988.000 | 29.800 | | | | |
| 112 | 23016570000 | PETROV, S | 28 VIGNE ROAD | SUMMERSTRAND | 60252.000 | 3762902.000 | 37.000 | | | | |
| 113 | 23016760000 | KRIGE, IA | 11 VIGNE ROAD | SUMMERSTRAND | 59975.000 | 3762815.000 | 40.000 | 50.0 | 10.0 | | |
| 114 | 23016800000 | HENDRIN PROPERTIES CC | 19 VIGNE ROAD | SUMMERSTRAND | 60055.000 | 3762860.000 | 37.000 | | | | |
| 115 | 23016880000 | DORFLING, NJ | 20 BULBRING ROAD | SUMMERSTRAND | 60012.000 | 3762890.000 | 40.000 | | | | |
| 116 | 23016930000 | VAN RENSBERG | 10 BULBRING ROAD | SUMMERSTRAND | 59912.000 | 3762833.000 | 38.500 | 70.0 | | 6.58 | 32.42 |
| 117 | 23016940000 | GREYVENSTEIN, R | 8 BULBRING ROAD | SUMMERSTRAND | 59892.000 | 3762821.000 | 38.500 | 42.0 | | | |
| 118 | 23016950000 | BERNADE, AJ | 6 BULBRING ROAD | SUMMERSTRAND | 59871.000 | 3762810.000 | 38.500 | | | | |

| No. | ERFNO | NAME | STREET ADDRESS | SUBURB | -Y CO-ORD | X CO-ORD | ELEVATION(m) | BH_DEPTH(m) | YIELD(m3/hr) | WLMBGL(m) | WLAMSL(m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 119 | 23016970000 | SCHULTZ, SP | 27 VIGNE AVENUE | SUMMERSTRAND | 60163.510 | 3762922.490 | 40.000 | 60.0 | | | |
| 120 | 23017170000 | TEMPLER, BM | 30 BULBRING ROAD | SUMMERSTRAND | 60140.000 | 3762962.000 | 41.000 | 42.0 | 3.0 | | |
| 121 | 23017360000 | BOSCH, JK | 68 WINCHESTER ROAD | SUMMERSTRAND | 60270.000 | 3762750.000 | 33.000 | 60.0 | 3.0 | 13 | 20 |
| 122 | 23019050000 | WIESE, TG | 9 KOLBE CRESCENT | SUMMERSTRAND | 60329.800 | 3762739.370 | 34.000 | 40.0 | 10.0 | | |
| 123 | 23021100000 | PIENAAR, DR | 24 HARVEY STREET | SUMMERSTRAND | 59832.000 | 3763164.000 | 46.000 | | | 7.1 | 38.9 |
| 124 | 23021610000 | CROSS, MA | 5 SOLOMON CLOSE | SUMMERSTRAND | 60160.380 | 3762072.150 | 30.000 | 96.0 | | | |
| 125 | 23021830000 | HART, EE | 4 MILLER STREET | SUMMERSTRAND | 60095.000 | 3762201.000 | 33.000 | 90.0 | 6.0 | | |
| 126 | 24000960000 | MILLER, IJW | 18 CAMELIA CRESCENT | SUNDRIDGE PARK | 49097.000 | 3757911.000 | 132.000 | 50.0 | 4.0 | | |
| 127 | 24003020000 | BUWALDA, CM | 58 HONEYSUCKLE AVENUE | SUNDRIDGE PARK | 48618.000 | 3758639.000 | 138.000 | 60.0 | 4.5 | | |
| 128 | 24004620000 | CROUSE, E | 7 SUNRIDGEPARK AVENUE | SUNRIDGEPARK | 49448.000 | 3757651.000 | 123.000 | | | | |
| 129 | 27000200000 | WILLIAMS, A | 4 BOSHOFF STREET | WESTERING | 48358.000 | 3757368.000 | 143.000 | | | 0.9 | 142.1 |
| 130 | 27006880000 | PEINKE | 15 COSMOS STREET | WESTERING | 47812.790 | 3756403.070 | 140.000 | 105.0 | 2.0 | 108.28 | 31.72 |
| 131 | 30012220000 | SCHEEPERS, G | 2 FILIPPUS | THEESCOMBE | 45646.970 | 376096.709 | 3.000 | | | | |
| 132 | 32000170000 | HOUZE, AAP | 87/89 9TH AVENUE | WALMER | 53600.000 | 3760460.000 | 60.000 | | | | |
| 133 | 32000300000 | PEARSON, NP | 20 ALCOCK ROAD | WALMER | 54316.000 | 3760188.000 | 64.000 | 100.0 | 1.2 | | |
| 134 | 32000470000 | CLARENDON PARK SCHOOL | 50 SEVENTH AVENUE | WALMER | 54350.000 | 3760570.000 | 70.500 | 100.0 | 7.2 | | |
| 135 | 32000570000 | BENADE, W | 29 SHORT ROAD | WALMER | 53304.000 | 3760872.000 | 81.000 | 100.0 | 1.2 | | |
| 136 | 32000620000 | RUBIN | 197 CHURCH ROAD | WALMER | 52256.000 | 3761129.000 | 90.000 | 100.0 | 3.0 | | |
| 137 | 32001060000 | DAKIN | 132 CHURCH ROAD | WALMER | 53425.000 | 3761147.000 | 68.000 | | | | |
| 138 | 32001090000 | DIX-PEEK, BM | 27 11TH AVENUE | WALMER | 53199.000 | 3761323.000 | 72.000 | | | 11 | 6.4 |
| 139 | 32001790000 | EXLEY, FR | 12 11TH AVENUE | WALMER | 53190.000 | 3761589.000 | 80.000 | 93.0 | 10.0 | 5.73 | 74.27 |
| 140 | 32002890000 | VOSLOO, PW | 56 ALBERT ROAD | WALMER | 56044.000 | 3761235.000 | 59.000 | 45.0 | | | |
| 141 | 32003400000 | MOLYNEAUX, JA | 20 THOMAS ROAD | WALMER | 54220.000 | 3760005.000 | 46.000 | | | | |
| 142 | 32004660000 | SNIJMAN, CJA | 69 9TH AVENUE | WALMER | 53743.050 | 3760706.600 | 70.000 | 90.0 | 6.0 | | |
| 143 | 32004730000 | ROGERS, AC | 9 SHORT ROAD | WALMER | 53565.000 | 3760790.000 | 77.000 | | | | |
| 144 | 32004820000 | RAYNER, HM | 110 RIVER ROAD | WALMER | 53172.000 | 3760888.000 | 81.000 | 110.0 | 1.2 | | |
| 145 | 32004870000 | LANE, BA | 98 SHORT ROAD | WALMER | 52550.000 | 3761098.000 | 86.000 | | | | |
| 146 | 32004960000 | ADLER, AJ | 68 SHORT ROAD | WALMER | 52968.000 | 3761118.000 | 79.000 | 110.0 | 2.0 | | |
| 147 | 32004980000 | CORNISH, C | 64SHORT ROAD | WALMER | 53010.000 | 3761117.000 | 79.000 | 102.0 | 3.0 | 4.3 | 74.4 |
| 148 | 32005700000 | TWL INVESTMENT TRUST | 6 SHORT ROAD | WALMER | 53676.000 | 3760839.000 | 74.000 | | | | |
| 149 | 32006560000 | JUDD, BJ | 104 CHURCH ROAD | WALMER | 53763.000 | 3760991.910 | 66.000 | | | | |
| 150 | 32006640000 | PUTTER, J | 160 CHURCH ROAD | WALMER | 53174.000 | 3761256.000 | 73.000 | 110.0 | 2.5 | | |
| 151 | 32006910000 | LUWMI TRUST | 230 CHURCH ROAD | WALMER | 52325.000 | 3761247.000 | 89.000 | | | | |
| 152 | 32007270000 | SEAMAN, VN | 236 WATER ROAD | WALMER | 52539.000 | 3761410.000 | 85.000 | 100.0 | 3.0 | | |
| 153 | 32007600000 | SCHECKTER, SB | 17 11TH AVENUE | WALMER | 53237.170 | 3761498.260 | 77.000 | 110.0 | 2.5 | | |
| 154 | 32007990000 | DIAS, LC | 112 WATER ROAD | WALMER | 53817.000 | 3761184.000 | 64.000 | | | | |
| 155 | 32008000000 | BOOYSEN FAMILY TRUST | 110 WATER ROAD | WALMER | 53827.740 | 3761129.050 | 62.000 | | | | |
| 156 | 32008670000 | BENNETT, AC | 41 MAIN ROAD | WALMER | 54981.150 | 3760682.440 | 70.000 | | | 35.38 | 34.62 |
| 157 | 32010100000 | MENZIES, P | 192 MAIN ROAD | WALMER | 53312.000 | 3761559.000 | 78.000 | | | | |
| 158 | 32010120000 | MARKRAM, A | 194 MAIN ROAD | WALMER | 53286.000 | 3761568.000 | 79.000 | 100.0 | | 5 | 74 |
| 159 | 32010740000 | WIEGAND, H | 287 VILLIERS ROAD | WALMER | 52336.000 | 3761645.000 | 100.000 | | | | |
| 160 | 32010770000 | PARK, TR | 281 VILLIERS ROAD | WALMER | 52430.000 | 3761654.000 | 100.000 | | | | |
| 161 | 32010820000 | ROBERTSON, HBD | 158 PROSPECT ROAD | WALMER | 53556.730 | 3761637.390 | 79.000 | | | | |
| 162 | 32010840000 | REID, GE | 227 VILLIERS ROAD | WALMER | 53606.000 | 3761654.000 | 79.000 | 70.0 | 2.0 | | |
| 163 | 32011070000 | KNUTH, RB | 185 FORDYCE ROAD | WALMER | 54142.000 | 3761436.000 | 72.000 | 109.0 | | | |
| 164 | 32012980000 | VAN STADEN, PJ | 52 FORDYCE ROAD | WALMER | 55876.000 | 3760762.000 | 66.000 | | | | |
| 165 | 32015600000 | VAN DER MERWE, AG | 95 HEUGH ROAD | WALMER | 55580.370 | 3761152.590 | 65.000 | 103.0 | 8.0 | | |
| 166 | 32015850000 | FERREIRA, SG | 74 VILLIERS ROAD | WALMER | 55850.000 | 3760951.000 | 66.000 | | | | |
| 167 | 32017500000 | CADLE, B | 67 ALBERT ROAD | WALMER | 55931.000 | 3761198.000 | 60.000 | 110.0 | | | |
| 168 | 32017630000 | ELLIS,SS | 94 HEUGH ROAD | WALMER | 55641.000 | 3761234.000 | 62.000 | 75.0 | 8.0 | | |
| 169 | 32018840000 | COLESKE, WJ | 5 3RD AVENUE | WALMER | 56232.000 | 3761201.000 | 59.000 | 86.0 | | | |
| 170 | 32019340000 | PE MUNICIPALITY | EIGHTH AVENUE | WALMER | 54130.640 | 3761045.190 | | | | | |
| 171 | 32019350000 | PE MUNICIPALITY | KING EDWARD PARK | WALMER | 53690.810 | 3762029.400 | 90.000 | 58 | 10 | 11.5 | 82 |
| 172 | 32019350000 | WALMER COUNTRY CLUB NO.1 | BUFFELSFONTEIN ROAD | WALMER | 52495.000 | 3762895.000 | 107.000 | | | 12.5 | 78.5 |
| 173 | 32019350000 | WALMER COUNTRY CLUB NO.2 | BUFFELSFONTEIN ROAD | WALMER | 52925.000 | 3762555.000 | 101.000 | | | | |
| 174 | 32019350000 | WALMER COUNTRY CLUB NO.3 | BUFFELSFONTEIN ROAD | WALMER | 53460.000 | 3762645.000 | 96.000 | | | | |
| 175 | 32019350000 | WALMER COUNTRY CLUB NO.4 | BUFFELSFONTEIN ROAD | WALMER | 52932.000 | 3762216.000 | 103.000 | | | | |
| 176 | 32019480000 | PE KENNEL CLUB | VICTORIA DRIVE | WALMER | 55654.200 | 3763403.950 | 103.000 | 50.0 | 3.0 | | |

| No. | ERFNO | NAME | STREET ADDRESS | SUBURB | -Y CO-ORD | X CO-ORD | ELEVATION(m) | BH_DEPTH(m) | YIELD(m3/hr) | WLMBGL(m) | WLAMSL(m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 177 | 32019480000 | TELKOM CLUB | VICTORIA DRIVE | WALMER | 52540.000 | 3764120.000 | 110.000 | | | | |
| 178 | 32019810000 | HARTY, JP | 12 NEWCOMBE AVENUE | WALMER | 50109.560 | 3763293.540 | 144.000 | | | 31.5 | 112.5 |
| 179 | 32019820000 | HOGG, BK | 10 IDYLWYDE CRESCENT | WALMER | 51139.000 | 3763234.000 | 140.000 | | | | |
| 180 | 32020080000 | SOFOKLEOUS, V | 187 HEUGH ROAD | WALMER | 54548.000 | 3761598.000 | 62.200 | | | | |
| 181 | 32020350000 | REPTON, PJ | 132 PROSPECT ROAD | WALMER | 53644.000 | 3761632.000 | 78.000 | | | | |
| 182 | 32020440000 | GRAHAM, SJ | 15 ST JOHNS AVENUE | WALMER | 53841.000 | 3760607.000 | 54.000 | | | | |
| 183 | 32025500000 | VAN DER WALT, A | 74 RIVER ROAD | WALMER | 53623.000 | 3760684.000 | 70.000 | | | 19.53 | 50.47 |
| 184 | 32025850000 | MALHERBE, AL | 231 WATER ROAD | WALMER | 53202.000 | 3761314.000 | 89.000 | 72.0 | 3.0 | | |
| 185 | 32025980000 | MATTHEWS, PD | 113 WATER ROAD | WALMER | 53600.450 | 3761161.060 | 64.000 | | | | |
| 186 | 32026390000 | KEMP, ES | 10 4TH AVENUE | WALMER | 55800.000 | 3761360.000 | 59.000 | 60.0 | | | |
| 187 | 32026450000 | TAVERNER, SM | 125 CHURCH ROAD | WALMER | 53197.000 | 3761143.000 | 74.000 | 100.0 | 3.0 | | |
| 188 | 32026570000 | CHURCH, SM | 186 CHURCH ROAD | WALMER | 52871.000 | 3761272.000 | 80.000 | 90.0 | 3.0 | | |
| 189 | 32026890000 | BEYLEVELD, HJJ | 34 SHORT ROAD | WALMER | 53301.000 | 3761021.400 | 76.000 | 100.0 | 2.0 | | |
| 190 | 32026920000 | HOFMEYER, ALC | 99 CHURCH ROAD | WALMER | 53470.000 | 3761035.000 | 76.000 | 140.0 | 1.2 | | |
| 191 | 32027230000 | CONNELLAN, PM | 54 THOMAS ROAD | WALMER | 53908.000 | 3760186.000 | 75.000 | 100.0 | 1.8 | | |
| 192 | 32027530000 | EASTWOOD, JC | 159 PROSPECT ROAD | WALMER | 53730.000 | 3761460.000 | 72.000 | | | 5.75 | 72.25 |
| 193 | 32028030000 | COOK, RP | 30 12TH AVENUE | WALMER | 53752.000 | 3760600.000 | 81.000 | 18.0 | 12.0 | | |
| 194 | 32028050000 | KOHLER, LE | 70 RIVER ROAD | WALMER | 53752.000 | 3760600.000 | 64.000 | 108.0 | 7.0 | | |
| 195 | 32028230000 | MC WILLIAMS, PJ | 41 10TH AVENUE | WALMER | 53510.000 | 3761020.000 | 74.000 | 112.0 | 9.0 | | |
| 196 | 32028350000 | PERROTT, JR | 49 SHORT ROAD | WALMER | 53130.000 | 3761000.000 | 79.000 | 38.0 | | | |
| 197 | 32028600000 | BLUMBERG, SA | 12 DORMY PLACE | WALMER | 51982.000 | 3760923.000 | 90.000 | | | 1 | 89 |
| 198 | 32028810000 | MILLER, P | 6 CLUB ROAD | WALMER | 52288.000 | 3760925.000 | 88.000 | | | 2.73 | 77.27 |
| 199 | 32028890000 | RUDMAN, LV | 32 GOLF ROAD | WALMER | 52508.000 | 3760794.000 | 84.000 | 80.0 | 1.2 | | |
| 200 | 32028970000 | STRYDOM, CJ | 10 CLUB ROAD | WALMER | 52470.000 | 3760849.000 | 85.000 | | | | |
| 201 | 32029000000 | VISSER, FC | 1 CLUB ROAD | WALMER | 52359.000 | 3760974.000 | 87.000 | 110.0 | | | |
| 202 | 32029010000 | HILL, ER | 3 CLUB ROAD | WALMER | 52363.000 | 3760931.000 | 87.000 | 72.0 | 2.5 | 1.5 | 86.5 |
| 203 | 32029050000 | KEHL, HJ | 140 RIVER ROAD | WALMER | 52491.000 | 3760932.000 | 86.000 | 30.0 | | | |
| 204 | 32029070000 | LEVIN, R | 77 SHORT ROAD | WALMER | 52515.000 | 3760998.000 | 86.000 | 85.0 | 2.5 | | |
| 205 | 32030330000 | VAN AARDE, FJ | 10 ALCOCK ROAD | WALMER | 54439.000 | 3760128.000 | 36.000 | | | | |
| 206 | 32030480000 | BALL, BS | 15 WATER ROAD | WALMER | 54896.000 | 3760549.000 | 70.000 | | | | |
| 207 | 32030630000 | SCOTT, PA | 5 HILLBROW PLACE | WALMER | 54900.000 | 3760471.000 | 69.000 | | | | |
| 208 | 32033330000 | DU PLESSIS, YS | 16 11TH AVENUE | WALMER | 53158.000 | 3761483.000 | 77.000 | 114.0 | 3.6 | 3 | 74 |
| 209 | 32036260000 | SKINNER, DHG | 166 WATER ROAD | WALMER | 53243.000 | 3761410.000 | 73.000 | | | | |
| 210 | 32036490000 | BRETT, ES | 146 CHURCH ROAD | WALMER | 53327.000 | 3761195.000 | 70.000 | | | | |
| 211 | 32038800000 | HERMAN,GS | 17 13TH AVENUE | WALMER | 52535.000 | 3761281.000 | 85.000 | 100.0 | 4.5 | | |
| 212 | 32038810000 | WILLIAMS, MA | 214 CHURCH ROAD | WALMER | 52537.000 | 3761248.000 | 85.000 | | | | |
| 213 | 32038820000 | BOOYSEN, L | 38 CHURCH ROAD | WALMER | 54540.000 | 3760606.950 | 72.000 | 110.0 | 3.0 | | |
| 214 | 32039640000 | PLEKKER | 152 PROSPECT ROAD | WALMER | 53620.000 | 3761610.000 | 78.000 | | | | |
| 215 | 32039860000 | MILLWOOD CORNER BODY | 162 MAIN ROAD | WALMER | 53703.000 | 3761398.000 | 71.000 | | | | |
| 216 | 32040170000 | PEDERSEN, C | 10 IDYLWYLDE CRESCENT | WALMER HEIGHTS | 51150.000 | 3763310.000 | 143.000 | 69.0 | 2.0 | 29.7 | 110.3 |
| 217 | 32040180000 | GAIL TAVERNER TRUST | 86 SHORT ROAD | WALMER | 52699.000 | 3761111.000 | 83.000 | | | | |
| 218 | 32040370000 | SPEYERS, SA | 135 CHURCH ROAD | WALMER | 53042.240 | 3761146.060 | 78.000 | | | | |
| 219 | 32040730000 | ROBERTSON, B | 6 LIONEL ROAD | WALMER | 51737.000 | 3759846.000 | 105.000 | | | 1.2 | 103.8 |
| 220 | 32041360000 | EHINGER, L | 75 SHORT ROAD | WALMER | 52591.000 | 3761012.000 | 85.000 | | | | |
| 221 | 32041370000 | MOLLER, JJ | 75 SHORT ROAD | WALMER | 52571.370 | 3760967.330 | 85.000 | 100.0 | 3.0 | | |
| 222 | 32041510000 | VERNON GRAMANDA SCHOOL | HEUGH ROAD | WALMER | 54430.000 | 3761940.000 | 70.000 | | | | |
| 223 | 32041520000 | BRICKNELL, NW | 141 PROSPECT ROAD | WALMER | 53892.870 | 3761400.880 | 70.000 | | | | |
| 224 | 32041730000 | SUNDE, HP | 53 SHORT ROAD | WALMER | 53033.060 | 3761030.000 | 79.000 | 30.0 | 0.9 | | |
| 225 | 32041990000 | ADLER, VJ | 49 10TH AVENUE | WALMER | 53427.000 | 3760801.000 | 80.000 | | | | |
| 226 | 32048010000 | LLOYD, CPA | 52 SHORT ROAD | WALMER | 53101.860 | 3761069.680 | 75.000 | | | | |
| 227 | 32050150000 | FOGARTY, TG | 43 CHURCH ROAD | WALMER | 54500.440 | 3760530.980 | 71.000 | | | | |
| 228 | 32050160000 | DATMAN | 39 CHURCH ROAD | WALMER | 54790.281 | 3761103.062 | 72.000 | | | 33.2 | 38.8 |
| 229 | 33000760000 | COOK, RA | 19 KITCHING ROAD | CHARLO | 50752.000 | 3762275.000 | 125.000 | | | | |
| 230 | 33014730000 | KUSTERER, WE | 14 MARTIN ROAD | CHARLO | 50869.250 | 3761780.502 | 118.000 | 85.0 | 7.0 | | |
| 231 | 360 0000 | DOUGLAS-JONES, AJ | 12 WOODLANDS AVE | LORRAINE | | | | 80 | 2.5 | 12 | 116 |
| 232 | 36000850000 | VAN DER MERWE, SD | 66 VERDUN ROAD | LORRAINE | 46612.000 | 3760608.000 | 156.000 | | | | |
| 233 | 36000930000 | DU TOIT, LM | 98 VERDUN ROAD | LORRAINE | 46923.000 | 3760663.000 | 156.000 | 70.0 | | 5.7 | 150.3 |
| 234 | 36017550000 | SEAMAN, D | 262 KRAGGA KAMMA ROAD | LORRAINE | 46615.760 | 3759561.900 | | 100.0 | | 1.5 | |
| 235 | 36019180000 | SAMUELS, DA | 29 LOURDES AVE | LORRAINE | 47265.000 | 3759864.000 | 137.000 | | | 0.67 | 136.33 |

| No. | ERFNO | NAME | STREET ADDRESS | SUBURB | -Y CO-ORD | X CO-ORD | ELEVATION(m) | BH_DEPTH(m) | YIELD(m3/hr) | WLMBGL(m) | WLAMSL(m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 236 | 36054090000 | PARKER, AH | ASCOT STUD | THEESCOMBE | 47611.956 | 3761750.750 | 94.500 | 68 | | 58 | 36.5 |
| 237 | 99002980000 | MACKAY | MELLOWMEAD | LOVEMORE PARK | 46745.593 | 3765654.594 | 53.000 | | | 7 | 46 |
| 238 | 99002860000 | MAHLERT | ALTMARK | LOVEMORE PARK | 46724.533 | 3765554.660 | 58.200 | | | 33.6 | 24.6 |

**Boreholes outside of the PE municipal area**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 239 | 990 0000 | GREEF W. | GLENDORE ROAD | THEESCOMBE | 51423.971 | 3746261.871 | 114.000 | | | 10 | 104 |
| 240 | 990 0000 | WADE T. | GLENDORE ROAD | THEESCOMBE | 51424.922 | 3746443.627 | 125.000 | | | 11 | 114 |
| 241 | 99000180000 | CILLIE, H | KRAGGA KAMMA ROAD | THEESCOMBE | 42312.792 | 3760845.005 | 195.000 | | | 1.7 | 178.3 |
| 242 | 99000460000 | THEOPHILUS, AJ | GREENBUSHES | THEESCOMBE | 39775.920 | 3761278.550 | 180.000 | 186.0 | 4.0 | 29.7 | 113.3 |
| 243 | 99002850000 | ELIOT | CROSSWINDS | LOVEMORE PARK | 46382.658 | 3765575.162 | 50.500 | | | 23.7 | 26.6 |
| 244 | 99002860000 | FUGARD | ASHRAM | LOVEMORE PARK | 46582.937 | 3765546.567 | 56.100 | | | 5.65 | 50.45 |
| 245 | 99003050000 | PUFFETT, R | 843 SARDINIA BAY ROAD | LOVEMORE PARK | 48491.871 | 3765262.214 | 91.000 | 94 | | 10.45 | 80.55 |
| 246 | 99003410000 | NICKELSON | OVER-THE-MOON | LOVEMORE PARK | 47674.276 | 3765583.432 | 76.100 | | | 7.6 | 68.5 |
| 247 | 99003450000 | BARTLETT | | LOVEMORE PARK | 47354.776 | 3765439.476 | 72.900 | | | 43 | 29.9 |
| 248 | 99003510000 | DANHOER | SCOTSAM | LOVEMORE PARK | 47018.087 | 3765034.779 | 81.900 | 220 | | 9.17 | 72.73 |
| 249 | 99003510000 | LONG, S | SCOTSAM | LOVEMORE PARK | | | | 220 | | 9.2 | 70.8 |
| 250 | 99004090000 | PUFFETT, R | 843 SARDINIA BAY ROAD | LOVEMORE PARK | | | | | | | |
| 251 | 99007400000 | STONE, TC | STONE'S THROW | LOVEMORE PARK | 48140.731 | 3764679.926 | 103.800 | | | 10.7 | 84.3 |
| 252 | 99007780000 | ONVLEE, C | 250 KRAGGA KAMMA ROAD | KRAGGA KAMMA | 46815.000 | 3759360.000 | 127.000 | | | | |
| 253 | 99019350000 | PE TURF CLUB | ARLINGTON R. COURSE NO. | ARLINGTON | 51535.000 | 3763685.000 | 113.000 | 18 | 7 | 20 | 94 |
| 254 | 99019480000 | ROVER MOTORCROSS | VICTORIA DRIVE | THEESCOMBE | 51375.000 | 3765620.000 | 97.000 | | | | |
| 255 | 99019520000 | WELLS J. | GLENDORE ROAD NO2 | THEESCOMBE | 51330.000 | 3764420.000 | 112.000 | | | | |
| 256 | 99019520000 | WELLS J. | GLENDORE ROAD NO3 | THEESCOMBE | 51500.000 | 3764436.000 | 115.000 | | | | |
| 257 | 99019520000 | WELLS J. | GLENDORE ROAD NO4 | THEESCOMBE | 51480.000 | 3764410.000 | 115.000 | | | | |
| 258 | 99019520000 | WELLS J. | GLENDORE ROAD NO1 | THEESCOMBE | 51290.000 | 3764440.000 | 112.000 | | | | |
| 259 | 99040340000 | PE TURF CLUB | ARLINGTON R. COURSE NO. | ARLINGTON | 51915.000 | 3763632.000 | 110.000 | | 7 | 4 | 106 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 04019000000 | 37 | 21-Jul-93 | Donkin Reserve | 57290.000 | 3759405.000 | 91 | | | | | | | | | | 112 | | | | | | | |
| 04019000000 | 37 | 10-Aug-93 | Donkin Reserve | 57290.000 | 3759405.000 | 91 | | | | | | | | | | 132 | | | | 73 | 26.0 | | 115.092 |
| 04019000000 | 37 | 12-Jun-95 | Donkin Reserve | 57290.000 | 3759405.000 | 104 | | 694 | | | | | | | | 153 | | | | 75 | 31.0 | | 137.225 |
| 04031820000 | 24 | 18-Jun-93 | Crusaders Club | 56380.000 | 3759900.000 | 301 | 4.9 | 2210 | 379 | 379 | 379 | 210 | 589 | 356 | 233 | 277 | 0.15 | 186 | 345.0 | 263 | 152.0 | 0.19 | 672.843 |
| 04031820000 | 24 | 17-Jul-93 | Crusaders Club | 56380.000 | 3759900.000 | 135 | | | | | | | | | | 266 | | | | | | | |
| 04031820000 | 24 | 10-Aug-93 | Crusaders Club | 56380.000 | 3759900.000 | 118 | 2.1 | 666 | 85 | 85 | 85 | 48 | 133 | 39 | 94 | 216 | 0.06 | 176 | 7.0 | 102 | 7.4 | 0.17 | 32.7568 |
| 04031820000 | 24 | 25-Oct-93 | Crusaders Club | 56380.000 | 3759900.000 | 102 | | | | | | | | | | 203 | | | | 78 | 8.5 | | 37.6261 |
| 04031820000 | 24 | 20-Nov-93 | Crusaders Club | 56380.000 | 3759900.000 | 104 | | | | | | | | | | 193 | | | | 74 | 0.4 | | 1.77064 |
| 04031820000 | 24 | 14-Dec-93 | Crusaders Club | 56380.000 | 3759900.000 | 103 | | | | | | | | | | 178 | | | | 64 | 0.3 | | 1.28371 |
| 04031820000 | 24 | 24-Feb-94 | Crusaders Club | 56380.000 | 3759900.000 | 92 | 0.7 | | 44 | 44 | 44 | 69 | 113 | 37 | 76 | 242 | | 162 | 11.0 | | 9.3 | | 41.1674 |
| 04031820000 | 24 | 17-Mar-94 | Crusaders Club | 56380.000 | 3759900.000 | 93 | 0.6 | | 53 | 53 | | | | | | 181 | | | | 65 | 8.9 | | 39.3967 |
| 04031820000 | 24 | 21-Apr-94 | Crusaders Club | 56380.000 | 3759900.000 | 94 | 0.2 | 544 | 47 | 47 | 47 | 70 | 117 | 42 | 75 | 186 | 0.05 | 167 | 6.0 | 84 | 3.5 | 0.10 | 15.4931 |
| 04031820000 | 24 | 20-May-94 | Crusaders Club | 56380.000 | 3759900.000 | 112 | 0.4 | 654 | | | | | | | | 221 | | | | 81 | 6.5 | | 28.7729 |
| 04031820000 | 24 | 21-Jun-94 | Crusaders Club | 56380.000 | 3759900.000 | 95 | 0.2 | 562 | 54 | 54 | 54 | 45 | 99 | 30 | 69 | 181 | 0.04 | 151 | 5.0 | 68 | 7.1 | 0.12 | 31.4289 |
| 04031820000 | 24 | 07-Jul-94 | Crusaders Club | 56380.000 | 3759900.000 | 94 | 0.4 | 546 | 52 | 52 | 52 | 29 | 81 | 22 | 59 | 197 | 0.11 | 142 | 3.0 | 69 | 8.4 | 0.11 | 37.1834 |
| 04031820000 | 24 | 31-Aug-94 | Crusaders Club | 56380.000 | 3759900.000 | 102 | | 644 | | | | | | | | 180 | | | | 73 | 0.1 | | 0.61972 |
| 04031820000 | 24 | 21-Sep-94 | Crusaders Club | 56380.000 | 3759900.000 | 111 | | 710 | | | | | | | | 219 | | | | 86 | 7.6 | | 33.6422 |
| 04031820000 | 24 | 26-Sep-94 | Crusaders Club | 56380.000 | 3759900.000 | 97 | | 572 | | | | | | | | 188 | | | | 73 | 8.7 | | 38.5114 |
| 04031820000 | 24 | 12-Oct-94 | Crusaders Club | 56380.000 | 3759900.000 | 123 | 0.7 | 698 | 102 | 102 | 102 | 61 | 163 | 62 | 101 | 239 | 0.01 | 177 | 12.0 | 95 | 7.7 | 0.21 | 34.0848 |
| 04031820000 | 24 | 10-Nov-94 | Crusaders Club | 56380.000 | 3759900.000 | 127 | | 812 | | | | | | | | 269 | | | | 107 | 6.8 | | 30.1009 |
| 04031820000 | 24 | 08-Dec-94 | Crusaders Club | 56380.000 | 3759900.000 | 94 | | 600 | | | | | | | | 212 | | | | 81 | 8.7 | | 38.5114 |
| 04031820000 | 24 | 05-Jan-95 | Crusaders Club | 56380.000 | 3759900.000 | 149 | 0.9 | 1076 | 83 | 83 | 83 | 148 | 231 | 125 | 106 | 216 | 0.04 | 167 | 45.0 | 136 | 31.0 | 0.11 | 137.225 |
| 04031820000 | 24 | 15-Mar-95 | Crusaders Club | 56380.000 | 3759900.000 | 126 | | 748 | | | | | | | | 244 | | | | 101 | 6.9 | | 30.5435 |
| 04031820000 | 24 | 16-Mar-95 | Crusaders Club | 56380.000 | 3759900.000 | 123 | | 804 | | | | | | | | 238 | | | | 101 | 7.0 | | 30.9862 |
| 04031820000 | 24 | 05-May-95 | Crusaders Club | 56380.000 | 3759900.000 | 97 | 0.7 | 646 | 62 | 62 | 62 | 46 | 108 | 33 | 75 | 181 | 0.05 | 153 | 6.0 | 77 | 1.8 | 0.09 | 7.96788 |
| 04031820000 | 24 | 09-May-95 | Crusaders Club | 56380.000 | 3759900.000 | 109 | | 696 | | | | | | | | 201 | | | | 78 | 6.6 | | 29.2156 |
| 04031820000 | 24 | 01-Jun-95 | Crusaders Club | 56380.000 | 3759900.000 | 110 | | 778 | | | | | | | | 215 | | | | 88 | 5.3 | | 23.461 |
| 04031820000 | 24 | 12-Jun-95 | Crusaders Club | 56380.000 | 3759900.000 | 116 | | 746 | | | | | | | | 242 | | | | 102 | 5.7 | | 25.2316 |
| 04031820000 | 43 | 17-Nov-93 | PEM St.Georges Park | 56240.000 | 3759375.000 | 180 | | | | | | | | | | 437 | | | | 85 | 0.1 | | 0.22133 |
| 04034050000 | 16 | 07-Jun-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 183 | 0.3 | 1056 | 48 | 48 | 48 | 147 | 195 | 75 | 120 | 511 | 0.02 | 286 | 5.0 | 135 | 4.4 | 0.12 | 19.477 |
| 04034050000 | 16 | 17-Jul-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 180 | | | | | | | | | | 490 | | | | | | | |
| 04034050000 | 16 | 10-Aug-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 174 | | | | | | | | | | 483 | | | | 97 | 3.6 | | 15.9358 |
| 04034050000 | 16 | 14-Sep-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 177 | 2.5 | 1012 | 41 | 41 | 41 | 185 | 226 | 85 | 141 | 462 | 0.44 | 291 | 5.0 | 73 | 3.6 | 0.12 | 15.9358 |
| 04034050000 | 16 | 16-Nov-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 177 | | | | | | | | | | 356 | | | | 140 | 3.5 | | 15.4931 |
| 04034050000 | 16 | 12-Jan-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 164 | 0.2 | 982 | 42 | 42 | 42 | 148 | 190 | 69 | 121 | 490 | 0.01 | 254 | 4.5 | 86 | 2.8 | 0.12 | 12.3945 |
| 04034050000 | 16 | 08-Feb-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 174 | 2.5 | | 41 | 41 | 41 | 195 | 236 | 88 | 148 | 437 | | 284 | 10.0 | 86 | 3.6 | | 15.9358 |
| 04034050000 | 16 | 10-Feb-94 | 8 Hallack Road | 55569.000 | 3760077.000 | | | | | | | | | | | | | | | | | | |
| 04034050000 | 16 | 09-Mar-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 181 | 0.8 | | 43 | 43 | | | | | | 462 | | | | 80 | 4.4 | | 19.477 |
| 04034050000 | 16 | 14-Apr-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 183 | 0.6 | 976 | 41 | 41 | 41 | 224 | 265 | 104 | 161 | 460 | 0.01 | 316 | 8.0 | 85 | 4.9 | 0.35 | 21.6903 |
| 04034050000 | 16 | 09-May-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 173 | 0.3 | 966 | 41 | 41 | | | | | | 490 | | | | 93 | 4.1 | | 18.1491 |
| 04034050000 | 16 | 09-Jun-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 182 | | 1014 | | | | | | | | 460 | | | | 103 | 4.3 | | 19.0344 |
| 04034050000 | 16 | 13-Jul-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 185 | 0.3 | 1006 | 49 | 49 | 49 | 153 | 202 | 78 | 124 | 501 | 0.36 | 318 | 4.0 | 83 | 4.8 | 0.05 | 21.2477 |
| 04034050000 | 16 | 10-Aug-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 182 | | 1010 | | | | | | | | 422 | | | | 83 | 5.1 | | 22.5757 |
| 04034050000 | 16 | 14-Sep-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 181 | | 1044 | | | | | | | | 465 | | | | 86 | 4.9 | | 21.6903 |
| 04034050000 | 16 | 12-Oct-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 183 | 2.5 | 1150 | 57 | 57 | 57 | 156 | 213 | 82 | 131 | 472 | 0.26 | 270 | 9.0 | 92 | 4.3 | 0.21 | 19.0344 |
| 04034050000 | 16 | 12-Dec-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 177 | | 1012 | | | | | | | | 316 | | | | 93 | 5.0 | | 22.133 |
| 04034050000 | 16 | 10-Jan-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 184 | 0.4 | 1110 | 45 | 45 | 45 | 168 | 213 | 82 | 131 | 419 | 0.01 | 273 | 8.0 | 91 | 4.7 | 0.05 | 20.805 |
| 04034050000 | 16 | 09-Feb-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 183 | | 986 | | | | | | | | 446 | | | | 97 | 5.0 | | 22.133 |
| 04034050000 | 16 | 10-Mar-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 182 | | 1156 | | | | | | | | 371 | | | | 94 | 4.6 | | 20.3624 |
| 04034050000 | 16 | 11-Apr-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 181 | 1.7 | 1028 | 46 | 46 | 46 | 152 | 198 | 75 | 123 | 432 | 0.02 | 278 | 8.0 | 94 | 4.0 | 0.05 | 17.7064 |
| 04034050000 | 16 | 09-May-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 182 | | 1012 | | | | | | | | 428 | | | | 80 | 4.5 | | 19.9197 |
| 04034050000 | 16 | 12-Jun-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 181.9 | | 972 | | | | | | | | 389 | | | | 100 | 4.3 | | 19.0344 |
| 04035960000 | 38 | 21-Jul-93 | Fort Frederick | 57435.000 | 3759820.000 | 77 | | | | | | | | | | 92 | | | | | | | |
| 04035960000 | 38 | 10-Aug-93 | Fort Frederick | 57435.000 | 3759820.000 | 74 | | | | | | | | | | 94 | | | | 70 | 9.7 | | 42.938 |
| 04035960000 | 38 | 09-May-94 | Fort Frederick | 57435.000 | 3759820.000 | 77 | 45.0 | 508 | 99 | 99 | | | | | | 101 | | | | 85 | 10.3 | | 45.594 |
| 04035960000 | 38 | 14-Jul-94 | Fort Frederick | 57435.000 | 3759820.000 | 85 | 19.0 | 620 | 116 | 116 | 116 | 22 | 138 | 62 | 76 | 114 | 0.25 | 104 | 5.0 | 83 | 13.1 | 0.23 | 57.9885 |
| 06000560000 | 2 | 03-Jun-93 | 3 Whitney Street | 50952.464 | 3757754.59 | 75 | 1.5 | 422 | 26 | 26 | 26 | 45 | 71 | 23 | 48 | 152 | 0.08 | 105 | 3.0 | 60 | 3.9 | 0.10 | 17.2637 |
| 06000560000 | 2 | 10-Aug-93 | 3 Whitney Street | 50952.464 | 3757754.59 | 87 | | | | | | | | | | 199 | | | | 63 | 3.0 | | 13.2798 |
| 06000560000 | 2 | 14-Sep-93 | 3 Whitney Street | 50952.464 | 3757754.59 | 98 | 1.1 | 520 | 17 | 17 | 17 | 103 | 120 | 43 | 77 | 239 | 0.03 | 160 | 4.0 | 46 | 1.5 | 0.11 | 6.6399 |
| 06000560000 | 2 | 16-Nov-93 | 3 Whitney Street | 50952.464 | 3757754.59 | 90 | | | | | | | | | | 241 | | | | 44 | 1.8 | | 7.96788 |
| 06000560000 | 2 | 12-Jan-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 93 | 0.5 | 488 | 16 | 16 | 16 | 71 | 87 | 29 | 58 | 230 | 0.02 | 134 | 1.6 | 38 | 1.7 | 0.05 | 7.52522 |
| 06000560000 | 2 | 08-Feb-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 100 | 0.9 | | 24 | 24 | 24 | 85 | 109 | 36 | 73 | 256 | | 156 | 6.0 | 40 | 1.4 | | 6.19724 |
| 06000560000 | 2 | 10-Feb-94 | 3 Whitney Street | 50952.464 | 3757754.59 | | | | | | | | | | | | | | | | | | |
| 06000560000 | 2 | 09-Mar-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 80 | 4.6 | | 69 | 69 | | | | | | 151 | | | | 53 | 1.9 | | 8.41054 |
| 06000560000 | 2 | 14-Apr-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 93 | 0.6 | 488 | 17 | 17 | 17 | 97 | 114 | 46 | 68 | 245 | 0.03 | 158 | 4.0 | 45 | 1.9 | 0.05 | 8.27774 |
| 06000560000 | 2 | 09-May-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 90 | 0.4 | 490 | 15 | 15 | | | | | | 226 | | | | 47 | 2.3 | | 10.1812 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 04019000000 | 37 | 21-Jul-93 | Donkin Reserve | 57290.000 | 3759405.000 | 91 | | | | | | | | | | 112 | | | | | | | |
| 04019000000 | 37 | 10-Aug-93 | Donkin Reserve | 57290.000 | 3759405.000 | 91 | | | | | | | | | | 132 | | | | 73 | 26.0 | | 115.092 |
| 04019000000 | 37 | 12-Jun-95 | Donkin Reserve | 57290.000 | 3759405.000 | 104 | | 694 | | | | | | | | 153 | | | | 75 | 31.0 | | 137.225 |
| 04031820000 | 24 | 18-Jun-93 | Crusaders Club | 56380.000 | 3759900.000 | 301 | 4.9 | 2210 | 379 | 379 | 379 | 210 | 589 | 356 | 233 | 277 | 0.15 | 186 | 345.0 | 263 | 152.0 | 0.19 | 672.843 |
| 04031820000 | 24 | 17-Jul-93 | Crusaders Club | 56380.000 | 3759900.000 | 135 | | | | | | | | | | 266 | | | | | | | |
| 04031820000 | 24 | 10-Aug-93 | Crusaders Club | 56380.000 | 3759900.000 | 118 | 2.1 | 666 | 85 | 85 | 85 | 48 | 133 | 39 | 94 | 216 | 0.06 | 176 | 7.0 | 102 | 7.4 | 0.17 | 32.7568 |
| 04031820000 | 24 | 25-Oct-93 | Crusaders Club | 56380.000 | 3759900.000 | 102 | | | | | | | | | | 203 | | | | 78 | 8.5 | | 37.6261 |
| 04031820000 | 24 | 20-Nov-93 | Crusaders Club | 56380.000 | 3759900.000 | 104 | | | | | | | | | | 193 | | | | 74 | 0.4 | | 1.77064 |
| 04031820000 | 24 | 14-Dec-93 | Crusaders Club | 56380.000 | 3759900.000 | 103 | | | | | | | | | | 178 | | | | 64 | 0.3 | | 1.28371 |
| 04031820000 | 24 | 24-Feb-94 | Crusaders Club | 56380.000 | 3759900.000 | 92 | 0.7 | | 44 | 44 | 44 | 69 | 113 | 37 | 76 | 242 | | 162 | 11.0 | | 9.3 | | 41.1674 |
| 04031820000 | 24 | 17-Mar-94 | Crusaders Club | 56380.000 | 3759900.000 | 93 | 0.6 | | 53 | 53 | | | | | | 181 | | | | 65 | 8.9 | | 39.3967 |
| 04031820000 | 24 | 21-Apr-94 | Crusaders Club | 56380.000 | 3759900.000 | 94 | 0.2 | 544 | 47 | 47 | 47 | 70 | 117 | 42 | 75 | 186 | 0.05 | 167 | 6.0 | 84 | 3.5 | 0.10 | 15.4931 |
| 04031820000 | 24 | 20-May-94 | Crusaders Club | 56380.000 | 3759900.000 | 112 | 0.4 | 654 | | | | | | | | 221 | | | | 81 | 6.5 | | 28.7729 |
| 04031820000 | 24 | 21-Jun-94 | Crusaders Club | 56380.000 | 3759900.000 | 95 | 0.2 | 562 | 54 | 54 | 54 | 45 | 99 | 30 | 69 | 181 | 0.04 | 151 | 5.0 | 68 | 7.1 | 0.12 | 31.4289 |
| 04031820000 | 24 | 07-Jul-94 | Crusaders Club | 56380.000 | 3759900.000 | 94 | 0.4 | 546 | 52 | 52 | 52 | 29 | 81 | 22 | 59 | 197 | 0.11 | 142 | 3.0 | 69 | 8.4 | 0.11 | 37.1834 |
| 04031820000 | 24 | 31-Aug-94 | Crusaders Club | 56380.000 | 3759900.000 | 102 | | 644 | | | | | | | | 180 | | | | 73 | 0.1 | | 0.61972 |
| 04031820000 | 24 | 21-Sep-94 | Crusaders Club | 56380.000 | 3759900.000 | 111 | | 710 | | | | | | | | 219 | | | | 86 | 7.6 | | 33.6422 |
| 04031820000 | 24 | 26-Sep-94 | Crusaders Club | 56380.000 | 3759900.000 | 97 | | 572 | | | | | | | | 188 | | | | 73 | 8.7 | | 38.5114 |
| 04031820000 | 24 | 12-Oct-94 | Crusaders Club | 56380.000 | 3759900.000 | 123 | 0.7 | 698 | 102 | 102 | 102 | 61 | 163 | 62 | 101 | 239 | 0.01 | 177 | 12.0 | 95 | 7.7 | 0.21 | 34.0848 |
| 04031820000 | 24 | 10-Nov-94 | Crusaders Club | 56380.000 | 3759900.000 | 127 | | 812 | | | | | | | | 269 | | | | 107 | 6.8 | | 30.1009 |
| 04031820000 | 24 | 08-Dec-94 | Crusaders Club | 56380.000 | 3759900.000 | 94 | | 600 | | | | | | | | 212 | | | | 81 | 8.7 | | 38.5114 |
| 04031820000 | 24 | 05-Jan-95 | Crusaders Club | 56380.000 | 3759900.000 | 149 | 0.9 | 1076 | 83 | 83 | 83 | 148 | 231 | 125 | 106 | 216 | 0.04 | 167 | 45.0 | 136 | 31.0 | 0.11 | 137.225 |
| 04031820000 | 24 | 15-Mar-95 | Crusaders Club | 56380.000 | 3759900.000 | 126 | | 748 | | | | | | | | 244 | | | | 101 | 6.9 | | 30.5435 |
| 04031820000 | 24 | 16-Mar-95 | Crusaders Club | 56380.000 | 3759900.000 | 123 | | 804 | | | | | | | | 238 | | | | 101 | 7.0 | | 30.9862 |
| 04031820000 | 24 | 05-May-95 | Crusaders Club | 56380.000 | 3759900.000 | 97 | 0.7 | 646 | 62 | 62 | 62 | 46 | 108 | 33 | 75 | 181 | 0.05 | 153 | 6.0 | 77 | 1.8 | 0.09 | 7.96788 |
| 04031820000 | 24 | 09-May-95 | Crusaders Club | 56380.000 | 3759900.000 | 109 | | 696 | | | | | | | | 201 | | | | 78 | 6.6 | | 29.2156 |
| 04031820000 | 24 | 01-Jun-95 | Crusaders Club | 56380.000 | 3759900.000 | 110 | | 778 | | | | | | | | 215 | | | | 88 | 5.3 | | 23.461 |
| 04031820000 | 24 | 12-Jun-95 | Crusaders Club | 56380.000 | 3759900.000 | 116 | | 746 | | | | | | | | 242 | | | | 102 | 5.7 | | 25.2316 |
| 04031820000 | 43 | 17-Nov-93 | PEM St.Georges Park | 56240.000 | 3759375.000 | 180 | | | | | | | | | | 437 | | | | 85 | 0.1 | | 0.22133 |
| 04034050000 | 16 | 07-Jun-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 183 | 0.3 | 1056 | 48 | 48 | 48 | 147 | 195 | 75 | 120 | 511 | 0.02 | 286 | 5.0 | 135 | 4.4 | 0.12 | 19.477 |
| 04034050000 | 16 | 17-Jul-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 180 | | | | | | | | | | 490 | | | | | | | |
| 04034050000 | 16 | 10-Aug-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 174 | | | | | | | | | | 483 | | | | 97 | 3.6 | | 15.9358 |
| 04034050000 | 16 | 14-Sep-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 177 | 2.5 | 1012 | 41 | 41 | 41 | 185 | 226 | 85 | 141 | 462 | 0.44 | 291 | 5.0 | 73 | 3.6 | 0.12 | 15.9358 |
| 04034050000 | 16 | 16-Nov-93 | 8 Hallack Road | 55569.000 | 3760077.000 | 177 | | | | | | | | | | 356 | | | | 140 | 3.5 | | 15.4931 |
| 04034050000 | 16 | 12-Jan-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 164 | 0.2 | 982 | 42 | 42 | 42 | 148 | 190 | 69 | 121 | 490 | 0.01 | 254 | 4.5 | 86 | 2.8 | 0.12 | 12.3945 |
| 04034050000 | 16 | 08-Feb-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 174 | 2.5 | | 41 | 41 | 41 | 195 | 236 | 88 | 148 | 437 | | 284 | 10.0 | 86 | 3.6 | | 15.9358 |
| 04034050000 | 16 | 10-Feb-94 | 8 Hallack Road | 55569.000 | 3760077.000 | | | | | | | | | | | | | | | | | | |
| 04034050000 | 16 | 09-Mar-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 181 | 0.8 | | 43 | 43 | | | | | | 462 | | | | 80 | 4.4 | | 19.477 |
| 04034050000 | 16 | 14-Apr-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 183 | 0.6 | 976 | 41 | 41 | 41 | 224 | 265 | 104 | 161 | 460 | 0.01 | 316 | 8.0 | 85 | 4.9 | 0.35 | 21.6903 |
| 04034050000 | 16 | 09-May-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 173 | 0.3 | 966 | 41 | 41 | | | | | | 490 | | | | 93 | 4.1 | | 18.1491 |
| 04034050000 | 16 | 09-Jun-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 182 | | 1014 | | | | | | | | 460 | | | | 103 | 4.3 | | 19.0344 |
| 04034050000 | 16 | 13-Jul-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 185 | 0.3 | 1006 | 49 | 49 | 49 | 153 | 202 | 78 | 124 | 501 | 0.36 | 318 | 4.0 | 83 | 4.8 | 0.05 | 21.2477 |
| 04034050000 | 16 | 10-Aug-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 182 | | 1010 | | | | | | | | 422 | | | | 83 | 5.1 | | 22.5757 |
| 04034050000 | 16 | 14-Sep-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 181 | | 1044 | | | | | | | | 465 | | | | 86 | 4.9 | | 21.6903 |
| 04034050000 | 16 | 12-Oct-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 183 | 2.5 | 1150 | 57 | 57 | 57 | 156 | 213 | 82 | 131 | 472 | 0.26 | 270 | 9.0 | 92 | 4.3 | 0.21 | 19.0344 |
| 04034050000 | 16 | 12-Dec-94 | 8 Hallack Road | 55569.000 | 3760077.000 | 177 | | 1012 | | | | | | | | 316 | | | | 93 | 5.0 | | 22.133 |
| 04034050000 | 16 | 10-Jan-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 184 | 0.4 | 1110 | 45 | 45 | 45 | 168 | 213 | 82 | 131 | 419 | 0.01 | 273 | 8.0 | 91 | 4.7 | 0.05 | 20.805 |
| 04034050000 | 16 | 09-Feb-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 183 | | 986 | | | | | | | | 446 | | | | 97 | 5.0 | | 22.133 |
| 04034050000 | 16 | 10-Mar-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 182 | | 1156 | | | | | | | | 371 | | | | 94 | 4.6 | | 20.3624 |
| 04034050000 | 16 | 11-Apr-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 181 | 1.7 | 1028 | 46 | 46 | 46 | 152 | 198 | 75 | 123 | 432 | 0.02 | 278 | 8.0 | 94 | 4.0 | 0.05 | 17.7064 |
| 04034050000 | 16 | 09-May-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 182 | | 1012 | | | | | | | | 428 | | | | 80 | 4.5 | | 19.9197 |
| 04034050000 | 16 | 12-Jun-95 | 8 Hallack Road | 55569.000 | 3760077.000 | 181.9 | | 972 | | | | | | | | 389 | | | | 100 | 4.3 | | 19.0344 |
| 04035960000 | 38 | 21-Jul-93 | Fort Frederick | 57435.000 | 3759820.000 | 77 | | | | | | | | | | 92 | | | | | | | |
| 04035960000 | 38 | 10-Aug-93 | Fort Frederick | 57435.000 | 3759820.000 | 74 | | | | | | | | | | 94 | | | | 70 | 9.7 | | 42.938 |
| 04035960000 | 38 | 09-May-94 | Fort Frederick | 57435.000 | 3759820.000 | 77 | 45.0 | 508 | 99 | 99 | | | | | | 101 | | | | 85 | 10.3 | | 45.594 |
| 04035960000 | 38 | 14-Jul-94 | Fort Frederick | 57435.000 | 3759820.000 | 85 | 19.0 | 620 | 116 | 116 | 116 | 22 | 138 | 62 | 76 | 114 | 0.25 | 104 | 5.0 | 83 | 13.1 | 0.23 | 57.9885 |
| 06000560000 | 2 | 03-Jun-93 | 3 Whitney Street | 50952.464 | 3757754.59 | 75 | 1.5 | 422 | 26 | 26 | 26 | 45 | 71 | 23 | 48 | 152 | 0.08 | 105 | 3.0 | 60 | 3.9 | 0.10 | 17.2637 |
| 06000560000 | 2 | 10-Aug-93 | 3 Whitney Street | 50952.464 | 3757754.59 | 87 | | | | | | | | | | 199 | | | | 63 | 3.0 | | 13.2798 |
| 06000560000 | 2 | 14-Sep-93 | 3 Whitney Street | 50952.464 | 3757754.59 | 98 | 1.1 | 520 | 17 | 17 | 17 | 103 | 120 | 43 | 77 | 239 | 0.03 | 160 | 4.0 | 46 | 1.5 | 0.11 | 6.6399 |
| 06000560000 | 2 | 16-Nov-93 | 3 Whitney Street | 50952.464 | 3757754.59 | 90 | | | | | | | | | | 241 | | | | 44 | 1.8 | | 7.96788 |
| 06000560000 | 2 | 12-Jan-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 93 | 0.5 | 488 | 16 | 16 | 16 | 71 | 87 | 29 | 58 | 230 | 0.02 | 134 | 1.6 | 38 | 1.7 | 0.05 | 7.52522 |
| 06000560000 | 2 | 08-Feb-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 100 | 0.9 | | 24 | 24 | 24 | 85 | 109 | 36 | 73 | 256 | | 156 | 6.0 | 40 | 1.4 | | 6.19724 |
| 06000560000 | 2 | 10-Feb-94 | 3 Whitney Street | 50952.464 | 3757754.59 | | | | | | | | | | | | | | | | | | |
| 06000560000 | 2 | 09-Mar-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 80 | 4.6 | | 69 | 69 | | | | | | 151 | | | | 53 | 1.9 | | 8.41054 |
| 06000560000 | 2 | 14-Apr-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 93 | 0.6 | 488 | 17 | 17 | 17 | 97 | 114 | 46 | 68 | 245 | 0.03 | 158 | 4.0 | 45 | 1.9 | 0.05 | 8.27774 |
| 06000560000 | 2 | 09-May-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 90 | 0.4 | 490 | 15 | 15 | | | | | | 226 | | | | 47 | 2.3 | | 10.1812 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 06000560000 | 2 | 13-Jul-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 82 | 2.3 | 564 | 59 | 59 | 59 | 55 | 114 | 40 | 74 | 170 | 0.09 | 93 | 3.0 | 66 | 3.7 | 0.10 | 16.3784 |
| 06000560000 | 2 | 14-Sep-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 78 | | 482 | | | | | | | | 153 | | | | 61 | 0.1 | | 0.22133 |
| 06000560000 | 2 | 12-Oct-94 | 3 Whitney Street | 50952.464 | 3757754.59 | 77 | 3.2 | 628 | 89 | 89 | 89 | 48 | 137 | 83 | 54 | 141 | 0.19 | 91 | 4.0 | 57 | 2.1 | 0.06 | 9.29586 |
| 06000560000 | 2 | 15-Mar-95 | 3 Whitney Street | 50952.464 | 3757754.59 | 87 | | 564 | | | | | | | | 174 | | | | 65 | 4.4 | | 19.477 |
| 06000560000 | 2 | 21-Jun-95 | 3 Whitney Street | 50952.464 | 3757754.59 | | | | | | | | | | | | | | | | | | |
| 06002980000 | 13 | 04-Jun-93 | 14 Thames Road | 50660.000 | 3757926.000 | 509 | 3.7 | 3110 | 157 | 157 | 157 | 429 | 586 | 210 | 376 | 1689 | 0.74 | 860 | 14.0 | 170 | 0.2 | 0.36 | 0.75252 |
| 06002980000 | 13 | 10-Aug-93 | 14 Thames Road | 50660.000 | 3757926.000 | 498 | | | | | | | | | | 1386 | | | | 237 | 0.1 | | 0.44266 |
| 06002980000 | 13 | 14-Sep-93 | 14 Thames Road | 50660.000 | 3757926.000 | 496 | 2.6 | 2982 | 158 | 158 | 158 | 560 | 718 | 285 | 433 | 1632 | 0.10 | 847 | 17.0 | 147 | 0.1 | 0.40 | 0.22133 |
| 06002980000 | 13 | 18-Nov-93 | 14 Thames Road | 50660.000 | 3757926.000 | 486 | | | | | | | | | | 1299 | | | | 184 | 0.1 | | 0.22133 |
| 06002980000 | 13 | 12-Jan-94 | 14 Thames Road | 50660.000 | 3757926.000 | 469 | 1.7 | 2966 | 154 | 154 | 154 | 468 | 622 | 233 | 389 | 1541 | 0.06 | 799 | 13.0 | 143 | 0.1 | 0.44 | 0.22133 |
| 06002980000 | 13 | 08-Feb-94 | 14 Thames Road | 50660.000 | 3757926.000 | 497 | 0.8 | | 152 | 152 | 152 | 518 | 670 | 246 | 424 | 1343 | | 825 | 30.0 | 183 | 0.1 | | 0.44266 |
| 06002980000 | 13 | 09-Mar-94 | 14 Thames Road | 50660.000 | 3757926.000 | 506 | 0.7 | | 161 | 161 | | | | | | 1488 | | | | 120 | 0.1 | | 0.22133 |
| 06002980000 | 13 | 14-Apr-94 | 14 Thames Road | 50660.000 | 3757926.000 | 504 | 0.5 | 2850 | 155 | 155 | 155 | 638 | 793 | 325 | 468 | 1620 | 0.11 | 923 | 23.0 | 164 | 0.1 | 0.43 | 0.57546 |
| 06002980000 | 13 | 09-Jun-94 | 14 Thames Road | 50660.000 | 3757926.000 | 509 | | 3060 | | | | | | | | 1461 | | | | 159 | 0.1 | | 0.22133 |
| 06002980000 | 13 | 13-Jul-94 | 14 Thames Road | 50660.000 | 3757926.000 | 512 | 1.2 | 2828 | 158 | 158 | 158 | 416 | 574 | 200 | 374 | 1499 | 0.45 | 804 | 11.0 | 153 | 0.1 | 0.05 | 0.22133 |
| 06002980000 | 13 | 10-Aug-94 | 14 Thames Road | 50660.000 | 3757926.000 | 504 | | 3062 | | | | | | | | 1364 | | | | 172 | 0.2 | | 0.66399 |
| 06002980000 | 13 | 15-Sep-94 | 14 Thames Road | 50660.000 | 3757926.000 | 502 | | 2920 | | | | | | | | 1490 | | | | 148 | 0.0 | | 0.17706 |
| 06002980000 | 13 | 13-Dec-94 | 14 Thames Road | 50660.000 | 3757926.000 | 494 | | 2920 | | | | | | | | 1533 | | | | 161 | 0.2 | | 0.79679 |
| 06002980000 | 13 | 10-Jan-95 | 14 Thames Road | 50660.000 | 3757926.000 | 509 | 1.1 | 3010 | 161 | 161 | 161 | 534 | 695 | 275 | 420 | 1380 | 0.01 | 821 | 23.0 | 164 | 0.2 | 0.37 | 0.84105 |
| 07008590000 | 8 | 03-Jun-93 | 5 Norland Crescent | 47300.000 | 3758698.000 | 815 | 30.0 | 4866 | 192 | 192 | 192 | 916 | 1108 | 394 | 714 | 2455 | 2.65 | 1340 | 17.0 | 306 | 0.1 | 0.64 | 0.22133 |
| 07008590000 | 8 | 10-Aug-93 | 5 Norland Crescent | 47300.000 | 3758698.000 | 790 | | | | | | | | | | 2471 | | | | 363 | 0.1 | | 0.22133 |
| 07008590000 | 8 | 14-Sep-93 | 5 Norland Crescent | 47300.000 | 3758698.000 | 812 | 42.0 | 4836 | 200 | 200 | 200 | 1042 | 1242 | 514 | 728 | 2633 | 3.64 | 1345 | 19.0 | 293 | 0.1 | 0.70 | 0.22133 |
| 07008590000 | 8 | 11-Nov-93 | 5 Norland Crescent | 47300.000 | 3758698.000 | 807 | | | | | | | | | | 2542 | | | | 288 | 0.1 | | 0.22133 |
| 07008590000 | 8 | 12-Jan-94 | 5 Norland Crescent | 47300.000 | 3758698.000 | 774 | 51.0 | 4848 | 185 | 185 | 185 | 933 | 1118 | 427 | 691 | 2619 | 3.60 | 1235 | 20.0 | 280 | 0.1 | 0.80 | 0.22133 |
| 07008590000 | 8 | 08-Feb-94 | 5 Norland Crescent | 47300.000 | 3758698.000 | 798 | 22.0 | | 182 | 182 | 182 | 1198 | 1380 | 545 | 835 | 2512 | | 1355 | 31.0 | 394 | | | |
| 07008590000 | 8 | 14-Apr-94 | 5 Norland Crescent | 47300.000 | 3758698.000 | 815 | 47.0 | 5412 | 193 | 193 | 193 | 1213 | 1406 | 562 | 844 | 2466 | 3.36 | 1399 | 31.0 | 374 | 0.1 | 0.70 | 0.22133 |
| 07008590000 | 8 | 09-Jun-94 | 5 Norland Crescent | 47300.000 | 3758698.000 | 810 | | 4840 | | | | | | | | 2446 | | | | 300 | 0.1 | | 0.22133 |
| 07008590000 | 8 | 13-Jul-94 | 5 Norland Crescent | 47300.000 | 3758698.000 | 793 | 60.0 | 4748 | 190 | 190 | 190 | 895 | 1085 | 386 | 699 | 2533 | 4.49 | 1290 | 12.0 | 272 | 0.1 | | 0.22133 |
| 07008590000 | 8 | 10-Aug-94 | 5 Norland Crescent | 47300.000 | 3758698.000 | 799 | | 4940 | | | | | | | | 2242 | | | | 288 | 0.1 | | 0.22133 |
| 07008590000 | 8 | 14-Sep-94 | 5 Norland Crescent | 47300.000 | 3758698.000 | 798 | | 4668 | | | | | | | | 2312 | | | | 289 | 0.1 | | 0.22133 |
| 07008590000 | 8 | 12-Oct-94 | 5 Norland Crescent | 47300.000 | 3758698.000 | 813 | 41.0 | 4884 | 197 | 197 | 197 | 999 | 1196 | 461 | 735 | 2517 | 0.03 | 1293 | 34.0 | 305 | 0.1 | 0.41 | 0.22133 |
| 07008590000 | 8 | 12-Dec-94 | 5 Norland Crescent | 47300.000 | 3758698.000 | 778 | | 4930 | | | | | | | | 2379 | | | | 289 | 0.1 | | 0.22133 |
| 07008590000 | 8 | 10-Jan-95 | 5 Norland Crescent | 47300.000 | 3758698.000 | 809 | 42.0 | 4912 | 196 | 196 | 196 | 998 | 1194 | 478 | 716 | 2276 | 3.94 | 1273 | 26.0 | 299 | 0.1 | 0.05 | 0.22133 |
| 07008590000 | 8 | 13-Feb-95 | 5 Norland Crescent | 47300.000 | 3758698.000 | 799 | | 4868 | | | | | | | | 2402 | | | | 323 | 0.0 | | 0.04427 |
| 07008590000 | 8 | 10-Mar-95 | 5 Norland Crescent | 47300.000 | 3758698.000 | 786 | | 4892 | | | | | | | | 2142 | | | | 305 | 0.0 | | 0.04427 |
| 07008590000 | 8 | 20-Apr-95 | 5 Norland Crescent | 47300.000 | 3758698.000 | 819 | 53.0 | 5090 | 198 | 198 | 198 | 937 | 1135 | 457 | 678 | 2101 | 0.28 | 1244 | 32.0 | 300 | 0.0 | 0.05 | 0.02213 |
| 07008590000 | 8 | 11-May-95 | 5 Norland Crescent | 47300.000 | 3758698.000 | 728 | | 4804 | | | | | | | | 2038 | | | | 281 | 0.1 | | 0.22133 |
| 07008590000 | 8 | 28-Jun-95 | 5 Norland Crescent | 47300.000 | 3758698.000 | 793 | | 4544 | | | | | | | | 2799 | | | | 294 | 0.2 | | 0.88532 |
| 12000720000 | 42 | 10-Aug-93 | 78 Kabega Road | 46808.230 | 3758480.000 | 320 | | | | | | | | | | 1006 | | | | 86 | 0.1 | | 0.22133 |
| 12000720000 | 42 | 14-Sep-93 | 78 Kabega Road | 46808.230 | 3758480.000 | 325 | 20.0 | 1952 | 44 | 44 | 44 | 342 | 386 | 150 | 236 | 948 | 2.28 | 511 | 7.0 | 50 | 0.1 | 0.19 | 0.22133 |
| 12000720000 | 42 | 12-Jan-94 | 78 Kabega Road | 46808.230 | 3758480.000 | 321 | 2.0 | 2038 | 52 | 52 | 52 | 331 | 383 | 142 | 241 | 1070 | 0.12 | 519 | 8.3 | 64 | 0.1 | 0.25 | 0.22133 |
| 12000720000 | 42 | 09-Mar-94 | 78 Kabega Road | 46808.230 | 3758480.000 | 340 | 8.1 | | 76 | 76 | | | | | | 955 | | | | 82 | 0.1 | | 0.22133 |
| 12000720000 | 42 | 14-Apr-94 | 78 Kabega Road | 46808.230 | 3758480.000 | 344 | 48.0 | 2234 | 83 | 83 | 83 | 354 | 437 | 177 | 260 | 1042 | 43.80 | 542 | 7.0 | 115 | 0.1 | 0.24 | 0.22133 |
| 12000720000 | 42 | 09-May-94 | 78 Kabega Road | 46808.230 | 3758480.000 | 323 | 60.0 | 1884 | 65 | 65 | | | | | | 950 | | | | 93 | 0.1 | | 0.22133 |
| 12000720000 | 42 | 09-Jun-94 | 78 Kabega Road | 46808.230 | 3758480.000 | 337 | | 2006 | | | | | | | | 998 | | | | 73 | 0.1 | | 0.22133 |
| 12000720000 | 42 | 13-Jul-94 | 78 Kabega Road | 46808.230 | 3758480.000 | 339 | 27.5 | 1926 | 44 | 44 | 44 | 309 | 353 | 125 | 223 | 897 | 5.71 | 504 | 5.0 | 95 | 0.1 | 0.05 | 0.22133 |
| 12000720000 | 42 | 14-Sep-94 | 78 Kabega Road | 46808.230 | 3758480.000 | 338 | | 2016 | | | | | | | | 1056 | | | | 67 | 0.1 | | 0.22133 |
| 12000720000 | 42 | 12-Oct-94 | 78 Kabega Road | 46808.230 | 3758480.000 | 339 | 1.6 | 2074 | 42 | 42 | 42 | 360 | 402 | 152 | 250 | 1027 | 1.08 | 533 | 12.0 | 72 | 0.1 | 0.39 | 0.22133 |
| 12000720000 | 42 | 10-Jan-95 | 78 Kabega Road | 46808.230 | 3758480.000 | 341 | 17.0 | 1990 | 41 | 41 | 41 | 338 | 379 | 146 | 233 | 921 | 3.07 | 512 | 11.0 | 70 | 0.1 | 0.05 | 0.22133 |
| 12000720000 | 42 | 13-Feb-95 | 78 Kabega Road | 46808.230 | 3758480.000 | 335 | | 2120 | | | | | | | | 946 | | | | 71 | 0.0 | | 0.04427 |
| 12000720000 | 42 | 08-Mar-95 | 78 Kabega Road | 46808.230 | 3758480.000 | 342 | | 2044 | | | | | | | | 999 | | | | 74 | 0.0 | | 0.04427 |
| 12000720000 | 42 | 20-Apr-95 | 78 Kabega Road | 46808.230 | 3758480.000 | 342 | 12.0 | 1994 | 45 | 45 | 45 | 341 | 386 | 153 | 233 | 1046 | 4.71 | 521 | 12.0 | 64 | 0.0 | 0.23 | 0.02213 |
| 12000720000 | 42 | 11-May-95 | 78 Kabega Road | 46808.230 | 3758480.000 | 323 | | 2064 | | | | | | | | 1005 | | | | 64 | 0.1 | | 0.22133 |
| 12000720000 | 42 | 28-Jun-95 | 78 Kabega Road | 46808.230 | 3758480.000 | 338 | | 1844 | | | | | | | | 1118 | | | | 68 | 0.1 | | 0.22133 |
| 14001480000 | 30 | 18-Jun-93 | P.E. Golf Club | 53965.000 | 3759040.000 | 150 | 1.3 | 952 | 230 | 230 | 191 | 0 | 191 | 87 | 104 | 316 | 0.25 | 223 | 5.0 | 77 | 1.7 | 0.31 | 7.43669 |
| 14001480000 | 30 | 17-Jul-93 | P.E. Golf Club | 53965.000 | 3759040.000 | 163 | | | | | | | | | | 352 | | | | | | | |
| 14001480000 | 30 | 10-Aug-93 | P.E. Golf Club | 53965.000 | 3759040.000 | 130 | | | | | | | | | | 313 | | | | 77 | 2.5 | | 11.0665 |
| 14001480000 | 30 | 19-Jan-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 153 | 3.0 | 868 | 56 | 56 | 56 | 93 | 149 | 46 | 103 | 360 | | 267 | 1.9 | 90 | 2.8 | | 12.3945 |
| 14001480000 | 30 | 22-Feb-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 139 | 0.2 | | 32 | 32 | 32 | 111 | 143 | 48 | 95 | 349 | | 257 | 6.6 | | 2.2 | | 9.73852 |
| 14001480000 | 30 | 17-Mar-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 143 | 0.6 | | 35 | 35 | | | | | | 334 | | | | 62 | 2.5 | | 11.0665 |
| 14001480000 | 30 | 21-Apr-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 143 | 0.8 | 764 | 36 | 36 | 36 | 161 | 197 | 93 | 104 | 360 | 0.01 | 258 | 4.0 | 71 | 2.5 | 0.05 | 11.0665 |
| 14001480000 | 30 | 20-May-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 147 | 0.7 | 800 | | | | | | | | 362 | | | | 66 | 2.3 | | 10.1812 |
| 14001480000 | 30 | 21-Jun-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 145 | 0.4 | 808 | 40 | 40 | 40 | 108 | 148 | 50 | 98 | 370 | 0.03 | 237 | 7.0 | 66 | 2.5 | 0.15 | 11.0665 |
| 14001480000 | 30 | 21-Sep-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 146 | | 842 | | | | | | | | 359 | | | | 66 | 2.4 | | 10.6238 |
| 14001480000 | 30 | 12-Oct-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 147 | 0.5 | 838 | 43 | 43 | 43 | 94 | 137 | 47 | 90 | 375 | 0.02 | 231 | 7.0 | 67 | 2.6 | 0.22 | 11.5092 |
| 14001480000 | 30 | 10-Nov-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 147 | | 836 | | | | | | | | 379 | | | | 68 | 2.3 | | 10.1812 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 14001480000 | 30 | 08-Dec-94 | P.E. Golf Club | 53965.000 | 3759040.000 | 171 | | 1082 | | | | | | | | 397 | | | | 96 | 0.5 | | 2.2133 |
| 14001480000 | 30 | 05-Jan-95 | P.E. Golf Club | 53965.000 | 3759040.000 | 145 | 0.5 | 928 | 84 | 84 | 84 | 75 | 159 | 62 | 97 | 297 | 0.02 | 217 | 7.0 | 74 | 2.6 | 0.21 | 11.5092 |
| 14001480000 | 30 | 16-Mar-95 | P.E. Golf Club | 53965.000 | 3759040.000 | 145 | | 808 | | | | | | | | 342 | | | | 69 | 2.4 | | 10.6238 |
| 14001480000 | 30 | 05-May-95 | P.E. Golf Club | 53965.000 | 3759040.000 | 144 | 0.5 | 792 | 67 | 67 | 67 | 84 | 151 | 57 | 94 | 340 | 0.01 | 217 | 6.0 | 72 | 2.9 | 0.24 | 12.8371 |
| 14001480000 | 30 | 01-Jun-95 | P.E. Golf Club | 53965.000 | 3759040.000 | 141 | | 786 | | | | | | | | 370 | | | | 74 | 2.7 | | 11.9518 |
| 14001480000 | 30a | 21-Jun-94 | P.E. Golf Club | 54285.000 | 3758980.000 | 225 | 11.0 | 1250 | 52 | 52 | 52 | 233 | 285 | 120 | 165 | 606 | 0.20 | 363 | 10.0 | 79 | 1.3 | 0.05 | 5.75458 |
| 14001480000 | 30a | 10-Aug-94 | P.E. Golf Club | 54285.000 | 3758980.000 | 225 | | 1310 | | | | | | | | 650 | | | | 80 | 1.0 | | 4.4266 |
| 14001480000 | 30a | 21-Sep-94 | P.E. Golf Club | 54285.000 | 3758980.000 | 187 | | 1104 | | | | | | | | 490 | | | | 73 | 1.7 | | 7.52522 |
| 14001480000 | 30a | 12-Oct-94 | P.E. Golf Club | 54285.000 | 3758980.000 | 186 | 0.2 | 1076 | 29 | 29 | 29 | 143 | 172 | 56 | 116 | 508 | 0.45 | 294 | 9.0 | 73 | 1.7 | 0.31 | 7.52522 |
| 14001480000 | 30a | 10-Nov-94 | P.E. Golf Club | 54285.000 | 3758980.000 | 186 | | 1020 | | | | | | | | 521 | | | | 75 | 2.0 | | 8.8532 |
| 14001480000 | 30a | 08-Dec-94 | P.E. Golf Club | 54285.000 | 3758980.000 | 184 | | 1008 | | | | | | | | 564 | | | | 83 | 2.1 | | 9.29586 |
| 14001480000 | 30a | 05-Jan-95 | P.E. Golf Club | 54285.000 | 3758980.000 | 187 | 0.3 | 1034 | 34 | 34 | 34 | 142 | 176 | 58 | 118 | 451 | 0.02 | 288 | 8.0 | 76 | 1.9 | 0.05 | 8.41054 |
| 14001480000 | 30a | 16-Mar-95 | P.E. Golf Club | 54285.000 | 3758980.000 | 185 | | 992 | | | | | | | | 498 | | | | 75 | 2.1 | | 9.29586 |
| 14001480000 | 30a | 01-Jun-95 | P.E. Golf Club | 54285.000 | 3758980.000 | 180 | | 990 | | | | | | | | 488 | | | | 73 | 2.0 | | 8.8532 |
| 14001480000 | 31 | 18-Jun-93 | P.E. Golf Club | 53995.000 | 3758865.000 | 140 | 37.0 | 932 | 215 | 215 | 192 | 0 | 192 | 92 | 100 | 305 | 0.93 | 200 | 7.0 | 70 | 0.8 | 0.29 | 3.31995 |
| 14001480000 | 31 | 17-Jul-93 | P.E. Golf Club | 53995.000 | 3758865.000 | 167 | | | | | | | | | | 463 | | | | | | | |
| 14001480000 | 31 | 10-Aug-93 | P.E. Golf Club | 53995.000 | 3758865.000 | 157 | | | | | | | | | | 378 | | | | 91 | 5.6 | | 24.789 |
| 14001480000 | 31 | 26-Oct-93 | P.E. Golf Club | 53995.000 | 3758865.000 | 165 | | | | | | | | | | 401 | | | | 86 | 6.6 | | 29.2156 |
| 14001480000 | 31 | 16-Nov-93 | P.E. Golf Club | 53995.000 | 3758865.000 | 175 | | | | | | | | | | 511 | | | | 88 | 3.8 | | 16.8211 |
| 14001480000 | 31 | 22-Feb-94 | P.E. Golf Club | 53995.000 | 3758865.000 | 173 | 0.5 | | 23 | 23 | 23 | 188 | 211 | 76 | 135 | 555 | | 326 | 7.9 | | 4.5 | | 19.9197 |
| 14001480000 | 31 | 17-Mar-94 | P.E. Golf Club | 53995.000 | 3758865.000 | 173 | 1.2 | | 25 | 25 | | | | | | 398 | | | | 78 | 5.3 | | 23.461 |
| 14001480000 | 31 | 21-Apr-94 | P.E. Golf Club | 53995.000 | 3758865.000 | 167 | 0.6 | 1020 | 24 | 24 | 24 | 195 | 219 | 88 | 131 | 436 | 0.00 | 305 | 7.0 | 89 | 5.0 | 0.05 | 22.133 |
| 14001480000 | 31 | 20-May-94 | P.E. Golf Club | 53995.000 | 3758865.000 | 171 | 0.3 | 1004 | | | | | | | | 457 | | | | 87 | 5.9 | | 26.1169 |
| 14001480000 | 31 | 21-Jun-94 | P.E. Golf Club | 53995.000 | 3758865.000 | 169 | 3.9 | 980 | 81 | 81 | 81 | 99 | 180 | 67 | 113 | 390 | 0.10 | 287 | 8.0 | 94 | 5.2 | 0.12 | 23.0183 |
| 14001480000 | 31 | 10-Aug-94 | P.E. Golf Club | 53995.000 | 3758865.000 | 172 | | 1154 | | | | | | | | 335 | | | | 93 | 0.1 | | 0.44266 |
| 14001480000 | 31 | 21-Sep-94 | P.E. Golf Club | 53995.000 | 3758865.000 | 177 | | 1020 | | | | | | | | 462 | | | | 79 | 5.1 | | 22.5757 |
| 14001480000 | 31 | 12-Oct-94 | P.E. Golf Club | 53995.000 | 3758865.000 | 160 | 1.1 | 854 | 36 | 36 | 36 | 105 | 141 | 43 | 98 | 392 | 0.02 | 260 | 8.0 | 97 | 7.5 | 0.24 | 33.1995 |
| 14001480000 | 31 | 10-Nov-94 | P.E. Golf Club | 53995.000 | 3758865.000 | 175 | | 978 | | | | | | | | 472 | | | | 87 | 5.0 | | 22.133 |
| 14001480000 | 32 | 18-Jun-93 | P.E. Golf Club | 54000.000 | 3758635.000 | 120 | 2.6 | 680 | 76 | 76 | 76 | 52 | 128 | 51 | 77 | 287 | 0.01 | 188 | 4.0 | 69 | 4.2 | 0.18 | 18.636 |
| 14001480000 | 32 | 17-Jul-93 | P.E. Golf Club | 54000.000 | 3758635.000 | 129 | | | | | | | | | | 301 | | | | | | | |
| 14001480000 | 32 | 10-Aug-93 | P.E. Golf Club | 54000.000 | 3758635.000 | 120 | | | | | | | | | | 270 | | | | 81 | 4.4 | | 19.477 |
| 14001480000 | 32 | 26-Oct-93 | P.E. Golf Club | 54000.000 | 3758635.000 | 118 | | | | | | | | | | 519 | | | | 75 | 4.3 | | 19.0344 |
| 14001480000 | 32 | 16-Nov-93 | P.E. Golf Club | 54000.000 | 3758635.000 | 125 | | | | | | | | | | 300 | | | | 42 | 4.1 | | 18.1491 |
| 14001480000 | 32 | 19-Jan-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 127 | 0.4 | 670 | 25 | 25 | 25 | 114 | 139 | 46 | 93 | 305 | | 226 | 5.6 | 65 | 4.4 | | 19.477 |
| 14001480000 | 32 | 22-Feb-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 128 | 0.3 | | 29 | 29 | 29 | 102 | 131 | 43 | 88 | 307 | | 232 | 6.5 | | 4.8 | | 21.2477 |
| 14001480000 | 32 | 17-Mar-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 132 | 0.3 | | 25 | 25 | | | | | | 306 | | | | 62 | 4.2 | | 18.5917 |
| 14001480000 | 32 | 21-Apr-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 134 | 0.2 | 706 | 24 | 24 | 24 | 177 | 201 | 79 | 122 | 331 | 0.00 | 289 | 10.0 | 108 | 4.4 | 0.05 | 19.477 |
| 14001480000 | 32 | 20-May-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 130 | 2.5 | 712 | | | | | | | | 306 | | | | 72 | 4.6 | | 20.3624 |
| 14001480000 | 32 | 21-Jun-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 132 | 2.1 | 700 | 26 | 26 | 26 | 106 | 132 | 45 | 87 | 315 | 0.04 | 218 | 6.0 | 71 | 5.1 | 0.05 | 22.5757 |
| 14001480000 | 32 | 10-Aug-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 139 | | 762 | | | | | | | | 282 | | | | 73 | 4.6 | | 20.3624 |
| 14001480000 | 32 | 21-Sep-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 135 | | 786 | | | | | | | | 324 | | | | 64 | | | |
| 14001480000 | 32 | 12-Oct-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 131 | 0.1 | 726 | 26 | 26 | 26 | 90 | 116 | 38 | 78 | 321 | 0.00 | 210 | 6.0 | 74 | 5.1 | 0.18 | 22.5757 |
| 14001480000 | 32 | 10-Nov-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 133 | | 724 | | | | | | | | 327 | | | | 76 | 5.1 | | 22.5757 |
| 14001480000 | 32 | 08-Dec-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 133 | | 738 | | | | | | | | 367 | | | | 79 | 4.9 | | 21.6903 |
| 14001480000 | 32 | 05-Jan-95 | P.E. Golf Club | 54000.000 | 3758635.000 | 138 | 1.4 | 758 | 25 | 25 | 25 | 96 | 121 | 39 | 82 | 297 | 0.02 | 216 | 7.0 | 73 | 4.7 | 0.11 | 20.805 |
| 14001480000 | 32 | 16-Mar-95 | P.E. Golf Club | 54000.000 | 3758635.000 | 135 | | 744 | | | | | | | | 314 | | | | 75 | 4.6 | | 20.3624 |
| 14001480000 | 32 | 05-May-95 | P.E. Golf Club | 54000.000 | 3758635.000 | 137 | 0.4 | 722 | 27 | 27 | 27 | 98 | 125 | 40 | 85 | 329 | 0.01 | 216 | 6.0 | 75 | 5.1 | 0.13 | 22.5757 |
| 14001480000 | 32 | 21-Jun-94 | P.E. Golf Club | 54000.000 | 3758635.000 | 134 | 2.0 | 700 | 22 | 22 | 22 | 99 | 121 | 45 | 76 | 320 | 0.02 | 227 | 6.0 | 65 | 8.6 | 0.05 | 38.0688 |
| 14001480000 | 32a | 10-Aug-94 | P.E. Golf Club | 54300.000 | 3758800.000 | 134 | | 716 | | | | | | | | 320 | | | | 61 | 8.1 | | 35.8555 |
| 14001480000 | 32a | 21-Sep-94 | P.E. Golf Club | 54300.000 | 3758800.000 | 132 | | 756 | | | | | | | | 314 | | | | 72 | 5.2 | | 23.0183 |
| 14001480000 | 32a | 12-Oct-94 | P.E. Golf Club | 54300.000 | 3758800.000 | 132 | 0.4 | 722 | 21 | 21 | 21 | 85 | 106 | 38 | 68 | 326 | 0.03 | 217 | 6.0 | 64 | 8.9 | 0.07 | 39.3967 |
| 14001480000 | 32a | 10-Nov-94 | P.E. Golf Club | 54300.000 | 3758800.000 | 114 | | 622 | | | | | | | | 288 | | | | 65 | 6.9 | | 30.5435 |
| 14001480000 | 32a | 08-Dec-94 | P.E. Golf Club | 54300.000 | 3758800.000 | 112 | | 642 | | | | | | | | 277 | | | | 71 | 6.6 | | 29.2156 |
| 14001480000 | 32a | 05-Jan-95 | P.E. Golf Club | 54300.000 | 3758800.000 | 118 | 0.4 | 724 | 32 | 32 | 32 | 70 | 102 | 42 | 60 | 274 | 0.02 | 189 | 6.0 | 64 | 6.9 | 0.05 | 30.5435 |
| 14001480000 | 32a | 01-Jun-95 | P.E. Golf Club | 54300.000 | 3758800.000 | 134 | | 752 | | | | | | | | 348 | | | | 80 | 3.7 | | 16.3784 |
| 14002420000 | 19 | 08-Jun-93 | 8 Mill Park Road | 54785.000 | 3759026.000 | 84 | 0.5 | 502 | 30 | 30 | 30 | 63 | 93 | 18 | 75 | 152 | 0.04 | 116 | 3.0 | 92 | 5.2 | 0.10 | 23.0183 |
| 14002420000 | 19 | 17-Jul-93 | 8 Mill Park Road | 54785.000 | 3759026.000 | 105 | | | | | | | | | | 198 | | | | | | | |
| 14002420000 | 19 | 10-Aug-93 | 8 Mill Park Road | 54785.000 | 3759026.000 | 89 | | | | | | | | | | 178 | | | | 88 | 5.6 | | 24.789 |
| 14002420000 | 19 | 14-Sep-93 | 8 Mill Park Road | 54785.000 | 3759026.000 | 100 | 0.7 | 692 | 32 | 32 | 32 | 78 | 110 | 31 | 79 | 202 | 0.04 | 167 | 5.0 | 81 | 6.4 | 0.19 | 28.3302 |
| 14002420000 | 19 | 11-Nov-93 | 8 Mill Park Road | 54785.000 | 3759026.000 | 101 | | | | | | | | | | 204 | | | | 72 | 6.2 | | 27.4449 |
| 14002420000 | 19 | 12-Jan-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 100 | 0.7 | 572 | 26 | 26 | 26 | 59 | 85 | 23 | 62 | 218 | 0.03 | 158 | 4.2 | 73 | | 0.12 | |
| 14002420000 | 19 | 08-Feb-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 98 | 1.3 | | 24 | 24 | 24 | 71 | 95 | 23 | 72 | 204 | | 167 | 7.0 | 77 | 5.0 | | 22.133 |
| 14002420000 | 19 | 09-Mar-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 99 | 0.7 | | 25 | 25 | | | | | | 138 | | | | 39 | 7.1 | | 31.4289 |
| 14002420000 | 19 | 14-Apr-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 101 | 0.8 | 520 | 26 | 26 | 26 | 59 | 85 | 21 | 64 | 210 | 0.04 | 162 | 6.0 | 75 | 6.6 | 0.20 | 29.2156 |
| 14002420000 | 19 | 09-May-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 98 | 0.5 | 566 | 27 | 27 | | | | | | 217 | | | | 76 | 5.8 | | 25.6743 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 14002420000 | 19 | 09-Jun-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 97 | | 546 | | | | | | | | 206 | | | | 84 | 6.5 | | 28.7729 |
| 14002420000 | 19 | 13-Jul-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 82 | 1.3 | 492 | 37 | 37 | 37 | 61 | 98 | 21 | 77 | 172 | 0.06 | 107 | 3.0 | 93 | 5.7 | 0.12 | 25.2316 |
| 14002420000 | 19 | 10-Aug-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 89 | | 528 | | | | | | | | 164 | | | | 77 | 6.4 | | 28.3302 |
| 14002420000 | 19 | 14-Sep-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 90 | | 542 | | | | | | | | 188 | | | | 80 | 6.6 | | 29.2156 |
| 14002420000 | 19 | 12-Oct-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 93 | 0.4 | 572 | 28 | 28 | 28 | 60 | 88 | 21 | 67 | 193 | 0.02 | 147 | 5.0 | 81 | 6.0 | 0.05 | 26.5596 |
| 14002420000 | 19 | 12-Dec-94 | 8 Mill Park Road | 54785.000 | 3759026.000 | 99 | | 590 | | | | | | | | 229 | | | | 81 | 6.3 | | 27.8876 |
| 14002420000 | 19 | 10-Jan-95 | 8 Mill Park Road | 54785.000 | 3759026.000 | 101 | 0.4 | 588 | 27 | 27 | 27 | 57 | 84 | 23 | 61 | 192 | 0.01 | 165 | 5.0 | 80 | 6.7 | 0.09 | 29.6582 |
| 14002420000 | 19 | 09-Feb-95 | 8 Mill Park Road | 54785.000 | 3759026.000 | 102 | | 584 | | | | | | | | 212 | | | | 84 | 6.3 | | 27.8876 |
| 14002420000 | 19 | 10-Mar-95 | 8 Mill Park Road | 54785.000 | 3759026.000 | 101 | | 456 | | | | | | | | 214 | | | | 82 | 7.3 | | 32.3142 |
| 14002420000 | 19 | 11-Apr-95 | 8 Mill Park Road | 54785.000 | 3759026.000 | 101 | 0.6 | 538 | 34 | 34 | 34 | 57 | 91 | 26 | 65 | 212 | 0.49 | 161 | 6.0 | 79 | 6.1 | 0.05 | 27.0023 |
| 14002420000 | 19 | 09-May-95 | 8 Mill Park Road | 54785.000 | 3759026.000 | 94 | | 544 | | | | | | | | 187 | | | | 77 | 6.2 | | 27.4449 |
| 14002420000 | 19 | 12-Jun-95 | 8 Mill Park Road | 54785.000 | 3759026.000 | 98 | | 568 | | | | | | | | 208 | | | | 80 | 6.3 | | 27.8876 |
| 14002650000 | 25 | 18-Jun-93 | Grey High School | 55080.000 | 3759275.000 | 117 | 6.0 | 660 | 50 | 50 | 50 | 59 | 109 | 33 | 76 | 296 | 0.65 | 189 | 3.0 | 76 | 3.0 | 0.10 | 13.1913 |
| 14002650000 | 25 | 10-Aug-93 | Grey High School | 55080.000 | 3759275.000 | 85 | | | | | | | | | | 157 | | | | 87 | 4.2 | | 18.5917 |
| 14002650000 | 25 | 29-Sep-93 | Grey High School | 55080.000 | 3759275.000 | 82 | 4.1 | 442 | 25 | 25 | 25 | 63 | 88 | 26 | 62 | 175 | 1.18 | 134 | 5.0 | 80 | 2.0 | 0.20 | 8.8532 |
| 14002650000 | 25 | 16-Nov-93 | Grey High School | 55080.000 | 3759275.000 | | | | | | | | | | | | | | | | | | |
| 14002650000 | 25 | 14-Dec-93 | Grey High School | 55080.000 | 3759275.000 | 89 | 0.7 | | | | | | | | | 161 | | | | 61 | 3.9 | | 17.2637 |
| 14002650000 | 25 | 19-Jan-94 | Grey High School | 55080.000 | 3759275.000 | 76 | 3.5 | 456 | 24 | 24 | 24 | 45 | 69 | 20 | 49 | 152 | | 106 | 4.2 | 71 | 2.1 | | 9.29586 |
| 14002650000 | 25 | 22-Feb-94 | Grey High School | 55080.000 | 3759275.000 | 77 | 1.6 | | 22 | 22 | 22 | 57 | 79 | 22 | 57 | 168 | | 130 | 4.1 | | 4.1 | | 18.1491 |
| 14002650000 | 25 | 17-Mar-94 | Grey High School | 55080.000 | 3759275.000 | 78 | 1.4 | | 23 | 23 | | | | | | 160 | | | | 72 | 4.5 | | 19.9197 |
| 14002650000 | 25 | 21-Apr-94 | Grey High School | 55080.000 | 3759275.000 | 77 | 1.6 | 420 | 23 | 23 | 23 | 59 | 82 | 28 | 54 | 153 | 0.04 | 118 | 4.0 | 73 | 4.3 | 0.05 | 19.0344 |
| 14002650000 | 25 | 20-May-94 | Grey High School | 55080.000 | 3759275.000 | 80 | 2.5 | 450 | | | | | | | | 156 | | | | 73 | 4.5 | | 19.9197 |
| 14002650000 | 25 | 21-Jun-94 | Grey High School | 55080.000 | 3759275.000 | 83 | 1.7 | 542 | 52 | 52 | 52 | 70 | 122 | 64 | 58 | 165 | 0.27 | 129 | 3.0 | 74 | 4.1 | 0.07 | 18.1491 |
| 14002650000 | 25 | 07-Jul-94 | Grey High School | 55080.000 | 3759275.000 | 79 | 1.1 | 444 | 23 | 23 | 23 | 46 | 69 | 15 | 54 | 176 | 0.38 | 117 | 3.0 | 82 | 4.1 | 0.09 | 18.1491 |
| 14002650000 | 25 | 10-Aug-94 | Grey High School | 55080.000 | 3759275.000 | 96 | | 558 | | | | | | | | 212 | | | | 75 | 3.4 | | 15.0504 |
| 14002650000 | 25 | 26-Sep-94 | Grey High School | 55080.000 | 3759275.000 | 77 | | 442 | | | | | | | | 156 | | | | 74 | 4.2 | | 18.5917 |
| 14002650000 | 25 | 12-Oct-94 | Grey High School | 55080.000 | 3759275.000 | 79 | 1.2 | 420 | 23 | 23 | 23 | 50 | 73 | 18 | 55 | 160 | 0.20 | 124 | 5.0 | 79 | 4.4 | 0.22 | 19.477 |
| 14002650000 | 25 | 10-Nov-94 | Grey High School | 55080.000 | 3759275.000 | 121 | | 664 | | | | | | | | 292 | | | | 78 | 3.3 | | 14.6078 |
| 14002650000 | 25 | 08-Dec-94 | Grey High School | 55080.000 | 3759275.000 | 133 | | 742 | | | | | | | | 363 | | | | 86 | 3.1 | | 13.7225 |
| 14002650000 | 25 | 05-Jan-95 | Grey High School | 55080.000 | 3759275.000 | 146 | 0.3 | 802 | 22 | 22 | 22 | 101 | 123 | 34 | 89 | 326 | 0.02 | 113 | 6.0 | 80 | 2.2 | 0.07 | 9.73852 |
| 14002650000 | 25 | 16-Mar-95 | Grey High School | 55080.000 | 3759275.000 | 122 | | 820 | | | | | | | | 231 | | | | 78 | 3.3 | | 14.6078 |
| 14002650000 | 25 | 05-May-95 | Grey High School | 55080.000 | 3759275.000 | 112 | 2.4 | 728 | 67 | 67 | 67 | 62 | 129 | 61 | 68 | 226 | 0.13 | 166 | 5.0 | 78 | 3.7 | 0.04 | 16.3784 |
| 14002650000 | 25 | 01-Jun-95 | Grey High School | 55080.000 | 3759275.000 | 180 | | 752 | | | | | | | | 364 | | | | 85 | 2.9 | | 12.8371 |
| 14009890000 | 18 | 08-Jun-93 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 150 | 1.6 | 884 | 16 | 16 | 16 | 142 | 158 | 50 | 108 | 434 | 0.11 | 218 | 3.0 | 58 | 0.5 | 0.05 | 2.0805 |
| 14009890000 | 18 | 10-Aug-93 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 139 | | | | | | | | | | 411 | | | | 56 | 0.4 | | 1.72637 |
| 14009890000 | 18 | 14-Sep-93 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 147 | 0.7 | 784 | 17 | 17 | 17 | 161 | 178 | 65 | 113 | 387 | 0.08 | 221 | 3.0 | 58 | 1.1 | 0.05 | 4.86926 |
| 14009890000 | 18 | 11-Nov-93 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 149 | | | | | | | | | | 405 | | | | 50 | 1.0 | | 4.33807 |
| 14009890000 | 18 | 12-Jan-94 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 150 | 1.1 | 846 | 20 | 20 | 20 | 137 | 157 | 54 | 103 | 423 | 0.10 | 200 | 3.2 | 47 | | 0.07 | |
| 14009890000 | 18 | 08-Feb-94 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 146 | 0.5 | | 17 | 171 | 17 | 180 | 197 | 70 | 127 | 384 | | 239 | 9.0 | 53 | 1.3 | | 5.53325 |
| 14009890000 | 18 | 09-Mar-94 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 154 | 0.9 | | 17 | 17 | | | | | | 409 | | | | 44 | 0.7 | | 3.09862 |
| 14009890000 | 18 | 14-Apr-94 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 157 | 0.3 | | 17 | 17 | 17 | 218 | 235 | 91 | 144 | 437 | 0.03 | 266 | 6.0 | 51 | 0.7 | 0.05 | 3.05435 |
| 14009890000 | 18 | 09-Jun-94 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 145 | | 810 | | | | | | | | 388 | | | | 47 | 1.0 | | 4.2938 |
| 14009890000 | 18 | 13-Jul-94 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 148 | 1.4 | 838 | 19 | 19 | 19 | 134 | 153 | 48 | 105 | 415 | 0.12 | 185 | 3.0 | 49 | 1.3 | 0.05 | 5.75458 |
| 14009890000 | 18 | 14-Sep-94 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 152 | | 850 | | | | | | | | 415 | | | | 48 | 0.9 | | 3.98394 |
| 14009890000 | 18 | 12-Oct-94 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 152 | 0.5 | 846 | 24 | 24 | 24 | 143 | 167 | 56 | 111 | 422 | 0.08 | 220 | 6.0 | 52 | 1.1 | 0.10 | 4.86926 |
| 14009890000 | 18 | 12-Dec-94 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 135 | | 814 | | | | | | | | 400 | | | | 52 | 0.9 | | 3.98394 |
| 14009890000 | 18 | 10-Jan-95 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 155 | 0.8 | 830 | 28 | 28 | 28 | 148 | 176 | 63 | 113 | 376 | 0.02 | 225 | 6.0 | 52 | 1.1 | 0.06 | 4.86926 |
| 14009890000 | 18 | 11-May-95 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 141 | | 840 | | | | | | | | 366 | | | | 48 | 2.2 | | 9.73852 |
| 14009890000 | 18 | 12-Jun-95 | 47 Wychwood Avenue | 53145.000 | 3759304.000 | 128 | | 746 | | | | | | | | 339 | | | | 58 | 3.6 | | 15.9358 |
| 15028720000 | 20 | 14-Jun-93 | Fedlife Building | 53170.000 | 3758100.000 | 62 | 7.1 | 356 | 81 | 81 | 69 | 0 | 69 | 38 | 31 | 108 | 0.22 | 94 | 7.0 | 47 | 2.6 | 0.19 | 11.5092 |
| 15028720000 | 20 | 17-Jul-93 | Fedlife Building | 53170.000 | 3758100.000 | 141 | | | | | | | | | | 264 | | | | | | | |
| 15028720000 | 20 | 10-Aug-93 | Fedlife Building | 53170.000 | 3758100.000 | 153 | | | | | | | | | | 282 | | | | 98 | 9.2 | | 40.7247 |
| 15028720000 | 20 | 29-Sep-93 | Fedlife Building | 53170.000 | 3758100.000 | 135 | 7.6 | 954 | 121 | 121 | 121 | 16 | 137 | 63 | 74 | 259 | 0.21 | 234 | 9.0 | 112 | 1.0 | 0.20 | 4.2938 |
| 15028720000 | 20 | 25-Oct-93 | Fedlife Building | 53170.000 | 3758100.000 | 135 | | | | | | | | | | 289 | | | | 84 | 9.6 | | 42.4954 |
| 15028720000 | 20 | 16-Nov-93 | Fedlife Building | 53170.000 | 3758100.000 | 140 | | | | | | | | | | 318 | | | | 90 | 11.0 | | 48.6926 |
| 15028720000 | 20 | 24-Feb-94 | Fedlife Building | 53170.000 | 3758100.000 | 259 | 7.2 | | 255 | 255 | 255 | 46 | 301 | 116 | 185 | 505 | | 462 | 19.0 | | 8.7 | | 38.5114 |
| 17016790000 | 1 | 03-Jun-93 | 12 West Street | 52765.000 | 3758016.000 | | 0.9 | 500 | 23 | 23 | 23 | 29 | 52 | 19 | 33 | 171 | 0.09 | 147 | 2.0 | 60 | 16.0 | 0.05 | 70.8256 |
| 17016790000 | 1 | 10-Aug-93 | 12 West Street | 52765.000 | 3758016.000 | 50 | | | | | | | | | | 61 | | | | 53 | 11.0 | | 48.6926 |
| 17016790000 | 1 | 14-Sep-93 | 12 West Street | 52765.000 | 3758016.000 | 81 | 0.7 | 622 | 27 | 27 | 27 | 51 | 78 | 31 | 47 | 125 | 0.40 | 149 | 3.0 | 57 | 15.0 | 0.17 | 66.399 |
| 17016790000 | 1 | 16-Nov-93 | 12 West Street | 52765.000 | 3758016.000 | 76 | | | | | | | | | | 177 | | | | 70 | 14.0 | | 61.9724 |
| 17016790000 | 1 | 12-Jan-94 | 12 West Street | 52765.000 | 3758016.000 | 67 | 0.9 | 396 | 28 | 28 | 28 | 8 | 36 | 12 | 24 | 109 | 0.10 | 111 | 1.7 | 52 | 0.3 | 0.10 | 1.32798 |
| 17016790000 | 1 | 08-Feb-94 | 12 West Street | 52765.000 | 3758016.000 | 83 | 4.5 | | 28 | 28 | 28 | 36 | 64 | 27 | 37 | 153 | | 145 | 2.0 | 59 | 13.8 | | 61.0871 |
| 17016790000 | 1 | 10-Feb-94 | 12 West Street | 52765.000 | 3758016.000 | | | | | | | | | | | | | | | | | | |
| 17016790000 | 1 | 09-Mar-94 | 12 West Street | 52765.000 | 3758016.000 | 77 | 0.6 | | 24 | 24 | | | | | | 128 | | | | 43 | 14.7 | | 65.071 |
| 17016790000 | 1 | 14-Apr-94 | 12 West Street | 52765.000 | 3758016.000 | 66 | 0.3 | 386 | 23 | 23 | 23 | 22 | 45 | 17 | 28 | 107 | 0.03 | 119 | 24.0 | 50 | 11.5 | 0.05 | 50.9059 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 17016790000 | 1 | 09-May-94 | 12 West Street | 52765.000 | 3758016.000 | 76 | 3.9 | 464 | 29 | 29 | | | | | | 134 | | | | 77 | 12.8 | | 56.6605 |
| 17016790000 | 1 | 09-Jun-94 | 12 West Street | 52765.000 | 3758016.000 | 77 | | 504 | | | | | | | | 144 | | | | 68 | 7.0 | | 30.9862 |
| 17016790000 | 1 | 13-Jul-94 | 12 West Street | 52765.000 | 3758016.000 | 80 | 2.3 | 464 | 28 | 28 | 28 | 16 | 44 | 15 | 29 | 164 | 0.41 | 107 | 1.0 | 62 | 12.2 | 0.10 | 54.0045 |
| 17016790000 | 1 | 10-Aug-94 | 12 West Street | 52765.000 | 3758016.000 | 50 | | 318 | | | | | | | | 69 | | | | 46 | 10.0 | | 44.266 |
| 17016790000 | 1 | 14-Sep-94 | 12 West Street | 52765.000 | 3758016.000 | 50 | | 318 | | | | | | | | 77 | | | | 47 | 9.4 | | 41.61 |
| 17016790000 | 1 | 12-Oct-94 | 12 West Street | 52765.000 | 3758016.000 | 91 | 0.7 | 536 | 38 | 38 | 38 | 36 | 74 | 34 | 40 | 171 | 0.01 | 149 | 4.0 | 60 | 16.2 | 0.04 | 71.7109 |
| 17016790000 | 1 | 12-Dec-94 | 12 West Street | 52765.000 | 3758016.000 | 71 | | 462 | | | | | | | | 203 | | | | 24 | 14.0 | | 61.9724 |
| 17016790000 | 1 | 10-Jan-95 | 12 West Street | 52765.000 | 3758016.000 | 74 | 135.0 | 444 | 29 | 29 | 29 | 19 | 48 | 17 | 31 | 133 | 0.20 | 127 | 4.0 | 58 | 12.2 | 0.10 | 54.0045 |
| 17016790000 | 1 | 13-Feb-95 | 12 West Street | 52765.000 | 3758016.000 | 72 | | 374 | | | | | | | | 123 | | | | 56 | 14.0 | | 61.9724 |
| 17016790000 | 1 | 10-Mar-95 | 12 West Street | 52765.000 | 3758016.000 | 73 | | 492 | | | | | | | | 132 | | | | 58 | 12.0 | | 53.1192 |
| 17016790000 | 1 | 11-Apr-95 | 12 West Street | 52765.000 | 3758016.000 | 73 | 5.6 | 434 | 33 | 33 | 33 | 13 | 46 | 17 | 29 | 135 | 0.35 | 125 | 4.0 | 58 | 12.0 | 0.07 | 53.1192 |
| 17016790000 | 1 | 09-May-95 | 12 West Street | 52765.000 | 3758016.000 | 80 | | 488 | | | | | | | | 139 | | | | 53 | 14.0 | | 61.9724 |
| 17016790000 | 1 | 12-Jun-95 | 12 West Street | 52765.000 | 3758016.000 | 72.7 | | 466 | | | | | | | | 132 | | | | 60 | 14.0 | | 61.9724 |
| 21001090000 | 34 | 07-Jul-93 | Vital Link | 54150.000 | 3768830.000 | 160 | 9.7 | 1026 | 279 | 279 | 279 | 178 | 457 | 388 | 69 | 344 | 0.33 | 151 | 2.9 | 49 | 0.2 | 0.34 | 0.88532 |
| 21001090000 | 34 | 11-Nov-93 | Vital Link | 54150.000 | 3768830.000 | 173 | | | | | | | | | | 337 | | | | 46 | 0.2 | | 0.75252 |
| 21001090000 | 34 | 17-Mar-94 | Vital Link | 54150.000 | 3768830.000 | 165 | 0.6 | | 277 | 277 | | | | | | 336 | | | | 42 | 0.1 | | 0.22133 |
| 21001090000 | 34 | 21-Apr-94 | Vital Link | 54150.000 | 3768830.000 | 153 | 0.6 | 960 | 267 | 267 | 267 | 248 | 515 | 433 | 82 | 308 | 0.02 | 159 | 4.0 | 48 | 0.1 | 0.35 | 0.22133 |
| 21001090000 | 34 | 20-May-94 | Vital Link | 54150.000 | 3768830.000 | 153 | 0.7 | 942 | | | | | | | | 292 | | | | 42 | 0.1 | | 0.22133 |
| 21001090000 | 34 | 21-Jun-94 | Vital Link | 54150.000 | 3768830.000 | 156 | 5.3 | 1012 | 269 | 269 | 269 | 190 | 459 | 386 | 73 | 307 | 0.49 | 145 | 3.0 | 41 | 0.4 | 0.21 | 1.85917 |
| 21001090000 | 34 | 07-Jul-94 | Vital Link | 54150.000 | 3768830.000 | 157 | 6.4 | 1054 | 271 | 271 | 271 | 125 | 396 | 326 | 70 | 339 | 2.43 | 136 | 3.0 | 37 | 0.1 | 0.18 | 0.48693 |
| 21001090000 | 34 | 10-Aug-94 | Vital Link | 54150.000 | 3768830.000 | 163 | | 1062 | | | | | | | | 312 | | | | 39 | 0.1 | | 0.53119 |
| 21001090000 | 34 | 22-Sep-94 | Vital Link | 54150.000 | 3768830.000 | 165 | | 1094 | | | | | | | | 338 | | | | 35 | 0.1 | | 0.22133 |
| 21001090000 | 34 | 12-Oct-94 | Vital Link | 54150.000 | 3768830.000 | 163 | 42.0 | 1082 | 283 | 283 | 283 | 130 | 413 | 345 | 68 | 339 | 21.80 | 150 | 3.0 | 31 | 0.1 | 0.42 | 0.22133 |
| 21001090000 | 34 | 10-Nov-94 | Vital Link | 54150.000 | 3768830.000 | 165 | | 1122 | | | | | | | | 357 | | | | 43 | 0.1 | | 0.22133 |
| 21001090000 | 34 | 13-Dec-94 | Vital Link | 54150.000 | 3768830.000 | 157 | | 1066 | | | | | | | | 345 | | | | 42 | 0.1 | | 0.44266 |
| 21001090000 | 34 | 05-Jan-95 | Vital Link | 54150.000 | 3768830.000 | 160 | 3.5 | 1076 | 279 | 279 | 279 | 108 | 387 | 323 | 64 | 322 | 0.03 | 141 | 2.0 | 46 | 0.2 | 0.32 | 0.70826 |
| 21001090000 | 34 | 16-Mar-95 | Vital Link | 54150.000 | 3768830.000 | 165 | | 1072 | | | | | | | | 317 | | | | 43 | 0.2 | | 0.88532 |
| 21001090000 | 34 | 05-May-95 | Vital Link | 54150.000 | 3768830.000 | 155 | 2.6 | 962 | 276 | 276 | 276 | 184 | 450 | 398 | 52 | 317 | 0.33 | 139 | 2.0 | 44 | 0.1 | 0.25 | 0.44266 |
| 21001090000 | 34 | 01-Jun-95 | Vital Link | 54150.000 | 3768830.000 | 157 | | 948 | | | | | | | | 354 | | | | 45 | 0.1 | | 0.22133 |
| 22006240000 | 11 | 02-Apr-92 | 17 Victoria Park | 57326.570 | 3760716.770 | 160 | | 1222 | 264 | 264 | 235 | 0 | 235 | 148 | 87 | 264 | | | | 87 | 8.7 | | 38.5114 |
| 22006240000 | 11 | 03-Jun-93 | 17 Victoria Park | 57326.570 | 3760716.770 | 78 | 0.3 | 558 | 96 | 96 | 96 | 28 | 124 | 80 | 44 | 133 | 0.07 | 96 | 2.0 | 59 | 2.6 | 0.17 | 11.5092 |
| 22006240000 | 11 | 10-Aug-93 | 17 Victoria Park | 57326.570 | 3760716.770 | 161 | | | | | | | | | | 229 | | | | 122 | 13.0 | | 57.5458 |
| 22006240000 | 11 | 14-Sep-93 | 17 Victoria Park | 57326.570 | 3760716.770 | 161 | 1.2 | 1168 | 270 | 270 | 269 | 0 | 269 | 163 | 106 | 252 | 0.05 | 245 | 3.0 | 112 | 14.0 | 0.32 | 61.9724 |
| 23006160000 | 5 | 03-Jun-93 | 21 Admiralty Way | 62141.000 | 3762843.000 | 236 | 2.7 | 1394 | 397 | 397 | 397 | 178 | 575 | 419 | 156 | 478 | 0.11 | 239 | 4.0 | 47 | 0.4 | 0.48 | 1.72637 |
| 23006160000 | 5 | 10-Aug-93 | 21 Admiralty Way | 62141.000 | 3762843.000 | 225 | | | | | | | | | | 480 | | | | 62 | 0.7 | | 3.09862 |
| 23006160000 | 5 | 14-Sep-93 | 21 Admiralty Way | 62141.000 | 3762843.000 | 229 | 0.6 | 1360 | 410 | 410 | 410 | 185 | 595 | 412 | 183 | 483 | 1.29 | 221 | 4.0 | 49 | 0.1 | 0.59 | 0.22133 |
| 23006160000 | 5 | 16-Nov-93 | 21 Admiralty Way | 62141.000 | 3762843.000 | 224 | | | | | | | | | | 348 | | | | 65 | 0.7 | | 3.01009 |
| 23006160000 | 5 | 08-Feb-94 | 21 Admiralty Way | 62141.000 | 3762843.000 | 219 | 0.4 | | 394 | 394 | 394 | 198 | 592 | 434 | 158 | 449 | | 249 | 4.0 | 56 | 0.4 | | 1.77064 |
| 23006160000 | 5 | 09-Mar-94 | 21 Admiralty Way | 62141.000 | 3762843.000 | 228 | 0.7 | | 393 | 393 | | | | | | 472 | | | | 42 | 0.1 | | 0.22133 |
| 23006160000 | 5 | 14-Apr-94 | 21 Admiralty Way | 62141.000 | 3762843.000 | 229 | 3.1 | 1366 | 407 | 407 | 407 | 179 | 586 | 415 | 171 | 473 | 0.05 | 283 | 2.3 | 54 | 0.1 | 0.66 | 0.22133 |
| 23006160000 | 5 | 09-Jun-94 | 21 Admiralty Way | 62141.000 | 3762843.000 | 232 | | 1486 | | | | | | | | 480 | | | | 70 | 0.2 | | 0.88532 |
| 23006160000 | 5 | 14-Jul-94 | 21 Admiralty Way | 62141.000 | 3762843.000 | 230 | 0.8 | 1478 | 416 | 416 | 416 | 138 | 554 | 399 | 155 | 492 | 0.05 | 250 | 3.0 | 52 | 0.1 | 0.47 | 0.22133 |
| 23006160000 | 5 | 10-Aug-94 | 21 Admiralty Way | 62141.000 | 3762843.000 | 232 | | 1550 | | | | | | | | 465 | | | | 57 | 0.7 | | 3.05435 |
| 23006160000 | 5 | 21-Sep-94 | 21 Admiralty Way | 62141.000 | 3762843.000 | 232 | | 1448 | | | | | | | | 472 | | | | 57 | 0.1 | | 0.22133 |
| 23006160000 | 5 | 12-Oct-94 | 21 Admiralty Way | 62141.000 | 3762843.000 | 229 | 0.4 | 1546 | 419 | 419 | 419 | 151 | 570 | 417 | 153 | 480 | 0.00 | 260 | 3.0 | 56 | 0.7 | 0.40 | 2.87729 |
| 23006160000 | 5 | 20-Dec-94 | 21 Admiralty Way | 62141.000 | 3762843.000 | 227 | | 1460 | | | | | | | | 355 | | | | 85 | 0.1 | | 0.22133 |
| 23006160000 | 5 | 10-Jan-95 | 21 Admiralty Way | 62141.000 | 3762843.000 | 232 | 0.3 | 1480 | 412 | 412 | 412 | 132 | 544 | 400 | 144 | 486 | 0.02 | 251 | 2.0 | 56 | 0.5 | 0.71 | 2.3461 |
| 23006160000 | 5 | 13-Feb-95 | 21 Admiralty Way | 62141.000 | 3762843.000 | 227 | | 1410 | | | | | | | | 455 | | | | 57 | 0.3 | | 1.46078 |
| 23006160000 | 5 | 27-Mar-95 | 21 Admiralty Way | 62141.000 | 3762843.000 | 231 | | 1412 | | | | | | | | 480 | | | | 61 | 0.5 | | 2.16903 |
| 23006160000 | 5 | 20-Apr-95 | 21 Admiralty Way | 62141.000 | 3762843.000 | 231 | 1.1 | 1406 | 395 | 395 | 395 | 176 | 571 | 421 | 150 | 480 | 0.10 | 262 | 5.0 | 84 | | 0.19 | 0 |
| 23006160000 | 5 | 09-May-95 | 21 Admiralty Way | 62141.000 | 3762843.000 | 229 | | 1428 | | | | | | | | 457 | | | | 43 | 0.1 | | 0.22133 |
| 23006160000 | 5 | 12-Jun-95 | 21 Admiralty Way | 62141.000 | 3762843.000 | 227 | | 1458 | | | | | | | | 480 | | | | 50 | 0.1 | | 0.44266 |
| 23014100000 | 6 | 03-Jun-93 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 196 | 0.2 | 1154 | 384 | 384 | 384 | 152 | 536 | 438 | 98 | 306 | 0.01 | 193 | 4.0 | 73 | 18.0 | 0.44 | 79.6788 |
| 23014100000 | 6 | 10-Aug-93 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 188 | | | | | | | | | | 262 | | | | 82 | 18.0 | | 79.6788 |
| 23014100000 | 6 | 14-Sep-93 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 189 | 0.8 | 1240 | 389 | 389 | 389 | 140 | 529 | 406 | 123 | 285 | 0.09 | 218 | 6.0 | 87 | 16.0 | 0.58 | 70.8256 |
| 23014100000 | 6 | 16-Nov-93 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 184 | | | | | | | | | | 285 | | | | 99 | 20.0 | | 88.532 |
| 23014100000 | 6 | 12-Jan-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 182 | 0.3 | 1164 | 382 | 382 | 382 | 91 | 473 | 378 | 95 | 278 | 0.04 | 169 | 3.5 | 75 | | 0.46 | 0 |
| 23014100000 | 6 | 09-Mar-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 187 | 0.4 | | 366 | 366 | | | | | | 304 | | | | 79 | 19.3 | | 85.4334 |
| 23014100000 | 6 | 14-Apr-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 189 | 0.3 | 1136 | 376 | 376 | 376 | 196 | 572 | 449 | 123 | 280 | 0.02 | 220 | 4.0 | 84 | 18.7 | 0.43 | 82.7774 |
| 23014100000 | 6 | 09-May-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 186 | 0.2 | 1172 | 379 | 379 | | | | | | 304 | | | | 89 | 7.0 | | 30.9862 |
| 23014100000 | 6 | 09-Jun-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 188 | | 1220 | | | | | | | | 287 | | | | 86 | 17.0 | | 75.2522 |
| 23014100000 | 6 | 14-Jul-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 188 | 0.4 | 1198 | 383 | 383 | 383 | 120 | 503 | 398 | 105 | 288 | 0.03 | 179 | 3.0 | 78 | 21.0 | 0.39 | 92.9586 |
| 23014100000 | 6 | 10-Aug-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 187 | | 1260 | | | | | | | | 265 | | | | 76 | 21.0 | | 92.9586 |
| 23014100000 | 6 | 21-Sep-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 186 | | 1206 | | | | | | | | 280 | | | | 81 | 19.0 | | 84.1054 |
| 23014100000 | 6 | 12-Oct-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 186 | 0.2 | 1232 | 384 | 384 | 384 | 114 | 498 | 400 | 98 | 283 | 0.37 | 178 | 4.0 | 88 | 19.0 | 0.64 | 84.1054 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 23014100000 | 6 | 20-Dec-94 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 188 | | 1162 | | | | | | | | 322 | | | | 91 | 21.0 | | 92.9586 |
| 23014100000 | 6 | 10-Jan-95 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 188 | 0.3 | 1238 | 388 | 388 | 388 | 144 | 532 | 431 | 101 | 281 | 0.05 | 177 | 4.0 | 84 | 19.9 | 0.56 | 88.0893 |
| 23014100000 | 6 | 13-Feb-95 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 186 | | 1354 | | | | | | | | 272 | | | | 86 | 19.0 | | 84.1054 |
| 23014100000 | 6 | 10-Mar-95 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 185 | | 1180 | | | | | | | | 288 | | | | 90 | 22.0 | | 97.3852 |
| 23014100000 | 6 | 20-Apr-95 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 193 | 0.4 | 1146 | 366 | 366 | 366 | 182 | 548 | 444 | 104 | 280 | 0.62 | 181 | 5.0 | 82 | 21.0 | 0.14 | 92.9586 |
| 23014100000 | 6 | 09-May-95 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 188 | | 1136 | | | | | | | | 245 | | | | 69 | 20.0 | | 88.532 |
| 23014100000 | 6 | 12-Jun-95 | 5 Kolbe Crescent | 60364.000 | 3762682.000 | 187 | | 1200 | | | | | | | | 301 | | | | 91 | 21.0 | | 92.9586 |
| 23016930000 | 15 | 07-Jun-93 | 10 Bulbring Road | 59912.000 | 3762833.000 | 211 | 0.4 | 1378 | 360 | 360 | 360 | 227 | 587 | 478 | 109 | 504 | 0.12 | 204 | 3.0 | 95 | 12.0 | 0.46 | 53.1192 |
| 23016930000 | 15 | 10-Aug-93 | 10 Bulbring Road | 59912.000 | 3762833.000 | 197 | | | | | | | | | | 351 | | | | 84 | 12.0 | | 53.1192 |
| 23016930000 | 15 | 16-Nov-93 | 10 Bulbring Road | 59912.000 | 3762833.000 | 192 | | | | | | | | | | 424 | | | | 87 | 12.0 | | 53.1192 |
| 23016930000 | 15 | 12-Jan-94 | 10 Bulbring Road | 59912.000 | 3762833.000 | 194 | 0.4 | 1118 | 351 | 351 | 351 | 195 | 546 | 442 | 104 | 324 | 0.02 | 172 | 2.2 | 66 | | 0.45 | |
| 23016930000 | 15 | 21-Sep-94 | 10 Bulbring Road | 59912.000 | 3762833.000 | 205 | | 1270 | | | | | | | | 363 | | | | 80 | 13.0 | | 57.5458 |
| 23016930000 | 15 | 20-Dec-94 | 10 Bulbring Road | 59912.000 | 3762833.000 | 200 | | 1296 | | | | | | | | 363 | | | | 78 | 15.0 | | 66.399 |
| 23016930000 | 15 | 10-Jan-95 | 10 Bulbring Road | 59912.000 | 3762833.000 | 199 | 0.4 | 1370 | 360 | 360 | 360 | 196 | 556 | 459 | 97 | 359 | 0.01 | 185 | 3.0 | 81 | 14.2 | 0.54 | 62.8577 |
| 23016930000 | 15 | 10-Mar-95 | 10 Bulbring Road | 59912.000 | 3762833.000 | 203 | | 1344 | | | | | | | | 344 | | | | 83 | 14.0 | | 61.9724 |
| 23016930000 | 15 | 12-Jun-95 | 10 Bulbring Road | 59912.000 | 3762833.000 | 200 | | 1280 | | | | | | | | 349 | | | | 76 | 14.0 | | 61.9724 |
| 23017360000 | 7 | 03-Jun-93 | 68 Winchester Way | 60270.000 | 3762750.000 | 239 | 0.4 | 1512 | 410 | 410 | 410 | 310 | 720 | 583 | 137 | 411 | 0.02 | 210 | 7.0 | 87 | 25.0 | 0.51 | 110.665 |
| 23017360000 | 7 | 10-Aug-93 | 68 Winchester Way | 60270.000 | 3762750.000 | 235 | | | | | | | | | | 398 | | | | 76 | 29.0 | | 128.371 |
| 23017360000 | 7 | 14-Sep-93 | 68 Winchester Way | 60270.000 | 3762750.000 | 239 | 0.6 | 1548 | 417 | 417 | 417 | 260 | 737 | 591 | 146 | 379 | 0.06 | 136 | 4.0 | 85 | 31.0 | 0.64 | 137.225 |
| 23017360000 | 7 | 16-Nov-93 | 68 Winchester Way | 60270.000 | 3762750.000 | 243 | | | | | | | | | | 440 | | | | 123 | 30.0 | | 132.798 |
| 23017360000 | 7 | 12-Jan-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 253 | 0.9 | 1652 | 403 | 403 | 403 | 296 | 699 | 572 | 127 | 472 | 0.03 | 198 | 7.9 | 102 | | 0.64 | |
| 23017360000 | 7 | 08-Feb-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 234 | 0.7 | | 398 | 398 | 398 | 335 | 733 | 598 | 135 | 408 | | 219 | 11.0 | 96 | 25.0 | | 110.665 |
| 23017360000 | 7 | 09-Mar-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 254 | 0.8 | | 398 | 398 | | | | | | 429 | | | | 74 | 32.0 | | 141.651 |
| 23017360000 | 7 | 14-Apr-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 251 | 1.4 | 1628 | 404 | 404 | 404 | 417 | 821 | 673 | 148 | 476 | 0.04 | 247 | 9.0 | 108 | 26.3 | 0.76 | 116.42 |
| 23017360000 | 7 | 09-May-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 248 | 0.5 | 1648 | 409 | 409 | | | | | | 464 | | | | 116 | 21.7 | | 96.0572 |
| 23017360000 | 7 | 09-Jun-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 249 | | 1690 | | | | | | | | 454 | | | | 97 | 25.0 | | 110.665 |
| 23017360000 | 7 | 14-Jul-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 249 | 1.9 | 1598 | 412 | 412 | 412 | 319 | 731 | 589 | 142 | 467 | 0.05 | 223 | 6.0 | 89 | 26.0 | 0.47 | 115.092 |
| 23017360000 | 7 | 10-Aug-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 256 | | 1664 | | | | | | | | 441 | | | | 91 | 28.0 | | 123.945 |
| 23017360000 | 7 | 21-Sep-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 260 | | 1644 | | | | | | | | 470 | | | | 101 | 28.0 | | 123.945 |
| 23017360000 | 7 | 12-Oct-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 258 | 0.3 | 1758 | 424 | 424 | 424 | 316 | 740 | 607 | 133 | 485 | 0.00 | 235 | 9.0 | 105 | 28.0 | 0.63 | 123.945 |
| 23017360000 | 7 | 20-Dec-94 | 68 Winchester Way | 60270.000 | 3762750.000 | 253 | | 1744 | | | | | | | | 381 | | | | 74 | 24.0 | | 106.238 |
| 23017360000 | 7 | 13-Feb-95 | 68 Winchester Way | 60270.000 | 3762750.000 | 264 | | 1938 | | | | | | | | 485 | | | | 111 | 25.0 | | 110.665 |
| 23017360000 | 7 | 10-Mar-95 | 68 Winchester Way | 60270.000 | 3762750.000 | 266 | | 1840 | | | | | | | | 503 | | | | 104 | 27.0 | | 119.518 |
| 23017360000 | 7 | 20-Apr-95 | 68 Winchester Way | 60270.000 | 3762750.000 | 272 | 0.5 | 1830 | 403 | 403 | 403 | 340 | 743 | 614 | 129 | 535 | 0.10 | 251 | 10.0 | 98 | 25.0 | 0.30 | 110.665 |
| 23017360000 | 7 | 09-May-95 | 68 Winchester Way | 60270.000 | 3762750.000 | 271 | | 1870 | | | | | | | | 433 | | | | 76 | 24.0 | | 106.238 |
| 23017360000 | 7 | 12-Jun-95 | 68 Winchester Way | 60270.000 | 3762750.000 | 266 | | 1734 | | | | | | | | 511 | | | | 97 | 24.0 | | 106.238 |
| 27006880000 | 40 | 10-Aug-93 | 15 Cosmos Street | 47812.79 | 3756403.07 | 332 | | | | | | | | | | 1006 | | | | 126 | 0.2 | | 0.88532 |
| 27006880000 | 40 | 14-Sep-93 | 15 Cosmos Street | 47812.79 | 3756403.07 | 335 | 5.9 | 2132 | 54 | 54 | 54 | 471 | 525 | 190 | 335 | 961 | 0.25 | 515 | 8.0 | 102 | 0.2 | 0.37 | 0.92959 |
| 27006880000 | 40 | 16-Nov-93 | 15 Cosmos Street | 47812.79 | 3756403.07 | 328 | | | | | | | | | | 961 | | | | 125 | 0.2 | | 0.88532 |
| 32000470000 | 23 | 18-Jun-93 | Clarendon Park | 54350 | 3760570 | 287 | 3.4 | 1722 | 61 | 61 | 61 | 306 | 367 | 135 | 232 | 828 | 0.30 | 420 | 6.0 | 116 | 0.4 | 0.10 | 1.9477 |
| 32000470000 | 23 | 10-Aug-93 | Clarendon Park | 54350 | 3760570 | 274 | | | | | | | | | | 763 | | | | 110 | 0.4 | | 1.77064 |
| 32000470000 | 23 | 10-Aug-93 | Clarendon Park | 54350 | 3760570 | 290 | | | | | | | | | | 802 | | | | 120 | 0.6 | | 2.65596 |
| 32000470000 | 23 | 14-Sep-93 | Clarendon Park | 54350 | 3760570 | 288 | 4.5 | 1842 | 33 | 33 | 33 | 395 | 428 | 168 | 260 | 823 | 0.23 | 465 | 8.0 | 118 | 0.3 | 0.17 | 1.41651 |
| 32000470000 | 23 | 29-Sep-93 | Clarendon Park | 54350 | 3760570 | 291 | 5.5 | 1710 | 33 | 33 | 33 | 393 | 426 | 175 | 251 | 836 | 0.33 | 439 | 10.0 | 150 | 0.4 | 0.05 | 1.77064 |
| 32000470000 | 23 | 25-Oct-93 | Clarendon Park | 54350 | 3760570 | 274 | | | | | | | | | | 757 | | | | 123 | 0.3 | | 1.32798 |
| 32000470000 | 23 | 16-Nov-93 | Clarendon Park | 54350 | 3760570 | 284 | | | | | | | | | | 809 | | | | 103 | 0.3 | | 1.46078 |
| 32000470000 | 23 | 16-Nov-93 | Clarendon Park | 54350 | 3760570 | 275 | | | | | | | | | | 696 | | | | 106 | | | |
| 32000470000 | 23 | 14-Dec-93 | Clarendon Park | 54350 | 3760570 | 286 | | | | | | | | | | 871 | | | | 93 | 0.1 | | 0.22133 |
| 32000470000 | 23 | 12-Jan-94 | Clarendon Park | 54350 | 3760570 | 285 | 17.0 | 1560 | 31 | 31 | 31 | 314 | 345 | 116 | 229 | 883 | 1.04 | 431 | 3.3 | 86 | 0.1 | 0.16 | 0.22133 |
| 32000470000 | 23 | 19-Jan-94 | Clarendon Park | 54350 | 3760570 | 294 | 9.4 | 1538 | 30 | 30 | 30 | 363 | 393 | 141 | 252 | 847 | | 520 | 6.6 | 86 | 0.3 | | 1.32798 |
| 32000470000 | 23 | 08-Feb-94 | Clarendon Park | 54350 | 3760570 | 299 | 4.0 | | 27 | 27 | 27 | 399 | 426 | 149 | 277 | 829 | | 475 | 13.0 | 105 | 0.4 | | 1.59358 |
| 32000470000 | 23 | 10-Feb-94 | Clarendon Park | 54350 | 3760570 | | | | | | | | | | | | | | | | | | |
| 32000470000 | 23 | 17-Mar-94 | Clarendon Park | 54350 | 3760570 | 285 | 28.0 | | 32 | 32 | | | | | | 803 | | | | 93 | 0.5 | | 1.99197 |
| 32000470000 | 23 | 09-Jun-94 | Clarendon Park | 54350 | 3760570 | 286 | | 1680 | | | | | | | | 817 | | | | 103 | 0.3 | | 1.46078 |
| 32000470000 | 23 | 21-Jun-94 | Clarendon Park | 54350 | 3760570 | 304 | 5.5 | 1708 | 30 | 30 | 30 | 435 | 465 | 185 | 280 | 856 | 0.11 | 483 | 13.0 | 109 | 0.4 | 0.05 | 1.81491 |
| 32000470000 | 23 | 07-Jul-94 | Clarendon Park | 54350 | 3760570 | 304 | 1.5 | 1708 | 30 | 30 | 30 | 310 | 340 | 105 | 235 | 917 | 0.16 | 476 | 5.0 | 94 | 0.5 | 0.05 | 2.39036 |
| 32000470000 | 23 | 13-Jul-94 | Clarendon Park | 54350 | 3760570 | 308 | 26.0 | 1810 | 48 | 48 | 48 | 331 | 379 | 139 | 240 | 987 | 0.13 | 440 | 5.0 | 89 | 0.5 | 0.20 | 2.39036 |
| 32000470000 | 23 | 10-Aug-94 | Clarendon Park | 54350 | 3760570 | 295 | | 1834 | | | | | | | | 837 | | | | 101 | 0.5 | | 1.99197 |
| 32000470000 | 23 | 12-Aug-94 | Clarendon Park | 54350 | 3760570 | 301 | | 1806 | | | | | | | | 795 | | | | 121 | 0.5 | | 2.03624 |
| 32000470000 | 23 | 14-Sep-94 | Clarendon Park | 54350 | 3760570 | 303 | | 1814 | | | | | | | | 907 | | | | 131 | 0.3 | | 1.23945 |
| 32000470000 | 23 | 22-Sep-94 | Clarendon Park | 54350 | 3760570 | 318 | | 1946 | | | | | | | | 916 | | | | 130 | 0.4 | | 1.81491 |
| 32000470000 | 23 | 12-Oct-94 | Clarendon Park | 54350 | 3760570 | 312 | 7.5 | 1918 | 31 | 31 | 31 | 369 | 400 | 134 | 266 | 905 | 0.89 | 476 | 11.0 | 110 | 0.4 | 0.24 | 1.81491 |
| 32000470000 | 23 | 13-Oct-94 | Clarendon Park | 54350 | 3760570 | 314 | 2.2 | 1930 | 28 | 28 | 28 | 373 | 401 | 143 | 258 | 919 | 0.03 | 472 | 11.0 | 115 | 0.5 | 0.23 | 2.2133 |
| 32000470000 | 23 | 10-Nov-94 | Clarendon Park | 54350 | 3760570 | 326 | | 1916 | | | | | | | | 974 | | | | 108 | 0.3 | | 1.50504 |
| 32000470000 | 23 | 08-Dec-94 | Clarendon Park | 54350 | 3760570 | 314 | | 1964 | | | | | | | | 1016 | | | | 113 | 0.5 | | 2.2133 |
| 32000470000 | 23 | 12-Dec-94 | Clarendon Park | 54350 | 3760570 | 300 | | 1782 | | | | | | | | 929 | | | | 105 | 0.5 | | 2.2133 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 32000470000 | 23 | 10-Jan-95 | Clarendon Park | 54350 | 3760570 | 315 | 2.7 | 1806 | 35 | 35 | 35 | 341 | 378 | 130 | 248 | 825 | 0.04 | 462 | 9.0 | 104 | 0.5 | 0.05 | 1.99197 |
| 32000470000 | 23 | 09-Feb-95 | Clarendon Park | 54350 | 3760570 | 306 | | 1790 | | | | | | | | 807 | | | | 113 | 0.5 | | 2.16903 |
| 32000470000 | 23 | 10-Mar-95 | Clarendon Park | 54350 | 3760570 | 308 | | 1892 | | | | | | | | 758 | | | | 123 | 0.6 | | 2.61169 |
| 32000470000 | 23 | 16-Mar-95 | Clarendon Park | 54350 | 3760570 | 309 | | 1828 | | | | | | | | 859 | | | | 106 | 0.6 | | 2.65596 |
| 32000470000 | 23 | 10-Apr-95 | Clarendon Park | 54350 | 3760570 | 325 | 0.7 | 1940 | 55 | 55 | 55 | 362 | 417 | 172 | 245 | 987 | 0.06 | 479 | 11.0 | 112 | 0.6 | 0.05 | 2.52316 |
| 32000470000 | 23 | 11-Apr-95 | Clarendon Park | 54350 | 3760570 | 314 | 0.6 | 1694 | 34 | 34 | 34 | 345 | 379 | 133 | 246 | 949 | 0.03 | 475 | 12.0 | 102 | 0.5 | 0.05 | 2.03624 |
| 32000470000 | 23 | 11-May-95 | Clarendon Park | 54350 | 3760570 | 282 | | 1814 | | | | | | | | 877 | | | | 107 | 0.6 | | 2.43463 |
| 32000470000 | 23 | 01-Jun-95 | Clarendon Park | 54350 | 3760570 | 311 | | 1734 | | | | | | | | 967 | | | | 103 | 0.3 | | 1.50504 |
| 32000470000 | 23 | 12-Jun-95 | Clarendon Park | 54350 | 3760570 | 320 | | 1754 | | | | | | | | 947 | | | | 105 | 0.5 | | 2.39036 |
| 32001790000 | 14 | 07-Jun-93 | 12 11th Avenue | 53190.000 | 3761589.000 | 171 | 13.0 | 1182 | 145 | 145 | 145 | 148 | 293 | 151 | 142 | 515 | 0.61 | 209 | 19.0 | 74 | 0.1 | 0.27 | 0.22133 |
| 32001790000 | 14 | 17-Jul-93 | 12 11th Avenue | 53190.000 | 3761589.000 | 169 | | | | | | | | | | 406 | | | | | | | |
| 32001790000 | 14 | 10-Aug-93 | 12 11th Avenue | 53190.000 | 3761589.000 | 160 | | | | | | | | | | 369 | | | | 41 | 0.1 | | 0.22133 |
| 32001790000 | 14 | 14-Sep-93 | 12 11th Avenue | 53190.000 | 3761589.000 | 176 | 2.6 | 1156 | 146 | 146 | 146 | 239 | 385 | 211 | 174 | 452 | 0.61 | 239 | 25.0 | 48 | 0.1 | 0.36 | 0.22133 |
| 32001790000 | 14 | 16-Nov-93 | 12 11th Avenue | 53190.000 | 3761589.000 | 174 | | | | | | | | | | 436 | | | | 45 | 0.1 | | 0.22133 |
| 32001790000 | 14 | 12-Jan-94 | 12 11th Avenue | 53190.000 | 3761589.000 | 170 | 3.7 | 1108 | 148 | 148 | 148 | 140 | 288 | 155 | 133 | 442 | 0.06 | 188 | 18.0 | 34 | 0.1 | 0.21 | 0.22133 |
| 32001790000 | 14 | 08-Feb-94 | 12 11th Avenue | 53190.000 | 3761589.000 | 171 | 4.2 | | 144 | 144 | 144 | 212 | 356 | 196 | 160 | 429 | | 215 | 20.0 | 36 | 0.1 | | 0.22133 |
| 32001790000 | 14 | 09-Mar-94 | 12 11th Avenue | 53190.000 | 3761589.000 | 177 | 10.0 | | 143 | 143 | | | | | | 479 | | | | 30 | 0.1 | | 0.22133 |
| 32001790000 | 14 | 14-Jul-94 | 12 11th Avenue | 53190.000 | 3761589.000 | 174 | 25.0 | 1114 | 162 | 162 | 162 | 145 | 307 | 160 | 147 | 429 | 8.73 | 198 | 14.0 | 38 | 0.1 | 0.19 | 0.22133 |
| 32001790000 | 14 | 10-Aug-94 | 12 11th Avenue | 53190.000 | 3761589.000 | 169 | | 1150 | | | | | | | | 386 | | | | 35 | 0.1 | | 0.22133 |
| 32001790000 | 14 | 15-Sep-94 | 12 11th Avenue | 53190.000 | 3761589.000 | 175 | | 1214 | | | | | | | | 406 | | | | 40 | 0.1 | | 0.22133 |
| 32001790000 | 14 | 12-Oct-94 | 12 11th Avenue | 53190.000 | 3761589.000 | 177 | 5.2 | 1178 | 153 | 153 | 153 | 158 | 311 | 165 | 146 | 442 | 0.66 | 209 | 23.0 | 38 | 0.1 | 0.29 | 0.22133 |
| 32001790000 | 14 | 13-Dec-94 | 12 11th Avenue | 53190.000 | 3761589.000 | 184 | | 1158 | | | | | | | | 501 | | | | 44 | 0.1 | | 0.22133 |
| 32001790000 | 14 | 10-Jan-95 | 12 11th Avenue | 53190.000 | 3761589.000 | 173 | 7.0 | 1178 | 152 | 152 | 152 | 160 | 312 | 170 | 142 | 438 | 0.02 | 205 | 23.0 | 40 | 0.1 | 0.19 | 0.22133 |
| 32001790000 | 14 | 09-Feb-95 | 12 11th Avenue | 53190.000 | 3761589.000 | 189 | | 1056 | | | | | | | | 446 | | | | 46 | 0.0 | | 0.04427 |
| 32001790000 | 14 | 10-Mar-95 | 12 11th Avenue | 53190.000 | 3761589.000 | 184 | | 1264 | | | | | | | | 468 | | | | 40 | 0.0 | | 0.04427 |
| 32001790000 | 14 | 11-Apr-95 | 12 11th Avenue | 53190.000 | 3761589.000 | 192 | 4.2 | 1232 | 171 | 171 | 171 | 143 | 314 | 173 | 141 | 533 | 0.03 | 225 | 21.0 | 41 | 0.0 | 0.05 | 0.02213 |
| 32001790000 | 14 | 11-May-95 | 12 11th Avenue | 53190.000 | 3761589.000 | 169 | | 1146 | | | | | | | | 490 | | | | 42 | 0.1 | | 0.22133 |
| 32001790000 | 14 | 12-Jun-95 | 12 11th Avenue | 53190.000 | 3761589.000 | 185 | | 1208 | | | | | | | | 480 | | | | 42 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 28-Jun-93 | 64 Short Road | 53010.000 | 3761117.000 | 414 | 68.0 | 2558 | 195 | 195 | 195 | 502 | 697 | 283 | 414 | 1437 | 29.00 | 638 | 5.4 | 163 | 0.1 | 0.27 | 0.22133 |
| 32004980000 | 33 | 17-Jul-93 | 64 Short Road | 53010.000 | 3761117.000 | 404 | | | | | | | | | | 1144 | | | | | | | |
| 32004980000 | 33 | 10-Aug-93 | 64 Short Road | 53010.000 | 3761117.000 | 429 | | | | | | | | | | 1230 | | | | 232 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 16-Nov-93 | 64 Short Road | 53010.000 | 3761117.000 | 345 | | | | | | | | | | 1246 | | | | 159 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 12-Jan-94 | 64 Short Road | 53010.000 | 3761117.000 | 353 | 56.0 | 2066 | 178 | 178 | 178 | 334 | 512 | 236 | 276 | 1057 | 4.89 | 518 | 6.1 | 125 | 0.1 | 0.29 | 0.22133 |
| 32004980000 | 33 | 08-Feb-94 | 64 Short Road | 53010.000 | 3761117.000 | 349 | 43.0 | | 164 | 164 | 164 | 414 | 578 | 272 | 306 | 938 | | 547 | 16.0 | 130 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 10-Feb-94 | 64 Short Road | 53010.000 | 3761117.000 | | | | | | | | | | | | | | | | | | |
| 32004980000 | 33 | 09-Mar-94 | 64 Short Road | 53010.000 | 3761117.000 | 356 | 40.0 | | 178 | 178 | | | | | | 957 | | | | 126 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 14-Apr-94 | 64 Short Road | 53010.000 | 3761117.000 | 356 | 79.0 | 2318 | 178 | 178 | 178 | 411 | 589 | 279 | 310 | 966 | 69.50 | 579 | 9.0 | 122 | 0.1 | 0.31 | 0.22133 |
| 32004980000 | 33 | 09-May-94 | 64 Short Road | 53010.000 | 3761117.000 | 348 | 80.0 | 2180 | 184 | 184 | | | | | | 956 | | | | 128 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 09-Jun-94 | 64 Short Road | 53010.000 | 3761117.000 | 361 | | 2166 | | | | | | | | 958 | | | | 127 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 14-Jul-94 | 64 Short Road | 53010.000 | 3761117.000 | 359 | 145.0 | 2162 | 206 | 206 | 206 | 272 | 478 | 205 | 273 | 987 | 7.90 | 548 | 3.0 | 104 | 0.1 | 0.05 | 0.22133 |
| 32004980000 | 33 | 10-Aug-94 | 64 Short Road | 53010.000 | 3761117.000 | 360 | | 2234 | | | | | | | | 918 | | | | 118 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 15-Sep-94 | 64 Short Road | 53010.000 | 3761117.000 | 360 | | 2226 | | | | | | | | 893 | | | | 113 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 12-Oct-94 | 64 Short Road | 53010.000 | 3761117.000 | 357 | 31.0 | 2202 | 179 | 179 | 179 | 345 | 524 | 240 | 284 | 975 | 5.60 | 542 | 11.0 | 133 | 0.1 | 0.53 | 0.22133 |
| 32004980000 | 33 | 12-Dec-94 | 64 Short Road | 53010.000 | 3761117.000 | 341 | | 2238 | | | | | | | | 1021 | | | | 122 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 10-Jan-95 | 64 Short Road | 53010.000 | 3761117.000 | 353 | 77.0 | 2266 | 187 | 187 | 187 | 310 | 497 | 241 | 256 | 867 | 9.34 | 509 | 9.0 | 107 | 0.1 | 0.05 | 0.53119 |
| 32004980000 | 33 | 09-Feb-95 | 64 Short Road | 53010.000 | 3761117.000 | 356 | | 2068 | | | | | | | | 932 | | | | 132 | | | |
| 32004980000 | 33 | 10-Mar-95 | 64 Short Road | 53010.000 | 3761117.000 | 346 | | 2128 | | | | | | | | 935 | | | | 135 | 0.0 | | 0.04427 |
| 32004980000 | 33 | 11-Apr-95 | 64 Short Road | 53010.000 | 3761117.000 | 361 | 77.0 | 2218 | 211 | 211 | 211 | 276 | 487 | 225 | 262 | 1024 | 15.34 | 541 | 10.0 | 109 | 0.0 | 0.22 | 0.02213 |
| 32004980000 | 33 | 11-May-95 | 64 Short Road | 53010.000 | 3761117.000 | 344 | | 2282 | | | | | | | | 1020 | | | | 110 | 0.1 | | 0.22133 |
| 32004980000 | 33 | 12-Jun-95 | 64 Short Road | 53010.000 | 3761117.000 | 360 | | 2138 | | | | | | | | 991 | | | | 107 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 18-Jun-93 | Walmer Country Club | 52495.000 | 3762895.000 | 226 | 12.0 | 1356 | 455 | 455 | 392 | 0 | 392 | 268 | 124 | 528 | 6.18 | 292 | 6.0 | 65 | 0.1 | 0.31 | 0.22133 |
| 32019350000 | 28 | 31-Aug-93 | Walmer Country Club | 52495.000 | 3762895.000 | 209 | | | | | | | | | | 505 | | | | 64 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 29-Sep-93 | Walmer Country Club | 52495.000 | 3762895.000 | 281 | 28.0 | 1758 | 210 | 210 | 210 | 248 | 458 | 299 | 159 | 784 | 14.50 | 395 | 13.0 | 60 | 0.1 | 0.24 | 0.22133 |
| 32019350000 | 28 | 26-Oct-93 | Walmer Country Club | 52495.000 | 3762895.000 | 205 | | | | | | | | | | 459 | | | | 59 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 16-Nov-93 | Walmer Country Club | 52495.000 | 3762895.000 | 219 | | | | | | | | | | | | | | 65 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 20-Dec-93 | Walmer Country Club | 52495.000 | 3762895.000 | 206 | | | | | | | | | | 458 | | | | 56 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 19-Jan-94 | Walmer Country Club | 52495.000 | 3762895.000 | 201 | 8.1 | 1206 | 131 | 131 | 131 | 236 | 367 | 243 | 124 | 501 | | 288 | | 49 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 22-Feb-94 | Walmer Country Club | 52495.000 | 3762895.000 | 202 | 17.0 | | 241 | 241 | 241 | 102 | 343 | 211 | 132 | 428 | | 294 | 7.8 | | 0.1 | | 0.22133 |
| 32019350000 | 28 | 17-Mar-94 | Walmer Country Club | 52495.000 | 3762895.000 | 219 | 45.0 | | 233 | 233 | | | | | | 479 | | | | 58 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 21-Apr-94 | Walmer Country Club | 52495.000 | 3762895.000 | 204 | 24.0 | 1292 | 140 | 140 | 140 | 273 | 413 | 267 | 146 | 480 | 1.76 | 320 | 6.0 | 60 | 0.1 | 0.20 | 0.22133 |
| 32019350000 | 28 | 20-May-94 | Walmer Country Club | 52495.000 | 3762895.000 | 245 | 26.0 | 1482 | | | | | | | | 586 | | | | 76 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 21-Jun-94 | Walmer Country Club | 52495.000 | 3762895.000 | 200 | 7.0 | 1298 | 242 | 242 | 242 | 193 | 435 | 309 | 126 | 447 | 0.47 | 265 | 6.0 | 62 | 0.1 | 0.01 | 0.22133 |
| 32019350000 | 28 | 07-Jul-94 | Walmer Country Club | 52495.000 | 3762895.000 | 237 | 5.0 | 1518 | 226 | 226 | 226 | 157 | 383 | 247 | 136 | 618 | 4.10 | 322 | 5.0 | 61 | 0.1 | 0.34 | 0.22133 |
| 32019350000 | 28 | 10-Aug-94 | Walmer Country Club | 52495.000 | 3762895.000 | 218 | | 1452 | | | | | | | | 552 | | | | 58 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 22-Sep-94 | Walmer Country Club | 52495.000 | 3762895.000 | 205 | | 1364 | | | | | | | | 457 | | | | 65 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 12-Oct-94 | Walmer Country Club | 52495.000 | 3762895.000 | 220 | 33.0 | 1336 | 243 | 243 | 243 | 155 | 398 | 274 | 124 | 528 | 19.80 | 295 | 7.0 | 64 | 0.1 | 0.41 | 0.22133 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 32019350000 | 28 | 10-Nov-94 | Walmer Country Club | 52495.000 | 3762895.000 | 223 | | 1414 | | | | | | | | 540 | | | | 64 | 0.1 | | 0.22133 |
| 32019350000 | 28 | 13-Dec-94 | Walmer Country Club | 52495.000 | 3762895.000 | 237 | | 1464 | | | | | | | | 486 | | | | 61 | 4.2 | | 18.5917 |
| 32019350000 | 28 | 05-Jan-95 | Walmer Country Club | 52495.000 | 3762895.000 | 236 | 0.8 | 1526 | 372 | 372 | 372 | 138 | 510 | 394 | 116 | 480 | 0.04 | 279 | 3.0 | 121 | 40.0 | 0.46 | 177.064 |
| 32019350000 | 28 | 16-Mar-95 | Walmer Country Club | 52495.000 | 3762895.000 | 210 | | 1232 | | | | | | | | 497 | | | | 63 | 0.1 | | 0.44266 |
| 32019350000 | 28 | 06-Apr-95 | Walmer Country Club | 52495.000 | 3762895.000 | 223 | 1.4 | 1328 | 293 | 293 | 293 | 126 | 419 | 309 | 110 | 432 | 0.10 | 264 | 4.0 | 98 | 4.0 | 0.05 | 17.7064 |
| 32019350000 | 29 | 18-Jun-93 | Walmer Country Club | 52925.000 | 3762555.000 | 212 | 13.0 | 1352 | 472 | 472 | 386 | 0 | 386 | 272 | 114 | 480 | 3.50 | 265 | 5.0 | 68 | 0.1 | 0.33 | 0.22133 |
| 32019350000 | 29 | 31-Aug-93 | Walmer Country Club | 52925.000 | 3762555.000 | 214 | | | | | | | | | | 526 | | | | 70 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 29-Sep-93 | Walmer Country Club | 52925.000 | 3762555.000 | 262 | 22.0 | 1654 | 221 | 221 | 221 | 182 | 443 | 293 | 150 | 720 | 11.70 | 370 | 11.0 | 55 | 0.1 | 0.24 | 0.22133 |
| 32019350000 | 29 | 16-Nov-93 | Walmer Country Club | 52925.000 | 3762555.000 | 217 | | | | | | | | | | 521 | | | | 64 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 20-Dec-93 | Walmer Country Club | 52925.000 | 3762555.000 | 200 | | | | | | | | | | 453 | | | | 56 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 19-Jan-94 | Walmer Country Club | 52925.000 | 3762555.000 | 199 | 22.0 | 1234 | 131 | 131 | 131 | 268 | 399 | 257 | 142 | 489 | | 311 | 6.6 | 49 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 22-Feb-94 | Walmer Country Club | 52925.000 | 3762555.000 | 242 | 28.0 | | 216 | 216 | 216 | 228 | 444 | 283 | 161 | 675 | | 388 | 10.0 | | | | |
| 32019350000 | 29 | 17-Mar-94 | Walmer Country Club | 52925.000 | 3762555.000 | 220 | 37.0 | | 213 | 213 | | | | | | 511 | | | | 52 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 21-Apr-94 | Walmer Country Club | 52925.000 | 3762555.000 | 201 | 20.0 | 1292 | 140 | 140 | 140 | 312 | 452 | 297 | 155 | 540 | 2.18 | 336 | 7.0 | 69 | 0.1 | 0.10 | 0.22133 |
| 32019350000 | 29 | 20-May-94 | Walmer Country Club | 52925.000 | 3762555.000 | 247 | 32.0 | 1474 | | | | | | | | 585 | | | | 74 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 21-Jun-94 | Walmer Country Club | 52925.000 | 3762555.000 | 208 | 7.5 | 1322 | 245 | 245 | 245 | 191 | 436 | 311 | 125 | 480 | 0.01 | 279 | 6.0 | 62 | 0.1 | 0.24 | 0.44266 |
| 32019350000 | 29 | 07-Jul-94 | Walmer Country Club | 52925.000 | 3762555.000 | 253 | 7.1 | 1628 | 217 | 217 | 217 | 166 | 383 | 236 | 147 | 696 | 6.56 | 342 | 6.0 | 62 | 0.1 | 0.23 | 0.22133 |
| 32019350000 | 29 | 10-Aug-94 | Walmer Country Club | 52925.000 | 3762555.000 | 231 | | 1442 | | | | | | | | 347 | | | | 57 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 22-Sep-94 | Walmer Country Club | 52925.000 | 3762555.000 | 205 | | 1362 | | | | | | | | 460 | | | | 63 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 12-Oct-94 | Walmer Country Club | 52925.000 | 3762555.000 | 243 | 0.4 | 1422 | 362 | 362 | 362 | 213 | 575 | 439 | 136 | 497 | 0.03 | 292 | 3.0 | 61 | 0.1 | 0.29 | 0.22133 |
| 32019350000 | 29 | 13-Dec-94 | Walmer Country Club | 52925.000 | 3762555.000 | 202 | | 1292 | | | | | | | | 502 | | | | 65 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 05-Jan-95 | Walmer Country Club | 52925.000 | 3762555.000 | 223 | 18.0 | 1498 | 238 | 238 | 238 | 118 | 356 | 245 | 111 | 487 | 0.16 | 289 | 5.0 | 65 | 0.1 | 0.47 | 0.22133 |
| 32019350000 | 29 | 16-Mar-95 | Walmer Country Club | 52925.000 | 3762555.000 | 206 | | 1236 | | | | | | | | 447 | | | | 63 | 0.1 | | 0.22133 |
| 32019350000 | 29 | 06-Apr-95 | Walmer Country Club | 52925.000 | 3762555.000 | 218 | 1.5 | 1348 | 287 | 287 | 287 | 128 | 415 | 308 | 107 | 432 | 0.08 | 260 | 3.0 | 100 | 3.9 | 0.05 | 17.2637 |
| 32019350000 | 29a | 20-May-94 | Walmer Country Club | 53460.000 | 3762645.000 | 252 | 6.4 | 1476 | | | | | | | | 480 | | | | 179 | 0.1 | | 0.22133 |
| 32019350000 | 29a | 21-Jun-94 | Walmer Country Club | 53460.000 | 3762645.000 | 251 | 0.3 | 1524 | 397 | 397 | 397 | 293 | 690 | 528 | 162 | 478 | 0.08 | 320 | 3.0 | 121 | 5.2 | 0.01 | 23.0183 |
| 32019350000 | 29a | 07-Jul-94 | Walmer Country Club | 53460.000 | 3762645.000 | 249 | 13.0 | 1490 | 406 | 406 | 406 | 148 | 554 | 435 | 119 | 511 | 1.61 | 278 | 3.0 | 140 | 0.1 | 0.44 | 0.22133 |
| 32019350000 | 29a | 10-Aug-94 | Walmer Country Club | 53460.000 | 3762645.000 | 245 | | | | | | | | | | 436 | | | | 114 | 2.3 | | 10.1812 |
| 32019350000 | 29a | 21-Sep-94 | Walmer Country Club | 53460.000 | 3762645.000 | 246 | | 1590 | | | | | | | | 483 | | | | 125 | 6.6 | | 29.2156 |
| 32019350000 | 29a | 10-Nov-94 | Walmer Country Club | 53460.000 | 3762645.000 | 242 | | 1434 | | | | | | | | 482 | | | | 122 | 5.6 | | 24.789 |
| 32019350000 | 29a | 16-Mar-95 | Walmer Country Club | 53460.000 | 3762645.000 | 226 | | 1328 | | | | | | | | 413 | | | | 119 | 0.7 | | 3.09862 |
| 32019350000 | 29a | 06-Apr-95 | Walmer Country Club | 53460.000 | 3762645.000 | 232 | 0.3 | 1350 | 381 | 381 | 381 | 114 | 495 | 402 | 93 | 427 | 0.01 | 270 | 2.0 | 119 | 4.7 | 0.05 | 20.805 |
| 32019350000 | 44 | 15-Sep-94 | PEM King Edward Pk. | 53690.810 | 3762029.400 | 275 | | 1674 | | | | | | | | 719 | | | | 82 | 0.1 | | 0.22133 |
| 32019350000 | 44 | 12-Oct-94 | PEM King Edward Pk. | 53690.810 | 3762029.400 | 290 | 45.0 | 1886 | 64 | 64 | 64 | 373 | 437 | 195 | 242 | 834 | 0.01 | 411 | 10.0 | 117 | 0.1 | 0.05 | 0.22133 |
| 32019350000 | 44 | 13-Dec-94 | PEM King Edward Pk. | 53690.810 | 3762029.400 | 271 | | 1760 | | | | | | | | 803 | | | | 102 | 0.1 | | 0.22133 |
| 32019480000 | 27 | 18-Jun-93 | Telkom Club | 52540.000 | 3764120.000 | 405 | 0.6 | 2560 | 395 | 395 | 395 | 380 | 775 | 575 | 200 | 986 | 0.00 | 524 | 3.0 | 245 | 12.7 | 0.29 | 56.2178 |
| 32019480000 | 27 | 23-Jun-93 | Telkom Club | 52540.000 | 3764120.000 | 398 | 0.4 | 2388 | 371 | 371 | 371 | 217 | 588 | 452 | 136 | 1090 | 0.03 | 492 | 2.0 | 220 | 14.9 | 0.27 | 65.9563 |
| 32019480000 | 27 | 17-Jul-93 | Telkom Club | 52540.000 | 3764120.000 | 395 | | | | | | | | | | 959 | | | | | | | |
| 32019480000 | 27 | 10-Aug-93 | Telkom Club | 52540.000 | 3764120.000 | 392 | | | | | | | | | | 923 | | | | 233 | 16.0 | | 70.8256 |
| 32019480000 | 27 | 29-Sep-93 | Telkom Club | 52540.000 | 3764120.000 | 396 | 0.5 | 2250 | 391 | 391 | 391 | 457 | 848 | 640 | 208 | 922 | 0.01 | 544 | 9.0 | 268 | 1.5 | 0.23 | 6.6399 |
| 32019480000 | 27 | 25-Oct-93 | Telkom Club | 52540.000 | 3764120.000 | 376 | | | | | | | | | | 841 | | | | 20 | 16.0 | | 70.8256 |
| 32019480000 | 27 | 16-Nov-93 | Telkom Club | 52540.000 | 3764120.000 | 393 | | | | | | | | | | 789 | | | | 109 | 17.0 | | 75.2522 |
| 32019480000 | 27 | 14-Dec-93 | Telkom Club | 52540.000 | 3764120.000 | 375 | | | | | | | | | | 912 | | | | 205 | | | |
| 32019480000 | 27 | 19-Jan-94 | Telkom Club | 52540.000 | 3764120.000 | 383 | 0.4 | 2278 | 390 | 390 | 390 | 453 | 843 | 615 | 228 | 901 | | 576 | 6.8 | 197 | | | |
| 32019480000 | 27 | 22-Feb-94 | Telkom Club | 52540.000 | 3764120.000 | 390 | 0.8 | | 380 | 380 | 380 | 443 | 823 | 595 | 228 | 907 | | 580 | 8.9 | | 18.0 | | 79.6788 |
| 32019480000 | 27 | 17-Mar-94 | Telkom Club | 52540.000 | 3764120.000 | 384 | 5.0 | | 419 | 419 | | | | | | 860 | | | | 203 | 16.4 | | 72.5962 |
| 32019480000 | 27 | 21-Apr-94 | Telkom Club | 52540.000 | 3764120.000 | 397 | 0.7 | 2392 | 398 | 398 | 398 | 593 | 991 | 732 | 259 | 903 | 0.01 | 611 | 3.0 | 234 | 9.6 | 0.37 | 42.4954 |
| 32019480000 | 27 | 20-May-94 | Telkom Club | 52540.000 | 3764120.000 | 398 | 0.4 | 2296 | | | | | | | | 864 | | | | 203 | 13.5 | | 59.7591 |
| 32019480000 | 27 | 21-Jun-94 | Telkom Club | 52540.000 | 3764120.000 | 400 | 0.4 | 2416 | 399 | 399 | 399 | 446 | 845 | 620 | 225 | 892 | 0.05 | 554 | 7.0 | 214 | 16.0 | 0.05 | 70.8256 |
| 32019480000 | 27 | 07-Jul-94 | Telkom Club | 52540.000 | 3764120.000 | 400 | 0.2 | 2420 | 393 | 393 | 393 | 406 | 799 | 586 | 213 | 995 | 0.04 | 544 | 3.0 | 220 | 16.0 | 0.55 | 70.8256 |
| 32019480000 | 27 | 10-Aug-94 | Telkom Club | 52540.000 | 3764120.000 | 402 | | 2466 | | | | | | | | 851 | | | | 210 | 14.0 | | 61.9724 |
| 32019480000 | 27 | 20-Sep-94 | Telkom Club | 52540.000 | 3764120.000 | 383 | | 2404 | | | | | | | | 908 | | | | 203 | 13.0 | | 57.5458 |
| 32019480000 | 27 | 22-Sep-94 | Telkom Club | 52540.000 | 3764120.000 | 402 | | 2576 | | | | | | | | 940 | | | | 214 | 13.0 | | 57.5458 |
| 32019480000 | 27 | 12-Oct-94 | Telkom Club | 52540.000 | 3764120.000 | 394 | 2.1 | 2420 | 396 | 396 | 396 | 378 | 774 | 575 | 199 | 930 | 0.12 | 527 | 6.0 | 214 | 15.6 | 0.49 | 69.055 |
| 32019480000 | 27 | 10-Nov-94 | Telkom Club | 52540.000 | 3764120.000 | 407 | | 2452 | | | | | | | | 977 | | | | 231 | 15.4 | | 68.1696 |
| 32019480000 | 27 | 13-Dec-94 | Telkom Club | 52540.000 | 3764120.000 | 394 | | 2440 | | | | | | | | 978 | | | | 230 | 13.0 | | 57.5458 |
| 32019480000 | 27 | 05-Jan-95 | Telkom Club | 52540.000 | 3764120.000 | 391 | 1.2 | 2498 | 392 | 392 | 392 | 334 | 726 | 545 | 181 | 984 | 0.03 | 524 | 5.0 | 217 | 14.3 | 0.05 | 63.3004 |
| 32019480000 | 27 | 10-Jan-95 | Telkom Club | 52540.000 | 3764120.000 | 403 | 0.4 | 2526 | 412 | 412 | 412 | 409 | 821 | 608 | 213 | 896 | 0.01 | 540 | 5.0 | 213 | 15.8 | 0.05 | 69.9403 |
| 32019480000 | 27 | 09-Feb-95 | Telkom Club | 52540.000 | 3764120.000 | 384 | | 2350 | | | | | | | | 898 | | | | 143 | 17.0 | | 75.2522 |
| 32019480000 | 27 | 13-Mar-95 | Telkom Club | 52540.000 | 3764120.000 | 384 | | 2296 | | | | | | | | 871 | | | | 221 | 16.0 | | 70.8256 |
| 32019480000 | 27 | 16-Mar-95 | Telkom Club | 52540.000 | 3764120.000 | 394 | | 2312 | | | | | | | | 870 | | | | 221 | 15.0 | | 66.399 |
| 32019480000 | 27 | 10-Apr-95 | Telkom Club | 52540.000 | 3764120.000 | 392 | 1.2 | 2432 | 422 | 422 | 422 | 282 | 704 | 530 | 174 | 893 | 0.21 | 495 | 3.0 | 221 | 18.0 | 0.05 | 79.6788 |
| 32019480000 | 27 | 11-May-95 | Telkom Club | 52540.000 | 3764120.000 | 336 | | 2406 | | | | | | | | 843 | | | | 207 | 17.0 | | 75.2522 |
| 32019480000 | 27 | 01-Jun-95 | Telkom Club | 52540.000 | 3764120.000 | 380 | | 2256 | | | | | | | | 889 | | | | 229 | 9.0 | | 39.8394 |
| 32019480000 | 27 | 21-Jun-95 | Telkom Club | 52540.000 | 3764120.000 | | | | | | | | | | | | | | | | | | |
| 32019480000 | 26 | 18-Jun-93 | P.E. Kennel Club | 55654.200 | 3763403.950 | 225 | 1.2 | 1518 | 493 | 493 | 493 | 27 | 520 | 448 | 72 | 516 | 0.13 | 231 | 0.8 | 68 | 2.3 | 0.29 | 10.0041 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 32019480000 | 26 | 30-Aug-93 | P.E. Kennel Club | 55654.200 | 3763403.950 | 216 | 0.3 | 1480 | | | | | 517 | 431 | 86 | 510 | 0.04 | 228 | 3.0 | 100 | 2.2 | 0.17 | 9.73852 |
| 32019480000 | 26 | 29-Sep-93 | P.E. Kennel Club | 55654.200 | 3763403.950 | 234 | 0.5 | 1574 | 246 | 246 | 246 | 312 | 558 | 470 | 88 | 603 | 0.02 | 256 | 2.0 | 67 | 2.5 | 0.20 | 11.0665 |
| 32019480000 | 26 | 01-Nov-93 | P.E. Kennel Club | 55654.200 | 3763403.950 | 229 | | | | | | | | | | 646 | | | | 93 | 2.1 | | 9.29586 |
| 32019480000 | 26 | 16-Nov-93 | P.E. Kennel Club | 55654.200 | 3763403.950 | 235 | | | | | | | | | | 691 | | | | 104 | 1.7 | | 7.52522 |
| 32019480000 | 26 | 14-Dec-93 | P.E. Kennel Club | 55654.200 | 3763403.950 | 233 | | | | | | | | | | 580 | | | | 91 | | | |
| 32019480000 | 26 | 17-Mar-94 | P.E. Kennel Club | 55654.200 | 3763403.950 | 238 | 0.3 | | 223 | 223 | | | | | | 535 | | | | 99 | 2.6 | | 11.5092 |
| 32019480000 | 26 | 07-Jul-94 | P.E. Kennel Club | 55654.200 | 3763403.950 | 241 | 0.2 | 1560 | 226 | 226 | 226 | 302 | 528 | 412 | 116 | 609 | 0.06 | 272 | 1.0 | 92 | 2.8 | 0.22 | 12.3945 |
| 32019480000 | 26 | 31-Aug-94 | P.E. Kennel Club | 55654.200 | 3763403.950 | 218 | 0.6 | | | | | | | | | 479 | | | | 70 | 2.7 | 0.27 | 11.9518 |
| 32019480000 | 26 | 22-Sep-94 | P.E. Kennel Club | 55654.200 | 3763403.950 | 215 | | 1380 | | | | | | | | 477 | | | | 74 | 2.8 | | 12.3945 |
| 32019480000 | 26 | 10-Nov-94 | P.E. Kennel Club | 55654.200 | 3763403.950 | 210 | | 1414 | | | | | | | | 487 | | | | 73 | 2.5 | | 11.0665 |
| 32019480000 | 26 | 13-Dec-94 | P.E. Kennel Club | 55654.200 | 3763403.950 | 241 | | 1612 | | | | | | | | 592 | | | | 99 | 1.8 | | 7.96788 |
| 32019480000 | 26 | 05-Jan-95 | P.E. Kennel Club | 55654.200 | 3763403.950 | 220 | 0.4 | 1482 | 256 | 256 | 256 | 230 | 486 | 421 | 65 | 511 | 0.03 | 230 | 0.7 | 79 | 2.1 | 0.50 | 9.29586 |
| 32019480000 | 39 | 21-Jul-93 | Victoria Park | 57035.000 | 3760815.000 | 274 | | | | | | | | | | 548 | | | | | | | 0 |
| 32019480000 | 39 | 10-Aug-93 | Victoria Park | 57035.000 | 3760815.000 | 283 | | | | | | | | | | 525 | | | | 173 | 24.0 | | 106.238 |
| 32019480000 | 39 | 14-Sep-93 | Victoria Park | 57035.000 | 3760815.000 | 275 | 0.4 | 1792 | 327 | 327 | 327 | 374 | 701 | 526 | 175 | 560 | 0.11 | 328 | 6.0 | 158 | 14.0 | 0.59 | 61.9724 |
| 32019480000 | 39 | 09-Mar-94 | Victoria Park | 57035.000 | 3760815.000 | 180 | 1.1 | | 193 | 193 | | | | | | 372 | | | | 65 | 9.1 | | 40.2821 |
| 32019480000 | 39 | 12-Oct-94 | Victoria Park | 57035.000 | 3760815.000 | 279 | 0.3 | 1764 | 343 | 343 | 343 | 343 | 686 | 531 | 155 | 596 | 0.02 | 314 | 4.0 | 160 | 15.0 | 0.25 | 66.399 |
| 32019480000 | 39 | 09-Feb-95 | Victoria Park | 57035.000 | 3760815.000 | 277 | | 1552 | | | | | | | | 336 | | | | 153 | 15.8 | | 69.9403 |
| 32019480000 | 39 | 10-Mar-95 | Victoria Park | 57035.000 | 3760815.000 | 281 | | 1796 | | | | | | | | 549 | | | | 162 | 20.0 | | 88.532 |
| 32019480000 | 39 | 11-Apr-95 | Victoria Park | 57035.000 | 3760815.000 | 290 | 0.4 | 1882 | 372 | 372 | 372 | 253 | 625 | 490 | 135 | 602 | 0.21 | 333 | 3.0 | 162 | 18.0 | 0.17 | 79.6788 |
| 32019480000 | 39 | 09-May-95 | Victoria Park | 57035.000 | 3760815.000 | 277 | | 1682 | | | | | | | | 539 | | | | 133 | 7.4 | | 32.7568 |
| 32019480000 | 39 | 12-Jun-95 | Victoria Park | 57035.000 | 3760815.000 | 277 | | 1828 | | | | | | | | 579 | | | | 157 | 15.0 | | 66.399 |
| 32019810000 | 3 | 03-Jun-93 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 165 | 0.2 | 900 | 197 | 197 | 197 | 83 | 280 | 206 | 74 | 339 | 0.04 | 215 | 4.0 | 57 | 4.8 | 0.17 | 21.2477 |
| 32019810000 | 3 | 10-Aug-93 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 163 | | | | | | | | | | 324 | | | | 64 | 4.3 | | 19.0344 |
| 32019810000 | 3 | 14-Sep-93 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 167 | 3.6 | 904 | 209 | 209 | 209 | 81 | 290 | 207 | 83 | 354 | 2.60 | 243 | 3.0 | 67 | 3.4 | 0.26 | 15.0504 |
| 32019810000 | 3 | 11-Nov-93 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 168 | | | | | | | | | | 349 | | | | 59 | 4.0 | | 17.7064 |
| 32019810000 | 3 | 14-Jan-94 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 162 | 0.3 | 936 | 206 | 206 | 206 | 58 | 264 | 194 | 70 | 277 | 0.39 | 212 | 3.0 | 63 | 4.4 | 0.25 | 19.477 |
| 32019810000 | 3 | 08-Feb-94 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 162 | 0.4 | | 203 | 203 | 203 | 113 | 316 | 234 | 82 | 334 | | 238 | 6.0 | 63 | 4.1 | | 18.1491 |
| 32019810000 | 3 | 09-Mar-94 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 165 | 3.4 | | 204 | 204 | | | | | | 353 | | | | 35 | 4.5 | | 19.9197 |
| 32019810000 | 3 | 14-Apr-94 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 175 | 0.5 | 926 | 224 | 224 | 224 | 143 | 367 | 276 | 91 | 417 | 0.04 | 276 | 5.0 | 74 | 3.4 | 0.40 | 15.0504 |
| 32019810000 | 3 | 09-May-94 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 167 | 0.3 | 942 | 208 | 208 | | | | | | 344 | | | | 62 | 4.4 | | 19.477 |
| 32019810000 | 3 | 14-Jun-94 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 166 | | | | | | | | | | 345 | | | | 70 | 4.3 | | 19.0344 |
| 32019810000 | 3 | 14-Jul-94 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 169 | 0.2 | 930 | 213 | 213 | 213 | 70 | 283 | 205 | 78 | 375 | 0.05 | 223 | 3.0 | 60 | 4.7 | 0.19 | 20.805 |
| 32019810000 | 3 | 21-Sep-94 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 172 | | 960 | | | | | | | | 359 | | | | 62 | 4.4 | | 19.477 |
| 32019810000 | 3 | 12-Oct-94 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 168 | 0.2 | 972 | 216 | 216 | 216 | 79 | 295 | 216 | 78 | 355 | 0.05 | 224 | 5.0 | 66 | 4.6 | 0.24 | 20.3624 |
| 32019810000 | 3 | 10-Jan-95 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 132 | 27.0 | 952 | 163 | 163 | 163 | 65 | 228 | 169 | 59 | 269 | 3.26 | 175 | 3.0 | 48 | 3.3 | 0.11 | 14.6078 |
| 32019810000 | 3 | 09-Feb-95 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 170 | | 906 | | | | | | | | 344 | | | | 70 | 5.0 | | 22.133 |
| 32019810000 | 3 | 13-Mar-95 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 171 | | 984 | | | | | | | | 358 | | | | 66 | 4.7 | | 20.805 |
| 32019810000 | 3 | 28-Jun-95 | 12 Newcombe Avenue | 50109.560 | 3763293.540 | 170 | | 996 | | | | | | | | 406 | | | | 66 | 4.5 | | 19.9197 |
| 32019820000 | 4 | 03-Jun-93 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 275 | 0.7 | 1642 | 156 | 156 | 156 | 343 | 499 | 353 | 146 | 686 | 0.10 | 308 | 7.0 | 118 | 4.6 | 0.14 | 20.3624 |
| 32019820000 | 4 | 10-Aug-93 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 267 | | | | | | | | | | 712 | | | | 130 | 4.6 | | 20.3624 |
| 32019820000 | 4 | 14-Sep-93 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 265 | 0.5 | 1644 | 156 | 156 | 156 | 360 | 516 | 350 | 166 | 704 | 0.03 | 373 | 9.0 | 123 | 3.3 | 0.16 | 14.6078 |
| 32019820000 | 4 | 11-Nov-93 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 269 | | | | | | | | | | 635 | | | | 120 | 3.1 | | 13.7225 |
| 32019820000 | 4 | 12-Jan-94 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 265 | 0.3 | 1506 | 150 | 150 | 150 | 280 | 430 | 304 | 126 | 491 | 0.01 | 302 | 5.0 | 122 | | 0.23 | |
| 32019820000 | 4 | 08-Feb-94 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 260 | 1.8 | | 149 | 149 | 149 | 356 | 505 | 359 | 146 | 643 | | 359 | 6.0 | 117 | 3.1 | | 13.7225 |
| 32019820000 | 4 | 09-Mar-94 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 266 | 12.0 | | 148 | 148 | | | | | | 644 | | | | 107 | 4.1 | | 18.1491 |
| 32019820000 | 4 | 09-May-94 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 263 | 3.5 | 1672 | 151 | 151 | | | | | | 705 | | | | 130 | 3.4 | | 15.0504 |
| 32019820000 | 4 | 14-Jun-94 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 263 | | | | | | | | | | 645 | | | | 130 | 4.1 | | 18.1491 |
| 32019820000 | 4 | 21-Sep-94 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 258 | | 1644 | | | | | | | | 630 | | | | 115 | 4.4 | | 19.477 |
| 32019820000 | 4 | 20-Dec-94 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 258 | | 1564 | | | | | | | | | | | | | 4.5 | | 19.9197 |
| 32019820000 | 4 | 10-Jan-95 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 261 | 3.0 | 1630 | 158 | 158 | 158 | 303 | 461 | 334 | 127 | 605 | 0.23 | 331 | 7.0 | 117 | 3.7 | 0.05 | 16.3784 |
| 32019820000 | 4 | 09-Feb-95 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 253 | | 1466 | | | | | | | | 525 | | | | 122 | 4.8 | | 21.2477 |
| 32019820000 | 4 | 13-Mar-95 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 247 | | 1432 | | | | | | | | 642 | | | | 120 | 4.3 | | 19.0344 |
| 32019820000 | 4 | 11-Apr-95 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 253 | 19.0 | 1494 | 162 | 162 | 162 | 245 | 407 | 293 | 114 | 644 | 5.30 | 336 | 6.0 | 108 | 2.9 | 0.05 | 12.8371 |
| 32019820000 | 4 | 09-May-95 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 252 | | 1504 | | | | | | | | 579 | | | | 95 | 3.4 | | 15.0504 |
| 32019820000 | 4 | 28-Jun-95 | 10 Idylwylde Crescent | 51139.000 | 3763234.000 | 249 | | 1400 | | | | | | | | 667 | | | | 112 | 4.6 | | 20.3624 |
| 32025500000 | 36 | 15-Jul-93 | 74 River Road | 53623.000 | 3760684.000 | 348 | 12.0 | 2270 | 164 | 164 | 164 | 357 | 521 | 268 | 253 | 1149 | 1.40 | 467 | 2.6 | 125 | 9.8 | 0.41 | 43.3807 |
| 32025500000 | 36 | 17-Jul-93 | 74 River Road | 53623.000 | 3760684.000 | 365 | | | | | | | | | | 992 | | | | | | | |
| 32025500000 | 36 | 10-Aug-93 | 74 River Road | 53623.000 | 3760684.000 | 362 | | | | | | | | | | 972 | | | | 151 | 9.2 | | 40.7247 |
| 32025500000 | 36 | 14-Sep-93 | 74 River Road | 53623.000 | 3760684.000 | 364 | 4.8 | 2298 | 174 | 174 | 174 | 391 | 565 | 284 | 281 | 1049 | 0.18 | 535 | 5.0 | 141 | 9.2 | 0.35 | 40.7247 |
| 32025500000 | 36 | 16-Nov-93 | 74 River Road | 53623.000 | 3760684.000 | 351 | | | | | | | | | | 1245 | | | | 161 | 10.0 | | 44.266 |
| 32025500000 | 36 | 12-Jan-94 | 74 River Road | 53623.000 | 3760684.000 | 347 | 54.0 | 2156 | 147 | 147 | 147 | 371 | 513 | 250 | 263 | 1018 | 4.35 | 508 | 1.3 | 129 | | 0.26 | |
| 32025500000 | 36 | 08-Feb-94 | 74 River Road | 53623.000 | 3760684.000 | 340 | 21.0 | | 139 | 139 | 139 | 433 | 572 | 283 | 289 | 873 | | 535 | 2.0 | 132 | 5.4 | | 23.9036 |
| 32025500000 | 36 | 09-Mar-94 | 74 River Road | 53623.000 | 3760684.000 | 349 | 16.0 | | 149 | 149 | | | | | | 922 | | | | | 10.4 | | 46.0366 |
| 32025500000 | 36 | 14-Apr-94 | 74 River Road | 53623.000 | 3760684.000 | 347 | 65.0 | 2244 | 146 | 146 | 146 | 442 | 588 | 294 | 294 | 932 | 13.70 | 516 | 2.0 | 132 | 11.1 | 0.30 | 49.1353 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 32025500000 | 36 | 09-May-94 | 74 River Road | 53623.000 | 3760684.000 | 352 | 25.0 | 2218 | 157 | 157 | | | | | | 939 | | | | 167 | 5.5 | | 24.3463 |
| 32025500000 | 36 | 15-Sep-94 | 74 River Road | 53623.000 | 3760684.000 | 348 | | 2120 | | | | | | | | 873 | | | | 130 | 11.0 | | 48.6926 |
| 32025500000 | 36 | 12-Oct-94 | 74 River Road | 53623.000 | 3760684.000 | 379 | 15.0 | 2779 | 162 | 162 | 162 | 624 | 786 | 585 | 201 | 1078 | 0.02 | 453 | 13.0 | 119 | | 0.21 | |
| 32026390000 | 17 | 07-Jun-93 | 10 4th Avenue | 55800.000 | 3761360.000 | 126 | 0.4 | 878 | 334 | 334 | 334 | 30 | 364 | 295 | 69 | 156 | 0.01 | 124 | 2.0 | 86 | 11.0 | 0.17 | 48.7811 |
| 32026390000 | 17 | 17-Jul-93 | 10 4th Avenue | 55800.000 | 3761360.000 | 124 | | | | | | | | | | 118 | | | | | | | |
| 32026390000 | 17 | 10-Aug-93 | 10 4th Avenue | 55800.000 | 3761360.000 | 121 | | | | | | | | | | 117 | | | | 62 | 13.0 | | 57.5458 |
| 32026390000 | 17 | 14-Sep-93 | 10 4th Avenue | 55800.000 | 3761360.000 | 127 | 0.2 | 966 | 346 | 346 | 346 | 31 | 377 | 296 | 81 | 174 | 0.13 | 137 | 3.0 | 41 | 12.0 | 0.28 | 53.1192 |
| 32026390000 | 17 | 16-Nov-93 | 10 4th Avenue | 55800.000 | 3761360.000 | 123 | | | | | | | | | | 178 | | | | 73 | 14.0 | | 61.9724 |
| 32026390000 | 17 | 12-Jan-94 | 10 4th Avenue | 55800.000 | 3761360.000 | 118 | 0.4 | 840 | 330 | 330 | 330 | 3 | 333 | 266 | 67 | 117 | 0.04 | 113 | 1.9 | 47 | | 0.15 | |
| 32026390000 | 17 | 08-Feb-94 | 10 4th Avenue | 55800.000 | 3761360.000 | 115 | 1.2 | | 325 | 325 | 325 | 41 | 366 | 296 | 70 | 115 | | 113 | 2.0 | 56 | 9.3 | | 41.1674 |
| 32026390000 | 17 | 09-Mar-94 | 10 4th Avenue | 55800.000 | 3761360.000 | 120 | 0.9 | | 324 | 324 | | | | | | 130 | | | | 41 | 11.0 | | 48.6926 |
| 32026390000 | 17 | 14-Apr-94 | 10 4th Avenue | 55800.000 | 3761360.000 | 116 | 0.2 | 786 | 324 | 324 | 324 | 67 | 391 | 314 | 77 | 120 | 0.01 | 129 | 1.4 | 52 | 8.6 | 0.25 | 38.0688 |
| 32026390000 | 17 | 09-May-94 | 10 4th Avenue | 55800.000 | 3761360.000 | 119 | 0.3 | 778 | 328 | 328 | | | | | | 128 | | | | 56 | 10.2 | | 45.1513 |
| 32026390000 | 17 | 09-Jun-94 | 10 4th Avenue | 55800.000 | 3761360.000 | 125 | | 828 | | | | | | | | 138 | | | | 58 | 12.4 | | 54.8898 |
| 32026390000 | 17 | 10-Aug-94 | 10 4th Avenue | 55800.000 | 3761360.000 | 123 | | 896 | | | | | | | | 130 | | | | 52 | 13.0 | | 57.5458 |
| 32026390000 | 17 | 15-Sep-94 | 10 4th Avenue | 55800.000 | 3761360.000 | 122 | | 840 | | | | | | | | 122 | | | | 53 | 12.0 | | 53.1192 |
| 32026390000 | 17 | 13-Dec-94 | 10 4th Avenue | 55800.000 | 3761360.000 | 117 | | 802 | | | | | | | | 121 | | | | 52 | 7.4 | | 32.7568 |
| 32026390000 | 17 | 10-Jan-95 | 10 4th Avenue | 55800.000 | 3761360.000 | 118 | 0.2 | 828 | 338 | 338 | 338 | 12 | 350 | 287 | 63 | 118 | 0.04 | 115 | 2.0 | 53 | 10.5 | 0.12 | 46.4793 |
| 32026390000 | 17 | 09-Feb-95 | 10 4th Avenue | 55800.000 | 3761360.000 | 123 | | 838 | | | | | | | | 119 | | | | 56 | 11.8 | | 52.2339 |
| 32026390000 | 17 | 10-Mar-95 | 10 4th Avenue | 55800.000 | 3761360.000 | 116 | | 788 | | | | | | | | 121 | | | | 57 | 11.0 | | 48.6926 |
| 32026390000 | 17 | 12-Jun-95 | 10 4th Avenue | 55800.000 | 3761360.000 | 121 | | 862 | | | | | | | | 127 | | | | 56 | 11.0 | | 48.6926 |
| 32029010000 | 12 | 04-Jun-93 | 6 Club Road | 52363.000 | 3760931.000 | 251 | 110.0 | 1634 | 173 | 173 | 173 | 207 | 380 | 184 | 196 | 634 | 23.10 | 336 | 3.0 | 80 | 0.1 | 0.27 | 0.22133 |
| 32029010000 | 12 | 17-Jul-93 | 6 Club Road | 52363.000 | 3760931.000 | 260 | | | | | | | | | | 636 | | | | | | | |
| 32029010000 | 12 | 10-Aug-93 | 6 Club Road | 52363.000 | 3760931.000 | 233 | | | | | | | | | | 564 | | | | 80 | 0.1 | | 0.44266 |
| 32029010000 | 12 | 16-Nov-93 | 6 Club Road | 52363.000 | 3760931.000 | 223 | | | | | | | | | | 444 | | | | 59 | 0.1 | | 0.22133 |
| 32029010000 | 12 | 12-Jan-94 | 6 Club Road | 52363.000 | 3760931.000 | 219 | 49.0 | 1426 | 141 | 141 | 141 | 119 | 260 | 138 | 122 | 408 | 2.70 | 306 | 2.0 | 48 | 0.1 | 0.25 | 0.22133 |
| 32029010000 | 12 | 08-Feb-94 | 6 Club Road | 52363.000 | 3760931.000 | 221 | 25.0 | | 133 | 133 | 133 | 188 | 321 | 170 | 151 | 583 | | 358 | 8.0 | 56 | 0.1 | | 0.22133 |
| 32029010000 | 12 | 09-Mar-94 | 6 Club Road | 52363.000 | 3760931.000 | 223 | 13.0 | | 125 | 125 | | | | | | 543 | | | | 53 | 0.1 | | 0.22133 |
| 32029010000 | 12 | 14-Apr-94 | 6 Club Road | 52363.000 | 3760931.000 | 227 | 32.0 | 1366 | 145 | 145 | 145 | 207 | 352 | 194 | 158 | 611 | 4.76 | 382 | 6.0 | 53 | 0.1 | 0.14 | 0.22133 |
| 32029010000 | 12 | 09-May-94 | 6 Club Road | 52363.000 | 3760931.000 | 225 | 52.0 | 1358 | 145 | 145 | | | | | | 590 | | | | 84 | 0.1 | | 0.22133 |
| 32029010000 | 12 | 09-Jun-94 | 6 Club Road | 52363.000 | 3760931.000 | 227 | | 1310 | | | | | | | | 586 | | | | 58 | 0.1 | | 0.22133 |
| 32029010000 | 12 | 14-Jul-94 | 6 Club Road | 52363.000 | 3760931.000 | 258 | 16.5 | 1608 | 197 | 197 | 197 | 200 | 397 | 213 | 184 | 694 | 2.12 | 376 | 3.0 | 70 | 0.1 | 0.27 | 0.22133 |
| 32029010000 | 12 | 10-Aug-94 | 6 Club Road | 52363.000 | 3760931.000 | 247 | | 1568 | | | | | | | | 522 | | | | 82 | | | |
| 32029010000 | 12 | 15-Sep-94 | 6 Club Road | 52363.000 | 3760931.000 | 232 | | 1468 | | | | | | | | 572 | | | | 58 | 0.1 | | 0.22133 |
| 32029010000 | 12 | 12-Oct-94 | 6 Club Road | 52363.000 | 3760931.000 | 242 | 22.0 | 1618 | 193 | 193 | 193 | 159 | 352 | 189 | 163 | 619 | 0.78 | 360 | 7.0 | 60 | 0.1 | 0.19 | 0.22133 |
| 32029010000 | 12 | 12-Dec-94 | 6 Club Road | 52363.000 | 3760931.000 | 222 | | 1428 | | | | | | | | 603 | | | | 53 | 0.1 | | 0.22133 |
| 32029010000 | 12 | 10-Jan-95 | 6 Club Road | 52363.000 | 3760931.000 | 228 | 6.6 | 1484 | 154 | 154 | 154 | 137 | 291 | 160 | 131 | 545 | 0.09 | 336 | 6.0 | 54 | 0.1 | 0.05 | 0.22133 |
| 32029010000 | 12 | 09-Feb-95 | 6 Club Road | 52363.000 | 3760931.000 | 225 | | 1412 | | | | | | | | 554 | | | | 66 | 0.0 | | 0.04427 |
| 32029010000 | 12 | 10-Mar-95 | 6 Club Road | 52363.000 | 3760931.000 | 227 | | 1536 | | | | | | | | 584 | | | | 63 | 0.0 | | 0.04427 |
| 32029010000 | 12 | 13-Mar-95 | 6 Club Road | 52363.000 | 3760931.000 | 227 | | 1276 | | | | | | | | 538 | | | | 61 | 0.2 | | 0.66399 |
| 32029010000 | 12 | 11-Apr-95 | 6 Club Road | 52363.000 | 3760931.000 | 227 | 25.0 | 1390 | 160 | 160 | 160 | 124 | 284 | 151 | 133 | 600 | 3.39 | 350 | 8.0 | 49 | 0.0 | 0.18 | 0.02213 |
| 32029010000 | 12 | 11-May-95 | 6 Club Road | 52363.000 | 3760931.000 | 214 | | 1452 | | | | | | | | 618 | | | | 56 | 0.1 | | 0.22133 |
| 32029010000 | 12 | 12-Jun-95 | 6 Club Road | 52363.000 | 3760931.000 | 259 | | 1592 | | | | | | | | 679 | | | | 66 | 0.1 | | 0.44266 |
| 32029010000 | 35 | 15-Jul-93 | 98 Verdun Road | 46923.000 | 3760663.000 | 101 | 25.0 | 659 | 59 | 59 | 59 | 60 | 119 | 54 | 65 | 258 | 7.78 | 128 | 0.7 | 3 | 0.0 | 0.22 | 0.08853 |
| 32029010000 | 35 | 10-Aug-93 | 98 Verdun Road | 46923.000 | 3760663.000 | 96 | | | | | | | | | | 248 | | | | 10 | 0.1 | | 0.22133 |
| 32029010000 | 35 | 14-Sep-93 | 98 Verdun Road | 46923.000 | 3760663.000 | 102 | 24.0 | 720 | 52 | 52 | 52 | 93 | 145 | 61 | 84 | 268 | 6.57 | 161 | 1.0 | 20 | 0.1 | 0.17 | 0.22133 |
| 32029010000 | 35 | 11-Nov-93 | 98 Verdun Road | 46923.000 | 3760663.000 | 98 | | | | | | | | | | 249 | | | | 20 | 0.1 | | 0.22133 |
| 32029010000 | 35 | 12-Jan-94 | 98 Verdun Road | 46923.000 | 3760663.000 | 97 | 64.0 | 682 | 57 | 57 | 57 | 65 | 122 | 53 | 69 | 246 | 4.72 | 137 | 1.2 | 12 | 0.1 | 0.14 | 0.22133 |
| 32029010000 | 35 | 08-Feb-94 | 98 Verdun Road | 46923.000 | 3760663.000 | 102 | 36.0 | | 65 | 65 | 65 | 99 | 164 | 73 | 91 | 247 | | 158 | 6.0 | 25 | 0.1 | | 0.22133 |
| 32029010000 | 35 | 09-Mar-94 | 98 Verdun Road | 46923.000 | 3760663.000 | 101 | 14.0 | | 63 | 63 | | | | | | 248 | | | | 19 | 0.1 | | 0.22133 |
| 32029010000 | 35 | 14-Apr-94 | 98 Verdun Road | 46923.000 | 3760663.000 | 103 | 51.0 | 696 | 55 | 55 | 55 | 85 | 140 | 55 | 85 | 265 | 16.60 | 159 | 2.0 | 24 | 0.1 | 0.16 | 0.22133 |
| 32029010000 | 35 | 09-May-94 | 98 Verdun Road | 46923.000 | 3760663.000 | 106 | 23.0 | 602 | 72 | 72 | | | | | | 278 | | | | 29 | 0.1 | | 0.22133 |
| 32029010000 | 35 | 09-Jun-94 | 98 Verdun Road | 46923.000 | 3760663.000 | 103 | | 618 | | | | | | | | 259 | | | | 22 | 0.1 | | 0.22133 |
| 32029010000 | 35 | 07-Jul-94 | 98 Verdun Road | 46923.000 | 3760663.000 | 96 | 75.0 | 662 | 57 | 57 | 57 | 59 | 116 | 46 | 70 | 263 | 12.30 | 124 | 1.0 | 29 | 0.1 | 0.08 | 0.22133 |
| 32029010000 | 35 | 21-Sep-94 | 98 Verdun Road | 46923.000 | 3760663.000 | 96 | | 620 | | | | | | | | 251 | | | | 14 | 0.1 | | 0.22133 |
| 32029010000 | 35 | 13-Dec-94 | 98 Verdun Road | 46923.000 | 3760663.000 | 100 | | 628 | | | | | | | | 268 | | | | 21 | 0.1 | | 0.22133 |
| 32029010000 | 35 | 09-Feb-95 | 98 Verdun Road | 46923.000 | 3760663.000 | 105 | | 728 | | | | | | | | 260 | | | | 25 | 0.0 | | 0.04427 |
| 36000930000 | 35 | 28-Jun-95 | 98 Verdun Road | 46923.000 | 3760663.000 | 105 | | 586 | | | | | | | | 322 | | | | 28 | 0.1 | | 0.22133 |
| 36011250000 | 41 | 10-Aug-93 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 334 | | | | | | | | | | 958 | | | | 94 | 0.1 | | 0.22133 |
| 36011250000 | 41 | 14-Sep-93 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 356 | 49.0 | 2208 | 170 | 170 | 170 | 367 | 537 | 264 | 273 | 1082 | 6.91 | 592 | 12.0 | 73 | 0.1 | 0.46 | 0.22133 |
| 36011250000 | 41 | 11-Nov-93 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 341 | | | | | | | | | | 891 | | | | 110 | 0.1 | | 0.22133 |
| 36011250000 | 41 | 08-Feb-94 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 358 | 23.0 | | 164 | 164 | 164 | 378 | 542 | 274 | 268 | 986 | | 587 | 16.0 | 94 | 0.1 | | 0.22133 |
| 36011250000 | 41 | 09-Mar-94 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 363 | 55.0 | | 171 | 171 | | | | | | 958 | | | | 82 | 0.1 | | 0.22133 |
| 36011250000 | 41 | 14-Apr-94 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 311 | 40.0 | 1518 | 170 | 170 | 170 | 294 | 464 | 237 | 227 | 872 | 5.36 | 508 | 10.0 | 93 | 0.1 | 0.40 | 0.22133 |
| 36011250000 | 41 | 09-Jun-94 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 305 | | 1824 | | | | | | | | 824 | | | | 85 | 0.1 | | 0.22133 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 36011250000 | 41 | 13-Jul-94 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 370 | 21.0 | 2244 | 180 | 180 | 180 | 258 | 438 | 206 | 232 | 1076 | 2.61 | 548 | 5.0 | 79 | 0.1 | 0.47 | 0.22133 |
| 36011250000 | 41 | 10-Aug-94 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 262 | | 1654 | | | | | | | | 695 | | | | 64 | 0.1 | | 0.22133 |
| 36011250000 | 41 | 14-Sep-94 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 340 | | 2132 | | | | | | | | 983 | | | | 84 | 0.3 | | 1.32798 |
| 36011250000 | 41 | 12-Oct-94 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 366 | 51.0 | 2320 | 184 | 184 | 184 | 295 | 479 | 247 | 232 | 1035 | 0.24 | 572 | 13.0 | 86 | 0.1 | 0.53 | 0.22133 |
| 36011250000 | 41 | 12-Dec-94 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 364 | | 2284 | | | | | | | | 1104 | | | | 86 | 0.1 | | 0.22133 |
| 36011250000 | 41 | 10-Jan-95 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 375 | 5.4 | 2324 | 151 | 151 | 151 | 296 | 447 | 218 | 229 | 951 | 0.15 | 558 | 12.0 | 91 | 0.1 | 0.05 | 0.22133 |
| 36011250000 | 41 | 09-Feb-95 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 325 | | 1850 | | | | | | | | 835 | | | | 89 | 0.0 | | 0.04427 |
| 36011250000 | 41 | 10-Mar-95 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 195 | | 1452 | | | | | | | | 458 | | | | 81 | 0.0 | | 0.04427 |
| 36011250000 | 41 | 20-Apr-95 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 279 | 34.0 | 1676 | 132 | 132 | 132 | 231 | 363 | 175 | 188 | 803 | 9.05 | 420 | 9.0 | 79 | 0.0 | 0.19 | 0.02213 |
| 36011250000 | 41 | 11-May-95 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 223 | | 1374 | | | | | | | | 600 | | | | 82 | 0.1 | | 0.22133 |
| 36011250000 | 41 | 28-Jun-95 | 308 Kragga Kamma | 39775.92 | 3761278.55 | 278 | | 1600 | | | | | | | | 716 | | | | 74 | 0.1 | | 0.22133 |
| 99003510000 | 10 | 03-Jun-93 | Scotsam | 47018.779 | 3765034.790 | 279 | 0.2 | 1580 | 251 | 251 | 251 | 109 | 360 | 276 | 84 | 626 | 0.11 | 412 | 3.0 | 179 | 2.1 | 0.22 | 9.29586 |
| 99003510000 | 10 | 10-Aug-93 | Scotsam | 47018.779 | 3765034.790 | 223 | | | | | | | | | | 500 | | | | 128 | 2.3 | | 10.1812 |
| 99003510000 | 10 | 11-Nov-93 | Scotsam | 47018.779 | 3765034.790 | 245 | | | | | | | | | | 517 | | | | 90 | 2.0 | | 8.8532 |
| 99003510000 | 10 | 12-Jan-94 | Scotsam | 47018.779 | 3765034.790 | 230 | 0.2 | 1346 | 235 | 235 | 235 | 53 | 288 | 220 | 68 | 557 | 0.02 | 332 | 2.2 | 135 | 2.5 | 0.19 | 11.0665 |
| 99003510000 | 10 | 08-Feb-94 | Scotsam | 47018.779 | 3765034.790 | 248 | 0.7 | | 229 | 229 | 229 | 151 | 380 | 287 | 93 | 560 | | 412 | 6.0 | 147 | 2.2 | | 9.73852 |
| 99003510000 | 10 | 14-Apr-94 | Scotsam | 47018.779 | 3765034.790 | 246 | 0.2 | 1358 | 245 | 245 | 245 | 60 | 305 | 233 | 72 | 550 | 1.86 | 373 | 5.0 | 139 | 2.3 | 0.18 | 10.1812 |
| 99003510000 | 10 | 09-May-94 | Scotsam | 47018.779 | 3765034.790 | 248 | 0.4 | 1382 | 244 | 244 | | | | | | 511 | | | | 153 | 2.5 | | 11.0665 |
| 99003510000 | 10 | 14-Jun-94 | Scotsam | 47018.779 | 3765034.790 | 225 | | | | | | | | | | 480 | | | | 126 | 2.4 | | 10.6238 |
| 99003510000 | 10 | 14-Jul-94 | Scotsam | 47018.779 | 3765034.790 | 244 | 0.2 | 1382 | 251 | 251 | 251 | 44 | 295 | 222 | 73 | 551 | 0.02 | 416 | 2.0 | 132 | 2.6 | 0.20 | 11.5092 |
| 99003510000 | 10 | 10-Aug-94 | Scotsam | 47018.779 | 3765034.790 | 246 | | 1506 | | | | | | | | 499 | | | | 130 | 3.0 | | 13.2798 |
| 99003510000 | 10 | 21-Sep-94 | Scotsam | 47018.779 | 3765034.790 | 242 | | 1414 | | | | | | | | 524 | | | | 132 | 2.9 | | 12.8371 |
| 99003510000 | 10 | 20-Dec-94 | Scotsam | 47018.779 | 3765034.790 | 225 | | 1314 | | | | | | | | 489 | | | | 127 | 2.4 | | 10.6238 |
| 99003510000 | 10 | 10-Jan-95 | Scotsam | 47018.779 | 3765034.790 | 247 | 0.2 | 1428 | 257 | 257 | 257 | 62 | 319 | 245 | 74 | 500 | 0.02 | 388 | 6.0 | 140 | 3.3 | 0.42 | 14.6078 |
| 99003510000 | 10 | 13-Feb-95 | Scotsam | 47018.779 | 3765034.790 | 243 | | 1552 | | | | | | | | 528 | | | | 151 | 3.0 | | 13.2798 |
| 99003510000 | 10 | 13-Mar-95 | Scotsam | 47018.779 | 3765034.790 | 247 | | 1384 | | | | | | | | 518 | | | | 135 | 3.1 | | 13.7225 |
| 99003510000 | 10 | 20-Apr-95 | Scotsam | 47018.779 | 3765034.790 | 251 | 0.3 | 1370 | 251 | 251 | 251 | 70 | 321 | 247 | 74 | 553 | 0.00 | 399 | 6.0 | 162 | 3.1 | 0.16 | 13.7225 |
| 99003510000 | 10 | 11-May-95 | Scotsam | 47018.779 | 3765034.790 | 241 | | 1324 | | | | | | | | 517 | | | | 141 | 3.6 | | 15.9358 |
| 99003510000 | 10 | 21-Jun-95 | Scotsam | 47018.779 | 3765034.790 | | | | | | | | | | | | | | | | | | |
| 99007400000 | 9 | 03-Jun-93 | Sardinia Bay | 48140.731 | 3764679.926 | 109 | 0.2 | 646 | 203 | 203 | 203 | 78 | 281 | 223 | 58 | 176 | 0.07 | 91 | 3.0 | 37 | 5.3 | 0.24 | 23.461 |
| 99007400000 | 9 | 10-Aug-93 | Sardinia Bay | 48140.731 | 3764679.926 | 103 | | | | | | | | | | 145 | | | | 82 | 4.4 | | 19.477 |
| 99007400000 | 9 | 14-Sep-93 | Sardinia Bay | 48140.731 | 3764679.926 | 105 | 0.2 | 658 | 209 | 209 | 209 | 82 | 291 | 220 | 71 | 148 | 0.34 | 109 | 4.0 | 43 | 3.6 | 0.36 | 15.9358 |
| 99007400000 | 9 | 20-Sep-93 | Sardinia Bay | 48140.731 | 3764679.926 | | | | | | | | | | | | | | | | | | |
| 99007400000 | 9 | 11-Nov-93 | Sardinia Bay | 48140.731 | 3764679.926 | 107 | | | | | | | | | | 161 | | | | 33 | 4.7 | | 20.805 |
| 99007400000 | 9 | 12-Jan-94 | Sardinia Bay | 48140.731 | 3764679.926 | 102 | 0.2 | 590 | 208 | 208 | 208 | 75 | 283 | 222 | 61 | 181 | 0.01 | 99 | 2.8 | 33 | 2.2 | 0.22 | 9.73852 |
| 99007400000 | 9 | 08-Feb-94 | Sardinia Bay | 48140.731 | 3764679.926 | 101 | 0.4 | | 196 | 196 | 196 | 122 | 318 | 247 | 71 | 155 | | 109 | 7.0 | 38 | 3.8 | | 16.8211 |
| 99007400000 | 9 | 09-Mar-94 | Sardinia Bay | 48140.731 | 3764679.926 | 104 | 0.5 | | 201 | 201 | | | | | | 167 | | | | 18 | 3.9 | | 17.2637 |
| 99007400000 | 9 | 14-Apr-94 | Sardinia Bay | 48140.731 | 3764679.926 | 107 | 0.4 | 586 | 204 | 204 | 204 | 103 | 307 | 240 | 67 | 166 | 0.01 | 115 | 3.0 | 34 | 4.6 | 0.18 | 20.3624 |
| 99007400000 | 9 | 09-May-94 | Sardinia Bay | 48140.731 | 3764679.926 | 102 | 0.3 | 594 | 208 | 208 | | | | | | 159 | | | | 38 | 5.4 | | 23.9036 |
| 99007400000 | 9 | 14-Jun-94 | Sardinia Bay | 48140.731 | 3764679.926 | 105 | | | | | | | | | | 165 | | | | 40 | 4.9 | | 21.6903 |
| 99007400000 | 9 | 16-Jun-94 | Sardinia Bay | 48140.731 | 3764679.926 | | | | | | | | | | | | | | | | | | |
| 99007400000 | 9 | 14-Jul-94 | Sardinia Bay | 48140.731 | 3764679.926 | 104 | 0.2 | 606 | 212 | 212 | 212 | 63 | 275 | 213 | 62 | 165 | 0.23 | 99 | 3.0 | 31 | 5.4 | 0.14 | 23.9036 |
| 99007400000 | 9 | 10-Aug-94 | Sardinia Bay | 48140.731 | 3764679.926 | 105 | | 714 | | | | | | | | 161 | | | | 34 | 5.4 | | 23.9036 |
| 99007400000 | 9 | 21-Sep-94 | Sardinia Bay | 48140.731 | 3764679.926 | 103 | | 688 | | | | | | | | 166 | | | | 31 | 5.8 | | 25.6743 |
| 99007400000 | 9 | 12-Oct-94 | Sardinia Bay | 48140.731 | 3764679.926 | 104 | 0.2 | 660 | 212 | 212 | 212 | 55 | 267 | 209 | 58 | 168 | 0.00 | 98 | 2.0 | 34 | 5.1 | 0.17 | 22.5757 |
| 99007400000 | 9 | 20-Dec-94 | Sardinia Bay | 48140.731 | 3764679.926 | 104 | | 622 | | | | | | | | 172 | | | | 37 | 5.3 | | 23.461 |
| 99007400000 | 9 | 10-Jan-95 | Sardinia Bay | 48140.731 | 3764679.926 | 103 | 0.2 | 606 | 213 | 213 | 213 | 63 | 276 | 219 | 57 | 166 | 0.04 | 98 | 3.0 | 31 | 5.6 | 0.23 | 24.789 |
| 99007400000 | 9 | 13-Feb-95 | Sardinia Bay | 48140.731 | 3764679.926 | 103 | | 720 | | | | | | | | 157 | | | | 33 | 5.2 | | 23.0183 |
| 99007400000 | 9 | 13-Mar-95 | Sardinia Bay | 48140.731 | 3764679.926 | 103 | | 616 | | | | | | | | 158 | | | | 36 | 5.6 | | 24.789 |
| 99007400000 | 9 | 20-Apr-95 | Sardinia Bay | 48140.731 | 3764679.926 | 105 | 0.2 | 658 | 211 | 211 | 211 | 61 | 272 | 215 | 67 | 163 | 0.00 | 99 | 3.0 | 31 | 5.7 | 0.05 | 25.2316 |
| 99007400000 | 9 | 21-Jun-95 | Sardinia Bay | 48140.731 | 3764679.926 | | | | | | | | | | | | | | | | | | 0 |
| 99040340000 | 21 | 18-Jun-93 | Arlington | 51915.000 | 3763632.000 | 195 | 4.5 | 1262 | 372 | 372 | 372 | 26 | 398 | 304 | 94 | 454 | 0.21 | 223 | 2.0 | 77 | 3.7 | 0.16 | 16.5555 |
| 99040340000 | 21 | 10-Aug-93 | Arlington | 51915.000 | 3763632.000 | 275 | | | | | | | | | | 465 | | | | 138 | 16.0 | | 70.8256 |
| 99040340000 | 21 | 25-Oct-93 | Arlington | 51915.000 | 3763632.000 | 269 | | | | | | | | | | 556 | | | | 107 | 15.0 | | 66.399 |
| 99040340000 | 21 | 16-Nov-93 | Arlington | 51915.000 | 3763632.000 | 304 | | | | | | | | | | 702 | | | | 147 | 15.0 | | 66.399 |
| 99040340000 | 21 | 14-Dec-93 | Arlington | 51915.000 | 3763632.000 | 277 | 0.5 | | | | | | | | | 519 | | | | 118 | 7.1 | | 31.4289 |
| 99040340000 | 21 | 19-Jan-94 | Arlington | 51915.000 | 3763632.000 | 282 | 0.5 | 1694 | 475 | 475 | 475 | 184 | 659 | 418 | 241 | 524 | | 432 | 20.0 | 118 | 8.7 | | 38.5114 |
| 99040340000 | 21 | 22-Feb-94 | Arlington | 51915.000 | 3763632.000 | 265 | 1.2 | | 466 | 466 | 367 | 0 | 367 | 155 | 212 | 458 | | 407 | 20.0 | | 12.0 | | 53.1192 |
| 99040340000 | 21 | 17-Mar-94 | Arlington | 51915.000 | 3763632.000 | 294 | 0.9 | | 492 | 492 | | | | | | 585 | | | | 127 | 13.4 | | 59.3164 |
| 99040340000 | 21 | 21-Jun-94 | Arlington | 51915.000 | 3763632.000 | 262 | 2.2 | 1562 | 495 | 495 | 495 | 88 | 583 | 368 | 215 | 453 | 0.06 | 376 | 21.0 | 112 | 12.2 | 0.27 | 54.0045 |
| 99040340000 | 21 | 07-Jul-94 | Arlington | 51915.000 | 3763632.000 | 311 | 0.2 | 1880 | 485 | 485 | 485 | 125 | 610 | 397 | 213 | 654 | 0.03 | 424 | 10.0 | 138 | 14.0 | 0.40 | 61.9724 |
| 99040340000 | 21 | 10-Aug-94 | Arlington | 51915.000 | 3763632.000 | 297 | | 1754 | | | | | | | | 538 | | | | 123 | 9.3 | | 41.1674 |
| 99040340000 | 21 | 22-Sep-94 | Arlington | 51915.000 | 3763632.000 | | | | | | | | | | | | | | | | | | |
| 99040340000 | 21 | 12-Oct-94 | Arlington | 51915.000 | 3763632.000 | 269 | 0.4 | 1652 | 510 | 510 | 510 | 23 | 533 | 339 | 197 | 500 | 0.03 | 379 | 20.0 | 115 | 15.0 | 0.51 | 66.399 |
| 99040340000 | 21 | 10-Nov-94 | Arlington | 51915.000 | 3763632.000 | 317 | | 1872 | | | | | | | | 670 | | | | 142 | 14.0 | | 61.9724 |

| Erf. No. | Bh.No. | Date | Address | -Y-Co-ord | -X-Co-ord | EC | Turb. | TDS | TA | BCA | CH | NCH | TH | Ca | Mg | Cl | Fe(t) | Na | K | SO4 | NO3-N | F | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | CaCO3 | | | | | | | | |
| 99040340000 | 21 | 13-Dec-94 | Arlington | 51915.000 | 3763632.000 | 303 | | 1832 | | | | | | | | 637 | | | | 137 | 11.0 | | 48.6926 |
| 99040340000 | 21 | 05-Jan-95 | Arlington | 51915.000 | 3763632.000 | 267 | 1.2 | 1788 | 494 | 494 | 489 | 0 | 489 | 305 | 184 | 492 | 0.03 | 371 | 17.0 | 119 | 12.9 | 0.68 | 57.1031 |
| 99040340000 | 21 | 16-Mar-95 | Arlington | 51915.000 | 3763632.000 | 314 | | 1916 | | | | | | | | 592 | | | | 128 | 13.0 | | 57.5458 |
| 99040340000 | 21 | 10-Apr-95 | Arlington | 51915.000 | 3763632.000 | 261 | 0.7 | 1708 | 485 | 485 | 482 | 0 | 482 | 298 | 184 | 467 | 0.11 | 369 | 17.0 | 118 | 14.0 | 0.16 | 61.9724 |
| 99040340000 | 21 | 01-Jun-95 | Arlington | 51915.000 | 3763632.000 | 225 | | 1602 | | | | | | | | 472 | | | | 127 | 13.0 | | 57.5458 |
| 99040340000 | 22 | 18-Jun-93 | Arlington | 51915.000 | 3763632.000 | 298 | 1.4 | 1798 | 492 | 492 | 492 | 107 | 599 | 384 | 215 | 589 | 0.03 | 412 | 13.0 | 141 | 17.5 | 0.38 | 77.4212 |
| 99040340000 | 22 | 10-Aug-93 | Arlington | 51915.000 | 3763632.000 | 246 | | | | | | | | | | 507 | | | | 122 | 9.1 | | 40.2821 |
| 99040340000 | 22 | 25-Oct-93 | Arlington | 51915.000 | 3763632.000 | 236 | | | | | | | | | | 528 | | | | 92 | 9.8 | | 43.3807 |
| 99040340000 | 22 | 16-Nov-93 | Arlington | 51915.000 | 3763632.000 | 205 | | | | | | | | | | 522 | | | | 76 | 3.4 | | 15.0504 |
| 99040340000 | 22 | 14-Dec-93 | Arlington | 51915.000 | 3763632.000 | 200 | 0.4 | | | | | | | | | 440 | | | | 67 | 3.1 | | 13.7225 |
| 99040340000 | 22 | 19-Jan-94 | Arlington | 51915.000 | 3763632.000 | 191 | 0.3 | 1198 | 195 | 195 | 195 | 256 | 451 | 341 | 110 | 457 | | 239 | | 62 | 3.4 | | 15.0504 |
| 99040340000 | 22 | 22-Feb-94 | Arlington | 51915.000 | 3763632.000 | 162 | 0.7 | | 129 | 129 | 129 | 236 | 365 | 263 | 102 | 372 | | 222 | 3.6 | | 1.3 | | 5.75458 |
| 99040340000 | 22 | 17-Mar-94 | Arlington | 51915.000 | 3763632.000 | 165 | 0.6 | | 124 | 124 | | | | | | 391 | | | | 37 | 1.4 | | 6.19724 |
| 99040340000 | 22 | 21-Apr-94 | Arlington | 51915.000 | 3763632.000 | 191 | 0.2 | 1146 | 204 | 204 | 204 | 328 | 532 | 399 | 133 | 395 | 0.00 | 252 | 3.0 | 78 | 4.9 | 0.14 | 21.6903 |
| 99040340000 | 22 | 20-May-94 | Arlington | 51915.000 | 3763632.000 | 191 | 0.4 | 1140 | | | | | | | | 424 | | | | 64 | 5.6 | | 24.789 |
| 99040340000 | 22 | 07-Jul-94 | Arlington | 51915.000 | 3763632.000 | 196 | 0.2 | 1202 | 207 | 207 | 207 | 203 | 410 | 299 | 111 | 450 | 0.06 | 218 | 2.0 | 67 | 5.6 | 0.23 | 24.789 |
| 99040340000 | 22 | 10-Aug-94 | Arlington | 51915.000 | 3763632.000 | 169 | | 1250 | | | | | | | | 416 | | | | 64 | 4.2 | | 18.5917 |
| 99040340000 | 22 | 22-Sep-94 | Arlington | 51915.000 | 3763632.000 | | | | | | | | | | | | | | | | | | |
| 99040340000 | 22 | 12-Oct-94 | Arlington | 51915.000 | 3763632.000 | 243 | 3.5 | 1476 | 312 | 312 | 312 | 250 | 562 | 443 | 119 | 518 | 0.72 | 284 | 2.0 | 114 | 12.0 | 0.35 | 53.1192 |
| 99040340000 | 22 | 10-Nov-94 | Arlington | 51915.000 | 3763632.000 | 198 | | 1214 | | | | | | | | 446 | | | | 75 | 5.6 | | 24.789 |
| 99040340000 | 22 | 13-Dec-94 | Arlington | 51915.000 | 3763632.000 | 167 | | 1148 | | | | | | | | 442 | | | | 44 | 2.0 | | 8.8532 |
| 99040340000 | 22 | 05-Jan-95 | Arlington | 51915.000 | 3763632.000 | 228 | 0.4 | 1398 | 267 | 267 | 267 | 192 | 459 | 359 | 100 | 500 | 0.03 | 266 | 3.0 | 100 | 8.5 | 0.42 | 37.6261 |
| 99040340000 | 22 | 16-Mar-95 | Arlington | 51915.000 | 3763632.000 | 203 | | 1224 | | | | | | | | 418 | | | | 73 | 6.1 | | 27.0023 |
| 99040340000 | 22 | 10-Apr-95 | Arlington | 51915.000 | 3763632.000 | 203 | 0.5 | 1258 | 228 | 228 | 220 | 177 | 397 | 605 | 92 | 425 | 0.17 | 232 | 3.0 | 77 | 6.0 | 0.05 | 26.5596 |
| 99040340000 | 22 | 01-Jun-95 | Arlington | 51915.000 | 3763632.000 | 198 | | 1170 | | | | | | | | 460 | | | | 90 | 4.6 | | 20.3624 |